# REGIONAL COMPETITIVE ADVANTAGE AND COMMONWEALTH GOVERNMENT FUNDING FOR SCIENCE AND TECHNOLOGY: THE CASE OF WESTERN AUSTRALIA

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**ABSTRACT** Within most federal systems of government, competition and rivalry exists between the states for central government funds for science and technology (S&T). This paper questions the Western Australian Government's argument that its allocation of Commonwealth Government funds for S&T should be based on population size. It shows that Western Australia's minerals and energy sector has produced a rich network of world-class research performers with dynamic links to local manufacturers. It is argued that an approach based on a resource-dependent path to economic growth is a more suitable basis for seeking increased funding. This approach, together with the underlying constructs of sophisticated buyers and contexted technologies is considered to provide a sound theoretical basis for governments of small but resource-rich economies mounting claims for an increased allocation of central government funds for S&T.

## 1. INTRODUCTION AND THEORETICAL FOUNDATIONS

The Western Australian Government has long argued that with 10 per cent of the Australian population, Western Australia's *fair* allocation of Commonwealth funds for S&T should be about the same (McGlue and Markey, 1991; Quekett, 1991, 1992; Rees *et al.*, 1992). However, in comparison to other States, notably Victoria, New South Wales and South Australia, the amount received has been measurably less (Saupin and Jevons, 1991). Over the years, this has sparked a degree of political consternation without really getting to the bottom of why Western Australia does not perform as well as other states.

In their study, Saupin and Jevons found that in the competition for Commonwealth Government funds, manufacturers in other states successful in winning grants had formed strong alliances with Commonwealth Government research institutions. These alliances spanned a range of *generic technologies* such as biotechnology, information systems and advanced materials: factors which go beyond population size alone.

This is problematic in that Western Australia's overall manufacturing sector is small, diverse and fragmented with a narrow range of world-class technological capability. There is scant evidence of backward and forward industry linkages,

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resulting in a general lack of industry clusters involving manufacturing and industrial research. These factors coalesce to act against the State's enterprises when competing for Commonwealth resources.

This is in contrast to the pockets of world-class manufacturing and supporting research institutions within the State's minerals and energy sector. Here, a virtuous cycle of dynamic growth has evolved to strengthen the international *competitive advantage* and *technological expansion* of local manufacturers who are not limited to the low-end of the value-added spectrum.[2] Over time, these manufacturers have graduated from being small, locally-orientated enterprises to internationally competitive companies. They are now involved in producing technologies with roots in the mining and energy sector but have diversified into other markets and industry applications.

Against this background, it is argued that Western Australia's justification for Commonwealth resources for S&T should be based on the State's unique competitive advantages which can be traced to the minerals and energy sector where the State has an historical comparative advantage. Adopting this approach would see Commonwealth Government resources strategically directed at further strengthening research and manufacturing with dynamic links to the resource sector. This approach should aim to promote long-run, regional *competitive advantage*, at the high end of the value-added spectrum. It would give the State Government a basis for policies designed to encourage sectoral growth inspired by strong demand-led innovation. Adopting the general thrust of this argument in principle has implications for the State's industry and S&T policies.

The theoretical foundation for this approach is well articulated by Argyrous (1996) drawing on Nicholas Kaldor's notions related to *cumulative causation*[3]. Here, historical factors inspire the growth of manufacturing drawing from a region's comparative factor advantages. Over time, other sectors of industry are gradually absorbed as demand for various intermediate, final and process technologies increases and spreads to involve other sectors, producing a network of vertically integrated industries. As the scope and quality of demand increases, the outcome is one of vertical specialisation involving technological diversification at the high end of the value-added chain.

The key factors which produce what might be viewed as a process of mulit-sector upgrade are technology transfer, transfer of organisational knowledge and the transfer of demand (Argyrous, 1996). The result produces a complex web of relations involving intense technological, manufacturing, social and business activities (Nelson and Winter, 1977). These relationships outline a certain *dynamic complementarity* when factors such as large and small companies, university research facilities and other supporting research infrastructures interact (Freeman *et al.*, 1982; Rothwell, 1983, 1984, 1985).

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[2] This approach is outlined by the *natural resource-dependant path* for economic growth, developed in another paper in this issue (Saupin, 1997).

[3] See Kaldor (1966) "Causes and Effects of the Slow Rate of Economic Growth in the United Kingdom"; and Kaldor (1972), "The Irrelevance of Equilibrium Economics", in *Further Essays on Economic Theory*, 1978, Holmes and Meier, New York.

Coupled with Western Australia's *natural resource-dependent competitive advantage* is its international competitive advantage. This is strongly linked to its historical competitive advantages in the minerals and energy sector. Here, a process of cumulative causation thrives because of problem solving activities involving close user-producer interaction coupled with learning-by-doing (Saupin, 1995). This process has given rise to internationally competitive firms with historic but dynamic links to static and immobile mineral and energy resources - the State's comparative factor advantages. Over time, these firms have ventured into other markets with highly sophisticated technologies which have applications beyond minerals and energy production.

To advance this argument, this paper begins with an overview of the distribution of Commonwealth Government funding for S&T across Australian states and territories. The aim is to demonstrate that macro-economic variables, such as population size and gross domestic product (GDP), can only be indicators for distributing funds.

Evidence is produced which shows that Western Australia has a strong manufacturing capability related to the mining and energy sector. *The natural resource-dependant path for sustained economic growth* and its related constructs of *sophisticated buyers* and *contexted technologies*, are introduced as a possible theoretical platform for the Western Australian Government's claims for a greater allocation of Commonwealth Government S&T funds and provide direction as to where resources should be focussed. This paper concludes with important implications for small, resource-rich economies competing for central government funding for industrial innovation.

## 2. THE DISTRIBUTION OF COMMONWEALTH FUNDING FOR S&T

Western Australia is a small and open economy with approximately nine percent of the nation's population, producing 10 per cent of the country's GDP. On this basis, the Western Australian Government has long argued that the State should receive between nine and 10 per cent of Commonwealth funds for S&T. In practice however, this has not been the case as shown in Table 1[4].

In *absolute* terms, Western Australia receives around three per cent of Commonwealth Government S&T funds which is well below the State's proportion of population and GDP. While the same applies to New South Wales, Queensland and the Northern Territory, the opposite is the case in Victoria, the Australian Capital Territory and South Australia. Allowing for differences in population size and GDP performance produces a *relative* measure of funding distribution, also shown in Table 1, which reveals that Western Australia in fact receives less than *any other* state.

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[4] See Phillimore and Marinova (1993a, 1993b) for a detailed overview of science and technology indicators in Western Australia.

**Table 1.** Commonwealth (Cwlth) and State Government Expenditure on S&T 1992-1993

| | Absolute | Cwlth/GDP (A$m) | Cwlth/Pop (A$m) | State/GDP (A$m) | State/Pop (A$m) |
|---|---|---|---|---|---|
| NSW | 18% | 0.17 | 35 | 0.12 | 25 |
| VIC | 28% | 0.36 | 71 | 0.14 | 28 |
| QLD | 8% | 0.16 | 29 | 0.28 | 50 |
| SA | 13% | 0.58 | 102 | 0.27 | 48 |
| WA | 3% | 0.11 | 23 | 0.22 | 48 |
| TAS | 5% | 0.72 | 120 | 0.26 | 43 |
| NT | 1% | 0.34 | 47 | 0.57 | 80 |
| ACT | 18% | 2.60 | 1207 | 0.00 | 1 |
| Australia | 100% | 0.31 | 61 | 0.18 | 35 |

**Source:** ABS Cats. 8104, 8109, 3101.0, 5242

In view of this situation, the Western Australian and other state governments have sought to redress this funding imbalance. This can also be seen in Table 1 where the financial contributions by the various state governments exceed that of the Commonwealth Government and the Australian average for all states. In the case of Western Australia, the level of commitment by the State Government is greater than that of the larger states such as New South Wales and Victoria. Except for the Northern Territory, it is generally on par with the smaller States. This suggests that the governments of some of the smaller states have sought to *augment* Commonwealth Government expenditure, as in the case of South Australia and to some extent Tasmania, while others, including Western Australia, Queensland, and the Northern Territory, appear to *compensate* for the lack of Commonwealth Government funds.

The important question to arise relates to the underlying causes for Western Australia's generally poor performance in obtaining Commonwealth resources for S&T. Some answers begin to emerge from a study conducted by Saupin and Jevons (1991), Table 2.

It can be seen that Western Australia does much better in winning discretionary technology grants than it does in winning generic technology grants. The reason for this is that private sector manufacturers successful in obtaining a generic technology grant were part of a strong consortium of local research institutions[5]. Discretionary grant winners, on the other hand, were generally not

[5] These consortiums involved major universities collaborating with internationally recognised research facilities such as Monash University and the Walter and Eliza Hall Research Institute and Commonwealth Government research agencies, most notably the Commonwealth Scientific Industrial Research Organisation (CSIRO), Australian Nuclear Science Technology Organisation (ANSTO), Defence Science Technology Organisation (DSTO), Rural Research Corporations and other recognised as Commonwealth Registered Research Agencies (RRA's).

**Table 2.** GIRD[6] Generic Technology and Discretionary Grants 1988-1993 ($M) by Population (POP) and GDP

| | Discretionary | Disc/Pop | Disc/GDP | Generic | Generic/Pop | Generic/GDP |
|---|---|---|---|---|---|---|
| NSW | 23.3 | 3.93 | 0.02 | 3.1 | 5.23 | 0.03 |
| VIC | 17.4 | 3.92 | 0.02 | 2.8 | 5.87 | 0.03 |
| QLD | 6.0 | 2.01 | 0.01 | 6.4 | 2.13 | 0.01 |
| WA | 5.8 | 3.50 | 0.02 | 4.8 | 2.94 | 0.01 |
| SA | 7.5 | 5.17 | 0.03 | 10.2 | 7.06 | 0.04 |
| TAS | 7.4 | 1.58 | 0.01 | 0.2 | 0.44 | 0.00 |
| ACT | 0.8 | 2.92 | 0.02 | 9.1 | 31.35 | 0.23 |
| NT | 0.0 | 0.00 | 0.00 | 0.0 | 0.00 | 0.00 |
| Total | 61.5 | 3.54 | 0.02 | 87.9 | 5.05 | 0.03 |

**Source:** Saupin and Jevons (1991)

**Table 3.** Number of Registered Research Agencies (RRA's) and CSIRO Staff

| | RRA's (Actual Staff) | | CSIRO(EFTSU)* (Actual Staff) | |
|---|---|---|---|---|
| | 1989 | 1994 | 1989 | 1992 |
| New South Wales | 20 | 50 | 28 | 2016 |
| Victoria | 14 | 50 | 30 | 2191 |
| Australian Capital Territory | 5 | 13 | 20 | 1512 |
| Queensland | 11 | 20 | 9 | 639 |
| South Australia | 7 | 19 | 5 | 368 |
| **Western Australia** | **5** | **19** | **4** | **314** |
| Tasmania | 9 | 10 | 3 | 223 |
| Northern Territory | 1 | 3 | 4 | 57 |

**Note:** * This unit of measurement normalises for part time and fractional staff.
**Source:** CSIRO Data Book (1989); IR&D Board, Annual Report (1988-89, 1992-93)

part of any such group[7]. These factors could pose a continuing problem for Western Australia given the limited level of representation of Commonwealth Government research agencies shown in Table 3 and given that attracting a main branch of CSIRO to Western Australia is a long term and arguably difficult objective to achieve.

In view of this, it is necessary to establish the basis of Western Australia's industrial research and manufacturing strength and, therefore, the competitive foundation upon which to attract a greater allocation of Commonwealth resources.

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[6] The Table shows the distribution of Commonwealth Government Grants for Industrial Research and Development (GIRD), administered by the Industrial Research and Development Board.

[7] Similar conclusions emerge from Saupin's (1995) analysis of the Commonwealth Government's 150% R&D Tax Concession Scheme. Western Australian firms faired poorly because they lacked the scale of investments in industrial research and development to take full advantage of the program.

## 3. WESTERN AUSTRALIA'S NATURAL RESOURCE SECTOR AND DYNAMIC INTERSECTORAL MANUFACTURING-RESEARCH LINKAGES

Case evidence shows that a strong network of industry and research linkages exists for the minerals and energy sector in Western Australia (Saupin 1995). This comes as a result of the scope, scale and quality of demand imposed on Western Australian manufacturers by the mining and energy sector. This is shown by the structure and scale of activities in chemicals and heavy engineering in the Kwinana Industrial Area, approximately 20 kilometres south of Perth, and at Kermerton near Bunbury in the South West of the State.

Major producers such as Alcoa, BHP Steel Rod and Bar Products Division of BHP Steel International, BP refinery (Kwinana) Pty Ltd, Cockburn Cement, Commonwealth Industrial Gases (CIG), Western Power and Western Mining Corporation Ltd, are fostering the development of a myriad of significantly smaller manufacturing companies. The Department of State Development's (1992b) study notes that Western Australian manufacturing is poised to grow in areas where the state has an established international competitive advantage.

## 4. OPERATING CONSTRUCTS OF THE NATURAL RESOURCE-DEPENDANT PATH TO SUSTAINED ECONOMIC GROWTH

Saupin (1995) developed two underlying constructs that underpin the natural resource-dependent path to sustained economic growth. These constructs are *sophisticated buyers* (world class buyers) and *contexted technologies* (technologies that are needed by sophisticated buyers in order to maintain their international technological leadership). Western Australia has around 725 sophisticated buyers either directly or indirectly related to the mining and energy sector. Included are 249 mining companies, 141 mineral exploration companies and 64 oil exploration companies, of which the major ones are shown in Table 4.

The demands which these companies impose on local technology and related equipment and supply markets are important. Of particular interest is the fact that they are not particularly high S&T performers. They prefer instead to concentrate on their core activities such as mine development and production while the development of innovative technologies in exploration, mining metallurgy and environmental protection, are out-sourced.

To meet the growing demands of these enterprises a deep and rich network of private and public sector consulting organisations and research performing institutions exist. A general measure of this richness is found in the Directory of Research and Development in Western Australia for 1993 (DSD, 1993b). It outlines the activities of 837 specialist private sector organisations, tertiary institutions and government agencies directly involved in R&D. Among these companies, more than 60 per cent are directly or indirectly involved in mineral exploration and processing, mining equipment manufacture and supply, specialist analytical services, and materials technology.

**Table 4.** Sophisticated Buyers in the Western Australian Mining and Energy Sectors

| Mining | Energy |
|---|---|
| The Broken Hill Proprietary Co. Ltd | Woodside Petroleum Ltd |
| BHP Minerals Pty Ltd | West Australian Petroleum Pty Ltd |
| BHP Mineral Exploration | (WAPET) |
| BHP Signals Group | BHP Petroleum Pty Ltd |
| CRA Pty Ltd | Pilbara Energy Pty Ltd (BHP) |
| Argyle Diamond Mines | |
| Hamersley Iron Pty Ltd | |
| Dampier Salt Ltd | |
| Robe River Iron Ore Ltd | |
| Mt Newman Mining Pty Ltd | |
| Eltin Minerals Pty Ltd | |
| The Clough Engineering Group | |
| MIM Exploration Pty Ltd | |
| Western Mining Corporation Ltd | |
| Griffin Coal Mining Co Pty Ltd | |
| Alcoa Pty Ltd | |

**Source:** Saupin (1995)

**Table 5.** Western Australian S&T Performing Companies, Technologies and Markets

| Company | Product | Market |
|---|---|---|
| Poseidon Scientific | Radar Filtering System | Mining |
| Goninan | Locomotives | Mining |
| Wiseda | Dump Trucks | Mining/Energy |
| GEMCO | Rail Fault Detection Systems | Mining |
| Begley Engineering | Acoustic Enclosures | Mining |
| Dawson | Pile Cleaning and Engineering | Energy |
| OKA | Special Purpose Vehicles | Mining |
| Weldtronics/ ANI | Hardfaced Fittings | Mining |
| Comsys Pty Ltd | Logic Controls, Systems Analysis | Mining/Energy |
| Timcast Pty Ltd | Foundry and General Engineering | Mining |
| PROK Group Limited | Bulk Material Handling Systems | Mining |
| Micro Control Engineering | Mimic Panels | Mining/Energy |
| Transcom International | Communications Technology | Mining/Energy |

**Source:** Saupin (1995)[8]

[8] Rojan Advanced Ceramics Ltd were chosen by the Australian Nuclear Science and Technology Organisation (ANSTO) to undertake a one year R&D contract valued at $80,000 and with ALCOA for $350,000 over three years. BHP Iron Ore's Signals Group, recognised as having achieved the status of world's best practice and demonstration, shifted their operations from Sydney to Perth; see Broken Hill Proprietary Ltd BHP (1992). Goninan also shifted their operations from the east coast to the west to be closer to their major customers.

**Table 6.** Contexted Technologies in the Western Australian Mining and Energy Resource Industries

| | |
|---|---|
| **Exploration Technologies** | |
| Aerial photography | Satellite/airborne scanner data |
| Airborne geophysics | Ground geophysics |
| Geochemical techniques | Image processing |
| Analytical techniques | Global positioning systems |
| Diamond drilling | Non-core drilling |
| **Mining Technologies** | |
| Mine planning systems | Rock mechanics technology |
| Blasting analysis | Ground reinforcement design |
| In-mine data transfer | Excavator load monitoring |
| Drill rig monitoring | Truck dispatch technology |
| Guidance control mechanism | Automated grounded movement sensors |
| **Mineral Processing Technologies** | |
| In-mine rock crushing | Conveyor monitoring |
| On-stream analysis | On-stream size analysis |
| Programmable logic controllers | Supervisory control and data acquisition |
| Interactive expert systems for process supervision | |
| Material characteristics and liberation analysis | |
| Automated material handling-particulate | |
| Automated material handling-slurries | |
| **Engineering Technologies** | |
| Condition monitoring systems | Welding technology |
| Energy conservation | |
| **Environmental Technologies** | |
| Air quality monitoring | Meteorological monitoring |
| Rehabilitation design | Waste disposal design |
| Water quality monitoring | Biological monitoring |

**Source:** Saupin (1995)

There are some 225 mining and quarrying equipment manufacturers and/or suppliers and 46 oil drilling equipment manufacturers and/or suppliers. Table 5 provides a few examples of manufacturing enterprises that have developed a wide variety of contexted technologies initially for Western Australian sophisticated buyers.

These enterprises are intense research performers who have built strong links with the State's manufacturers and other research institutions, primarily in Western Australia but also around the nation and overseas. The broad scope of contexted technologies to emerge from this network of high value-added activities can be seen in Table 6.

The institutional research network brings together manufacturers, mining companies, energy producers and private sector research enterprises into a web of applied knowledge production and is well established in Western Australia.

Institutional research support together with training in general mining, engineering, related trades, and management, as well as extensive research in mineral mapping and satellite imagery is provided by:

- Western Australian State Government's Bureau of Mines;
- Western Australian Chemistry Centre;
- Curtin University of Technology's West Australian School of Mines (WASM) at Kalgoorlie;
- West Australian Mining Services Consortium which is a joint venture initiative between Curtin University of Technology and Technical and Further Education (TAFE); and
- CSIRO Division of Exploration and Mining.

Curtin University of Technology is a key centre for teaching and research in exploration mapping and the University of Western Australia is renowned world-wide for its work in the identification of strategic mineral deposits. However, Curtin University of Technology deserves special mention due to its applied focus on the mining industry. Beside WASM, the University also hosts:

- Centre for Petroleum and Environmental Organic Chemistry
- Centre for Materials Technology;
- National Key Centre for Teaching and Research in Resource Exploration, interacting with the Department of Minerals Engineering and Extraction Metallurgy;
- Department of Mining Engineering and Mine Surveying;
- Department of Mineral Exploration and Mining Geology; and
- School of Applied Chemistry

(Curtin University of Technology, 1990, 1991, 1992).

Affiliated to WASM is the Brodie-Hall Research and Consultancy Centre which pursues basic and applied research into various aspects of mineral processing and extractive metallurgy, mining engineering and mine surveying, mineral exploration and mining geology (Western Australian School of Mines, Annual Magazine 88 Years, Curtin University of Technology).

The Australian Mining Industry Research Association (AMIRA) and Australian Petroleum Industry Research Association (APIRA), represented throughout Australia, in conjunction with the Western Australian counterpart, the Mining and Energy Research Institute of Western Australia (MERIWA), play a fundamental role in the technological advancement of Australia's mining and energy sector[9]. Their aim is to bring research organisations and industry together through collaborative research programs. In this respect, they act as research-funding brokers.

The well established science and research infrastructure for the minerals and energy sector in Western Australia has caused a dramatic shift in the concentration of Commonwealth Government research agencies to the state (Phillimore and Marinova, 1993a, 1993b). This could foreshadow the establishment of various other CSIRO's research institutes in the earth science

[9] See Slatyer (1992, p.4) for his comments on AMIRA as one the worlds largest and most effective technology brokerage organisations.

disciplines. The important conclusion is that there is currently poor representation in Western Australia of Commonwealth Government research organisations across the range of generic technologies. This is in contrast to those involved in earth science and related fields which can be seen in the type of Cooperative Research Centres established in Western Australia. These include:

- A. J. Parker CRC for Hydrometallurgy (CSIRO and Murdoch University),
- Cooperative Research Centre for Australian Mineral Exploration Technologies located at the Leeuwin Centre for Remote Sensing,
- Australian Petroleum Cooperative Research Centre (APCRC).
- Australian Geodynamics CRC, (CSIRO Division of Exploration and Geosciences);
- Cooperative Research Centre for Australian Landscape Evolution (CSIRO Division of Exploration and Geosciences);
- CRC for Legumes in Mediterranean Agriculture (University of Western Australia);
- CRC for Broadband Telecommunications and Networking (Curtin University of Technology); and
- CRC in Renewable Energy (Murdoch University).

Apart from the last three CRC's, all the others are linked to the minerals and energy sector.

Unique relationships, established on the basis of *contexted technologies*, have developed over the past decade between sophisticated buyers from Western Australia's mining and energy sector and local technology manufacturers. Small S&T enterprises and manufacturers have received substantial benefits. Information obtained from the Industrial Supplies Office (ISO) at the Western Australian Chamber of Commerce, and information obtained from the Western Australian Chamber of Mines and Energy, reveals that a growing number of small Western Australian manufacturers are establishing forward linkages with local mining companies, as well as backward linkages with Western Australian R&D companies related to the mining and energy sector. This seems to indicate a growing cluster of functionally interrelated activities converging on the historical mainspring of the Western Australian industrial economy.

## 5. WESTERN AUSTRALIA'S CASE FOR INCREASED S&T FUNDING: A NEW APPROACH

It is argued that the Western Australian Government's case for an increased allocation of Commonwealth funding for S&T needs a more focussed approach based on the State's historical factor assets. Success in winning Cooperative Research Centre's, the attraction of CSIRO divisions[10]; and the case evidence

[10] The establishment of the National Centre for Petroleum and Mineral Resources Research in Perth was announced in July 1997. This involves the relocation of CSIRO staff and resources including the Petroleum Resources Division from Victoria; the Mineral Exploration Division from NSW; and activities undertaken through CRC's within the Petroleum and Exploration Divisions in NSW and Victoria.

underscoring the depth and breadth of industrial and technological dynamism in the mining and energy sector, surely strengthens the State's case.

This approach stands in marked contrast to one where Western Australian manufacturers were trying to compete with eastern states rivals with rich networks of Commonwealth and state government research institutions. The Western Australian approach should revolve around strategies which strengthen the links between sophisticated buyers from the minerals and energy sector and manufacturers developing world-class, contexted technologies. The development of all participants into internationally competitive entities through market expansion and technological diversification should be a main objective of industry and technology policy.

Careful industry and technology planning supported by *appropriate* levels of funding could both strengthen and promote backward and forward linkages involving resource production, processing and related manufacturing (Confederation of Western Australian Industry, 1990; State Planning Commission, 1988)[11]. The justification for this proposal is the potential economic, commercial and technological significance to regional growth and competitive advantage depicted in Saupin (1997) as *the natural resource-dependant path to sustained economic growth.* The salience of this construct for S&T funding becomes apparent when the underlying operating constructs of sophisticated buyers and contexted technologies are introduced. These constructs explain why a dynamic complementarity exists between local manufacturers, resource producers and supporting research institutions. They also underline Western Australia's competitive advantage in vying for Commonwealth S&T funds and point to where these funds should be allocated.

## 6. CONCLUSIONS

Utilising population size and GDP as *absolute* and *relative* indicators for calculating the distribution of Commonwealth Government funds for S&T might only serve as approximate measures[12]. Moreover, these indicators do not point to *where* resources should be allocated if sustained economic growth and technological expansion are desired outcomes.

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[11] Gathering statistical support for this trend is hindered because the Australian Bureau of Statistics categories only report Australia's traditional manufacturing industries under food, beverage and tobacco, textiles, clothing and footwear. The *new growth sectors* of manufacturing which would include those which specifically service the mining and energy sector are either included under *other* or *not elsewhere classified* (nec). This signals the need to consider a new category such as *Manufacturing for Mining* which would help to accurately reflect the activities going on in this broad field. Given this problem, the only way to reflect what might actually be happening between the manufacturing and resource sectors is to look at case evidence and underlying operating principles.

[12] Taking relative population size as an absolute basis for calculating what may be construed as a *fair share* is important as various Western Australian Government's have traditionally mounted their claims for a *fair share* according to this measure.

Instead, the natural resource-dependant path to sustained economic growth with its supporting constructs of "sophisticated buyers" and "contexted technologies", coupled with principles embedded in the model provides the basis for a compelling argument for governments of small economies to recognise the importance of their historical factor endowments for economic growth and technological expansion. In the case of Western Australia, the argument for an increased allocation of S&T funding linked to the State's natural resources would enhance the competitive advantage of both the State and the nation in stimulating further economic development. In a regional setting, these constructs help to identify and prioritise industrial and technological activities where the application of resources will serve to enrich these activities as the basis for sustainable growth.

In conclusion, several points deserve emphasis. The first is that the application of Commonwealth Government resources for S&T with strong links to the minerals and energy sector is likely to help in the competitive technological development of local Western Australian small to medium-scale manufacturing enterprises. Second, Western Australia's world-class institutional infrastructure in earth science is a strong basis for attracting Commonwealth funds. Third, high quality research generally arises in small manufacturing enterprises when they work with sophisticated buyers from the mineral and energy sector, and fourth, regional competencies will not develop from efforts to attract funds for S&T for historically uncompetitive sectors of industry.

Four fruitful lines of inquiry emerge from this paper. The first is to estimate the quantum of Commonwealth Government resources. The second is to outline the implications for resource allocation. The third is to formulate policies which foster dynamic returns to scale, with links to the state's historical comparative factor advantages, across the manufacturing and service industries. The final one is to develop mechanisms that translate the constructs developed here into strategies for sustainable regional competitive advantage.

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