AUSTRALIA'S MANUFACTURING FUTURE

Discussion paper prepared for the Prime Minister's Manufacturing Taskforce

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This discussion paper has been prepared for the Prime Minister's Manufacturing Taskforce and Secretariat as part of the consideration of future strategic direction and implementation measures for the development of a dynamic, competitive and sustainable manufacturing sector in Australia.

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EXECUTIVE SUMMARY

Making it in a small open economy

- Small open economies can be successful in manufacturing and most successful small economies have competitive manufacturing sectors, but the key to such success is strong and sustained enterprise-level productivity performance
- Sustained manufacturing productivity performance in a high cost environment requires stable macroeconomic conditions, including sound fiscal management, low inflation and cooperative workplace relations, ensuring low unit labour costs
- Success factors for global manufacturing comprise a strategic approach to innovation, emphasis on quality and design, high calibre management and workforce skills and a supportive public policy and investment environment.
- The primary strategic focus of high performing manufacturing firms and organisations in successful small economies is high perceived value for money for customers with a secondary focus on low cost of operations
- Manufacturing is increasingly interdependent with services and increasingly operates in the context of geographically concentrated clusters and networks, some driven by foreign direct investment
- Opportunities are potentially enhanced rather than diminished by the presence of a resources sector, but require systematic supplier participation in resources projects and value adding to primary commodities

Commodity cycle and structural change

- Manufacturing is under pressure due to the high exchange rate and terms of trade ("Dutch disease"), and a balanced and diversified economy will be needed for high wage, high productivity jobs and long-term growth
- According to some economists, the "structural change" associated with the commodity boom and high dollar means that manufacturing is in terminal decline and that jobs and activity will shift to mining and services.
- However manufacturing remains important due to its role in generating innovation and technological change, addressing trade vulnerability and creating high skills jobs not just in manufacturing but across the economy
- While public debate is focused on government support and co-investment in manufacturing, substantial subsidies to mining are contributing to negative externalities such as the "hollowing out" of trade-exposed industries and services
- We cannot understand innovation intensive activities with traditional static equilibrium models, and hence these are being superseded by approaches emphasising competitive advantage, dynamic capabilities and the innovation system

Key features of Australian manufacturing

- Australian manufacturing developed over the 20th century behind tariff protection which promoted infant industries and domestic employment but ultimately stifled innovation and productivity enhancement

- Reduction of tariffs and microeconomic reform brought about significant changes in the structure of manufacturing and encouraged greater competitiveness and participation in global export markets
- Australian manufacturing employs about a million people, about the same as in the 1960s, but with much increased output, reflecting productivity gains which have an economy-wide impact, including on unit labour costs
- However productivity growth has now stalled, including in manufacturing, which amounts to a structural deterioration of the economy behind the substantial but temporary windfall gains from the mining boom
- Manufacturing is still predominantly low and medium tech and has more recently encompassed a small high tech sector in ICT and medical technologies, but it is simplistic to think that the latter will replace the former
- Major challenges for manufacturing lie in addressing poor record of collaboration with research institutions, building management and innovation capability, global orientation, "knowledge networks" and competitive clusters

Sources of competitive advantage

- Key source of competitive advantage in a high cost environment is innovation, which is not just technology but design and organisational innovation such as new business models, systems integration and high performance workplaces
- Manufacturing also has unique opportunities in Australia through access to resources projects and other primary industries, public procurement and the development of supplier capability in context of global value chains
- Around the world, manufacturing is repositioning with increased emphasis on renewable and alternative energy technologies, and Australia has opportunities to become part of these changes as well as leading some of them
- Manufacturing, whether medium or high tech, must incorporate new thinking around creativity, design integration together with other aspects of integrated innovation, business analytics and the customer experience
- This includes open or semi-open approaches to business innovation and information acquisition, sustainability, platform thinking and connectivity with the growing services and solutions culture

Workplace of the future

- Future manufacturing will depend on the cultural transformation of workplaces through new approaches to management and leadership, and the constructive engagement of workforces in change and innovation
- Workplaces will require greater absorptive capacity, to integrate and diffuse existing technologies and skills as well as to develop new ones as part of emerging manufacturing skills ecosystems
- The interdependence of production provides opportunities for collaboration, networks and cluster development by firms and with public agencies and research and education institutions, test and experimentation platforms including living labs
- Now and into the future, managers and workforces increasingly need not just specialised competencies but also "boundary-crossing" skills of teamwork, communication, creative thinking and problem-solving

New policy directions

- Innovation policy is industry policy for the 21st century, and it is designed both to shape the industrial structure of advanced economies and to improve the performance of firms and networks, grounded in innovation economics
- International experience of industry policy suggests that policy objectives and policy instruments, as well as policy responsibilities and policy governance systems, should be both distinct and interconnected at national, sector and enterprise levels
- Industry policy can take many forms, and in addition to direct assistance measures, it may include new structures for the development of national and sector priorities, regulatory regimes, cluster policies and public procurement
- In any comprehensive consideration of industry policy, attention should be given not only to the efficacy of public support and co-investment in manufacturing but also to the substantial subsidies and concessions to mining
- The Prime Minister's Science, Engineering and Innovation Council is insufficiently connected with the innovation system and should be renewed (or replaced) as a central focus of policy advice and coordination with the Industry Innovation Councils
- Enterprise Connect and other "customer-facing programs" have been a clear success but consideration could be given to scaling up and grouping these together, possibly in a semi-autonomous agency, with increased intervention sophistication and agility
- Public policy support is also required for the development of clusters and networks, which will be a powerful attraction to foreign direct investment and provide a platform to participate in global markets and supply chains.
- Agreed industry policy priorities must guide public procurement and the development of local supplier capability, and drive both the tendering process for resources projects as well as consequent value adding opportunities
- Cluster policy is well suited for increasing value adding to and value appropriation from resources where Australia has demonstrated comparative advantage, including those in mining, agriculture and education
- Workplaces have a key role in driving innovation and productivity growth, and new measures are required to build management capability and to engage employees in strategic decisions and their implementation.

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1. Making it in a small open economy

The demonstrated experience of manufacturing across the world is that it not only can but must be successful in small open economies. Significantly, many small economies are dependent for their continuing prosperity on a competitive and globally oriented manufacturing sector. While the structure of manufacturing and its relationship to the broader economy constantly changes, manufacturing remains pivotal for creating long-term growth and jobs, primarily through ongoing technological change and innovation.

Consider the combined Nordic countries which have a similar population size and land mass to that of Australia. These countries have experienced high wage costs for a much longer period than Australia but have produced higher GDP per capita and generated more large international companies per head than any other comparable region in the world, many in manufacturing – such as Ericsson in telecommunications, Sandvik tooling, Electrolux white goods, Volvo trucks and SKF roller bearings. In 2010, there was almost one and a half times the number of Nordic companies in the Forbes top companies list than Australian companies. These are the "peripheral" economies of Europe.

Other comparable small economies with strong manufacturing sectors include the Netherlands, Switzerland, Korea and Taiwan. Moreover, it is not just in these economies that manufacturing is repositioning and reinventing itself, but also in the regions of larger economies, such as Baden-Wurttemberg, with its highly globalised networks of Mittelstand companies and the UK's "M4 corridor" with the emergence of a new generation of "micro-multinationals". These regions exemplify the "spikiness" noted by Richard Florida which confers superior competitive advantage on geographically concentrated clusters of ingenuity and expertise in the "flat world" of enhanced mobility and interconnectedness depicted by Tom Friedman.

Competitive advantage is driven in these economies and regions by a relentless enterprise focused commitment to quality, design and innovation of products and processes. This commitment is underpinned by deeply embedded knowledge and skills "ecosystems", a participative approach to management and organisational change, constructive interaction with research and educational institutions and a supportive macroeconomic and public policy environment, which enables rather than prescribes future directions for both firms and industry sectors. In some cases, such as Ireland and Tennessee, competitive advantage may be developed through foreign direct investment, though this is not always a guarantee of success. In Ireland, a highly successful innovation model in global manufacturing and related services has been damaged almost irretrievably by a policy environment which encouraged finance and property speculation on a huge and unsustainable scale. More generally, however, the presence of internationally competitive manufacturing has been a key factor in the relatively stronger recovery of countries like Germany, Switzerland and Sweden from the global financial crisis. (Given that these countries have business driven economies not consumer driven economies, their recessions tend to be deeper and shorter – V-shaped – than those in countries like the UK.)

These countries understand that manufacturing success is largely determined by the productivity performance of their firms and organisations. While low cost competition will inevitably predominate in large parts of manufacturing, and has contributed to the "hollowing out" of manufacturing in some advanced countries, it is possible to achieve a

viable return on investment in a nominally high cost, high wage environment if productivity growth is such that real unit labour costs remain competitive, and constant innovation ensures that unique and desirable offerings that are difficult to substitute or imitate reach markets at a price point providing good value for money. This applies equally to low and medium tech industries, which make up the vast bulk of manufacturing in Australia, as it does to high tech industries.

The big question then is what drives productivity in advanced economies? Traditionally the answer has been the technological change and innovation embodied in capital equipment, but more recent evidence suggests that non-technological innovation is just as if not more important, including design and branding; new business models and production methods; systems integration and the firm's absorptive capacity; and the development of high performance work organisation and management capabilities. While ingenuity may be found in many Australian workplaces, Australia lags other advanced economies in these areas as may be seen from the comparison of intangible investments with Sweden in the figure below. A recent study from Sweden (Tillväxtverket, 2010) showed that these investments contributed 29 per cent of the productivity growth in manufacturing, which suggests that a factor in Australia's low productivity growth may be its comparatively low investment in intangibles.

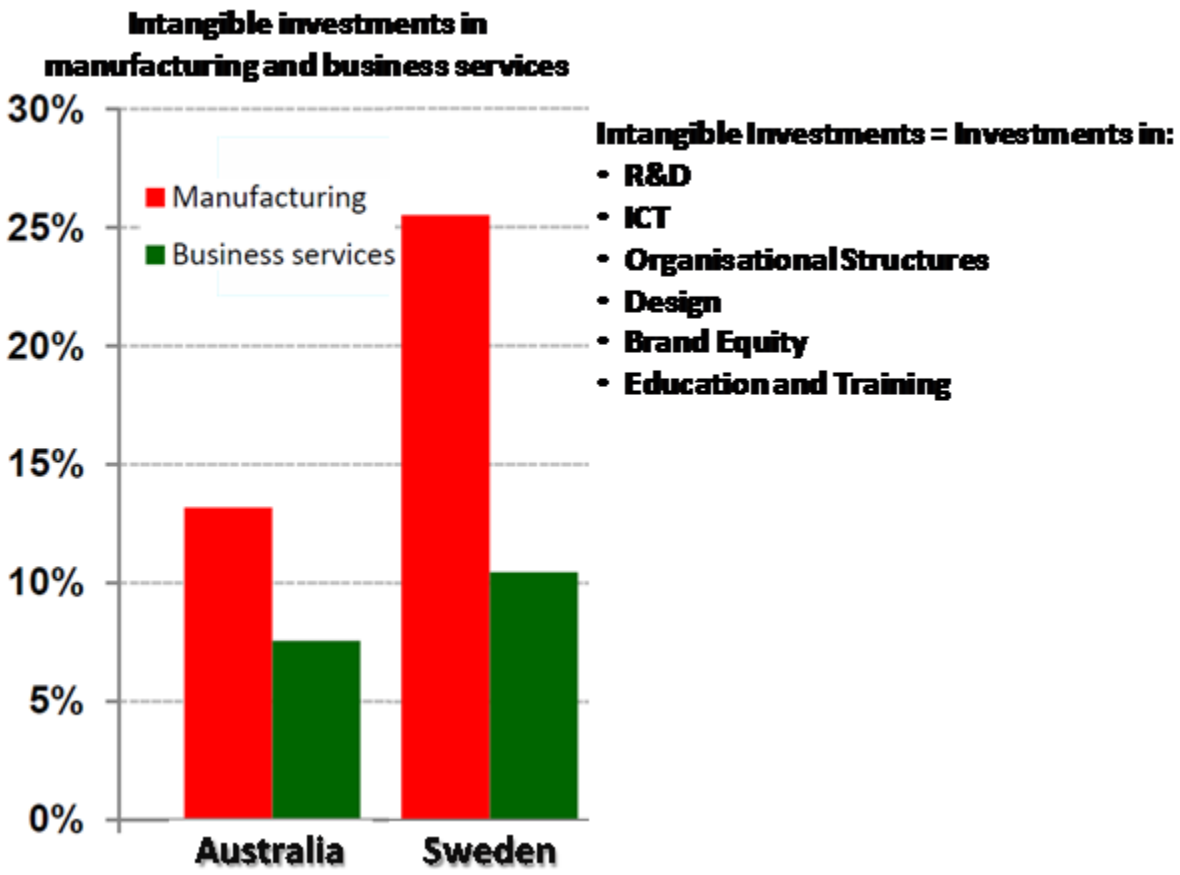

Figure 1: Per cent of value added in each sector. Figure extracted from Edquist (2011)

Dow's Advanced Manufacturing Plan for Australia notes that, "innovation is essential to a sustainable manufacturing sector and corollary to a robust advance manufacturing base

creating high value-add products" (Dow 2012: 15). However, innovation must be understood in broad terms. A recent large scale survey of German manufacturing SMEs found that for medium tech firms, which make up a substantial share of German firms, non-technological forms of innovation were the most significant source of productivity improvement, whereas it was only for high tech firms that science-based R&D figured more strongly (Kirner et al. 2009). In addition, as we will see later, a global survey of manufacturing SMEs in 16 countries, including Australia, found that productivity was closely associated with management practice, and that an incremental improvement in management capability had a disproportionately large impact on productivity performance (Bloom et al. 2007; Green et al. 2009).

Management of change in small economies

Significantly, the smaller the size of an economy, the stronger the argument for a government role in industry support, innovation, research and related areas. We will address the rationale for industry policy later, but it may be noted at this stage that one argument advanced for such a role draws on Ashby's "law of requisite variety" (1956, 1958), which has practical relevance for systems that need to survive and grow in uncertain environments. In this context, large economies have the ability to generate a large range of diverse options and are therefore better able to manage change than small economies, which can only generate a limited number of options (Roos 2012).

If the economy is large, there will always be some part of it that is performing at an optimal or near optimal level. Over time, this will compensate for the part of the economy that is performing at a sub-optimal level, which would otherwise decline and die but for being compensated for by the growth of the former. This will not happen instantaneously, but over time. If, on the other hand, the economy is small, then it may not have the opportunity to generate the optimal or near optimal response to change. Left to its own devices, the economy as a whole will decline without some form of intervention. In sum, the need for industrial policy is larger, the smaller the economy. To express it in neoclassical economic terms, the smaller the economy, the more pervasive is market failure as an attribute of the economy as a whole.

The increased openness of local economies does not change this fact since it is the "absorptive capacity"[1] of an economy that determines its ability to make use of information provided to it. So if the absorptive capacity does not increase while the information inflow increases, the economy will still not perform any better. This argument has major implications for attempts to migrate an economy towards a more advanced manufacturing base from a less advanced position.

A further rationale for government intervention in small economies comes from the area known as industrial or economic demography. Firms are constantly adapting to a changing reality and this adjustment often has a spatial dimension. In other words, the firm may

[1] The impact of externally produced knowledge on an economy's productivity depends on the capacity of the recipient economy to digest such knowledge and to make efficient and effective use of it, which requires the economy to have sufficient related (eg. technological) activity of its own. This is usually labelled the 'absorptive capacity' of an economy and was defined as a firm's ability to recognise the value of new information, assimilate it, and apply it to commercial ends (Cohen et al. 1990).

move from geographical point A to geographical point B. For an innovative firm underpinned by a specific knowledge domain there are two key determinants of location (everything else being equal):

- Access to sources of new knowledge in the key knowledge domain
- Access to lead customers for the innovation (product-service-system) offering that embodies the firm's operationalised knowledge.

This means that if access to both new knowledge and lead customers is substantially higher elsewhere, and even if the cost of doing business in this new location exposes the firm to a (temporary) cost disadvantage compared with competitors, it is likely that the firm will move. For example, if an Australian firm needs access to university researchers in California or Shanghai and the major lead customer for its products is in California or Shanghai, it is likely that the firm will relocate to California or Shanghai.

This relocation decision is also influenced by the decision-making power structure of the firm. If the firm is owned by one individual with a high preference for a given location, this may well nullify the rational choice (to relocate), whereas if the decision-making power rests with a group of diverse individuals with no location preference, it is more likely that the rational choice will be made. For example, a firm owned by a local entrepreneur who is strongly and positively embedded in the local community is less likely to move than the same firm owned by an international venture capital fund, everything else being equal.

If we combine this insight with studies of the effectiveness of public policy in this domain,[2] we can make a strong case that government intervention to secure the local presence of firms is justified. These interventions are mostly around:

- Providing access to lead users/customers in the public sector (procurement as a demand side policy tool is critical here)
- Providing access to knowledge providers (see discussion of Research and Technology Organisations in Roos and Pike, 2011). The *Australian Innovation System Report* shows that only 1.6 per cent of Australian businesses collaborate with universities and only 7.2 per cent were working with publically funded research agencies (DIISR 2011)
- Supporting local firms with suitable agglomeration and clustering initiatives (see the discussion of cluster initiatives below and in appendix).

Further, such interventions should not be made in isolation. Solís (2009) states that, "Policies regarding firm location, innovation, employment growth and new firm promotion should be coordinated, since all these matters share deep bonds". The implication, in line with the thinking in most small advanced economies, is that Australia, as a much smaller economy than both China and the US, can benefit significantly from an active and integrated industry, innovation and research policy.

This focus on increased integration and coordination in this area can also be seen at the EU level with the "Lead Market Initiative". This initiative is the first comprehensive effort towards a coordinated policy approach based on demand-side innovation policy in Europe,

[2] Including Audretsch 1998; Audretsch et al. 2004; Bartik 1985; Cheng et al. 2006; Friedman et al. 1992; Gabe 2003; Gabe et al. 2004; Guimarães et al. 1998; Hayter 1997; Head 1999; Lee 2008; Luger et al. 1985; McCann et al. 2003; Woodward 1992

aiming to accelerate time-to-market of bio-based products and services (European Commission, 2007, 2009a, 2009b and 2010; Toppinen et al. 2011). An associated initiative "Key Enabling Technologies" has recently been implemented in Europe (European Comission, 2009c), as well as in the US.

Small economies and manufacturing

International research and experience suggests that apart from the early enthusiasm for modularity and contract manufacture, globalisation of "disintegrated production" (sometimes known as globalisation of value chains) does not involve or foresee the elimination of manufacture within high-wage regions (Herrigel et al. 2009). Significantly, the continued existence of valuable expertise and human capital, proximity to customers and the need for short-term flexibility in the global allocation of capacity within multinational corporations all make manufacturing "sticky" in the developed world (Markusen 1996).

The research finds that regardless of where production and design occur, they retain many of the features of the two distinct models of disintegrated production, the first being the "industrial district/ local production" system, and the second, the "lean production/ collaborative supply chain" model. Multinational lead firms and large suppliers collaborate on design and manufacture around the world, but they also collaborate with more locally based small and medium-sized suppliers in each of the regions in which they operate. Uncertainty, combined with the imperatives of innovation and cost reduction, exert continuous pressures on the geographic division of labour in production that take the form of seeking the optimal balance of:

- Location of lowest production cost
- Location of highest innovation productivity
- Location of highest customer proximity

The pressures on MNCs generate a specific market environment for SMEs in high-wage regions. Innovation and cost-reduction capability are the key competencies in disintegrated production. Specialised SME suppliers that bring relevant know-how can take advantage of the two disintegrated production models.

However, SMEs must be able to contribute value in larger processes of inter-firm collaboration. They must be highly flexible, quick to respond, capable of meeting short lead times (between finalisation of order and delivery of finished parts). Where MNC lead firms and the lead plants of MNC suppliers are interweaving various products in various series sizes from various locations across their production facilities, SME suppliers to these firms must be able to produce a mixture of components in fluctuating volumes. This is one of the reasons for early adoption in these environments of technologies like "additive manufacturing" (also known as 3D Printing) that contribute to competitive operations in this demanding environment.

Herrigel et al (2009) point out that these general market characteristics have given rise to three developments among high-wage SMEs and regional governance institutions:

1. *Industrial districts and lean production*

   With the growing exposure to global logics of competition, innovation, cost reduction, and capacity allocation, the two principal production approaches increasingly merge. The role fluidity and ambiguity characteristic of the industrial district/ local production

system is mixing with the formal self-reflection and attention to both product innovation and cost reduction of lean production/ collaborative supply chain models (Sabel 2005a). The ability to perform a variety of roles has become a key competitive competence and a necessary competitive advantage within disintegrated production systems. Even in sectors where tie-ups still exists—eg. automotive and complex industrial machinery—producers within the supply chain increasingly occupy a variety of positions over time.

In entering into a relationship, neither the customer nor the supplier can have a clear idea of how the specific content of their ties will evolve. Will it be an intimate collaboration? Will collaboration fail and the customer ask for some other more arms-length service? Will other collaborators turn out to be necessary for the successful construction of a component system? Will the initial supplier lead the collaboration, or will the new supplier do so, or will the customer direct it all? These things are increasingly difficult to predict.

The character of a relationship with even a single customer can vary substantially over time and a series of discrete contracts. As a result, both customers and suppliers must be prepared to play a variety of roles (Kristensen 2008a, 2008b; Kristensen et al 2008; Herrigel 2009). This is a core practice in the industrial district/ local production system model of disintegrated production, but marks a departure from the originally more hierarchical lean production/ collaborative supply chain model. At the same time, all collaborators, regardless of their roles, find themselves under continuous pressure to reduce their costs and improve the quality and content of their products and services through increased innovation effectiveness.

Many large customer firms insist that their suppliers develop these capabilities (MacDuffie et al. 1997; Sako 2004). Indeed, many large customer firms have developed extensive internal supplier development organisations to teach their suppliers how to deploy continuous cost improvement mechanisms (SEA 2008). The dissemination of these lean practices has also become an important goal of public institutions in many industrial clusters (Whitford et al. 2004; Kristensen et al. 2008). The practices of the lean production/ collaborative supply chain model have begun to diffuse broadly, even among SME specialists within industrial districts and regional clusters where they were never prominent (Fieten et al. 1997; Whitford 2006).

2. Cooperative globalisation of SMEs

In the context of dramatic cost competition and the globalisation of their customers, SME supplier firms and specialists from high-wage regions have globalised. This process occurs in two main variants:

- The first involves regional clusters of specialists who collectively produce and assemble all components of a product. Italian industrial districts for shoemaking, ceramic tiles, or packaging machinery, which organise the offshore production of crucial processes or lower value-added products illustrate this trend (Camuffo 2003; Bellandi et al. 2005; Cainelli et al. 2006).
- The second involves internationalisation of SME suppliers to MNC lead firms and suppliers in integral-architecture manufacturing sectors. Typically, in these cases groupings of firms form an alliance to follow their customers into foreign markets (Herrigel 2007). This can be seen in Germany and Scandinavia.

The reasons for both variants of SME globalisation, however, are the same as those that have driven the globalisation of larger firms: cost-reduction pressures and customer demands for proximity of key collaborators in new locations. In many cases, SMEs from high-wage regions seek to relieve cost pressure in their home markets either by identifying suppliers in low-wage regions or by establishing their own production facilities in those places. Such moves follow a standard trajectory of initially outsourcing and offshoring the simplest operations, then establishing their own production in low-wage regions, often developing such capacity to accommodate customer demand. Either way, such moves are difficult for SMEs and are frequently undertaken in cooperation with external partners. This is particularly the case when it comes to identifying appropriate suppliers or locations in low-wage environments. Often, SMEs use network ties with larger customer firms to identify attractive potential suppliers or joint-venture partners in low-wage regions.

SMEs from high-wage regions are more severely challenged when it comes to following the customer into low-wage markets. Here the SME often simply lacks the financial leverage to establish its own the higher-volume production facilities in offshore locations that their mostly large MNC customers require. Nonetheless, SMEs feel compelled to globalise for fear that if they did not, they would lose key customers. In order to make such moves, SMEs therefore seek out partners. This can involve outright merger between firms or other interesting forms of cooperation. The range of possible variants of SME cooperation on a global scale is thus extremely great.

3. Regional dimension

Globalisation places great pressure on the regional governance structures that have historically been indispensable for the sustained competitiveness of disintegrated production clusters. Unlike the firms that they serve, the governance institutions and practices in regions where disintegrated production has been embedded cannot easily shift their operations offshore. They must focus on keeping the operations that remain in the high-wage regions competitive and capable of participating in the fluid roles and formal self-monitoring processes of global competition. This is not an easy adjustment.

Several very significant regional clusters of disintegrated production have been largely overwhelmed by these globalisation processes. They were not able to establish regional governance practices that could facilitate dynamic disintegrated globalisation (dei Ottati 2003; Honeck 1998). Globalisation of production, finance and marketing can create asymmetries of access to technology and information, thereby undermining existing mechanisms for containing opportunism and balancing competition and cooperation (Bigliardi et al. 2011; Zeitlin 2007; Dagnino et al. 2002). Further, the globalisation of disintegrated production generates demands for new public goods among regional and industry producers, which existing institutional infrastructures are unable fully to supply or even anticipate (Sabel 2005b; Bellandi 2006). The development in this domain is outlined in Crouch et al. (2001, 2004).

A central feature of many regional processes of governance adjustment has been the development of public or public-private collaborations for upgrading the manufacturing supply base. These kinds of extra-firm efforts aim at enhancing the core skills that SMEs require to participate in contemporary disintegrated production networks: the development of technical know-how, the ability to perform multiple roles, the ability to

continuously innovate in an integrated sense (technology, design business models, etc.) and the capacity to engage in continuous self-analysis for collaboration and cost reduction. A wide variety of institutional arrangements for this purpose already exist in different national and regional settings (Whitford et al. 2004; Herrigel 2009; Kristensen 2008b).

Yet efforts to create a pro-active, supportive architecture for the globalisation of SMEs from high-wage regions remain embryonic. Public and extra-firm efforts trail behind the informal efforts supporting globalisation outlined above, such as large multinational lead firms giving their SME suppliers tips on reliable offshore interlocutors and production locations, or SMEs collaborating amongst themselves to accomplish similar tasks. The identification of opportunities for high wage regions created by globalisation is still often overshadowed by expressions of anxiety and distress about potential threats. In a policy sense this can give rise to industry policies with an emphasis on providing life-support to yesterday's industries rather than enabling the growth of the industries of tomorrow.

Productivity growth in advanced economies

Productivity growth in advanced economies typically involves technological innovation, ie. expansion of the technological frontier. The extent of industrialisation is closely correlated with the overall level of economic development. The figure below describes the close relationship between the level of overall economic development as illustrated by per capita GDP (vertical axis) and the degree of industrialisation as represented by per capita manufacturing sector GDP (horizontal axis).

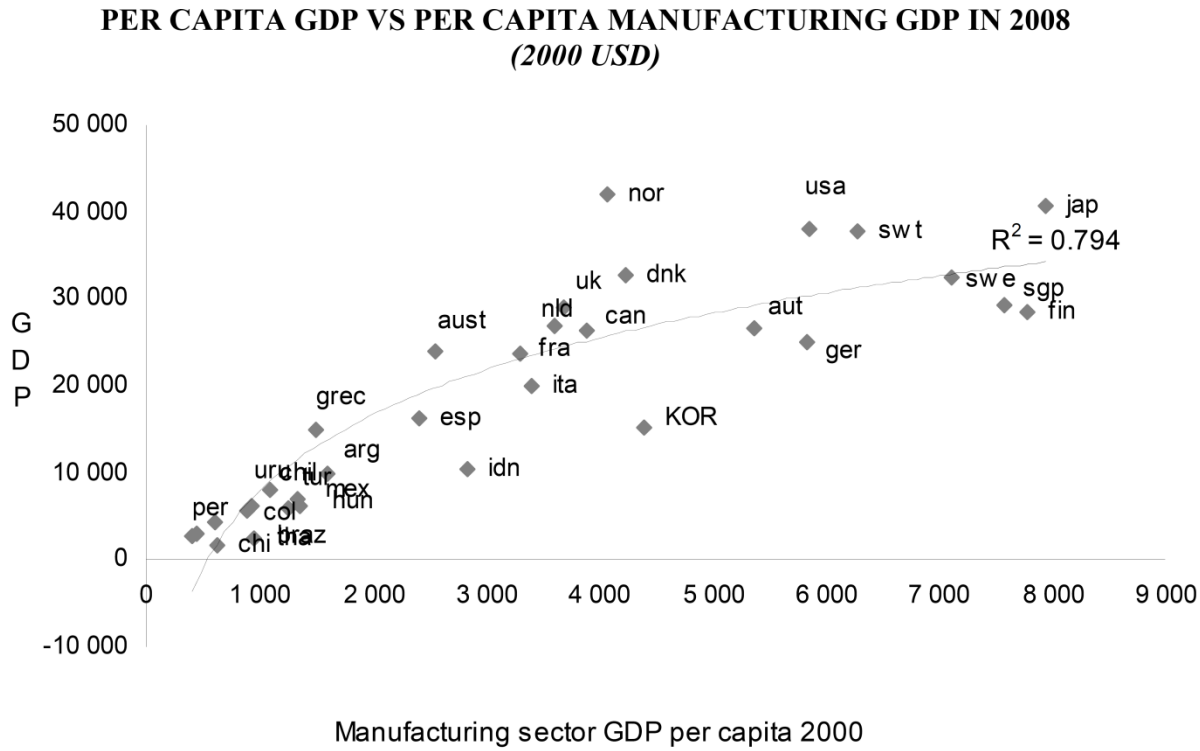

Figure 2: Manufacturing GDP vs. GDP (Economic Commission for Latin America and the Caribbean (ECLAC) and World Bank)

Two features stand out in the figure:

- First, the fact that advanced economies are highly industrialised economies —they exhibit a high per capita manufacturing GDP. Indeed, countries grouped in the NE quadrant in the figure, such as the US, Japan, Germany and northern European countries (e.g. Sweden, Finland), with the highest per capita GDP levels, are also those which reveal the highest per capita manufacturing GDP levels. Most European countries, as well as Canada, Australia and some Asian countries (e.g. South Korea) stand in the middle, albeit closer to the advanced group (Abeles et al, 2011).
- Second, the fact that the data shown in the figure fit a logarithmic function suggests that the impact of an increase in the weight of the manufacturing sector in the economy depends very much on initial conditions (Abeles et al, 2011).

Aggregate growth in productivity and value added in the two largest Nordic EU countries, Sweden and Finland, has been relatively high, though propelled to a much greater extent than elsewhere by the manufacturing sector. It has also relied less on productivity gains in the market services sector (although it may be seen from Table 1 below that in Sweden there was acceleration in market services productivity growth after 2001, which was primarily been driven by changing behaviour in the manufacturing sector). The large role of manufacturing in economic growth and productivity growth in the small open economies of Sweden and Finland makes them different from more service focused economies such as the UK (Uppenberg, 2011).

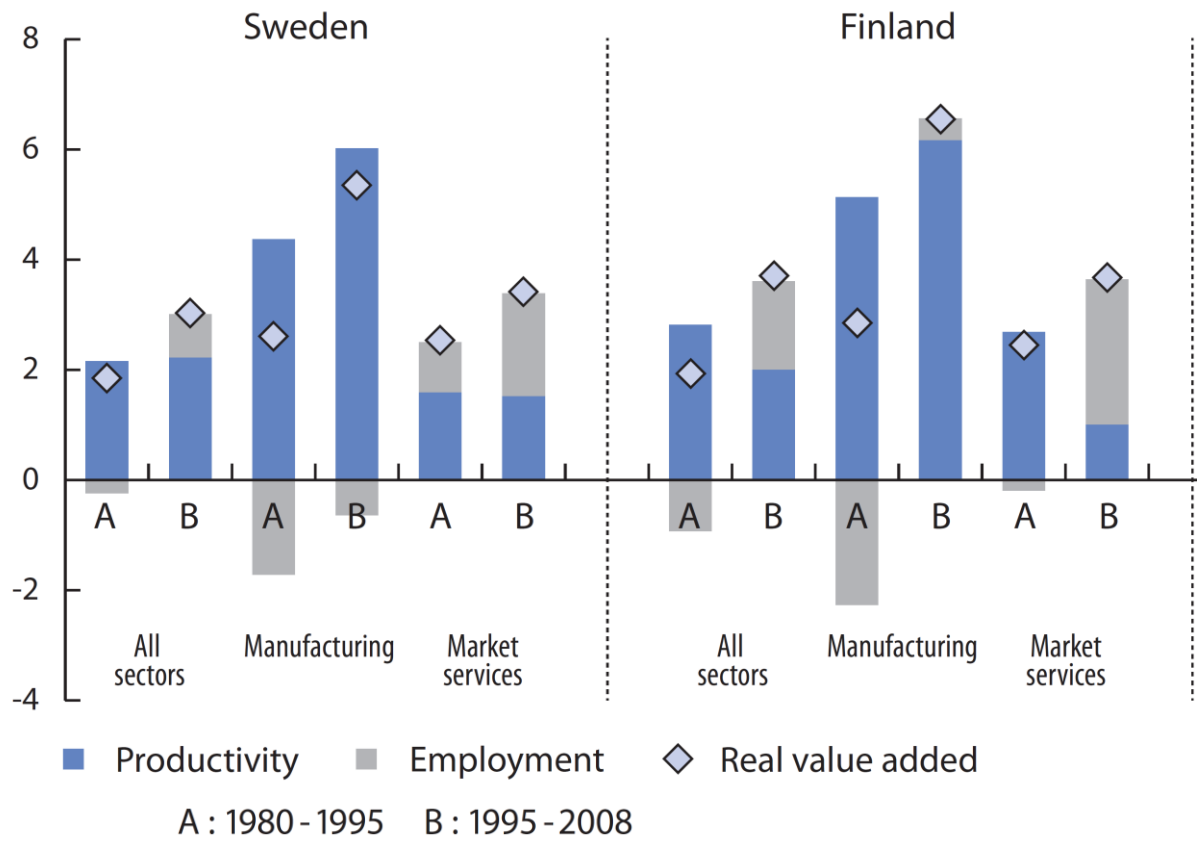

Figure 3: Contribution to average annual real value-added growth (percent) (OECD STAN Database) (Extracted from Uppenberg, 2011)

2001-2008	Average annual growth rates, percent														
	Total business sector			Manufacturing			Utilities			Construction			Market Services		
	RVA	Productivity	Employment	RVA	Productivity	Employment	RVA	Productivity	Employment	RVA	Productivity	Employment	RVA	Productivity	Employment
US	**2.2**	1.7	0.5	**3.0**	6.0	-2.8	**2.3**	3.4	-1.0	**-2.7**	-3.5	0.8	**2.5**	1.9	0.6
UK	**2.3**	1.6	0.8	**-0.1**	3.8	-3.8	**0.4**	1.5	-1.0	**2.5**	0.0	2.5	**3.7**	2.7	1.0
France	**1.7**	1.0	0.6	**0.3**	2.5	-2.1	**1.9**	3.1	-1.1	**1.3**	-1.5	2.8	**2.4**	1.3	1.0
Germany	**1.5**	1.1	0.3	**1.5**	2.4	-0.9	**2.0**	2.9	-0.9	**-2.7**	-0.3	-2.4	**2.0**	1.0	1.0
Netherlands	**2.0**	1.3	0.8	**1.5**	2.8	-1.4	**3.6**	3.8	-0.2	**0.6**	0.8	-0.2	**2.7**	1.6	1.0
Austria	**2.6**	1.5	1.0	**3.9**	3.9	0.0	**0.3**	0.6	-0.3	**1.4**	1.0	0.4	**2.8**	1.1	1.7
Sweden	**2.8**	2.2	0.6	**4.8**	6.4	-1.5	**-0.2**	-1.8	1.7	**2.0**	-1.0	3.1	**3.1**	1.9	1.2
Finland	**2.9**	1.7	1.2	**5.4**	6.3	-0.9	**0.4**	2.0	-1.6	**3.6**	0.3	3.2	**2.8**	0.7	2.1
Denmark	**1.2**	0.3	0.8	**0.5**	2.2	-1.7	**-0.7**	-1.5	0.9	**1.1**	-1.0	2.2	**2.3**	0.3	2.0
Australia	**0.9**[3]				**2.7**										

Table 1: Breakdown of real value-added growth (RVA) into productivity and employment growth (OECD STAN Database). The highest performance is shaded in yellow for subsector total and green for manufacturing productivity (extracted from Uppenberg, 2011)

As may also be seen from Figure 4 below, closer scrutiny of the investment data shows that the countries with high productivity growth are those that have a larger share of intangibles in total fixed assets. One recent study to provide a sectoral breakdown of intangible investment is Haskel et al. (2011), which finds that the distribution of intangible investment between manufacturing and market services differs substantially from country to country. Specifically, in the UK only one-quarter of total intangible investment is conducted in manufacturing, against half or even more in Germany and Sweden.

[3] Estimated from figure 8 in Eslake (2011)

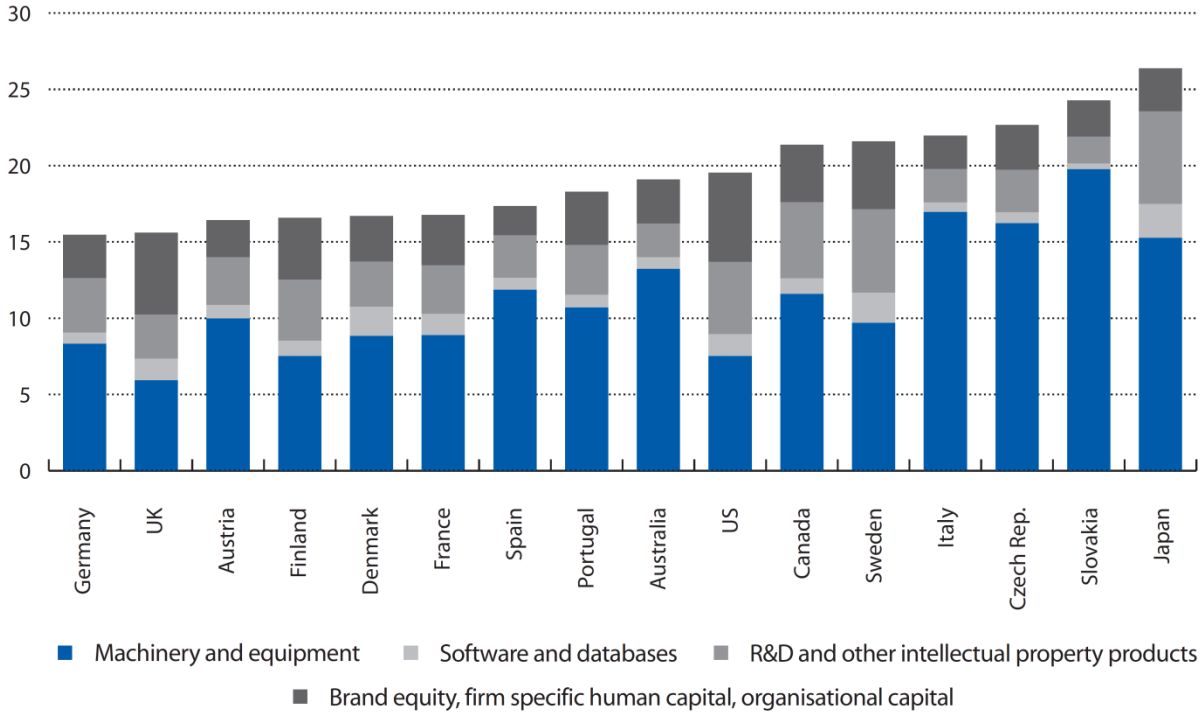

Figure 4: Investment in intangible assets, machinery and equipment (per cent of GDP, 2006 or latest available), OECD 2010 (Uppenberg, 2011)

In a recent study by Edquist (2011), comparing the investments by service firms and manufacturing firms in tangible and intangible assets (made up of R&D, ICT, organisational structures including business model innovation, design, brand equity, education and training), there was found to be a very small difference in the investments in tangibles between countries but a very large difference in the investments in intangibles as illustrated in Figure 1 in the beginning of the paper. This difference has a major effect in extracting value from investments in tangible assets as shown by Zhou et al (2009). In their study they find that the interaction effect of the advanced manufacturing technology investment and manufacturing infrastructure investment has a positive impact on firm profit and growth in Sweden, but does not have a positive impact on firm profit and growth in Singapore (which has a similar intangible investment pattern to Australia).

Eslake (2011) has shown that Australia's productivity performance, however measured, has deteriorated substantially since the late 1990s. In terms of simple decade-average comparisons:

- Labour productivity for the Australian economy as a whole grew at an average annual rate of 1.5 per cent over the ten years to 2009-10 (or 1.4 per cent per annum using the ABS "quality-adjusted" estimates for hours worked), compared with 2.1 per cent per annum over the ten years to 1999-2000, 1.4 per cent per annum over the ten years to 1989-90 and 2.8 per cent per annum over the ten years to 1979-80.
- Multi-factor productivity for the Australian economy as a whole was unchanged over the course of the 2000s (or declined at a 0.2 per cent average annual rate using "quality-adjusted" hours worked), compared with growth averaging 1.6 per cent per annum in the 1990s, 0.7 per cent per annum in the 1980s and 1.5 per cent per annum in the 1970s.
- Labour productivity for 12 of the industry components of the "market sector" (that is, excluding sectors in which productivity growth is notoriously difficult to measure,

in particular public administration and safety, education and training, and health care and social assistance) for which the Australian Bureau of Statistics has estimates going back before 1994-95 grew at an average annual rate of 1.9 per cent during the 2000s, compared with 2.6 per cent in the 1990s and 1.6 per cent in the 1980s;
- Market sector multi-factor productivity grew at an average annual rate of 0.2 per cent in the 2000s, compared with 1.4 per cent in the 1990s.

Growth in all the above measures of productivity deteriorated as the 2000s progressed. In particular, multi-factor productivity growth was negative during the second half of the past decade. This can also be seen in the figure below from the OECD.

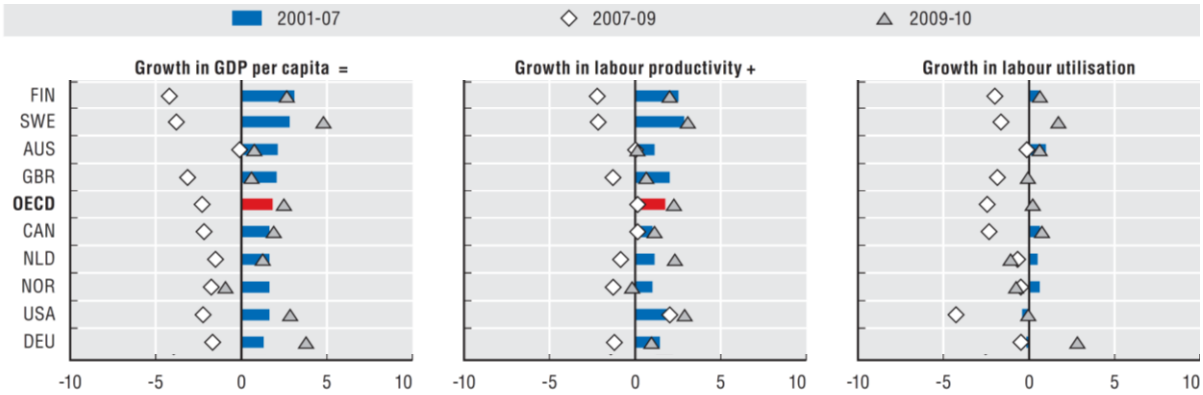

Figure 5: Decomposition of growth in GDP per capita, 2001-07, 2007-09 and 2009-10 (Total economy, percentage change at annual rate) (OECD, Productivity Database, June 2011) (Extracted from Figure on page 20 in OECD, 2011)

Eslake (2011) points out that it is plausible that at least part of the productivity decline is attributable to the fading of the impact of the reforms which are generally accepted to have been a substantial driver of the acceleration in productivity growth during the 1990s. It is also arguable that at least part of the slowdown in productivity growth since the turn of the century is attributable to the absence of any significant productivity-enhancing reforms since that time (including the reforms to the taxation system of 1999 and 2000). The dearth of reforms since 2000 is in part a result of changes in the political environment, including a lessening of interest now that the "easiest" reforms have been accomplished, and what remains is more challenging to core constituencies. Changes in voting behaviour have made political parties more sensitive to the views of those who perceive themselves as "losers" from the reforms of the 1980s and 1990s. It has also been argued that the lack of enthusiasm for reforms on the part of political leaders and the public at large is due, paradoxically, to the more prosperous circumstances of the last decade (Eslake, 2011).

As the profit share of Australia's national income has increased to unprecedented levels during the past decade (apart from the period immediately after the global financial crisis), businesses have also in general attached less importance to the pursuit of productivity gains at the enterprise or workplace level (which is where decisions that actually lead to higher levels of productivity are formulated and executed). A survey conducted by Telstra (2010) found that, among over 300 organizations each with over 200 employees:

- only 42 per cent measure their productivity, have specific productivity targets and know what they are, while 25 per cent don't measure their productivity at all;
- only 22 per cent believe that they can accurately measure productivity benefits when considering investment decisions; and

- only 34 per cent of firms assign individual responsibilities for productivity improvements.

The Telstra survey from 2011 confirme Australia's low productivity improvement on the firm level. The survey found that the productivity improvement deficit, defined as the difference between those who rank productivity as an important business priority (76%) and those who actually measure productivity and state they have achieved significant productivity improvements over the past 12 months (24%), has decreased from 59% in 2009 via 54% in 2010 to 52% in 2011. Although the trend is in the right direction the large number indicates that many organizations are struggling to deliver against their productivity priorities.

Eslake (2011) has also referred to the increasing volume of legislation and regulation in reaction to such issues as corporate scandals and various actual or perceived threats to "security". A common belief underpinning this legislation and regulation appears to be that it is both possible and desirable to eliminate various kinds of risk (to life, to property, to public order and safety, to people's savings, to standards of corporate or private behaviour, etc.) through additional legislative or regulatory action, irrespective of the probabilities attaching to those risks, irrespective of the adequacy of already existing legislation or regulation to that end, and irrespective of the costs of seeking to eliminate those risks relative to the benefits of doing so.

Much of this legislation and regulation has required the employment of additional staff, the acquisition of additional capital equipment or the costly modification of existing buildings and infrastructure, without resulting in the production of any additional (measured) goods or services, and often with the incidental effect of diverting the time and attention of other people from activities that would have otherwise resulted in the production of additional goods and services. The result is a negative impact on productivity.

Low productivity growth is a key factor in Australia's increasingly uncompetitive unit labour costs, as may be seen from this table:

COUNTRY	CPI % CHANGE Average Annual % Change 2000-2009	MANUFACTURING HOURLY LABOUR PRODUCTIVITY Average Annual % Change 2000-2010	UNIT LABOUR COST Average Annual % Change 2000-2010
UNITED STATES	2.50%	5.18%	-1.41%
SWEDEN	3.00%	4.42%	-1.01%
FINLAND	1.82%	4.54%	-0.99%
GERMANY	1.60%	1.82%	0.23%
CANADA	2.00%	0.89	1.63%
AUSTRALIA	**3.00%**	**1.93%**	**2.48%**

Table 2: Source: US Bureau of Labor Statistics: Unit Labor Costs are Employers Total Costs of Labor Including Direct Pay and All On Costs

Foreign direct investment

Data from Sweden and a review of the literature Bandick et al (2009) show that a substantial increase in foreign ownership in Sweden has influenced the demand for skills and labour. Estimating relative labour demand at the firm level and using propensity score matching with difference-indifference estimation, they were unable to reject the hypothesis that the relative demand for skilled labour tends to rise in non-multinationals (non-MNEs)—but not in multinationals (MNEs)—that become foreign-owned. Other interesting findings were that the larger presence of foreign MNEs in an industry appears to have a positive impact on the relative demand for skills in Swedish MNEs within the same industry and that the elasticity of substitution between skilled and less-skilled labour seems to be lower in MNEs than in non-MNEs.

The econometric analysis indicates that technology transfers are important when non-MNEs are acquired by foreign-owned firms. On the other hand, foreign acquisitions of Swedish MNEs seem to be explained by technology sourcing, since such acquisitions do not give rise to any effects on relative demand for skilled labour in the acquired firms. Furthermore, no evidence is found for the concerns put forward in the Swedish public debate that foreign-owned firms would move out skill-intensive activities from Sweden (Bandick et al, 2009).

Intensified competition for skilled labour in an industry, in particular between foreign MNEs and Swedish MNEs, leading to higher wages of skilled labour might explain why increased foreign presence in an industry has a positive impact on relative demand for skilled labour in Swedish MNEs within the same industry, while it has no effect on non-MNEs (Bandick et al., 2009). As skilled employees have larger knowledge about an MNE's firm-specific assets than less-skilled employees, one would expect that MNEs are more concerned about skilled worker turnover than non-MNEs. This could explain why MNEs are paying higher wage premium to skilled labour. It could also explain the significantly lower elasticity of substitution between skilled and less-skilled labour in MNEs than in non-MNEs in Swedish manufacturing (Bandick et al. 2009). The implication for Australia is that foreign direct investment in both local production and local integrated innovation activities (R&D, design, business model development, etc.) should be encouraged.

Competing in a low and high cost environments

The easiest way to determine whether a country is a high or low cost country is to use some form of price parity index. The most well-known is the Big-Mac index (although other indices like cost of living etc. could have been used but they all give the same result). It is based on the theory of purchasing-power parity (PPP), the notion that in the long run exchange rates should move towards the rate that would equalise the prices of a basket of goods and services around the world. Average prices should be lower in poor countries than in rich ones because labour costs are lower. If we use this index we get the following distribution of relative cost level and can identify the countries normally considered high cost countries. For Australia we see how it has moved from a medium to a high cost country since 2008. Recent OECD data also suggest that Australia is now the third highest cost country among advanced economies (OECD 2012).

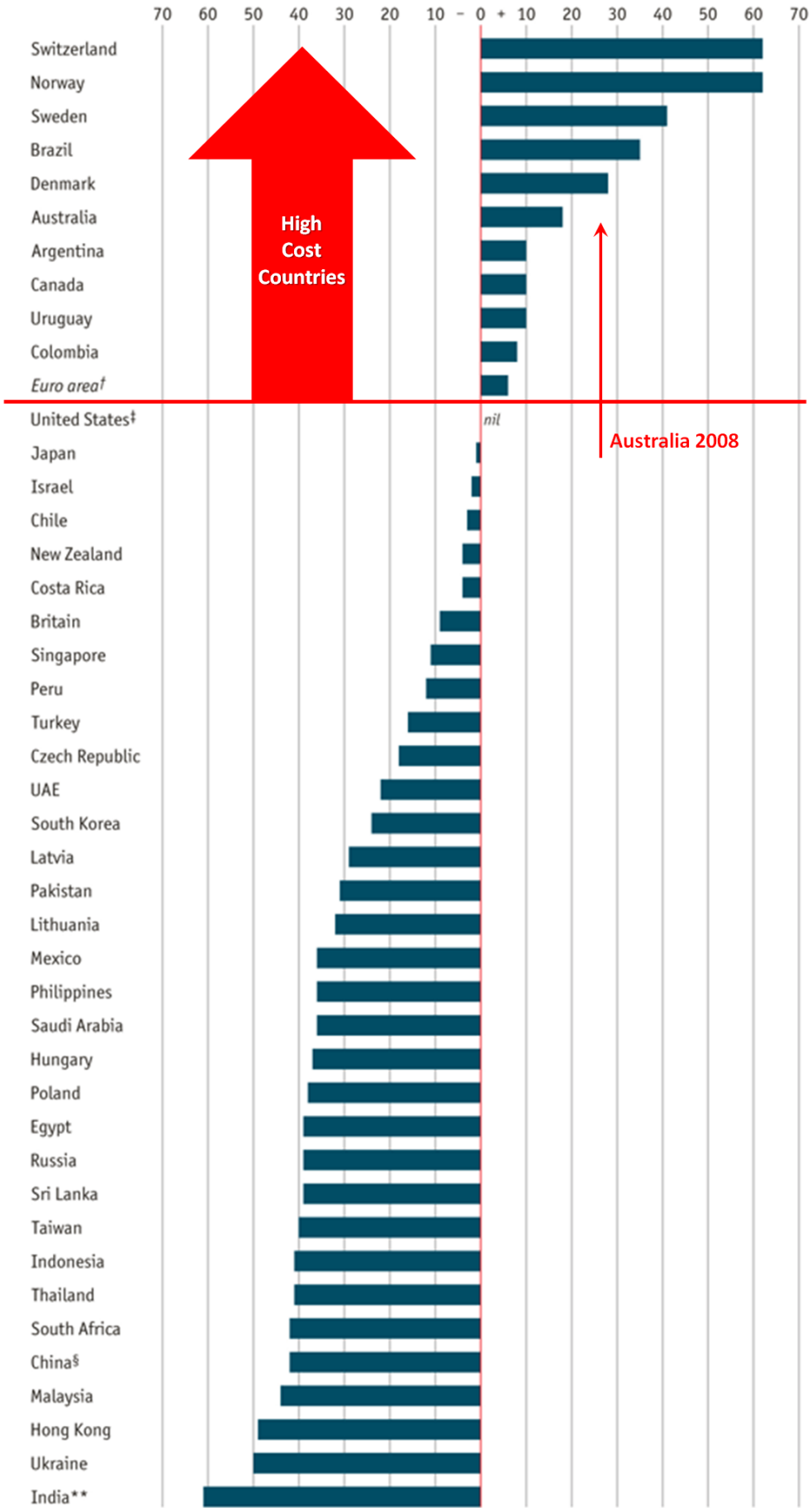

Figure 6: The MacDonald Price Parity Index, Economist January 11 2012

As a country moves from a low cost economy to a high cost economy firms have to find different ways of competing. Some of the differences are outlined in the following table.

	Low Cost Environment	High Cost Environment
Normal basis for competition:	Lowest cost	Highest Value for Money
Focus:	Efficiency	Efficiency + Effectiveness
Time horizon:	Short Term	Long Term
Innovation focus:	Tactical Problem Solving	Strategic Innovation
Innovation Behaviour:	Arbitrage	Value Creation & Value Appropriation
Government Policy Tools:	Supply Side	Demand Side
Mindset:	Owner	Custodian
Profit use:	Pocket	Re-Invest

Table 3: Illustrative differences between a high cost and a low cost environment

In a low cost environment most factors of production are available at lower or similar cost compared to other locations. With the development of technology and increased globalisation the share of factors of production, available at similar cost increase, making the remaining factors of production available at lower cost increasingly valuable as a basis for the firm's competitive advantage.

In a high cost environment this development combined with the increasingly shorter lead time for codification of tacit knowledge tend to continuously undermine firm competitiveness. To stay competitive firms in high cost environments must either shield some valuable pieces of knowledge from becoming globally accessible, or be able to create, acquire, accumulate and utilise codified knowledge a little faster than firms in cost-wise more favourably locations. This ability is strongly supported by close interaction with suppliers, customers and rivals. Furthermore, processes of knowledge creation are strongly influenced by specific localized capabilities such as resources, institutions, social and cultural structures.

Given that the above developments are highly dynamic there will be a regular flow of activities out of high cost environments, as can be seen in the figure below. These "lost" activities must be replaced by new activities through innovation and entrepreneurship in order to have a stable or growing economic base.

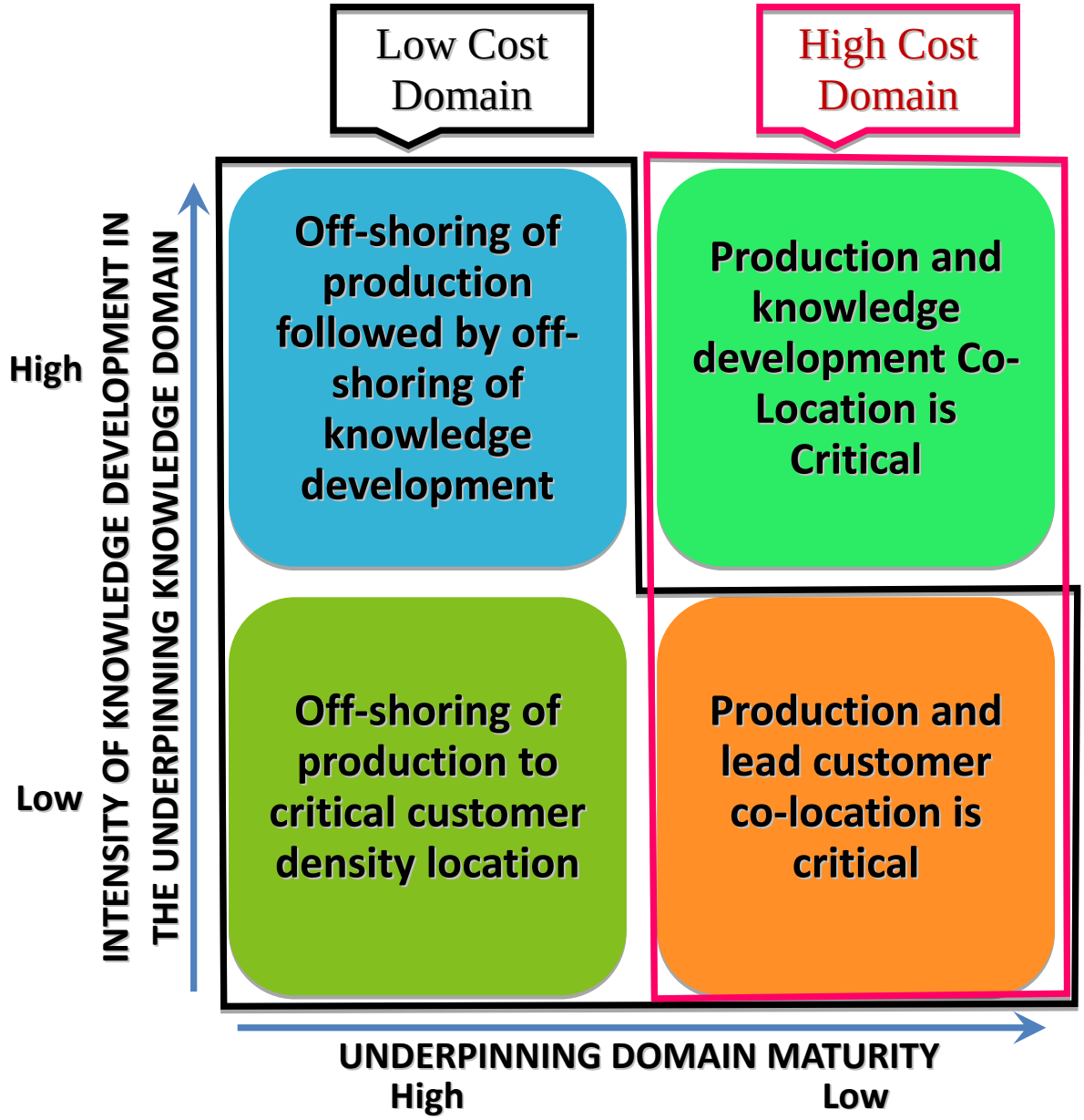

Figure 7: Illustration of the drivers of activity away from a high cost environment (Roos, 2012)

The above indicates the challenge of change that is required for Australian SMEs to operate successfully in the current (and foreseeable into the future) high cost environment. Features of success are integrated innovation, quality and design, management and workforce skills and supportive policy environment. At this point it is of interest to summarise the competitiveness and economic growth of different countries to provide an overall perspective, which we can see in the figure below.

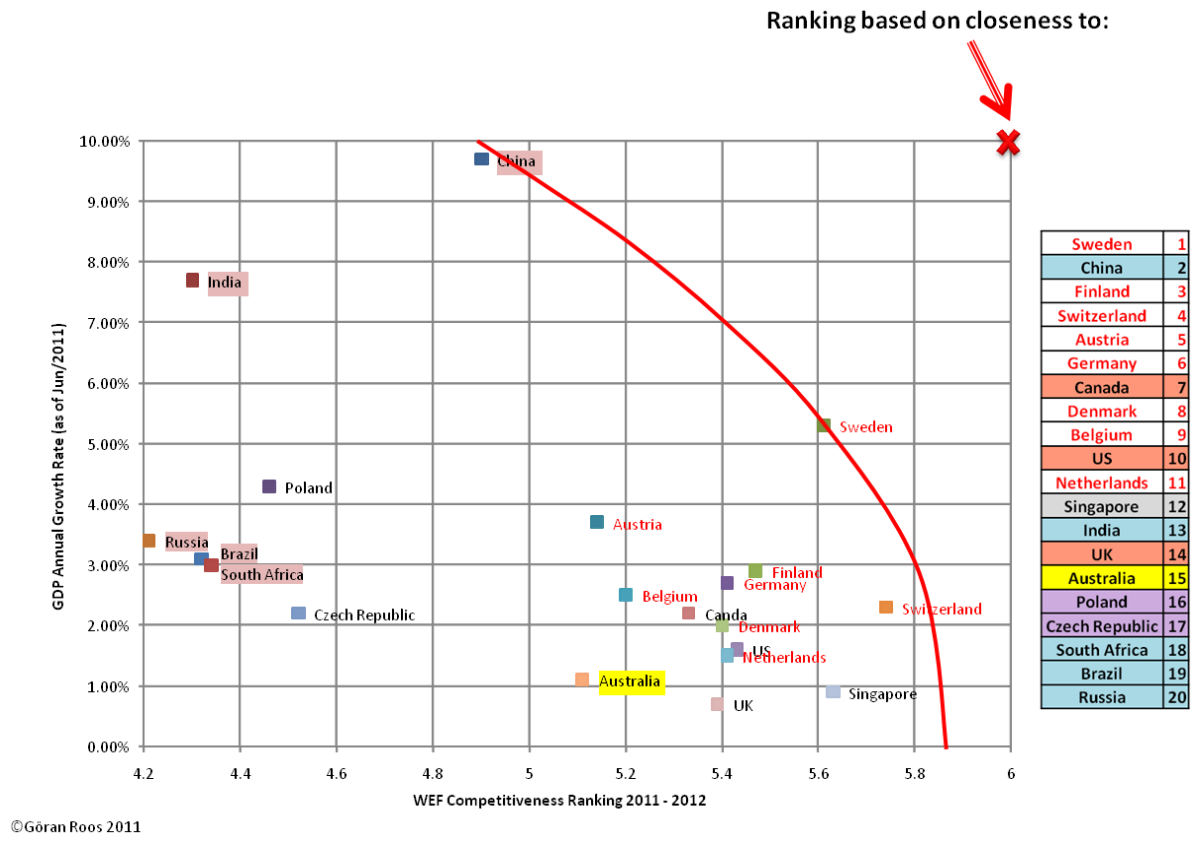

Figure 8: Competitiveness and economic growth (Roos, 2011)

Different types of SMEs in high cost environments

Andersén (2012) has developed a contemporary resource-based taxonomy of manufacturing micro, small, and medium-sized enterprises (MSMEs) through a cluster analysis of 186 Swedish manufacturing MSMEs. He identified six clusters:

- **Technocrats** (27 per cent). These companies have technological production capabilities and utilise them to a great extent. This also enables them to produce both complex and innovative products. However, the companies are inward-looking and do not market their products to a great extent. This distinguishes technocrats from, for example, prospector firms.
- **Conservatives** (22 per cent). These companies can be regarded as highly non-entrepreneurial, and in entrepreneurship research they are generally referred to as conservatives. Members of this group produce simple products and are below average in marketing as well as in innovation. This is generally the result of an unwillingness to adapt to a changing environment.
- **Marketeers** (19 per cent). This group of companies is extremely market-oriented and competes by producing complex products that require advanced technological facilities. However, their average level of innovation distinguishes them from traditional entrepreneurs. Thus, they are highly outward-looking in their efforts to maximise returns from their existing products.

- **Craftsmen** (16 per cent). A group of companies that are below average regarding several resources and capabilities. Their extremely low level of technological resources is the most apparent weakness. Their marketing capabilities are also well below average. They do, however, produce complex products. Thus, they are highly skilled but not in areas that require complex technological facilities; they produce more craftsman-like products.
- **Ikeas** (10 per cent). These companies compete by producing low-cost products and are highly innovative in their product development. They are also skilled in marketing and have strong relations with their customers. Companies such as Ikea and Wal-mart are typical examples of larger companies in this group. The products are not very complex to produce. The low-cost production ability does not have to imply that they adopt a low-cost strategy in the product market. However, this is likely to be the case for the majority of these companies.
- **Nomads** (6 per cent). These firms are below average on all fronts regarding resources and capabilities. Their lack of relational resources stands out most. These firms wander the markets from customer to customer (lack of relational resources) without much direction (lack of marketing capabilities). They do not have any apparent competitive advantages and can be classified as primitive and non-innovative.

From a policy perspective the three categories of firms that have high survivability potential and that, with further improvements, can reach very high levels of success are Technocrats, Marketeers and Ikeas (totalling 56 per cent of the studies firms), whereas the rest are under threat of downsizing and closure. It is important to recognise that SMEs that achieve long-term success in a high cost environment look different from successful SMEs in a low cost environment. Some of the key characteristics of successful SMEs in a high cost environment are depicted in the figure below:

Figure 9: Characteristics of successful SME's in high cost environments (Roos, 2012)

2. Commodity cycle and structural change

The challenges facing Australian manufacturing in the context of a high dollar, driven by increased terms of trade and relatively high real interest rates, are not unique. Other countries have addressed these challenges in a variety of ways. With the discovery of North Sea gas in the 1960s and 70s, for example, the rise of the Netherlands exchange rate decimated trade exposed sectors of manufacturing industry (the "Dutch disease"). The policy response was not to abandon manufacturing but to restructure, reengineer production processes and encourage a shift up the value chain, which occurred over subsequent decades with largely positive results.

Norway's response to similar pressures arising from the exploitation of its North Sea oil resources was to levy a 76 per cent resource rent tax, "quarantine" exchange rate effects through the accumulation of a sovereign wealth fund, and invest significant windfall gains in the development of research and innovation infrastructure. These measures were intended to create a balanced and diversified economy, with a niche competitive high value adding manufacturing presence, beyond the current resources boom, and they have largely succeeded in doing so. Norway is an exemplar of how to take advantage of a resources boom, while offsetting potentially adverse effects.

By contrast, the UK arguably squandered the opportunities available to it in similar circumstances with an "enclave" approach to accessing its substantial oil and gas reserves. While the newly established Offshore Supplies Office facilitated participation by local firms in activities such as platform construction, the main policy emphasis of the 1980s was to channel windfall gains to an Exchequer funded consumption boom at the expense of public infrastructure investment and to allow the market to accelerate the disintegration of British manufacturing. Only now, as the limitations of reliance on financial services become apparent, is public policy shifting to "rebalancing" the economy.

The idea that "structural change" in Australia should necessitate indiscriminate downsizing of manufacturing industry and a shift of activity to mining and services betrays a similar short-sightedness. It is not only simplistic (displaying a lack of insight into the complex interaction between manufacturing and other sectors), but it is based on a narrow neoclassical economic theory of production and trade, whose set of abstract axioms are either empirically unfalsifiable (such as consumer utility maximisation) or empirically falsified (such as constant returns to scale). The theory is unable to account for the actual pattern of production and trade, particularly for manufacturing in which increasing returns and technological change are central to an intra-industry pattern of international trade.

The gaps between the economics of the real world and the abstractions of neoclassical economics are becoming increasingly evident, particularly as it has now been established that even a minor deviation from the very strict conditions required for general equilibrium nullifies the model's predictions and policy implications. This has been acknowledged by the model's leading academic proponents in the "Theory of the Second Best". Once it is accepted that the neoclassical theory of production and trade cannot hold in the real world,

it follows that the policy prescriptions against industry assistance need to be critically examined.

We begin with the assumption that economies operate under perfect competition. Here firms in a given industry are assumed to have identical technology and, in turn, production costs. Firms and consumers have perfect foresight and present and future market changes are efficiently signalled in prices. Further, by definition, there can be no "trade secrets", brand loyalty or product differentiation. There are no barriers to entry or exit and this ensures that entrepreneurs will rapidly move their capital from unprofitable industries towards more profitable industries. The result of such mobility will be to efficiently allocate resources in response to changes in relative factors cost and consumer preferences. An economy is efficient when the returns to each factor of production are the same across all uses and the level of output of each commodity exactly matches demand such that it is not possible to reallocate resources without reducing consumer welfare.

Comparative versus competitive advantage

In relation to international trade, neoclassical theory claims that national welfare is maximised by having production in trade-exposed sectors conform to the principle of comparative advantage. Put simply, under comparative advantage it is assumed that countries are endowed with different proportions of factors of production of capital and labour and that nations specialise in the production of commodities which intensively use the factor which is relatively more abundant and exchange any surplus for different goods produced in other nations.

The policy implications of the theory of comparative advantage are clear-cut – consumer welfare is maximised with production and exchange being determined solely by unfettered markets. The role of government is limited to the provision of "public goods" and redressing a variety of "market failures" which by definition are assumed to be both limited in extent and remedied through policies such as taxes and incentives which are "market conforming".

However, it has been known for more than fifty years that the gains in per capita income from shifts in the inter-industry allocation of resources are quite small. It has also been established that the overwhelming source of gains in per capita income arise from technological change which improves the quality of factors of production and increases the efficiency of production. In addition, comparative advantage as a basis for policy is unsound as both its underlying assumptions regarding the operation of market economies and its predictions regarding international trade are counter-factual. Some of the counter-factual assumptions include:

- there are no international capital or labour flows
- only consumer goods are assumed to be traded internationally as flows of capital goods alter a nation's factor proportions
- the role of intermediate goods and services is ignored. Intermediate goods which are themselves not directly traded internationally but enter into the production of goods which are so traded may be produced with factor proportions very different from commodities which are exchanged internationally. In other words, the task of determining the factor proportions of traded commodities is not without ambiguity

- in addition the definition of capital and the determination of its quantity are assumed to be unambiguous. In reality the concept and valuation of capital is highly contested. For example, capital in money form is valued at the going interest rate. But if it is viewed as heterogeneous capital goods, each having different rates of productivity and subject to arbitrary accounting conventions and rates of depreciation, its aggregate value becomes highly ambiguous
- the productivity of labour and capital is identical across countries (ie. technology is identical) and there are no increasing returns in production. Productivity differences arising from differences in technological capacity across nations and the presence of diminishing average cost as output increases implies that some countries will have an absolute and possibly rising cost advantage across a broad range of commodities that is unrelated to their specific national factor proportions
- there are no quality differences in the "same" commodities across countries.

Comparative advantage predicts that countries specialise in the production of particular commodities so that international exchange should be based on inter-industry trade. In manufactures, which dominate world trade, intra-industry trade between developed economies is the dominant form of exchange. That is, countries produce and exchange "similar" products such as chemicals, processed food, motor vehicles, aircraft components, electronics, furniture, clothing and building materials. The basis of intra-industry trade is that most manufactured commodities are differentiated by features such as technology, design, quality, speed of delivery, degree of customisation to purchaser needs, after sales support, marketing and price. Such trade is based on national, industry and firm level differences in competitive advantage.

Competitive advantage is determined by myriad factors such as private and public investments in education and research, capacity for technology transfer across national borders, industries and firms, access to market information and efficient mechanisms for managing risk and uncertainty. It is concerned with dynamic efficiency in pursuing long term growth in per capita income through a complex interplay between private and public action. It requires investments and policies that stimulate the generation and diffusion of productive knowledge across firms and workers, enhancing the capacity for product, process and organisational innovation (Deraniyagala and Fine, 1999).

Competitive advantage suggests that states and businesses should pursue policies that create high-quality goods to sell at high prices in the market (Stutz et al 2007). On the firm level competitive advantage is grounded in a portfolio of resources – out of the five fundamental resource categories of financial, physical, relational, organisational and human/competence – that fulfil the characteristics of being durable, strategically valuable, scarce, difficult (or imposing a cost disadvantage) to imitate and difficult (or imposing a cost disadvantage) to substitute. On the regional or national level this still holds true but also includes inter-related portfolios of economic agents, like firms in cluster arrangements. For Australia, one of the critical aspects is the need to build clusters with competitive advantage around raw materials or input that can be generated locally drawing on comparative advantage (see Scott-Kemmis 2011).

Increasing returns and technical change

Two of the most critical problems for the neoclassical approach are the existence of increasing returns and endogenous technological change. Increasing returns arise when a given proportional increase in inputs to production results in a more than proportional increase in output. Neoclassical theory assumes production occurs under conditions of constant returns to scale – that is, inputs and outputs increase in the same proportion. The existence of increasing returns implies that: (1) the marginal productivity theory of income distribution is rejected as it is impossible to equate marginal factor incomes with their respective marginal productivities, (2) neoclassical price theory is rejected as marginal costs decline continuously. Numerous studies have found that actual firm pricing decisions are based on a mark-up on costs of production principle, and (3) increasing returns result in oligopoly or monopoly.

The sources of increasing returns are:

- Indivisibility – perfect competition requires perfect divisibility of factors of production. This is a necessary requirement for the existence of smooth continuously differentiable production functions. But for both technical and economic reasons factors are not perfectly divisible. This implies that a minimum threshold level of output is required to produce a variety of products and that capacity utilisation rates can be crucial to pricing and investment decisions.
- Specialisation – the division of labour as emphasised by Adam Smith generates productivity gains from employment of more specialised skills and equipment.
- Economies of increased dimensions – physical laws determine that the volume of solids increases proportionately greater than the surface area. These have been studied intensively in continuous process technologies such as oil refining employing tanks and pipelines, where a doubling of volumetric capacity can be achieved at a 60 per cent increase in cost.
- Economies of massed resources – the law of large numbers results in scale economies, when, for example, a plant operating several identical machines need stock proportionately fewer spare parts than a firm operating fewer machines.
- Economies of scope – it is frequently cheaper to produce two or more differentiated items from a single plant than to produce each item from a single dedicated plant. There are also a variety of economies that larger firms can attain. These include reduced costs through bulk purchasing of inputs, lower interest rates on borrowing capital and the spreading of fixed costs such as brand advertising over a large range of products.
- Superior techniques – increased output may enable the introduction of more efficient techniques, such as the replacement of batch production with automated flow techniques. In other words, increasing the scale of a plant may enable the adoption of the more efficient production techniques
- Technical or productive knowledge – this is increasingly recognised as a source of increasing returns. In addition, learning by doing can give rise to a cumulative increase in the volume of production which results in a significant increase in productivity and reduction in costs (Arrow 1962, Pratten 1971).

Studies have found that the minimum efficient scale of plants has been increasing steadily over the years, and increasing returns are a central characteristic of manufacturing industry.

The pervasiveness of increasing returns explain the increased spatial concentration of production in manufacturing generally and in sectors such as motor vehicles, pharmaceuticals, aerospace, defence and electronics.

Neoclassical analysis of technical change has been subject to fundamental criticism over the last two decades. Neoclassical growth accounting finds that technical change, or multi-factor productivity growth, is the most important contributor to growth in output per worker. However, because it regards such change as exogenous, neoclassical analysis has little to say about this key element in economic growth – it is essentially a "black box". Just as conventional economic analysis is counter-factual when confronted with the reality of international trade so too its contribution to the understanding of innovation is very limited.

The standard economic model assumes that the rate of technological change is exogenous (not determined within the economy), acquiring new knowledge is costless and all possible technologies are known and can be represented simply as production functions which relate different proportions of capital and labour to produce a given level of output. Identifying an optimal proportion of capital and labour for a given level of output simply depends on the ratio of their prices. Neoclassical analysis assumes perfect knowledge regarding the future. In reality, decisions regarding the use of new technologies by firms are frequently risky, with the potential for firms to be "locked-in" to inappropriate technologies (Dosi, Pavitt and Soete, 1990).

The implications of increasing returns and endogenous technical change for economic policy are profound. They suggest that a country or region with an initial competitive advantage will maintain or even increase its advantage over time. Competition is not based on a level playing field with all players facing the same costs of production, producing homogenous commodities, with the same technology and inputs.

The cumulative advantages of increasing returns and technical change can be created through strategic decision-making and cooperation between firms, their workforce, research and educational institutions and the government. These decisions include for example, inter-firm co-operation to establish networks to reap the benefits of technology diffusion, government assistance to reduce the risk of investment in generating and using new knowledge and work organisation structures to encourage continuous skill upgrading of the workforce.

Innovation and growth

Simth et al (2011) in their excellent paper explore the links between innovation performance and long-run growth. Their main conclusions are:

- There are diverse economic theories and models of growth, but they converge in putting innovation at the core of growth.
- Empirical studies demonstrate that investment in innovation is a core condition for enhanced business productivity at firm level.
- Innovation investments include tangible capital but more importantly intangible assets – such as Research and Development (R & D) but also design, intellectual property, software development, skills, managerial capability, marketing and branding.
- Across the firm population, higher innovation investments are associated with higher levels of new product innovation.

- In turn, higher levels of product innovation are associated with higher productivity in firms.
- Productivity growth is the central driver of economic growth overall.

Other recent studies show that technological change is the result of innovation by firms and public research institutions in production processes, products and services and organisational methods. Innovation lowers input use per unit of output and expands the size of the market by increasing the scope of human wants through the development of new products and services. Innovation is embodied in improvements in the efficiency and performance characteristics of capital, intermediate and consumer goods. Diffusing the stock of existing knowledge across the workforce and developing new productive knowledge is essential to implement new production methods and for problem-solving.

First, unlike standard economic goods, knowledge, conceived as a factor of production, is not subject to diminishing returns and does not depreciate as each increment in knowledge adds to the total stock of knowledge (Dowrick 2003).

Second, knowledge is "non-rivalrous" in that it can be employed by multiple producers simultaneously without affecting producers' costs. Another aspect of its non-depreciation and non-rivalry is that having been acquired by a producer it can continue to be used indefinitely so that its marginal cost effectively falls to zero. Knowledge is also non-excludable in that there are either no limits imposed by property rights on the use of knowledge or these rights are of finite duration (Arrow 1962).

Third, education, knowledge and skills have the property of a network externality, that is to say, the value in acquiring knowledge by any one user increases at a rate proportional to, or even greater than, the rate of increase in the number of other users. In other words, the productivity of any worker is enhanced not only by their individual level of skill but also by the average skill level amongst their fellow workers. Fourth, knowledge is a joint-product of production: expanding output also increases the accumulation of knowledge through learning by doing (Arrow 1962). Knowledge is thus both an input and output of production and innovation.[4]

In summary, these various properties of knowledge have been used to argue that the growth of knowledge is subject to increasing returns, that is, "knowledge acquired per unit of time is greater if the stock of publicly available knowledge is larger" (Prescott 1998). In addition, the growth of knowledge raises the productivity of capital investment when it is embodied in more recent vintages of physical capital goods and software. In turn, this

[4] A great deal of knowledge may well be 'free to use' but this does not imply that knowledge is a 'free good'. As Callon (1994) has shown there are degrees of non-rivalry and non-excludability and often significant private and public investments required to make knowledge non-rivlarous and non-excludable. The most important example of these private and public investments is education. Arrow deals with 'knowledge' at a very high level of abstraction, which also hides the fact that much knowledge is 'sticky' in that it is not easily transferred. This implies that improvements in knowledge can, to varying degrees, be localised in a firm or region. That is to say some knowledge is 'sticky' because it cannot be readily codified and costlessly transmitted. For example, knowledge may be sticky because it is context dependent, say the operation of a unique industrial process or the information may be only tacitly understood.

accounts for the presence of increasing returns to capital investment at an economy-wide level, as evidenced by the long-run increase in the capital-labour ratio (Romer 1994).

These properties of knowledge have also been used to explain important long-run trends, especially rising workforce educational attainment, rising R&D intensity (R&D as a share of value added) and increase in the breadth of technologies subject to R&D by large individual firms. First, growth in the "volume" of knowledge requires ever higher workforce skills to identify, assess and implement new knowledge. Second, the complex input-output relations that typify large firms require them to keep up to date not only with technological advances in inputs from a multiplicity of supplier firms, but also to constantly devise new uses and improvements to their own products and services which are also typically used as inputs by a multiplicity of firms across many industries.

One measure of this tendency is the growing propensity for large firms to engage in R&D and patent activity across a range of industrial classifications that is much wider than the industrial classification of the products or service they make. "[L]arge firms and the products they make depend on many fields of technological competence, the number of which is increasing over time with the widening range of technological opportunities emerging from improvements in computing and other technologies. In order to assimilate this range of emerging technologies, large firms simultaneously increase their internal competencies, form alliances with external sources, and *increase* their overall R&D expenditures" (Patel and Pavitt,2000).

Role of government

The role of government in advanced economies is not simply to address "market failure" but rather the constraints facing firms and the public sector in generating and diffusing productive knowledge. These constraints arise from inherent characteristics of innovation and market economies and include the following:

Costs in acquiring and assessing knowledge: any change in production methods or developing new products and services by a firm involves potentially costly search and experimentation. Acquiring, evaluating and implementing knowledge, even that which is already widely distributed, involves significant costs. "[T]he costs of searching for and translating even freely available information into terms useful to local firms are not trivial. And there are great economies in centralising these activities in organisations with special capabilities to carry them out. Efficiency requires that these costs, separate from the vastly lesser variable costs of dissemination, be borne but once. Otherwise each potential beneficiary of the same information would have to replicate the search and translation costs that would far better be shared, as fixed costs, in some way among all the potential beneficiaries" (UNIDO 2004).

These search and evaluation costs lead governments around the world to establish technology diffusion programmes, directed mostly at SMEs, which serve to spread best practice not just in the use of technologies but also management and work organisation practices (ITIF 2011).

Risk and uncertainty: it has long been recognised that because the outcomes of activities such as R&D are inherently uncertain and consequently the rewards from investing in such activities risky that either incentives to firms or direct public expenditure in scientific and

technological activity is an appropriate response. In the absence of these interventions, there is a strong bias towards less risky innovation. In other words, the level of private investment in innovation will be lower than is warranted. It is important to note however that only around one third of total innovation expenditures by the business sector in Australia are for R&D. However, firms undertaking non-R&D innovations also report that cost and risk remain the principal constraints on these activities (ABS 8158.0).

External economies: external economies are benefits rendered by one firm to another without recompense. The most important current example is the idea of "knowledge spill-over" from one firm to another. Knowledge spill-overs involve the inter-firm transmission of productive knowledge resulting from factors such as labour mobility and imperfections in securing all property rights over inventions, eg. reverse engineering and knowledge disclosed in patent applications. Like risk and uncertainty, external economies cause a divergence between the private and social returns on private investment resulting in a lower level of private investment than is desirable. By subsidising specific private investments the state can seek to reconcile private and social returns

Failures in innovation systems: modern studies of technical change find that the capacity of firms to identify and implement product and process improvement depends on a set of complex inter-locking institutions such as equipment suppliers, customers, industry associations, consultants, universities and public and private research, standards and testing facilities. These complex institutional interactions form regional, national and even international "innovation systems" (Nelson 1993).

Innovation systems are subject to a variety of problems which can impede the flow of productive knowledge (Smith 1998). Just as individual firms face the problem of identifying and processing an ever rising volume of market and technical information so too innovation "systems" require efficient coordination to avoid duplication of effort and ensure a ready flow of information. Three commonly recognised examples of such coordination failures include:

- First, poor communication of the results of university and public sector scientific research to firms and the difficulty firms have in identifying researchers who can assist in resolving technical problems.
- Second, there can be failures in infrastructural provision and investment. Infrastructures of various types may be vital for innovation (e.g. high speed communications) but there is under or inappropriate investment in their development. There may be a key role for public policy in such investment appraisal and investment.
- Finally, the exploitation of particular market opportunities requires specialised skills, equipment and market knowledge which can take many decades to develop. The specialisation of firms and supporting innovation systems can result in "technological lock-in" which inhibits firms from exploiting market opportunities arising from a major shift in technology or market demand.

Coordination failures: imperfect information also gives rise to coordination failures in investment decisions. The classic example is that of a planned new steel mill producing with new technology and larger capacity to greatly lower unit costs. However, at current rates of consumption the proposed plant would be only marginally profitable. A simultaneous

decision to invest in the new steel plant and expand steel consumption, say by increasing investment in industries that are an intensive user of the output of the steel industry, such as shipbuilding, would result in higher output and lower costs all round. The coordination of investments such as these requires strategic decision-making and consultation between private investors and the state. From the point of view of dynamic efficiency, such intervention is "market conforming" in the sense that such interventions are based on a proper understanding of the economy.

Effects of reducing protection: the primary orientation of government industry policy over the last two decades has been that of reducing protective measures, such as tariffs, in the belief that increased competition will spur innovation and productivity. It has been found, however, that for Australian manufacturing industry productivity growth is negatively correlated with tariff reduction, though it is strongly positively correlated with increasing output, capital investment and an increase in R&D intensity (National Office for the Information Economy 2004: 38). Reduced protection can, if it leads to a reduction in the demand for local manufactures due to a rise in imports, constrain productivity and innovation. This is because manufacturing productivity is causally linked to rising manufacturing output. This relation, known as Verdoorn's Law, arises because increased output lifts capacity utilisation rates, scale economies are exploited, learning by doing occurs at a faster rate and rising demand accelerates investment in newer and more productive equipment. Across the OECD a 1 per cent increase in manufacturing output increases productivity by 1 per cent (McCombie, Pugno and Soro 2002).

The policy implication of Verdoorn's Law is that to offset the impact of reduced protection other measures designed to promote innovation and productivity are required. For example, Sheehan (1998) found that the only Australian manufacturing industries to lift their share of exports to East Asia over the 1980s and 1990s, after the substantial reduction in tariffs over the period, were those that were subject to comprehensive industry plans such as the steel, car and pharmaceutical industries.

External vulnerability: the principal justification for the international move from fixed to floating currencies over the last forty years was that the latter would bring trade flows into balance and lessen the effect of terms of trade shocks. The global experience to date is that floating exchange rates do not equilibrate national trade flows. Indeed several mechanisms have been identified whereby trade imbalances may become self-reinforcing.

The failure of exchange rates to produce external trade balance is largely due to the fact that the primary determinant of exchange rate movements is capital flows, be they short term currency speculation and hedging or long term debt and equity portfolio flows. These capital flows are not only much larger in volume than trade flows but are determined by factors which can push a currency in the opposite direction to that required to achieve a trade balance. For example flows of overseas capital into the stock market, domestic banks accessing offshore savings to on lend for investment and consumption in Australia and the flow of overseas funds into the mining industry have resulted in a significant appreciation of the $A.

Monetary policy directed at reducing inflation induced by the resource boom has attracted significant short term capital inflows, again appreciating the currency. This appreciation is adversely affecting innovation intensive sectors, especially manufacturing. It has been suggested that "exchange rate movements are… a necessary aspect of the process of

structural adjustment by which resources are induced to move between sectors within the economy in order to best exploit changing economic circumstances" (Productivity Commission 2008). Such a position is only tenable if it can be demonstrated that currency movements result in an optimal allocation of resources.

In light of the global experience with floating currencies and the capacity of exchange rates to be sustained at levels that can damage trade exposed sectors, it is prudent economic management to ensure the economy remains broadly balanced. Given the inability of exchange rates to bring national trade and capital flows into balance, other means such as policies to shape the industrial structure and performance of firms may be required.

Concern over large external imbalances was a consistent theme in Australian economic policy for over one hundred years. From the mid-1980s concern over the growing Current Account Deficit (CAD), which arose from trade deficits and net payment of interest and dividends on foreign savings, drove Australia economic policy. Policy responses included deflation to reduce import levels, a heightened role for industry policy to reduce import propensity and lift export propensity and reducing the public sector borrowing requirement.

By the mid-1990s attitudes to the CAD had become far more sanguine. Despite this reversal in official perceptions it is the case that there are justifiable concerns over the sustainability of such large external imbalances and that these imbalances represent a genuine vulnerability. The current global "credit crunch" is the result of official policy indifference in many developed countries over many years to the growth of private debt. These private debt levels are now perceived as unsustainable. This demonstrates the rapidity with which market perceptions of conventional economic "wisdom" can change and the profound economic consequences of such altered perceptions.

3. Key features of Australian manufacturing

The current squeeze on Australian manufacturing is seen by the Productivity Commission, Reserve Bank and financial market commentators as inevitable "structural change" by which productive inputs are reallocated to the resource sector to achieve a higher return. However, this misunderstands the role of manufacturing in the economy as a producer and user of advanced technologies, and the long-term consequences of decline.

Manufacturing is certainly becoming more globalised, more knowledge-intensive and more interdependent with value-adding services, such as design, engineering, computing and marketing. However, its future remains important for Australia's long-term economic prosperity for at least two reasons: first, manufacturing drives innovation and technological change – key elements of our productivity performance – and second it contributes to our external trade balance. This section will examine the policy background to the development of Australian manufacturing, the change in the nature of manufacturing, especially its increased integration with services, and its significance for the Australian economy.

Origins of industry policy

Most histories of Australian industry policy depict the approach to manufacturing assistance from the late 19th century until the early 1980s as "carte blanche protectionism" (Bell 1993: 25). The prominent role of the state in the settlement of Australia and throughout most of the 19th and 20th centuries in the monopoly provision of infrastructure, as well as its central role in other activities such as education and health services, created an ideological consensus around state direction of industrial development. Over this time, a wide range of support mechanisms for manufacturing were established, including tariffs, import quotas, production bounties and government procurement. The objective of industry policy was primarily to establish a large integrated manufacturing base and was justified by a number of reasons, including:

- to generate employment to sustain population growth, especially through migration. It was argued that population growth would be limited if agriculture was the principal economic activity. The demand for labour was restricted by the very high levels of productivity in the Australian agricultural sector that had already been achieved by the end of the 19th century. Interest in population growth was driven primarily by concerns regarding defence of a large land mass. Moreover, the growth of manufacturing, especially enterprises in regional areas that were involved in the processing of agricultural produce or supplying inputs to agriculture, was seen as essential to promote the decentralisation of a growing population, and to meet the defence needs of the nation, given Australia's remoteness from traditional suppliers of defence goods, such as Britain.
- To improve wages and conditions of the workforce. Protection of industry from imports was closely linked with social policies to use the industrial relations system to improve wages and conditions for workers. In effect, the industrial relations system, based on industry level awards and "comparative wage justice", was used to redistribute the rents generated by protection to the workforce. The system of "protection all round" for capital and labour in Australia was explicitly used as a substitute for other income-redistribution mechanisms such as generous state welfare payments (as practiced, for

instance, in northern European countries). Establishing a large manufacturing base in the regions was also seen as a means to reduce geographic income gaps.

- To redress persistent balance-of-payments deficits, given the heavy reliance on overseas capital for public and private investment and persistent deficits in manufacturing imports. For most of Australia's economic history, growth has been subject to a severe balance-of-payments constraint, and the goal of maintaining a positive balance of payments has been central to government policy. In practice this meant maintaining a rate of economic growth that was consistent with a positive, or at least neutral, trade balance. Using fiscal and monetary policy to regulate the balance of payments resulted in "stop-go" economic growth. The ceiling on the rate at which the economy was allowed to grow could be lifted if the trade deficit was reduced through a strategy of developing an import-replacing manufacturing industry.

Throughout the 19th and most of the 20th centuries, manufacturing activity was the defining feature of modernity, with its associations of power over nature and belief that moral progress was not only compatible with material progress but actually found expression in growing personal and community wealth. This commitment to modernity, when combined with an ideology of national development, provided a powerful stimulus to state initiatives to develop a manufacturing base, and significantly in the form of tariff protection was accepted by all governments, whatever their persuasion.

The imposts on agricultural inputs due to protection were, to some extent, offset by rising domestic demand for agricultural produce as a result of rapid population growth and rising incomes generated through manufacturing in industry. It was also offset by extensive government support for the development and diffusion of technology to primary industry through federal- and state government agricultural research stations, extension services, the CSIRO and primary industry–based university courses. These initiatives were critical to developing an internationally competitive agricultural base. Having a local manufacturing base also permitted innovations in farm equipment, often developed by farmers, to be quickly translated into new products. In addition, agriculture itself received a broad range of price support through tariffs, domestic production quotas, export price support schemes and collective marketing arrangements.

Protection was highly successful in its own terms in creating an integrated manufacturing sector; establishing a base for the supply of sophisticated defence equipment (especially the case during World War II much less so currently); raising the ceiling on the balance of payments constraint, and sustaining population growth and decentralisation. Manufacturing also underpinned sustained growth in productivity and per-capita income growth, at least until the late 1970s. Indeed, for much of the post-war period the economy was in a virtuous circle of demand growth, stimulated by population growth and a rising supply capacity that was generated by an import-replacement strategy.

However, insufficient priority was given in this approach to issues of efficiency, productivity and quality. While important measures were put in place to encourage productivity, these were greatly outweighed by concerns to promote employment growth. These measures were also strongly resisted by the central economic agencies. At the heart of the system of protection as it developed in Australia from the late 19th century to the early 1980s was a profound paradox. The state intervened in the market in a quite intrusive manner to foster the development of manufacturing industry but did not, with equal force, ensure firms

operated close to world benchmark levels of productivity. In other words, the state was prepared to act at a macro level but not at the micro level of the firm or industry in matters such as technological upgrading, optimal firm size, quality, design capacity and efficient work organisation methods. This, in turn, reflected a characteristic ambivalence in the Australian economic bureaucracy, given the overwhelming commitment of Treasury and other central agencies to the economic orthodoxy of laissez faire, which implied constraining wherever possible the involvement of the state in the detailed operation of firms and industries.

Protection developed in Australia as a pragmatic political and cultural response to particular historical and economic circumstances. It was advocated by representatives of capital and labour who, with the exception of those associated with the 1929 Brigden report on *The Australian Tariff*, did not feel the need to argue their case on the basis of a coherent and well-articulated theory of growth and development. By the late 1970s it was evident that the system of protection was acting as a brake on the achievement of productivity, efficiency and quality, including in the following ways:

- Lack of export orientation meant that firms were not required to become internationally competitive in terms of price and quality. Some firms were, in fact, technologically advanced but these were not the norm.
- State government procurement policies encouraged firms to establish plants of suboptimal size in separate States. The small average size of firms also restricted the capacity of firms to realise scale economies and invest in R&D, capital investment and workforce training.
- Governments encouraged foreign investment to promote growth of industry, but did not require the transfer of advanced plant and work organisation methods, so these "branch plants" often used out-dated technology. Foreign investors were keen to set up in Australia to access the local market, protected from potential competitors behind the tariff wall. These branch plants did minimal R&D other than that required to adapt overseas designed products and services to local conditions. The head offices of multinational companies also frequently placed restrictions on the capacity of local plants to export. This was done to control the level of intra-company competition in overseas markets.

Post-war North Asian industry policy serves as an important counterpoint to the system of protection in Australia over the same period. During this period, policy-makers in Japan developed a far-sighted strategy that combined import replacement and export promotion. Japan used an extensive system of tariffs, bounties, quotas, non-tariff barriers, loans to local firms, government procurement and technology diffusion to firms. The apparent paradox of high levels of simultaneous import protection and high levels of exports has been identified by Wade (1990) and others. It was designed to accelerate the process of learning by doing or using, and to realise increasing returns by increasing the size of the market available to firms. Wade (1990: 363) has argued that it is "misleading... to present import substitution and export promotion as mutually exclusive strategies... at the individual industry level, import substitution and export promotion can be complementary" (Wade 1990: 363).

Key strategies for preventing inefficiency in protected industries were: the temporary nature of assistance; and tying assistance to the achievement of specific performance measures, such as productivity gains or export targets (Wade 1990: 359; World Bank 1993:

9). While the details of North Asian industrial development policies are well established and do not require repetition here, the important conclusion from such a comparison for this paper is that the unconditional protection provided in the Australian model contained neither incentives to perform at the highest standards nor guidance to achieve such standards.

The implementation of the Button Plan from 1983 to the early 1990s marked an important turning point in Australia's approach to industry policy. These plans combined incremental tariff reductions with measures to lift productivity and export performance. Given the considerable costs to labour displaced by these measures, extensive structural adjustment assistance was also provided, in the form of retraining and interregional labour mobility. Importantly, measures were tailored to the needs of specific industries. Various performance targets were set for firms, such as productivity levels, exports and R&D, in return for government assistance such as grants for capital equipment upgrading, R&D incentives, import credits, workforce training, improvement of work organisation and rationalising the number of firms in an industry.

In addition, other complementary measures were introduced by the government, such as incentives to the venture capital industry, a productivity advisory service to firms through the National Industry Extension Service, and improved links between university researchers and business, for example through the Cooperative Research Centres program. The industry plans and other supporting measures were successful in lifting the international competitiveness of industries subject to the plans (Sheehan, Pappas & Cheng 1994). The demise of most of the plans during the 1990s has been associated with deterioration in the relative export performance of these industries.

Over the last two to three decades, there has been a major shift in the conduct of national industry policy within the OECD, largely reflecting developments in the understanding of the importance of innovation in lifting productivity and competitiveness. Innovation encompasses a broad range of improvements in production processes, including organisational advances, and improvements in products and services that enter into final consumption. This shift is indicated in the rapid growth of investment, by both the private and public sector, in measures to generate new knowledge and distribute new and existing knowledge across firms and the workforce. Some of the major policy-oriented insights arising from the study of innovation are discussed below.

Innovations are derived from multiple sources. As previously indicated, problem-solving and learning that occur in the production process are the most important sources of product and process innovation, not fundamental scientific breakthroughs. Innovation also results from the flow of ideas for improvements from capital-goods producers to users of equipment and software, and vice versa, and from final consumers to producers. The international transmission of new technologies and methods by foreign direct investment is also important. The predominant form of innovation is thus gradual or incremental and depends on the ready flow of information across firms, industries and public and private research facilities.

To a large extent, the market facilitates this flow of productive knowledge by providing innovators with economic incentives to distribute their products and services widely and to inform potential purchasers of the benefits of adopting these improvements. The inherent tendency to clustering of related firms also provides technology benefits, such as the

development of specialist suppliers and the sharing of learning that occurs through a mobile local workforce and reverse engineering of products and services. These benefits also contribute to the "spikiness" of particular economic regions which have achieved superior competitive advantage in a "flatter", more interconnected world (Green 2008).

However, it has also been shown that there are significant barriers to the production and distribution of productive knowledge. There are high potential costs for individual firms in identifying new technologies, evaluating these technologies and adapting them to the production of their particular goods or services. There is also considerable inefficiency and waste involved in each firm expending resources on these activities, many of which could be more efficiently provided by a limited number of suppliers. Investing in the production of new knowledge is also risky as, by definition, the outcome is uncertain. All of these constraints apply with particular force to SMEs. There are very significant productivity gains to be had by ensuring that the largest possible number of firms is able to introduce incremental improvements. Accordingly, across the OECD, governments have worked with industry to assist firms in overcoming these barriers through technology awareness and diffusion programs, inter-firm information sharing and collaboration and improving the linkages between firms and research and educational institutions.

Changing shape of manufacturing

It is not intended in this paper to reproduce the data on Australian manufacturing which may be found in the Taskforce paper *State of the Manufacturing Sector* and other reports such as the Australian Business Foundation's *Manufacturing Futures* (Kennedy ABF 2011). These provide a comprehensive overview of current trends in Australian manufacturing. We focus here on one of the problems that impede economic analysis of the manufacturing sector today, which is the statistical ambiguity created by the blurring of the boundaries between manufacturing and services. For example, data from the World Economic Forum suggests that in an innovation driven economy, the most advanced form, the average manufacturing sectoral value-added as a percentage of GDP, is around 18 per cent (Schwab 2010). This figure has been disputed by a number of commentators.

The Royal Society, in their 2009 review, also pointed to the blurring of boundaries between services and manufacturing. This review cited other similar commentary to the effect that, "In practice, there is no clear line between what counts as services and what has been made … The distinction owes more to government statisticians than anything else" ("Coming in from the cold", *Economist*, January 10 2009). Likewise, a UK Department of Trade and Industry report concluded that, "it is preferable to look at service activities as opposed to service sectors ... but in practice this is difficult to do as most statistics are based on sectors as defined by the standard industrial classification. The technical inadequacies of the official statistics pose significant methodological complications" (DTI 2007).

If we take this problem of cross-over into account and try to understand the move from products towards services (and from services towards products) we find that around 30 per cent of manufacturing firms offer some type of service (23 per cent in Australia). Half of those (15 per cent) offer solutions and systems (a total of 4 per cent in Australia) and these are nowadays normally classified as service firms in official statistics (Neely 2009). In turn, due to the digitalisation of both the manufacturing process as well as many service

processes, some service firms are also becoming producers of digital offerings and are thus comparable to digital manufacturing firms.

Even if we include only the additional 15 per cent of goods from producers newly classified as service firms, we can conclude that, in an innovation economy, the business of making things probably makes up value-added as a share of GDP of higher than 30 per cent. This sizable number, together with its multiplier effect into the rest of the economy, suggests why economies such as Sweden, that are recovering well after the global financial crisis are all based on high value added and technologically advanced export oriented manufacturing integrated with a rapidly growing advanced business services sector.

The above discussion raises the fundamental question of what do we mean by manufacturing in the 21st century? Manufacturing is frequently misunderstood and the common impression of manufacturing, the transformation of raw materials into finished products, is more and more misleading and will soon become totally outdated. Manufacturing includes the whole chain of activities from research and innovation through to recycling of the provided object. Physical fabrication is only one, increasingly small part of the whole manufacturing process. Already in 2006 Livesey identified four basic types of manufacturers, purely taking into account the service element:

- Service led producers provide customers with services based on a significant production capability
- Product manufacturers who focus on generating value through production
- Service manufacturers who have little or no production and generate value from services which are based around a product
- System integrators who control the channel to customers and manage an external production network.

This is illustrated in the figure below:

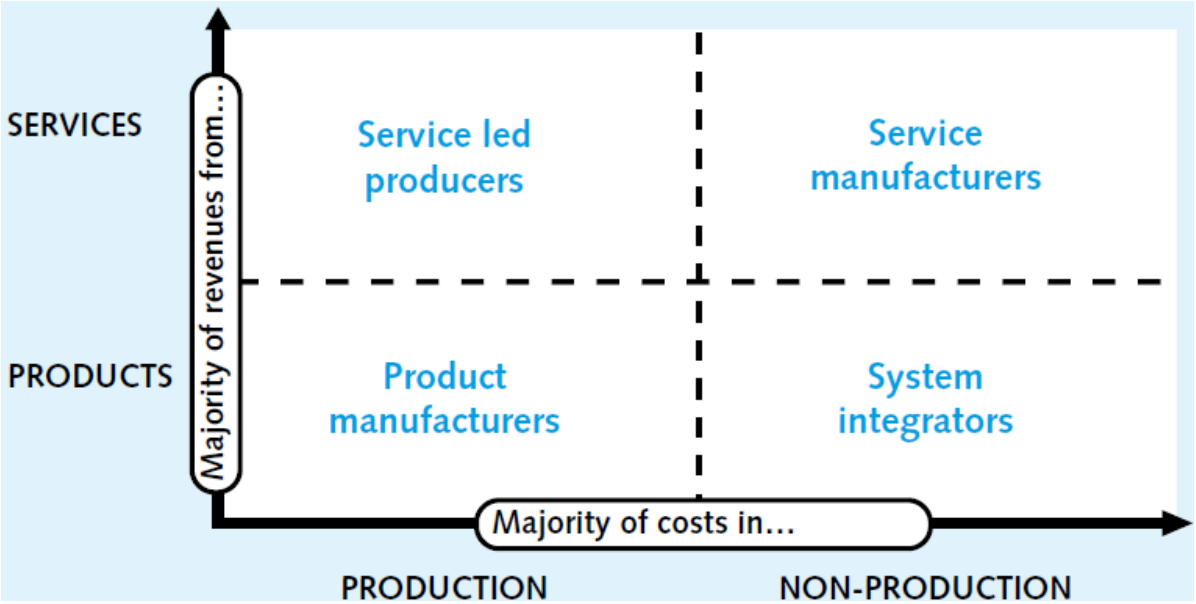

Figure 10: Types of service based manufacturers (Livesey, 2006)

The changing technology landscape has supported an increase in the share of the total value added that service manufacturers generate through services and system integration.

"Servitisation"

Competing through service is no longer limited to service companies. Manufacturing companies are becoming a major, not to say the largest single, component of the service industry. This is due to the increasing importance of service in gaining a competitive advantage (Gebauer et al. 2012). As early as 2002 this increasing "servitisation" of the manufacturing industry was shown by the Australian Expert Group in Industry Studies to be widespread and diverse. Nearly 75 per cent of the manufacturing firms surveyed as part of the study reported that they incorporated and sold services in their product offerings to customers. A more recent study by Neeley (2009) found the following types of services offered by manufacturing firms:

Services offered	per cent of manufacturing firms offering
Design and Development Services	21.74 per cent
Systems and Solutions	15.61 per cent
Retail and Distribution Services	12.02 per cent
Maintenance and Support Services	11.81 per cent
Installation and Implementation Services	5.02 per cent
Financial Services	3.75 per cent
Property and Real Estate	3.66 per cent
Consulting Services	2.63 per cent
Outsourcing and Operating Services	1.67 per cent
Procurement Services	1.14 per cent
Leasing Services	0.99 per cent
Transportation and Trucking Services	0.21 per cent
TOTAL OFFERING SERVICES	30.05 per cent

Table 4: Types of services offered by manufacturing firms (Neeley, 2009)

It is clear that services are now part of the manufacturing process and that the offering resulting from manufacturing is a product-service system in some form. Ren (2009) provides a framework for service in manufacturing firms and this framework is outlined in the figure below, illustrating the importance and "embeddedness" of services in the manufacturing sector of advanced economies.

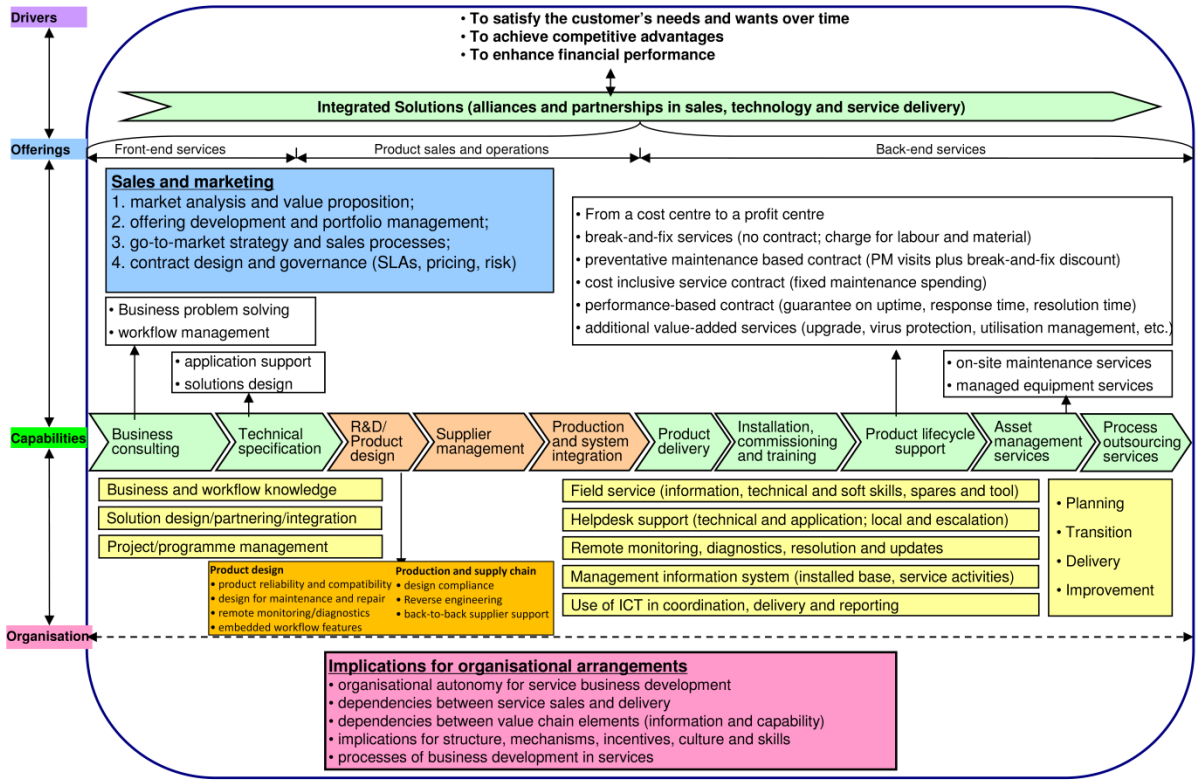

Figure 11: Framework for understanding services from manufacturing firms (Extracted from Ren, 2009)

Why manufacturing matters

The significance of manufacturing is essentially that, first, it drives innovation and technological change – key elements of our productivity performance – and second it contributes to our external trade balance.

On the first point, Australian manufacturing allocates $4.5 billion each year to research and development, or one quarter of total private sector expenditure. This is directed to adapting existing technologies and developing new ones, increasingly as part of an advanced services economy. And even more is spent on "non-R&D" innovation, such as new business models, systems integration and high performance work and management practices, with diffusion effects throughout the economy. Even in the car industry, for every $90 spent on inputs such as parts and steel, a further $10 goes to external engineering, scientific and computing expertise. And in some other industries, the production process is becoming integrated within a constellation of activities designed to enhance the customer experience, but which are not counted as manufacturing in the national statistics.

As relates to the second point, without a manufacturing base, Australia would need to import more consumer and capital goods, exacerbating our chronic inability to run a positive trade balance. Even with record highs in our currency, terms of trade and commodity export volumes, our export revenues are barely sufficient to pay for rising volumes of imported manufactures. In recent years, according to Treasury, the trade deficit has represented up to a half of our current account deficit, and simultaneously our productivity performance has stagnated. In this context, borrowing to import manufactures together with the repatriation of resource profits expose serious vulnerabilities in our external position. Before the global financial crisis, conventional wisdom regarded the current account deficit as irrelevant, a view corresponding with the "efficient markets

hypothesis". Since then, however, economic opinion has switched as financial markets have savaged those countries excessively dependent on foreign borrowings.

As we have seen, the evidence suggests that the developed economies emerging most strongly from the downturn are those such as Germany, Switzerland and Sweden with dynamic, competitive manufacturing sectors. Accelerating deindustrialisation results in countries going backwards technologically with a diminished capacity for innovation. Other industries cannot substitute for this loss in capacity. While in Australia the resources sector has recently increased its research and development spending to match that of manufacturing, the Australian Business Foundation and Lateral Economics have shown that this is directed mostly at tax minimisation rather than technology maximisation. Current changes to the research and development tax concessions are intended to reduce these loopholes (it is interesting to note that the high performing manufacturing and R&D countries like Sweden, Finland, Germany, etc. have no R&D tax subsidies).

Domestic high tech manufacturing and services supplying the resources sector are also small. According to the Australian Bureau of Agricultural and Resource Economics, annual sales of consulting and software services and equipment to the local and overseas mining industry amount to just 2.2 per cent of total annual manufacturing sales. The resources boom is not going to save or substitute for a robust manufacturing sector. Given that multiplier estimates are notoriously unreliable – varying between two and five additional jobs across the economy for every one created in manufacturing – it is interesting to note attempts by the mining industry to establish a similar or even larger multiplier effect. Dennis has simply pointed out that, "the rapid growth of the mining industry combined with their determination to continue to rely on the multiplier effect to exaggerate their size, has highlighted the potential absurd results that can be derived from input output modelling" (Dennis 2012: 6).

Looking to the future, manufacturing directly employs one in five engineers, and many more indirectly as consultants. Without a solid manufacturing base, Australia faces the prospect of losing scientific, engineering and computing expertise that has taken generations to nurture in research and production. These skills, at both university and vocational level, will be critical to new growth industries such as biotechnology and renewable energy. The skills developed within manufacturing are core infrastructure skills upon which every modern economy depends. Many people initially trained in manufacturing move to other industries. Where will the engineers, technicians, welders, maintenance fitters and machinists come from to install and maintain our telecommunications, power stations, water plants, transport and defence systems? According to the National Centre for Vocational Education Research, the resources sector does not train for these skills, but rather "buys them in".

How long will the taxpayer support billions of dollars each year spent by universities and public research agencies into solar energy, aerospace, micro-electronics, advanced materials, nanotechnology or biotechnology when the industries that can use these high level skills to innovate and make new products have disappeared. The Productivity Commission has already questioned public support for science and engineering when the benefits of the resulting knowledge accrue increasingly to other nations? The transfer of Australian solar panel technology to China, from whom we now source production, is a case in point. Clearly, the knowledge and skills required to import, install and maintain imported manufactures and technologies are much less than those needed for design and manufacture. Just consider the scientific, engineering and technical inputs for the

production of a solar panel, motor car, jet engine or plasma TV compared with the relatively modest skills required for their installation and maintenance.

Recent experience should be sufficient to dispel the myth that advanced economies can offshore their manufacturing base and retain "high value" design and marketing. Asian firms that started as cheap no-name makers of western-designed and branded products have quickly become global design, brand and innovative manufacturing leaders. Manufacturing is changing the world and is itself changing as the prime source of transformational products and services. Australia's commodity boom is an opportunity to build this transformational capacity, especially in new and emerging industries, not to let it slip away in the name of a "black box" economic model which fails to recognise the significance of innovation and technological change.

What has not changed in Australia, despite more than two decades of trade liberalisation, is the predominance of low to medium tech manufacturing in our industry structure, such as steel, non-ferrous processing, motor vehicles, building products, basic chemicals and food processing. These are also the areas most threatened by international competition, especially from emerging economies. By contrast, we scarcely register in high tech and medium high tech manufacturing, such as pharmaceuticals, scientific instruments, electronics, advanced chemicals, aerospace and electrical equipment, despite some notable successes over the years. These are the fastest growing areas of world trade, but also the areas where Australia experiences its largest trade deficit. At the same time, while the resources sector is providing windfall gains for consumers and shareholders, its impact on manufacturing competitiveness has been far from benign. As well as the effect of exchange rate appreciation, there are limited opportunities in downstream processing and supply chain access for local manufacturers, who also face increased wage costs and skill shortages due to mining recruitment.

These are the dimensions of Australia's public policy dilemma. While it is easy to say that a commodities boom is the kind of problem other countries wish they had, it is nevertheless a real problem for our non-mining trade-exposed industries. They require a policy framework which enables them to restructure and reinvent themselves, both to enhance their competitiveness during the boom and to ensure that Australia has a balanced and diversified economy when the boom comes to an end, as it most surely will. The alternative is continuing manufacturing decline. As we have seen, some would argue on the basis of a static equilibrium model of the economy that this is not a problem at all but simply "structural change" which results in a re-allocation of labour and capital, leaving us all better off. This conventional model is static because it excludes innovation, and equilibrium because it assumes all resources are fully employed.

As we have argued in the previous section, the main deficiency of the conventional model is that it confines itself to asking how a fixed quantity of resources can be efficiently allocated. Consequently, it sees industry assistance policy as literally a zero-sum game, with some firms benefiting at the expense of other producers and consumers, with no net economic gain. However, influenced by the work of Joseph Schumpeter, economists and policy-makers are now modelling capitalism as a "dynamic system", driven by technology and innovation, where change is the only constant. It is increasingly recognised that because innovation is risky and expensive, and information is costly to acquire and use, government has a role in reducing risk and encouraging the uptake and diffusion of new technologies and skills.

The present government has gone some way to bringing innovation to the forefront of industry policy. This has included support not only for R&D and entrepreneurial start-ups in high tech manufacturing but also the development of innovation capability in low and medium tech firms through programs such as Enterprise Connect, and most recently the Industrial Transformation Research Program to encourage collaboration with research and educational institutions. It is important to acknowledge that industry policy is not simply about replacing low and medium tech manufacturing with high tech, which is as unrealistic as it would be counter-productive. Already considerable innovation takes place in these firms, but rather than investing in their own R&D, their focus is on technology absorption, systems integration and business model adaptation.

We argue that a shared vision of future manufacturing should have five main elements. First, it should intensify the engagement of industry with research and educational institutions, given the importance of public research in Australia's innovation system. Second, it should further enhance the "absorptive capacity" of manufacturing firms, along with more effective local procurement, so they are better placed to participate in global markets and supply chains. Third, it should promote regional and local industry clustering as a platform for superior competitive advantage and a magnet for foreign direct investment. Fourth, it should encourage manufacturing activities around inputs where Australia has comparative advantage, including in mineral resources, agricultural raw materials and education. And finally, there should be a renewed emphasis on management and workplace innovation as the key to long-term growth and competitiveness.

As we will see in section 5, a recent study of management practice and productivity showed that the area where Australian managers lag world best practice by the largest margin is "instilling a talent mindset". This finding has now been confirmed and further elaborated by an important new study on the leadership, culture and management practices of high performing workplaces by the Society for Knowledge Economics. If future jobs are about talent and creativity, they will also require a workplace of the future.

4. Sources of competitive advantage

Innovation is critical for success in any industry, and the higher the cost environment and the faster the speed of new knowledge development in the domains underpinning the firm, the more critical it becomes. This means that for Australian manufacturing, innovation is fundamental not just for growth but for its survival. Globalisation of R&D and innovation challenges the way value is created in small, open economies, particularly since more and more of the production of goods and services is conducted in discrete stages in global value chains and in specific regions around the globe. Measuring this kind of innovation and enterprise dynamic is difficult and relying on simple one-dimensional indicators will be misleading in diagnosing and framing the challenges ahead as well as directions for future policy.

Competitive advantage for a high cost economy can be measured on its export of goods priced 30 per cent higher than similar OECD products as compared with goods priced similarly or 30 per cent lower than similar OECD products. For a high cost country like Sweden its exports were distributed as roughly 40 per cent for high priced goods, 50 per cent for comparably prices goods and 10 per cent for lower priced goods in 2005 with a change of +20 per cent for the higher priced goods, -10 per cent for the comparably priced good and no change for the lower priced goods between 1997 and 2005. Sweden's national innovation system has increased productivity in terms of both higher labour productivity and higher total factor productivity (TFP) compared with other comparable EU countries. The TFP indicator thus points to a high degree of innovativeness for Sweden. Evidence of Sweden's success according to an increase in high product quality in exports corroborates this picture.

Innovation dynamics imply continuous change and several factors influence this change:

- *R&D development among businesses*

  In the innovation discourse, knowledge creation and knowledge exploitation are core issues. This is the main reason why R&D as an input factor gets so much attention in innovation analysis. In general, however, we know very little about how R&D expenditures relate to domestic growth. From a business perspective, R&D expenditure is motivated by hopes to enhance the enterprise's ability to compete in the market. Manufacturing is the key R&D spender in Sweden, a country with a very high share of industry being sophisticated business service firms, manufacturing still stands for 75 per cent of the total R&D spend. Another characteristic is that R&D spend in manufacturing does not seem to be impacted by changes in the economic environment in which the firm operates and a significant share of manufacturing firms is increasing or plan to increase their R&D spending whilst almost none are decreasing their spending. In manufacturing there is also a close link between production and R&D and co-location is very strong, indicating that having one offshored will lead to the other being offshored as well.

- *Renewal by means of other intangible investments*

  According to van Ark et al. (2009), countries vary greatly in the allocation of investment in intangibles, such as R&D, mineral exploration, authorship/copy rights, product development in the financial industry, design, trademarks and marketing, training and

skills development, management and organisational change. In general, advanced countries invest much more in intangible capital and the structure of intangible investments is also different in the service sector compared with manufacturing, although the totals are almost equal. Over time, there is evidence that the manufacturing sector invests a larger share in intangible investment than in tangible (ordinary capital investments). These results point in two directions: one is the resemblance in core activities of the two sectors; another is the question of whether this trend in investment patterns has policy implications.

- *Innovation activities among enterprises*

  While R&D and investments in intangibles are costs incurred for the purpose of generating income for the enterprise, there are few measures of the results of these investments besides the revenue figures of the enterprises. The norm in advanced high cost countries seems to be that 50 per cent of firms spend monies on traditional R&D and that 5 per cent of the average firm's turnover is due to products new to the market.

- *Renewal by the means of new entrepreneurship*

  Innovation is integrated in the dynamics of entrepreneurship, but there are also huge problems regarding how to measure entrepreneurship and its contributions to innovation and productivity. For a venture to have an impact on growth and structural change, ie. creative destruction, it must be on a path of high growth within a limited number of years after its birth. The proportion of high growth enterprises 2007 with respect to growth in employment and revenue (per cent) is shown below:

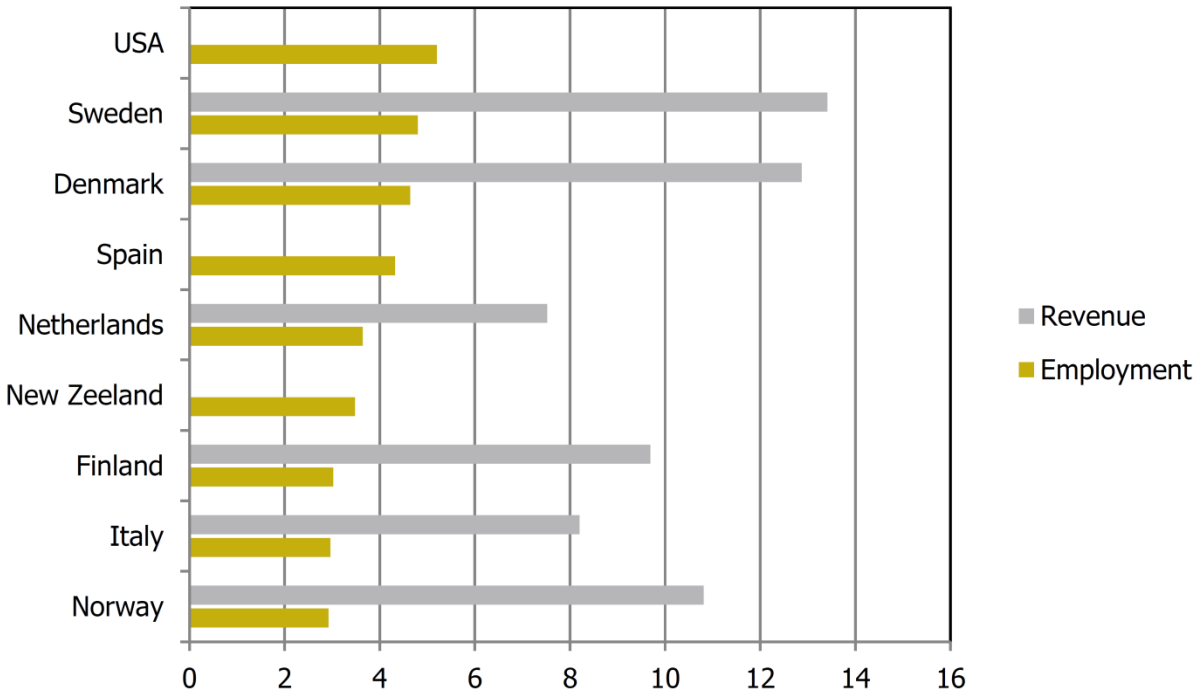

Figure 12: Swedish Government (2011), primary source Eurostat and OECD

- *Renewal through new forms of interaction in the value chain where the role of the service sector increases in importance*

As the industrial structure of advanced countries has shifted away from products towards the delivery of services, sector leaders have become increasingly aware that technical change and R&D describe only some of the sources of increased productivity in the economy. It is important to point out the very strong link that exists between manufacturing and services. When business tasks can be digitised and activities can be unbundled, it opens up possibilities to offer services to many customers, both in manufacturing and in services and both by manufacturing firms and service firms. This unbundling of services and connections to other sectors show up in input-output statistics where analysis suggests that the link between services and manufacturing appears to have been strengthened in recent years (Lind 2010). The mutual dependence between sectors has increased, which has been significant for the rapid international growth of productivity and export capacity.

These interconnections (one often speaks of a trade-investment-service nexus) also appear in export statistics where service exports have grown faster than manufacturing exports. These observations of a close connection between manufacturing and services also imply a more complex innovation dynamics which single static indicators do not capture. The close interplay and development of interconnected sector innovation systems between large multinational companies (irrespective of ownership) and a sophisticated knowledge-intensive business services sector is likely to be a major driving force for specialisation and renewal.

- *Global value chains as a driver of innovation*

  Value chains for a given product can now be divided into discrete steps to a much larger degree than before. The main impetus for this development is changing production techniques and technologies for control of production and logistics by the use of digital technology and communication technology. These discrete divisions of the value chain have transferred the concept of out-sourcing or off-shoring from one organisation to another, from one region of the world to another region of the world. The results from the analysis of intangible investments indicate that the manufacturing sector has reduced its material investments, which is in line with the off-shoring hypothesis. However, both the manufacturing and the service sectors have increased their intangible investments considerably. This is in line with the hypothesis that outsourcing of more advanced services demands further investments, but not of a material kind. Service exports have also increased significantly.

- *Innovation premium through geographical agglomeration*

  The development of the knowledge and service economy creates new challenges for innovation strategies and creates a need to broaden existing policy frameworks, also for manufacturing. Clearly, service companies are not connected to public R&D systems to the same degree as manufacturing (although that is now recognised by major funding agencies). One striking result of various Swedish studies on innovation and productivity is that the innovation premium of being located close to large metropolitan region is high and particularly strong for companies that have a high level of service innovation content (Lööf et al. 2011). Again, this challenges existing policy frameworks.

  Increased interconnectedness also seems to increase the demand for human capital. In general, there is a close link between the ability to export and advanced skill requirements (Syverson 2010). Furthermore, service companies that export are

demonstrably highly productive, and companies that export both goods and services have a 15 per cent higher labour productivity than companies that export only goods or only services. This might be another indication of the existence of complementarities between goods and services production in the modern knowledge economy. Swedish studies, particularly of various service sub-sectors, point to a close correlation between the level and quality of human capital, productivity and service export intensity (Elisasson et al. 2010). For instance, service sectors with a high degree of employees with higher education tend to have higher export intensity. Companies with a high degree of service exports tend to have a higher level of employees with a higher education degree compared to companies that do not export and companies exporting only manufactured physical goods.

The technology aspects have been touched upon in the excellent CSIRO paper for the Taskforce, but it is worth making a few summary and complementary points:

- The development in individual technology domains combined with technological convergence (not only between ICT/Nano/Bio/Cogno but also in and between other domains) and the conversion of these advances to engineering solutions is exposing most manufacturing industries to dramatic opportunities (and threats) over the coming decade. The change that is facing the manufacturing sector can only be described as an industrial revolution. An example can be to compare the digital technology effects on the printing industry and its associated value chain since around 1990 (see figure below) with what will happen due to additive manufacturing technologies in parts of the manufacturing industry.

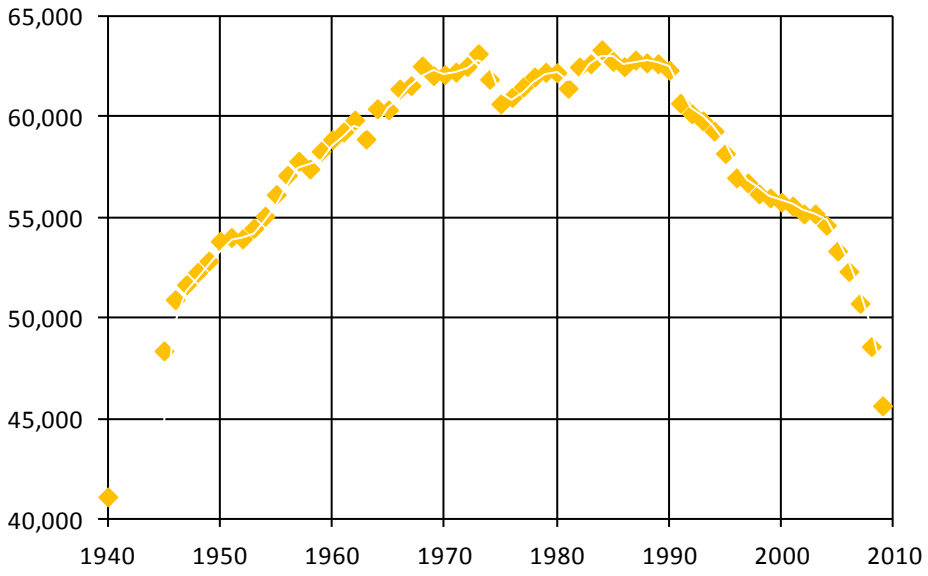

Figure 13: Circulation of Daily Newspapers in the US (Roos, 2011)

- The importance of and interaction between other knowledge domains and the science and technology domain when it comes to underpinning new innovations. These other knowledge domains are eg. design, art, hermeneutics, business models etc.
- The complex interactions between geographically anchored co-specialised resources, making it difficult if not impossible to reallocate freed up resources within the economy from a manufacturing base whilst achieving productivity and value creating levels that approach the original ones. This can be exemplified by the unwillingness of workers

being made redundant to move and by the problem of selling a used piece of specialised and customised equipment freed up through bankruptcy.

- The increasing integration between manufacturing and service and between R&D and production, forcing the development of mixed firms and of co-located production and R&D activities.
- The criticality of generic technology platforms that depend on commonly used infra-technologies (often in the form of industry standards); both of these elements are quasi-public goods and therefore require government support.

This all points to the systemic nature of manufacturing and the lack of value allocated to abandoned or freed-up resources as a consequence of Schumpeterian change, making any neoclassical economic approach to these issues questionable, if not futile.

Building competitive advantage

At the firm level, competitive advantage is grounded in a portfolio of resources, from the five fundamental resource categories of financial, physical, relational, organisational and human/competence, that fulfil the characteristics of being durable, strategically valuable, scarce, difficult (or imposing a cost disadvantage) to imitate and difficult (or imposing a cost disadvantage) to substitute (Roos et al. 2005/2006). On the regional or national level this still holds true but also includes inter-related portfolios of economic agents in the national or regional innovation system, like e.g. firms in the form of clusters. One of the critical issues facing countries with a comparative advantage in the production of potential inputs to value adding activities, is the need to build clusters with competitive advantage related to these inputs. Here it is worth examining Scandinavian and Canadian examples around mining and forestry. Some examples are illustrated in the figure below:

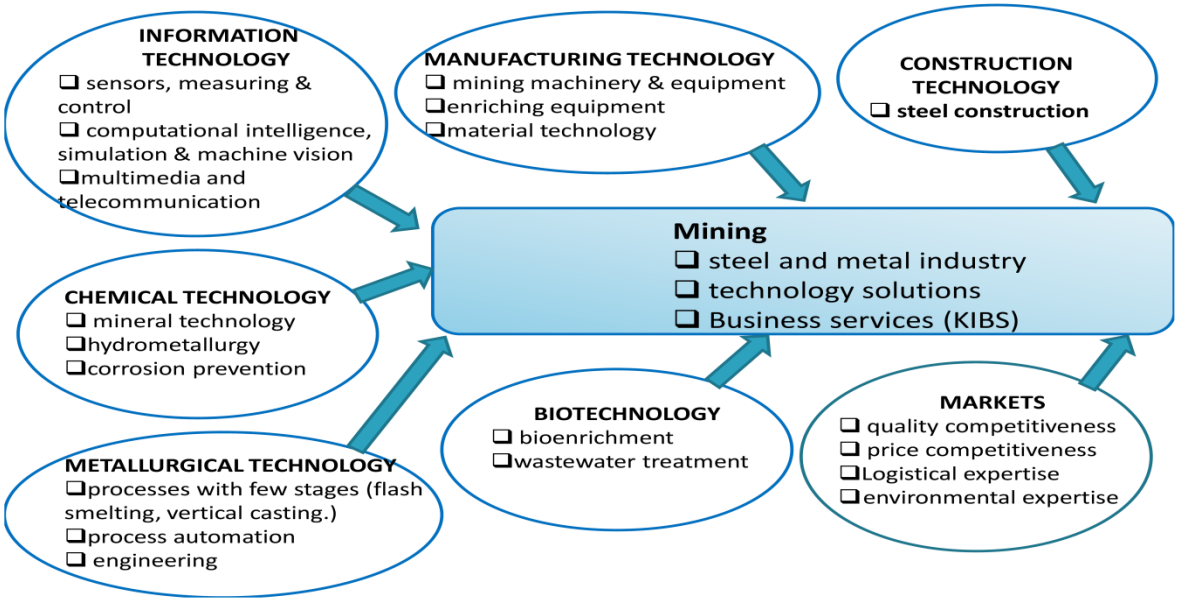

Figure 14: Scandinavian cluster example from Mining (Scott-Kemmis, 2011)

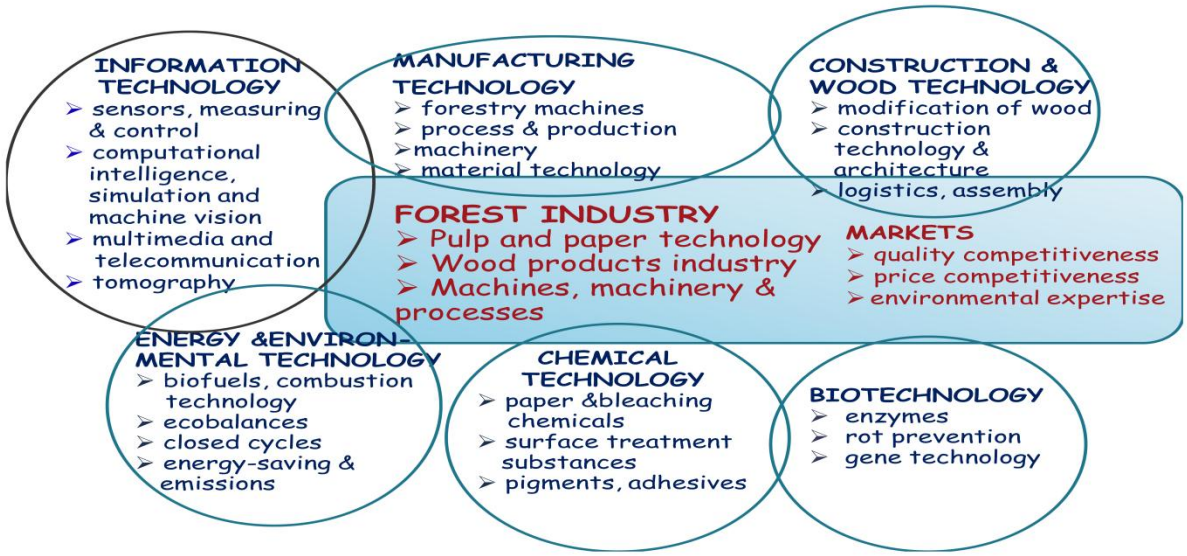

Figure 15: Scandinavian cluster example from Forestry (Scott-Kemmis, 2011)

The economic effects of the Finnish Forestry Cluster can be seen from the following three Figures:

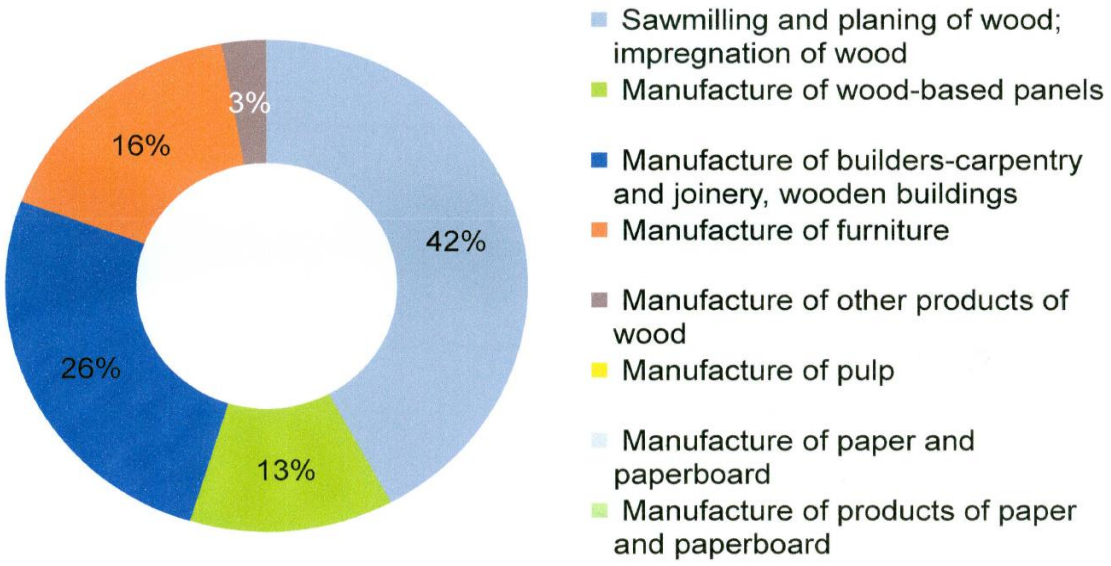

Figure 16: The total forest industry production value by industry sectors (Total production value in 2010 was EUR 20.4 billion) (SOURCE: Statistics Finland /Industrial statistics on manufacturing. 2010 preliminary data updated 26.9.2011)

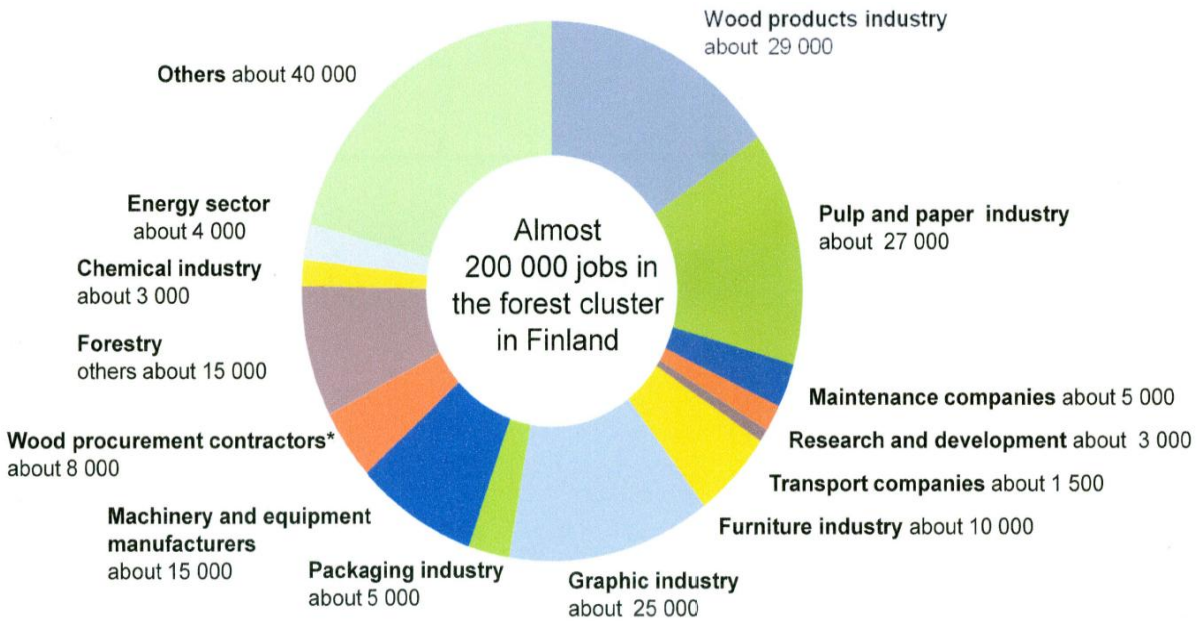

Figure 17: Employment in the Finnish forest cluster (SOURCE: Finnish Forest Industries Federation. * roundwood harvesting and transportation)

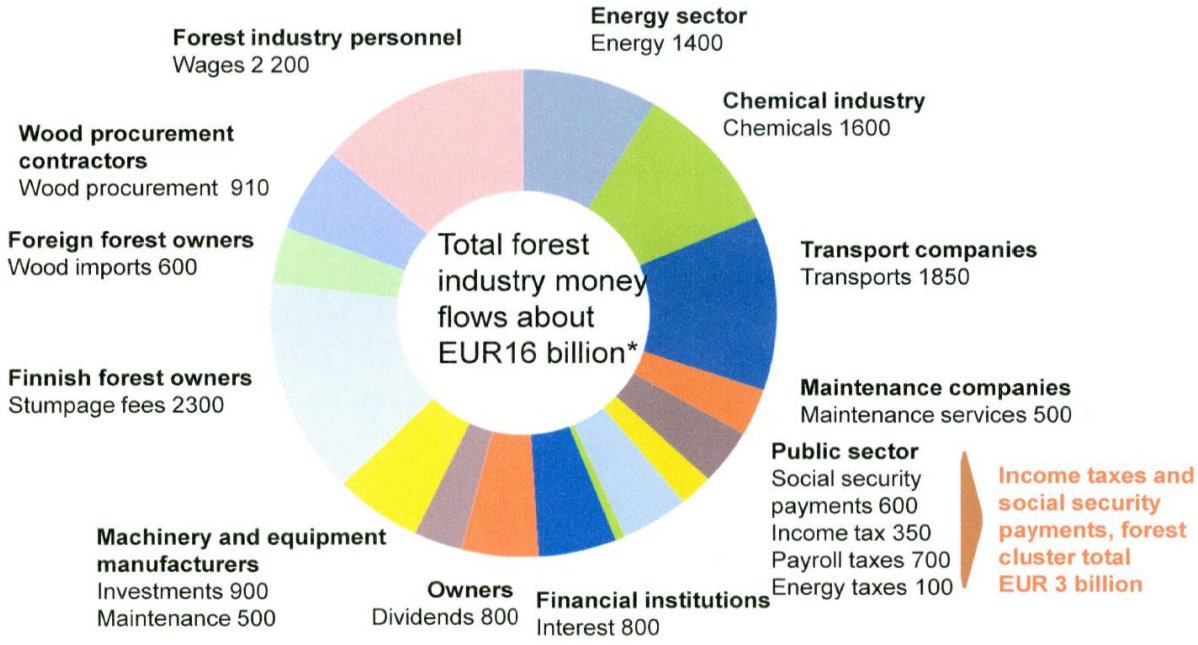

Figure 18: Key money flows of the Finnish forest industry (EUR millions) (SOURCE: Finnish Forest Industries Federation, (*) Excl. intra-sector sales)

But these outcomes do not happen instantaneously and the timeline for the Finnish Forestry Cluster development is shown in the figure below:

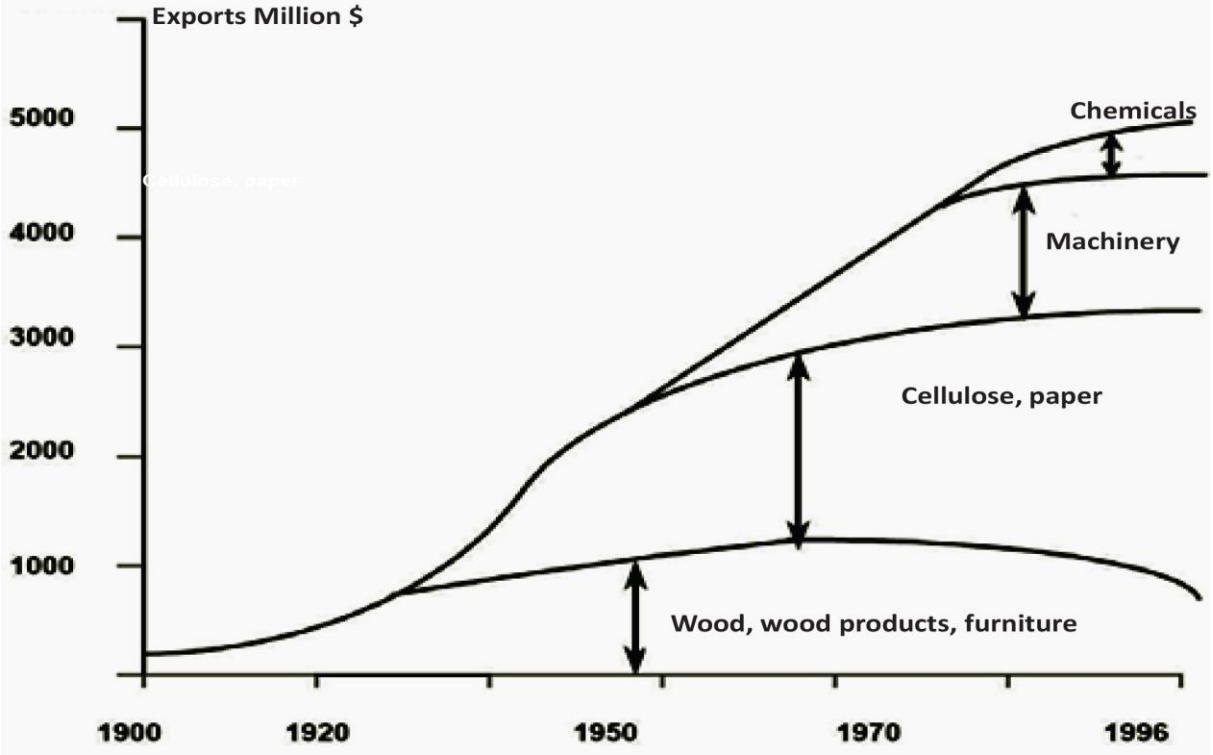

Figure 19: Development of the Forest Industry and Linkages in Finland (Fuchslocher, 2007)

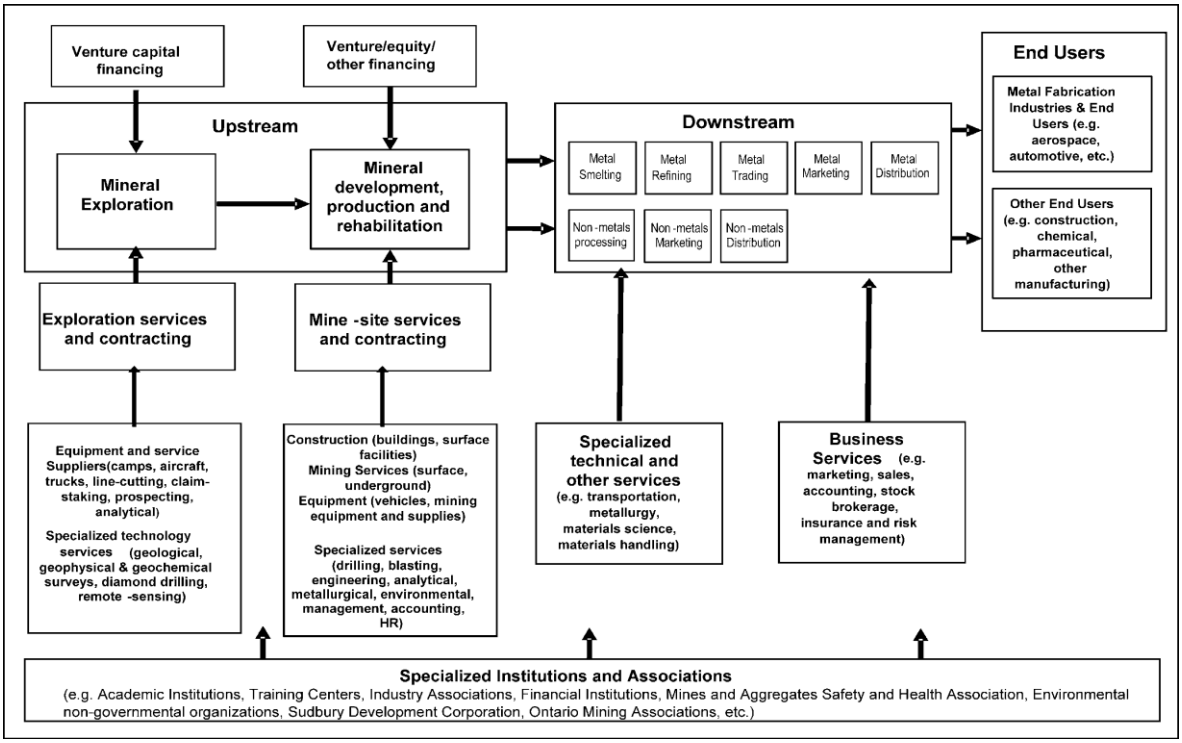

Figure 20: Schematic view of the mineral industry cluster in Ontario. The diagram design is adapted from Porter (1998), with content from the Ontario Ministry of Northern Development and Mines

Managing innovation in the new environment

Effectively managing innovation and operations in this increasingly complex product-service systems environment will require increased capabilities in many areas. The EU (2010) in the "Factories for the Future" roadmap outlines key drivers for the competitive evolution of R&D in the new manufacturing environment:

- Cost efficiency, with extensive adoption of standards in production machinery, equipment and controls and massive use of the lean approach
- Optimised consumption of resources through the use of energy and material efficient processes and machinery, renewable power sources, and smart energy management with extensive recovery of heat and dissipated energy
- Short time-to-market (from the concept to new products on the market), enabled by ICT applications
- Increased focus on high added value components/goods through the use of enabling processing technologies and enhanced materials
- Adaptability/ re-configurability through a modular approach in production systems, in order to maximise autonomy and interaction capability of machinery and continuous re-use of existing infrastructures
- Higher and more stable product quality through increased process robustness and accuracy, while ensuring easy process maintainability
- Higher productivity under enhanced safety and ergonomics conditions, through an upstream integration in factory design of workplace optimisation for human well being
- Increased reusability of production systems towards global interoperable factories, which can provide services and develop products anytime and anywhere, independently of the technologies, culture or language in use in the different production sites
- New products, requiring new manufacturing technologies adapted to new features.

As a consequence, manufacturing research and policy should focus on the transformation of present factories towards re-usable, flexible, modular, intelligent, digital, virtual, affordable, easy-to-adapt, easy-to-operate, easy-to-maintain and highly reliable "Factories of the Future". Although the EU focus is valid, it is still a limited outlook which does not take into account the complexity of innovation required in the emerging manufacturing environment. Two types of innovations are executed in a firm, with differing objectives and outcomes (Roos 2011):

- First, innovations which increase the value created by the firm:
    - Technology based (eg. moving from chemically to biotechnology based production in pharmaceutical firms)
    - Design based (eg. the role of design in creating loyalty and profits in Apple)
    - Efficiency improving (eg. reducing costs through the application of lean manufacturing)
    - Art Based (eg. art as a contributor to perceived value in luxury products)
    - Hermeneutic based (eg. the creation of a predictable emotional state in films by using music)

  (the latter two will not be discussed further in this paper, but see Roos, 2012)

- Second, innovations which maximise the share of this created value that can be appropriated by the firm:
  - Business model innovations
  - Effectiveness improving innovations

These together with the enablers of innovation and the innovation strategy and innovation management system are illustrated in the diagram below:

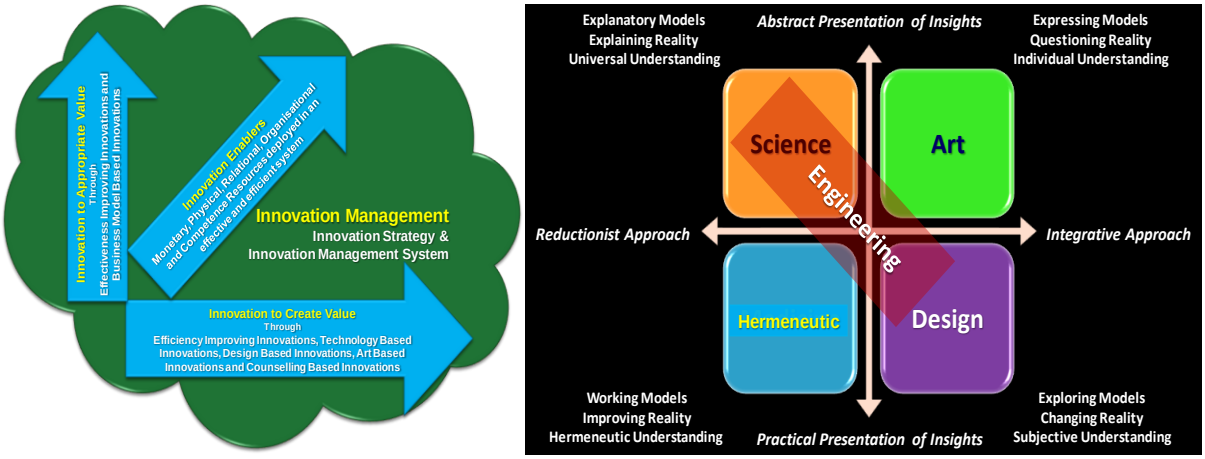

Figure 21: Left hand side shows what makes up an integrated approach to innovation. Right hand side shows differences between four key knowledge domains underpinning value creating innovation activities (Roos, 2011)

Public statistics tend to capture the technology based and the efficiency improving innovations but tend to miss the rest. Yet these other (design based, business model and effectiveness improving) innovations usually absorb substantially higher investments in firms. Hence recent public statistics provide a distorted picture of the knowledge development and innovation intensity in firms. An example is to look at the design vs. R&D investment in the UK as shown is the figures below.

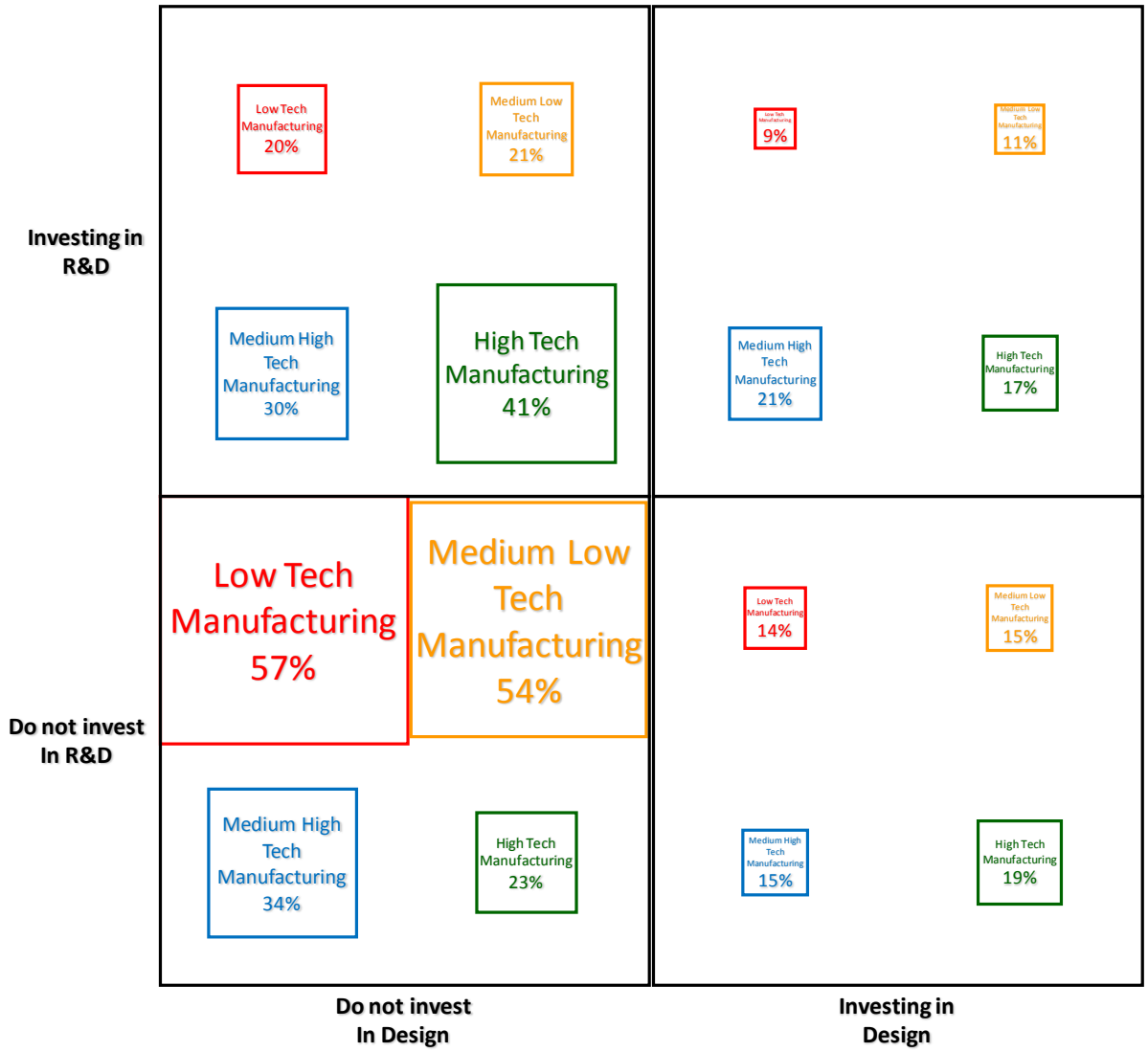

Figure 22: Share of UK manufacturing sectors investing in R&D, Design, both or neither (Extracted from data in Tether, 2003)

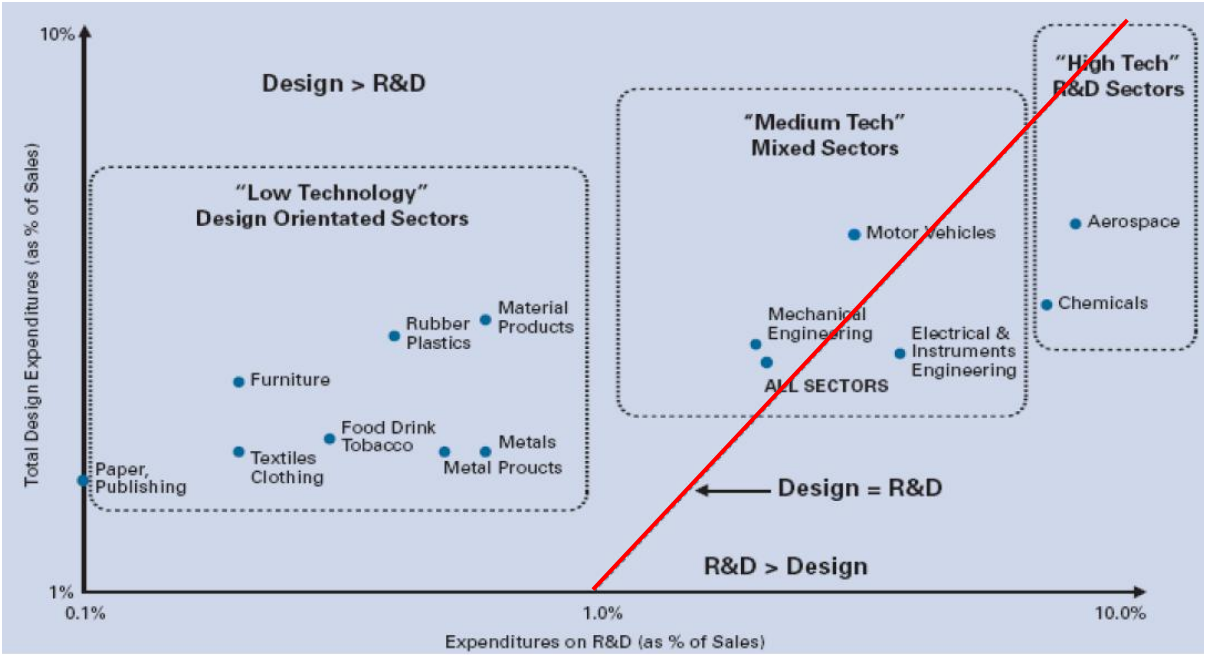

Figure 23: Relative importance of Design and R&D in different UK manufacturing Sectors (Tether, 2003)

Firm innovation is basically a business process like any other business process and must be managed as such. Innovation builds on many factors, including creativity and research. Innovation is a group process due to the complexity of modern product-service systems offerings whereas creativity is an individual process and hence the link between creativity and firm innovation is a weak one – creativity can be over-emphasised in studies of individuals and entrepreneurs as opposed to growing systems and process oriented firms. Nor does research always lead to innovation, and hence investment in research does not automatically generate innovation. This is especially true if the investment in research is in one sector (e.g. universities), whereas innovation is expected to take place in the business sector (see Roos et al. 2011). The management of innovation is critical and is generally a weak area in Australian SMEs (Roos 2012).

Technology based innovation

The accelerating speed of scientific and technological development requires an even more vigilant and pro-active approach to technology based innovation. This is an area where many firms feel comfortable since they have been dealing with technology for a long time. Unfortunately, this sense of security is frequently misplaced, since it is the overlap of existing technologies and the emergence of new technologies which will form the basis for breakthrough innovations in value creation and generate creative destruction of existing firms not driving or reacting to the change. Examples of critical new technologies for manufacturing that are outside the classical manufacturing domains would be, for example, social media, nano-enabled engineering, additive manufacturing, printed intelligence, industrial biotechnology, synthetic biology, machine-augmented cognition, cognitive science, new energy storage technologies, meta-materials, man-machine interface, virtual reality, etc. They will all have transformative impact on manufacturing and this will here be exemplified by additive manufacturing [commonly known as 3D-printing] but it could have been any of the other emerging technologies:

> *3D printing — transformative technology:* 3D printing will usher in a revolution in fabrication (Rhoades 2005). 3D Printing will be for the manufacturing industry what laser and ink jet printing was for the printing industry. 3D Printing will:
>
> - Changes the dominant economic logic of making things from economies of scale to economies of scope enabling mass-personalisation.
> - Lowers the cost of entry into manufacturing by reducing the amount of conventional industrial infrastructure – machine tools, testing equipment and related factory hardware – that companies require to be considered serious industrial players
> - Requires re-thinking existing design methodologies and rapid prototyping approaches and is a perfect complement to a Living Lab
> - Facilitates for both imitators and innovators to get goods to market fast. Competitive advantages may thus be shorter-lived than ever before and although the competitive advantages of large and well organised global manufacturers will remain, the artisan production worker will return to prominence.

Technology based innovation has wide ranging impacts. It offers necessary opportunities for new value creation but also provides the foundation on which additional value

appropriation can be built. The technology that enabled the provision of SMS services also enabled revenue sharing models — the former a technology based innovation application and the latter a business model innovation application.

Australian manufacturing firms are on the whole good at technology-based innovation (albeit at the tactical end in the form of reactive problem-solving rather than on the strategic end), but their awareness of technologies outside their core activity domain is generally weak. This is to be expected since most firms are small and hence do not have the man-hours available nor the wide range of competence necessary to keep track of all relevant developments that may impact them from outside their core domains.

A recent study of Nordic companies found that 89 per cent developed products by combining different technologies or technical solutions, which traditionally were not used in their industry (Larsen et al. 2009). In addition, new to international and domestic market innovations add up to around 26 per cent for Sweden and 30 per cent for Finland, compared with only 12 per cent of Australian firms in 2008-09 (2.4 per cent with one or more product innovations that were new to international markets and 9.6 per cent with one or more product innovations that were new to their domestic market). Australian firms are much more likely to modify or adopt products or processes that already exist in domestic markets, which "might contribute to specialization but will not necessarily create or confer any "first mover" competitive advantage" (Department of Innovation, Industry, Science and Research 2011: 26).

The ability to achieve results of this nature requires a broad ability among SMEs to manage innovation within the framework of both emerging "substitutional" technologies, eg. replacing plastics with transparent fibre based products in packaging as illustrated in the figure below, and converging technologies.

Figure 24: Biobased packaging demonstrators contain several novel techniques and materials developed at VTT: Biobased stand-alone films; Biobased barriers on board and bioadhesives; Translucent paper board scale (courtesy of VTT 2010)

Figure 25: VTT Technical Research Centre and Aalto University have developed a method which for the first time enables manufacturing of a wood-based and plastic-like material in large scale (courtesy of VTT 2012)

Design based innovation

Design is frequently misunderstood. Design basically has two roles to play in an innovation sense:

- In its easiest definition design based innovation is a system-level optimisation with the intent of changing the behaviour (and hence preferences) of the user in such a way that the user, the supplier and the key participants in the industry ecosystem all are better off after the behaviour has changed. Whereas technology based innovation tends to take a "component improvement leads to system improvement" view design tends to take a "system optimisation leads to user behaviour change" view.
- In its other role it is about ensuring the lowest cost in terms of material and manufacturability for a given object.

The Apple experience: The power of design is illustrated by the fierce user loyalty inspired by the way Apple's iPhone works. Users have changed their behaviour (how they interact with the device) and they are very happy with their new behaviour (benefiting to the user). This satisfying new behaviour leads to the purchase of applications (benefiting both application developers and Apple) and the use of more data (benefiting both the operators and Apple) and to them becoming loyal to the product (benefiting Apple and its supply base).

But design is not only about products it is also about services, solutions and business models. In all of these there is a need for design based innovations. Australian manufacturing firms are on the whole weak at design based innovation as compared to the

high level of design competence existing in leading manufacturing countries like Sweden, Germany and Switzerland and investment in design is low as compared with strong manufacturing counties like South Korea, China, Taiwan and Singapore. This can be illustrated by using the Design Innovation Ladder which is a four step strategic tool for understanding the extent to which businesses integrate design into their innovation processes. It uses four steps:

- Step 1 – Non-Design. For these companies, design plays a small or negligible role in product development.
- Step 2 – Design as Styling. The use of design in these businesses is primarily orientated towards the form and aesthetics of products.
- Step 3 – Design as Process enables more streamlined, efficient methods of getting a product or service to its target market.
- Step 4 – Design as Innovation. Companies on the top step of the ladder have a strategic concept of design use. Design is at the core of their business culture.

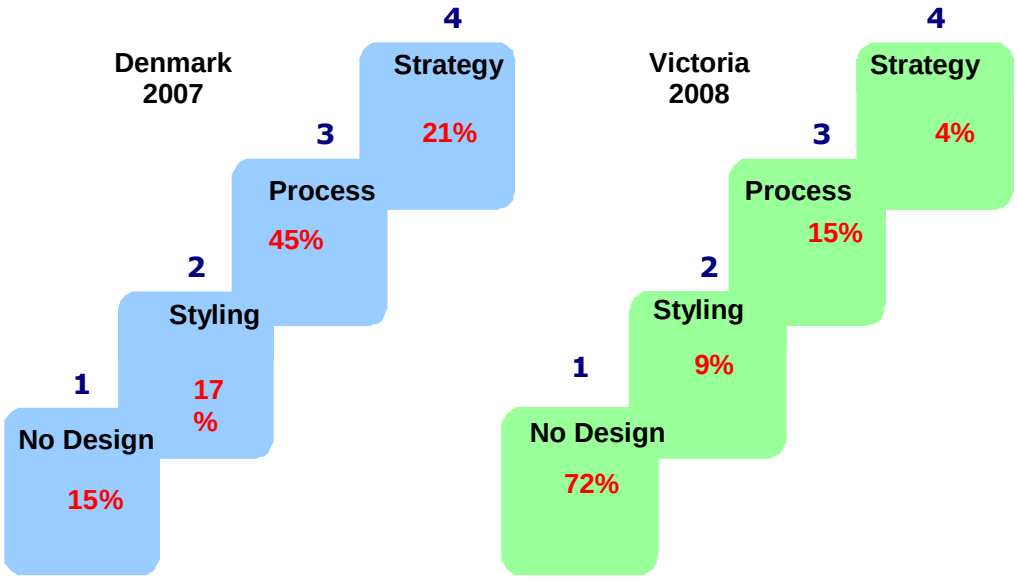

Figure 26: Comparison between Design Maturity in Danish and Victorian Firms (ICS, 2010)

This is also supported by the Design Competitiveness Ranking as shown in the table below:

Country	Design Competitiveness Ranking
Switzerland	1
Japan	2
Germany	3
Sweden	4
United States	5
Denmark	6
Finland	7
Netherlands	8
France	9
Singapore	11
Taiwan, China	13
United Kingdom	14
Korea, Rep	15
Canada	23
Australia	28

Table 5: Design competitiveness ranking 2010 (extracted from Immonen et al., 2010)

Other lenses and approaches to create value include Art and Hermeneutics which so far show less relevance to manufacturing outside the luxury goods sector and are not discussed here.

Efficiency improving innovation

Innovation based around efficiency improvements is well-known to most firms. It offers new ways of taking transaction costs out of the business. A transaction cost is a cost incurred in making an economic exchange and some of these different transaction costs have been given specific names (Dahlman 1979):

- Search and information costs, such as those incurred in determining that the required good is available on the market, or which has the lowest price, for example
- Bargaining costs, incurred in coming to an agreement with the other party to the transaction, contracting and so on
- Policing and enforcement costs of making sure the other party sticks to the terms of the contract. These may include legal costs.

The search for new ways of reducing transaction cost is an on-going battle for firms and is supported by technology based innovations, such as electronic invoicing systems and design, such as simple, one-stop electronic tendering systems for small government contracts. The impact of transaction cost based innovations on business models is either to simplify existing business models or to widen existing business models, which is a function of the maturity of the firm's operating environment. In addition, the make or buy decision creates new business opportunities when firms decide to outsource business functions and hence generate opportunities for new business models (Pynnönen et al. 2005).

Business model innovation

IBM's 2006 study of 765 global CEOs (IBM 2006a) found that the most financially successful put twice as much emphasis on business model innovation as did the underperformers. Business model innovation can have a more profound effect on profitability than any other type of innovation (IBM 2006b; Helin and Lehtonen, cited in Bonnici 2008). The outstanding success of new business models brought to market by Apple, Ryan Air, Ericsson and others bring this message home.

Outstanding recent business models:

Apple	iPhone	*Rapidly generated largest share of the profit pool*
Ryan Air	low cost airline	*rapid rise to most profitable airline in Europe in very short time*
Cirque du Soleil	high-brow circus	*Rapid rise to most profitable circus*
Ericsson	telecoms solutions provider	*Rapid rise to most profitable telecom equipment supplier from near bankruptcy 10 years ago*

Table 6: Examples of new and successful business models (Roos, 2011)

Modifying just one dimension and leaving the others unchanged can create a powerful business model innovation as this table exemplifies:

Dimension of change	Business model innovation
Value Proposition	Selling the iPod as a data storage device instead of as a music player
Key Stakeholder	Identifying the airports as the key customer for the airline rather than the flying passengers
Distribution Channel	Distributing Software via the internet instead of via the post on CD's
Relationship	Moving from a contractual relationship with a supplier to crowd-sourcing of the same service.
Value Configuration	Moving from craft based provision of an offering (value shop) to standardised mass-production of the same offering (value chain)
Resources	Moving from the physical product as the core of the offering to the brand as the core of the offering
Resource deployment structure	Outsourcing final assembly to the customer (self-service or flat-pack)
Partnerships	Chocolate producers partnering with Branded Spirit producers
Cost Structure	Moving from normal stock to consignment stock

Table 7: Examples of one-dimensional business model innovation (Roos, 2010)

In a recent study of the literature and of the way business models where addressed in 10 South Australian manufacturing firms (Roos, 2012) the business model concept was found to be a composite of the following dimensions:

1.	Positioning of THIS business within the company's strategy
2.	Description of the Product-Service-System/Solutions offering
3.	Identification of target customer segments, target consumer segments and other definitive stakeholders
4.	Value Proposition for each of the target customer segments, target consumer segments and other definitive stakeholders

5. Description how the target customer segments, target consumer segments and other definitive stakeholders capture value from the offering
6. What competitive advantage does the offering enable or contribute to within the target customer segments, target consumer segments and other definitive stakeholders
7. Value attribute, attribute preference and attribute performance for each of the target customer segments, target consumer segments and other definitive stakeholders
8. What requirements must be fulfilled by the target customer segments, target consumer segments and other definitive stakeholders in order to be able to benefit from the offering
9. Description of how the Product-Service-System/Solutions offering should be implemented at the target customer segments, target consumer segments and other definitive stakeholders to ensure the targeted benefits (value)
10. Place, role and strategy of THIS business in the business ecosystem of which it is part
11. Technology base of the Product-Service-System/Solutions offering
12. Design base of the Product-Service-System/Solutions offering
13. Art base of the Product-Service-System/Solutions offering
14. Counselling (Hermeneutic) base of the Product-Service-System/Solutions offering
15. Outgoing Logistics and Distribution Channel choice for each of the target customer segments, target consumer segments and other definitive stakeholders
16. Incoming Logistics and Supply Chain Choice
17. Relationship width, depth and frequency for each of the target customer segments and other definitive stakeholders
18. Value Configuration (Value Chain, Value Shop, Value Network) and associated transaction and coordination cost issues
19. Resources, Competitive Advantage and Resource Deployment Structure (IC Navigator)
20. Cost structure due to strategic choices and identification and management objectives for associated economic value added drivers as well as bankruptcy predicting indicators
21. Revenue Models with focus on accessing multiple profit pools and maximising the number of revenue streams/pricing logic combinations aimed at achieving an economic value added for the business exceeding the revenue stream from its primary offering

Table 8: The derived business model dimensions for manufacturing firms (Roos, 2012)

Effectiveness improving innovation

Innovation can improve effectiveness in one of the following ways: it can improve the match between the organisation's product or service and explicit or tacit stakeholder demand. For example, a firm increases sustainability by moving to bio-degradable packaging material from renewable sources. For a detailed example see e.g. the empirical study by Pike et al., 2006. And it can increase resource effectiveness. For example, a firm changes from a physical resource to a relational resource through outsourcing, or finds a way to lock-in key stakeholders (Kenney et al. 2011).

Innovation can also reduce coordination costs which are due to imperfect information and the opportunistic behaviour of organisational actors (Milgrom et al. 1992), factors contributing to uncertainty in the organisation. Brynjolfsson et al. (1994) differentiates

between internal costs of management, control system, rule and the like and external costs, such as costs of presentation (Williamson 1986). Coordination cost changes either increase the precision of existing business models or widen the coverage of existing business models.

Widening coverage is a key strategy for achieving high value appropriation. With very small actions the firm is able to participate in new value chains, thus accessing additional profit pools. In extreme cases the firm can generate a higher profit contribution from each item sold than the sales price of this item.

Policy implications

The implications of the different forms of innovation give rise to new ways of thinking about industry policy. Roos (2012) has developed the following framework at the meso-level:

Transformation is aimed at mature or declining groups that are very large in terms of employees, turn-over, geographical dispersion, systemic impact or tax contribution. The target groups are identified based on the historic development of world demand for offerings comparable to those produced by the local industry compared to the historic development of demand for the offerings produced by the local industry as well as the historic development of the profitability in the local industry, as outlined in the figure below (in essence this is about declining firms serving declining markets). The key objective of this policy is to retain the bulk of the firms in this industry by assisting them to transform their activities so that they can join value chains with a more positive outlook.

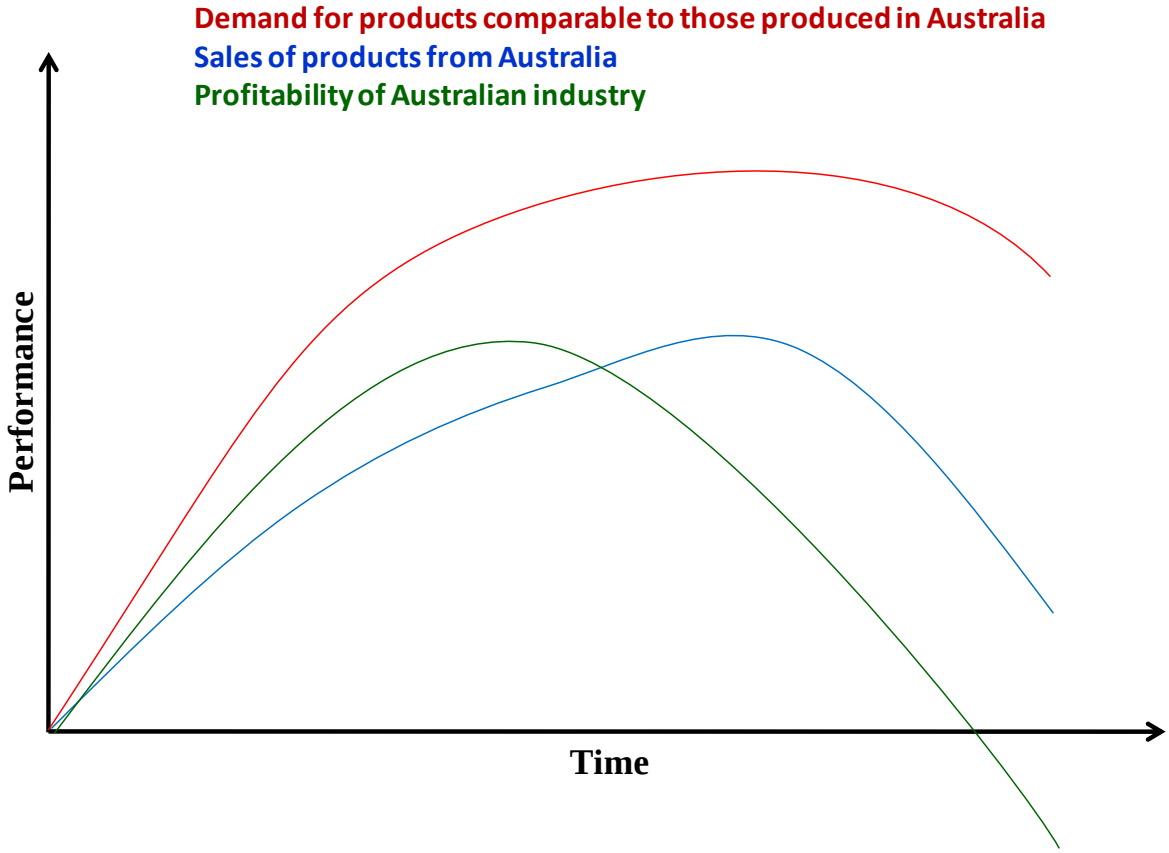

Figure 27: Boundary condition for the Transformation approach

Rejuvenation is aimed at mature or declining groups that are very large in terms of employees, turn-over, geographical dispersion, systemic impact or tax contribution. The target groups are identified based on the historic development of world demand for offerings comparable to those produced by the local industry compared to the historic development of demand for the offerings produced by the local industry as well as the historic development of the profitability in the local industry, as outlined in the diagram below (in essence this is about declining firms serving growing markets). The key objective of this policy is to increase the competitiveness of the bulk of the firms in this industry so that they can take market and profit pool share in the existing value chain.

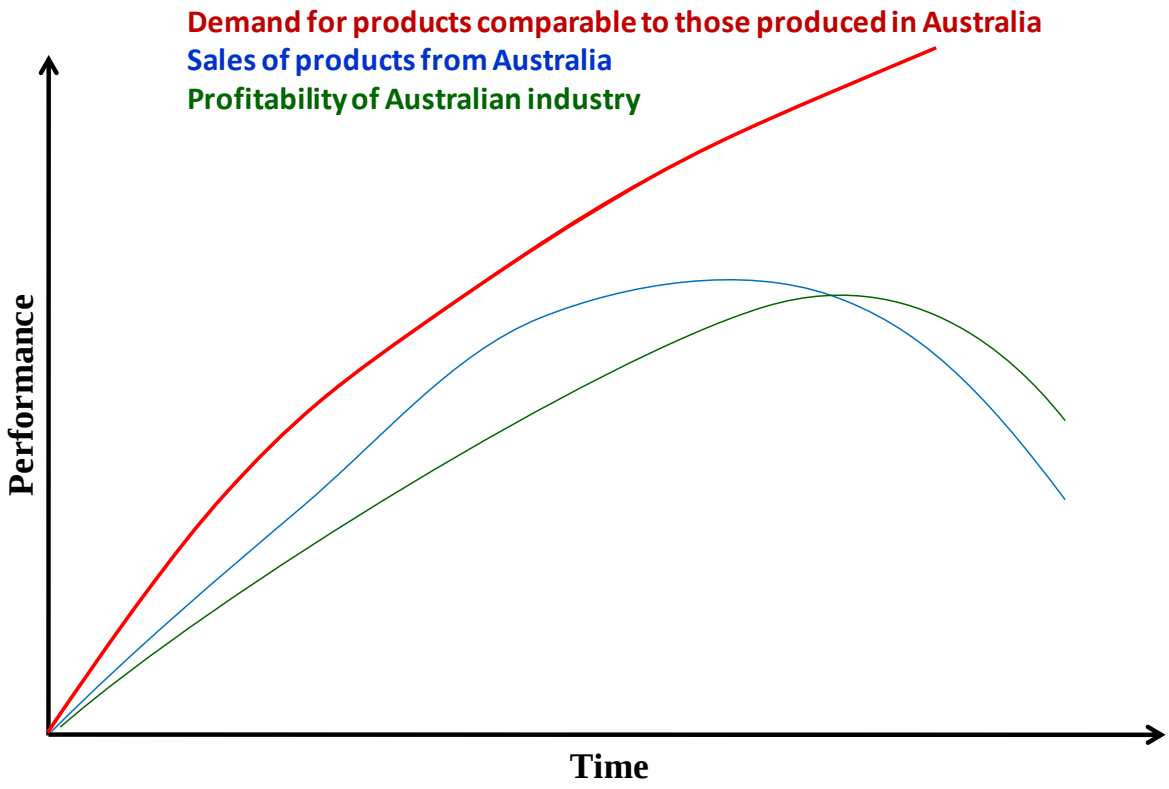

Figure 28: Boundary conditions for the rejuvenation approach

Grow is aimed at existing industry grounded in both comparative and competitive advantages with positive outlooks for its share of global business (i.e. the 15 per cent of SMEs that both have the capability and desire to grow) (in essence this is about small static or growing firms that are serving growing markets). The key objective of this policy is to grow the size, reach, competitiveness, profitability and profit pool share in the existing value chains of the bulk of the firms in this industry.

Build is aimed at industry grounded in future comparative and competitive advantages with positive outlooks for its share of global business. The key objective of this policy is to encourage the establishment of firms in these value chains through entrepreneurial start-ups, spin-offs, diversification or attraction of foreign firms.

Create is aimed at encouraging entrepreneurial activities leading to start-ups, grounded in an existing knowledge base and with existing lead customers grounded in future comparative and competitive advantages with positive outlooks for its share of global business.

5. Workplace of the future

The success of future manufacturing will depend not just on the development of new technologies and skills but also their diffusion through the innovation system and their effective "absorption" by firms and organisations. This will require an alignment of innovation strategy and organisational culture in the "workplace of the future". There are now abundant studies around the world which demonstrate the interdependence of high calibre management, an engaged workforce and firm level productivity, and yet these factors are generally undervalued by both corporate and public policy.

Most recently, Booz & Co's *Global Innovation 1000* study of the world's biggest R&D spenders found there was a more statistically robust relationship between firm performance and the strategic alignment of culture and corporate goals than with R&D spending, however measured. The study noted that the elements that make up a truly innovative company include "a focused innovation strategy, a winning overall business strategy, deep customer insight, great talent, and the right set of capabilities to achieve successful execution". However, the study went on to point out that, "more important than any of the individual elements… is the role played by corporate culture the organization's self-sustaining pattern of behaving, feeling, thinking, and believing – in tying them all together". The key problem is that in only about half of all companies surveyed does corporate culture support their innovation strategy, and about the same proportion report that their innovation strategy is "inadequately aligned" with overall corporate strategy.

The data from the Booz & Co study clearly show that "companies with unsupportive cultures and poor strategic alignment significantly underperform their competitors". It concludes that, "if more companies could gain traction in closing both the strategic alignment and culture gaps to better realize these goals and attributes, not only would their financial performance improve, but the data suggests that the potential gains might be large enough to improve the overall growth rate of the global economy".

Other international studies have made similar claims, with a steadily accumulating evidence base. In the US, a major longitudinal research project found that a third of US output growth stemmed from productivity enhancing innovations at the workplace level (Black and Lynch, 2001, 2004). In addition, the *WorkUSA Survey* has repeatedly shown that when employees are highly engaged, their companies achieved superior performance, including in a recent survey 26 per cent higher labour productivity, lower turnover and 13 per cent higher returns to shareholders over last 5 years (Watson Wyatt, 2009).

In the UK, a comprehensive Work Foundation study *Cracking the Performance Code* found that the best managed, most innovative 30 per cent of companies achieved higher growth, more sales per employee, higher profitability and more exports, and that increasing the "performance index" of just 10 per cent of companies in the bottom third of the sample to the average of the top third would add GBP 2.5 billion to UK GDP and 0.25 per cent to trend growth (Work Foundation, 2003, 2005).

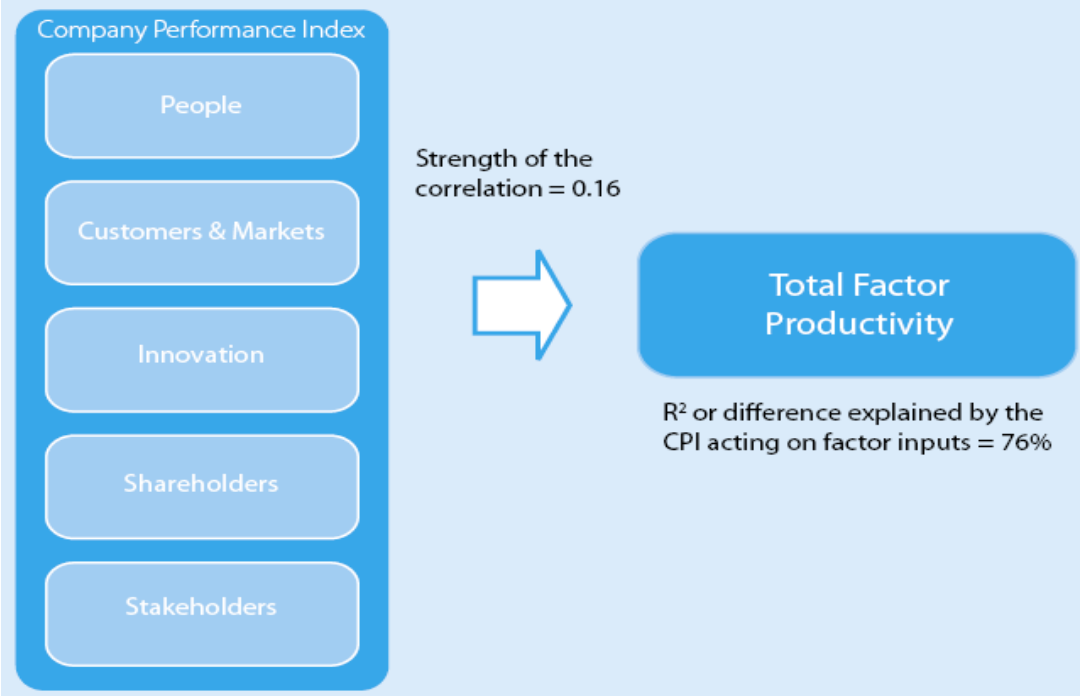

Figure 29: Performance & Productivity. Source: The Work Foundation, 2005

Management matters

The most significant recent international comparative study on management practice and productivity *Management Matters* was devised and undertaken by the London School of Economics in association with McKinsey & Co. Initially, the study encompassed around 6000 observations of manufacturing firms in 15 countries, but it was then extended to Australia as the result of a DIISR initiative. The research was conducted by a consortium of Australian universities and published as *Management Matters in Australia – Just how productive are we?* (Green, Agarwal et al 2009)

Using the methodology and scoring grid of 18 management characteristics in three categories of operations management, performance management and people management, the study found that managers in Australian manufacturing firms were in a "global second tier" of management quality, particularly in the area of "instilling a talent mindset" where they lagged furthest behind global best practice. This may be seen as a proxy for innovation capability. There was considerable variation in the survey sample according to the size and types of companies, with larger companies comparing favourably with their international counterparts and smaller companies forming a "long tail" of relatively mediocre management.

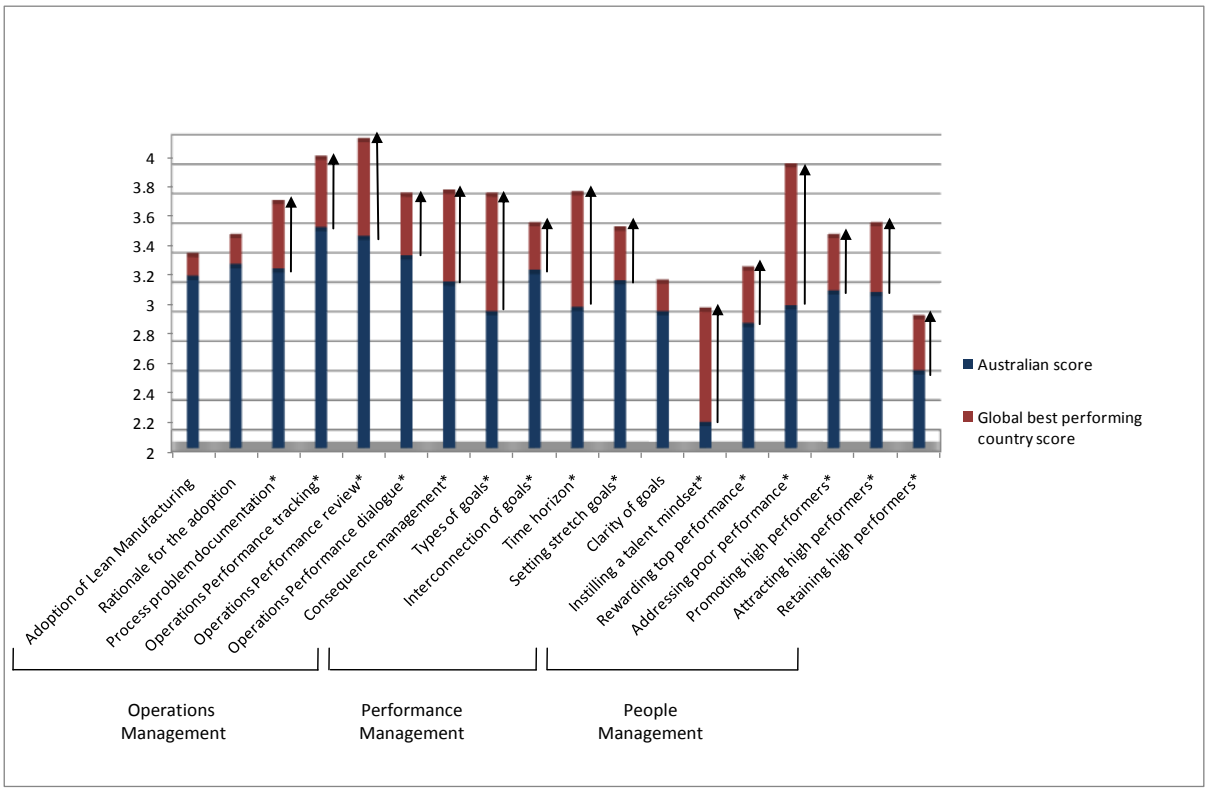

Figure 30: Source: Green, Agarwal et al, 2009

A particularly disturbing finding was the link between poor management calibre and low educational attainment, with the share of Australian managers with a tertiary qualification being among the lowest of all the countries studied. In countries with better performing managers, including the US, Sweden, Japan, Germany and Canada, the share with tertiary qualifications significantly exceeded that in Australia. The study did not examine the relevance of curriculum content, which will be the subject of a further initiative, the "Future of Management Education" project, currently being undertaken by the Australian Business Deans Council, in consultation with business leaders, and supported by DIISRTE.

The importance of high calibre management is demonstrated by the link in all countries, including Australia, with productivity performance at the firm level. The Australian study confirmed the LSE finding that "improving management practice is... associated with large increases in productivity and output", and it endorsed the policy conclusion that "Governments can play their part in encouraging the take-up of good management behaviour. Doing so may be the *single most cost-effective way of improving the performance of their economies…* Relentless improvement in educational standards is also essential. Better-managed firms need more highly skilled workers and they make better use of them, while better educated managers will be a key component of the performance transformation..." (Bloom, van Reenen, 2007)

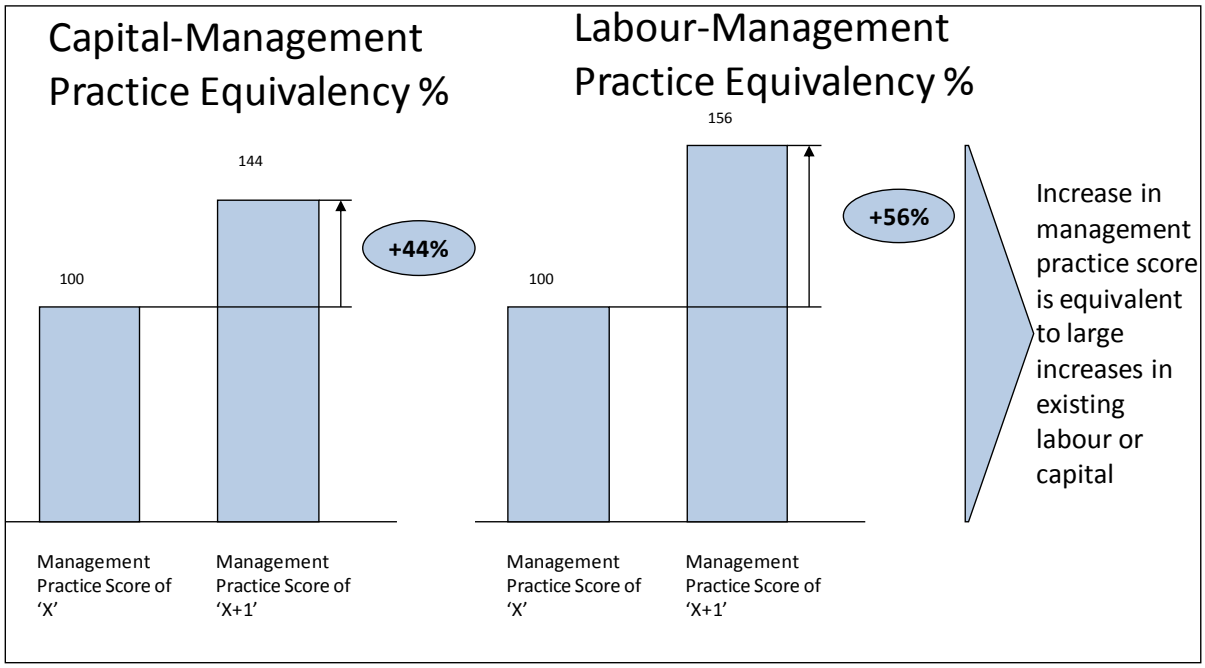

Figure 31: Source: Green, Agarwal et al, 2009

The 2008 Review of Australia's National Innovation System, *Venturous Australia*, noted that many innovation programs are "directed at technological or scientific innovation while only a few are directed at strengthening innovation management inside organisations, including leadership and culture… The challenge is how best to promote successful adoption and diffusion of high performance work systems in both the public and private sectors". The *Management Matters* report made it clear that the challenge has not gone away and that "addressing it is the key to linking short-term recovery to longer-term competitive advantage through better management of Australian firms and organisations".

At the same time, in 2009, the Australian Government's 10-year innovation strategy white paper *Powering Ideas – An Innovation Agenda for the 21st Century*, was the first public policy statement to recognise that, "Making innovation work requires a workforce with sophisticated skills of all kinds – including leadership and management skills. It also requires cooperative workplaces in which creativity is encouraged. Few organisations command all the skills needed to innovate successfully on their own. They must network and collaborate – locally and globally" (Australian Government, 2009). The discussion is no longer whether this should happen, but how.

There have been many contributors to this discussion since the Karpin report on leadership and management skills *Enterprising Nation* (1995), but perhaps none so focused, consultative and informed by research as the Society for Knowledge Economics. In a joint 2006 report with the Business Council of Australia *New Pathways to Prosperity: A National Innovation Framework for Australia*, the SKE was a pioneer in the Australian context in highlighting the role of organisational innovation and its "capacity to transform organisations through adaptation and absorption of new technologies, introduction of new operational processes and implementation of new workplace structures and practices" (SKE/BCA 2006).

The report argued that "as workplaces become more flexible and responsive in a changing competitive environment, the emphasis of economic reform will need to evolve to a new

stage – the leadership and management of Australian organisations, and the educational infrastructure and programs required to support the development of innovative capabilities within organisations". It proposed practical support for "improving the overall quality of leadership and management skills, particularly with regard to innovation strategy and processes within businesses", and for workforce-management partnerships "to drive innovation and productivity at the workplace by drawing more effectively on the talent and creativity of employees".

In 2011, the SKE extended this analysis with a report on *Leadership, Culture and Management Practices of High Performing Workplaces in Australia*, supported by DEEWR. This two-year study, involving 78 companies and more than 5600 employees in the services sector, found that high-performing workplaces "prioritise people management as a key priority, involve their people in decision making processes; are more responsive to customer and stakeholder needs; encourage a high degree of responsiveness to change and learning orientation, and enable their staff to fully use their skills and abilities at work" (Boedker et al 2011). As a result, they were up to 12 per cent more productive and three times more profitable than their peers, and performed better in many "intangible attributes" such as encouraging innovation, leadership and a fair workplace environment.

The significance of the SKE report does not just lie in its analysis. The foreword cites the Productivity Commission's recognition that, "Whatever the measurement challenges, an increase in overall productivity depends on the performance of individual firms, and on the competitive pressures that results in better performing firms and industries prevailing over others" (Productivity Commission 2010). Consequently, it states, "This report is a call to action. It provides clear evidence that improving Australia's productivity – or effectiveness at work and performance of our workplaces – is and will be largely a function of our commitment to develop leadership and management capabilities across all organisations in our economy. It is time to invest in this vital and undervalued lever of Australia's productivity performance".

Workforce involvement

A key element of management performance is the engagement of the workforce in the full range of innovation and productivity-enhancing initiatives in the enterprise. Traditionally, this has been problematic for Australian managers, with many union-employer schemes and agreements for employee involvement foundering. Given the increasing importance of workplace knowledge and agility in driving competitive advantage, the challenge of structured employee engagement can no longer be avoided. Productivity enhancement draws on three main domains:

First, continuous skill development is required for employees. Developing skills and competencies as part of investment in human capital is essential to improving the quality of workforces and workplace performance. New forms of work organisation, changes in the nature of work and new technologies require new and higher levels of qualifications, which include teamwork and communication skills as well as occupational skills, and which must be delivered through lifelong learning.

Second, as we have seen, continuous skill development is also needed for management, particularly given the comparatively low level of qualifications of Australian managers. The

requirement for management capability development is at least as pressing as that for employees.

The third domain for productivity enhancement is value creating and value appropriating innovations which are dependent for success on continuously increasing efficiency and effectiveness. This implies transformational change within the organisation in all possible dimensions. In some countries, the imperative for productivity improvement is embedded through a formal structure of engagement between employees and employers, particularly in high performing manufacturing countries, such as Sweden and Germany.

In Sweden, for example, engagement is enshrined in "co-determination" legislation, the 1976 Act on Employee Consultation and Participation in Working Life, so named because it is intended to promote employee participation in decision-making in the broadest sense. In terms of their content and origin, the provisions of the Act can be divided into two main groups:

- The first consists of provisions on the system of collective regulation in the labour market, carried over more or less unchanged from earlier legislation and covering the right to organise and to negotiation and mediation, together with collective agreements and their legal effects such as the peace obligation. Rules are also included on damages and other remedies for breach of collectively agreed or statutory provisions and on negotiation on grievances.
- The second group consists of the rules on employee participation and representative structures at the workplace (with no equivalent in previous legislation) whose introduction signalled what was essentially new about the Act. These rules on what is also termed industrial democracy did not overturn the long-established principle that, unless prescribed or agreed otherwise, management and the right to direct work rest in the hands of the employer.

Subsequently, the European Union introduced legislation establishing European Works Councils in large organisations operating in more than one member state, and more recently employee representative structures for consultation and information-sharing in all establishments with 50 or more employees. Member states implemented this legislation as "enabling" rather than prescriptive measures, so that companies themselves could determine the form of the consultative arrangements in the context of their different organisational and cultural attributes. The arrangements were designed to engage employees in decisions that affect them, in particular the development and implementation of cooperative workplace change and innovation, and it is arguable that they played some part in the recovery of the northern European economies, particularly manufacturing sectors, from the global financial crisis.

Collaboration strategies

There are implications too for the context in which firms and organisations operate, especially in manufacturing where firms are highly interdependent and rely on effective collaboration through customer-supplier relationships, access to skills and training and platforms for knowledge exchange with each other and with research and educational institutions. However, Australia's record in collaboration, particularly between industry and research institutions, lags behind almost all other OECD countries (DIISR 2011). This is clearly another related challenge for public policy.

On the one hand, many Australian firms have limited absorptive capacity and do not make the best use of existing technologies and skills, let alone new ones. As we have seen, this is fundamentally a "demand side" problem of corporate strategy, management and workplace culture, as well as the effectiveness or otherwise of public policy in diffusing ideas and techniques. On the other hand, there is also a "supply side" question about the extent to which research institutions, including universities, are prepared to engage with the issues facing firms, and this is as much about organisational as technological innovation.

An MIT study has found that in addition to three well understood areas of interaction between universities and industry – production of qualified graduates, scholarly published research and external consultancy – a new emerging area was the provision of public interactive spaces for "integrative thinking", knowledge exchange and open innovation (Lester et al 2004). A further study in conjunction with the University of Cambridge, comprising a survey of 3500 companies in the US and UK, confirmed the significance of "informal contacts", which were given a higher priority by companies as a source of innovation than the three more visible and recognised areas.

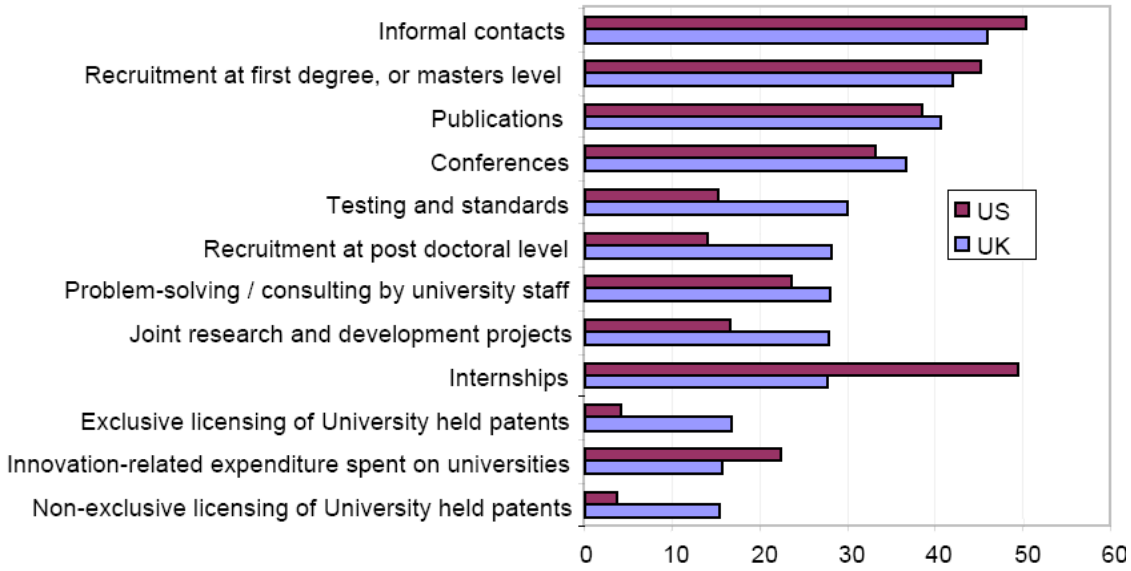

Figure 32: Source: A. Cosh, A. Hughes and R. Lester UK PLC Just How Innovative Are We? Cambridge MIT Institute 2005

The point is that many of the world's leading research universities are deeply engaged with industry, but not just through commercialisation and other traditional channels. It is increasingly recognised that innovation, far from being a linear process of transferring ideas to the market, is a complex, unpredictable and multifaceted process with infinite sources and multiple channels, often at the interface of disciplines. It is in this context that innovation labs and "living labs" have gained prominence in the creative culture of advanced economies, both challenging and complementing traditional channels of engagement. These provide opportunities not only for academics but also students to engage with external companies and organisations, entrepreneurial start-ups and new, more interactive ways of generating ideas in workplaces.

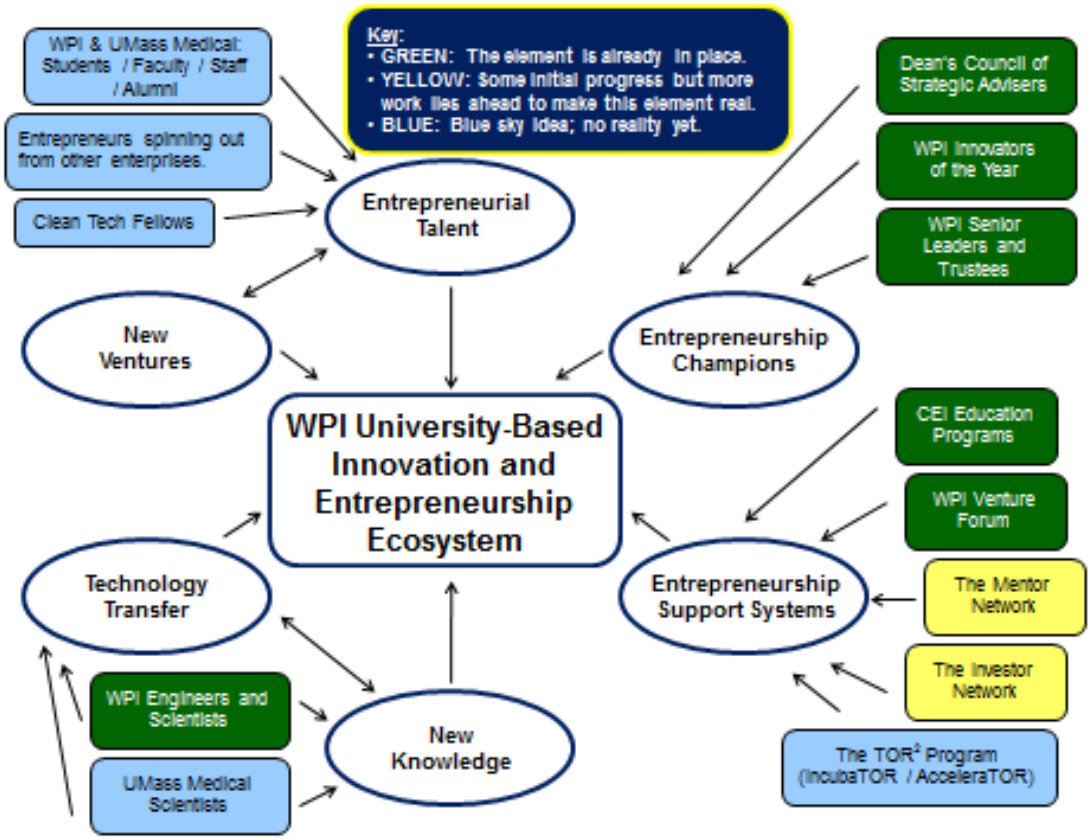

Figure 33: Source: Worcester Polytechnic Institute

Examples of innovation labs in the US and Europe include Stanford's d.school, University of Connecticut's edgelab, University of Toronto's DesignWorks, Denmark's MindLab, Aalto University's Design Factory and MIT's Living Labs. Asia is not far behind with early stage experimentation in Korea, Singapore and Taiwan, and even in Australia, the University of Technology Sydney has established U.lab and Swinburne University has introduced the Design Factory jointly with Aalto University. The hallmark of these labs is co-creation in multidisciplinary teams, involving students in problem-solving and "design thinking" with companies and organisations. Some, like Worcester Polytechnic Institute, have a specific focus on the "innovation and entrepreneurship ecosystem", which is also finds resonance in the collaborative innovation model proposed by the Kraft submission to the Taskforce. Clearly, the workplace of the future will need to draw not only on the talent and expertise of its own workforce but also on the "boundary-crossing" skills and entrepreneurial flair of the workforce of the future – and its next generation leaders.

6. New policy directions

There is an important role for industry policy in modern developed economies, but this role has evolved and will continue to evolve in the context of Australia's emerging national innovation system, with an increasing emphasis on building innovative and competitive capability in firms and organisations. This section provides an account of the rationale for industry policy in the light of recent developments in thinking about technical and organisational innovation, it proposes "design principles" for the implementation of manufacturing industry policy and makes a number of more specific recommendations for consideration by policy-makers.

Rationale for industry policy

Essentially industry policy involves interventions, first to affect the industrial structure of an economy, including the share of different industries within an economy, and second, to improve the performance of firms and clusters of firms within and across these industries. This performance is influenced by factors such as the removal of barriers to product and process innovation. In turn, this reflects the technological "absorptive capacity" of firms and the supporting educational, training and research institutions; access to efficient capital markets; access to cost-effective information regarding suppliers and markets, and implementation of work-organisation systems that encourage quality and continual improvement. The goals of industry policy typically include employment growth, per capita income growth, technological advancement, defence, correcting trade imbalances, equity, and community cohesion.

All developed and developing countries pursue forms of industry policy. Indeed, while most countries now express a strong preference for general assistance to all industries, rather than specific assistance to selected industries, no developed country has abandoned all forms of sectoral assistance. Further it is argued below that the goal of removing sectoral assistance is illusory as any government activity, including activities as disparate as vocational training or funding of CRCs, serves to direct resources to the benefit of particular industries. This section provides a short summary of the arguments that underpin the case for industry policy.

External vulnerability

The principal justification for the international move from fixed to floating currencies over the last 40 years was that the latter would bring trade flows into balance and lessen the effect of terms of trade shocks. The global experience to date is that floating exchange rates do not bring national trade flows into equilibrium. Indeed, several mechanisms have been identified whereby trade imbalances may become self-reinforcing. The failure of exchange rates to produce external trade balance is largely due to the fact that the primary determinant of exchange rate movements is capital flows, be they short-term currency speculation and hedging or long-term debt and equity portfolio flows.

These capital flows are not only much larger in volume than trade flows, but are determined by factors that can push a currency in the opposite direction to that required to achieve a trade balance. For example flows of overseas capital into the stock market, domestic banks accessing offshore savings to on-lend for investment and consumption in Australia and the

flow of overseas funds into the mining industry have resulted in a significant appreciation of the Australian dollar at a time when the large trade imbalance required a significant depreciation to be corrected. At the same time, monetary policy directed at reducing inflation through high interest rates has resulted in significant inflows, again appreciating the currency. It has been suggested that: "exchange rate movements are … a necessary aspect of the process of structural adjustment by which resources are induced to move between sectors within the economy in order to best exploit changing economic circumstances" (Productivity Commission 2008c: 6.9).

Such a position is only tenable if it can be demonstrated that currency movements result in an optimal allocation of resources. In light of the global experience with floating currencies and the capacity of exchange rates to be sustained at levels that can damage trade-exposed sectors, it is prudent economic management to ensure that the economy remains broadly balanced. Given the inability of exchange rates to bring national trade and capital flows into balance, other means may be required, such as policies to shape the industrial structure and performance of firms (see further Green 2008).

Concern over large external imbalances was a consistent theme in Australian economic policy for over 100 years. From the mid-1980s, concern over the growing current account deficit—which arose from trade deficits and net payment of interest and dividends on foreign savings—drove Australian economic policy. Policy responses included deflation to reduce import levels (culminating in the "recession we had to have"), a heightened role for industry policy to reduce import propensity and lift export propensity, and reducing the public sector borrowing requirement. By the mid-1990s, attitudes to the current account deficit had become far more sanguine.

Despite this reversal in official perceptions, there are justifiable concerns about the sustainability of such large external imbalances and that the genuine vulnerability that these imbalances represent. It may be argued that the current global "credit crunch" is the result of official policy indifference over many years in many developed countries to the growth of private debt, on the basis that the accumulation of debt represented an optimal global transfer from savers to investors. These private debt levels are now recognised as being unsustainable. This demonstrates the rapidity with which market perceptions of conventional economic "wisdom" can change and the profound economic consequences of such altered perceptions.

Non-industry neutrality of government activity

Conventional economic analysis draws a sharp distinction between macroeconomic fiscal and monetary policy on the one hand, which are assumed to operate at an economy-wide level without having a differential effect on particular industries, and industry policy on the other, which by definition is directed at specific industries. In reality this distinction is much less clear cut. Virtually any action of government in terms of regulation, taxation or budgetary expenditures, even action that is explicitly directed at the economy in general, has unintended industry-specific effects, whether minor or major. For example, public expenditure on roads or health has a profound effect on the allocation of private resources, be it consumption or investment. The extent to which the effects of government action on a particular industry, or on the economy more generally, will, on balance, be positive or negative depends on recognition of these effects.

Competitive advantage

The principal conventional argument against industry policy is that national welfare is maximised by having production in trade-exposed sectors conform to the principle of comparative advantage. Under comparative advantage it is assumed that countries are endowed with different proportions of factors of production such as capital and labour, and that nations specialise in the production of commodities which intensively use the factor that is relatively more abundant. Under this model it can be demonstrated that welfare gains can be generated if a nation specialises in the production of commodities that embody differences in relative factor proportions and then the nations exchange any surplus for different goods, produced in other nations.

It is also assumed that economies operate under perfect competition, which means that firms in a given industry are assumed to have identical technology and, in turn, production costs. Firms and consumers have perfect foresight, and present and future market changes are efficiently signalled in prices. Further, by definition there can be no "trade secrets", brand loyalty or product differentiation. There are no barriers to entry or exit and this ensures that entrepreneurs will rapidly move their capital from less profitable to more profitable industries. The result of such mobility will be to efficiently allocate resources in response to changes in relative factor costs and consumer preferences. An economy is allocatively efficient when the returns to each factor of production are the same across all uses, and the level of output for each commodity exactly matches demand, such that it is not possible to reallocate resources without reducing consumer welfare.

The policy implications of the theory of comparative advantage are clear cut: consumer welfare is maximised when production and exchange is determined solely by unfettered markets. The role of government is limited to the provision of "public goods" and redressing a variety of "market failures", which by definition are assumed to be both limited in extent and remedied through policies such as taxes and incentives that are "market conforming".

However, it has been known for decades that the gains in per capita income from shifts in the inter-industry allocation of resources are quite small. It has also been established that the overwhelming source of gains in per capita income arise from technological change that improves the quality of factors of production and increases the efficiency of production. In addition, comparative advantage is an unsound basis for policy, as both its underlying assumptions regarding the operation of market economies and its predictions regarding international trade are counter-factual. Some of the counter-factual assumptions include the following:

- There are no international capital or labour flows, only final goods are assumed to be traded internationally, as flows of capital goods alter a nation's factor proportions and it is assumed that there are no quality differences in the "same" commodities across countries.[5]

[5] Over the last 60 years the Hecksher–Ohlin–Samuelson trade model has undergone many permutations, for example by including internationally mobile factors, differences in the quality of factors across nations (e.g. skilled and unskilled labour) and monopolistic competition. Each of these is largely in response to the lack of realism in the original assumptions and developments in economic modelling. These permutations typically operate under *ceteris paribus* conditions, that is introducing one or two less unrealistic conditions while maintaining the remaining unrealistic assumptions.

- The role of intermediate goods and services is problematic. Intermediate goods, which are themselves not directly traded internationally but enter into the production of goods that are so traded, may be produced with factor proportions very different from commodities that are exchanged internationally. In other words, the task of determining the factor proportions of traded commodities is not without ambiguity.
- The definition of capital and the determination of its quantity are assumed to be unambiguous. The concept and valuation of capital is in fact highly contested. For example, capital in money form is valued at the going interest rate. But if it is viewed as heterogeneous capital goods, each having different rates of productivity and subject to arbitrary accounting conventions and rates of depreciation, its aggregate value becomes highly ambiguous.
- The productivity of labour and capital is assumed to be identical across countries (that is, technology is identical) and there are no increasing returns in production. Productivity differences arising from differences in technological capacity across nations and the presence of diminishing average cost as output increases imply that some countries will have an absolute and possibly rising cost advantage across a broad range of commodities that is unrelated to their specific national factor proportions.

Comparative advantage predicts that countries specialise in the production of particular commodities, so international exchange should be based on inter-industry trade. However, in manufactures, which dominate world trade, intra-industry trade between developed economies is the overwhelmingly dominant form of exchange. That is, countries produce and exchange "similar" products such as chemicals, processed food, motor vehicles, aircraft components, electronics, furniture, clothing and building materials. The basis of intra-industry trade is that most manufactured commodities are differentiated by features such as technology, design, quality, speed of delivery, degree of customisation to purchaser needs, after-sales support, marketing and price.

Such trade is based on differences in *competitive advantage* at the national, industry and firm level, which in turn is determined by factors, such as private and public investments in education, research, capacity for technology transfer across national borders, industries and firms, access to market information, and efficient mechanisms for managing risk and uncertainty. By contrast with comparative advantage, competitive advantage is concerned with dynamic efficiency gains to secure long-term growth in per capita income through investments and policies that promote the generation of productive knowledge, the diffusion of this knowledge across firms and workforces, the renewal of capital investment and the growth of productivity in enterprises through product and process innovation.

While the central policy implication of this approach is that such competitive advantage is created as the result of a complex interplay between private and public action, it is the doctrine of comparative advantage which implicitly underlies comparative static modelling used, for example, by the Productivity Commission in its estimates of the gains from trade induced by the removal of tariffs or other forms of industry assistance. Crucially, it assumes that there can be no productivity benefit from government industry policy, which simply represents a price impost on consumers or a cash transfer from taxpayers to subsidised producers respectively. (In addition to the theoretical problems with the pursuit of allocative efficiency through comparative advantage, there is the pragmatic problem identified by the PC itself in 2003 that Australia's tariffs are now so low and the potential

benefits associated with their removal so small that it is unclear whether there is any net welfare gain from further reductions.)

The following represent some of the assumptions in the modelling undertaken (Productivity Commission 2008a) for recent industry reviews:

- *There are no economies of scale:* The PC model is explicitly built on the assumption of constant returns to scale (Productivity Commission 2008a: 24), that is, costs of production are assumed to neither rise nor fall as output levels change. This means that, by definition, there can be no economic benefits associated with policies designed to lower the costs of production via the pursuit of economies of scale.
- *There are no adjustment costs:* While comparative static models such as the one used in recent PC modelling are much simpler than "dynamic" models, they conceal from policy makers the nature and extent of the adjustment costs associated with the pursuit of a policy goal. The estimated benefits of reduced industry assistance are small, but there is no estimate of the likely adjustment costs. In 2003, however, the PC noted that: "Some change, particularly involuntary change, can bring high adjustment costs when an industry or sector is contracting and alternative job opportunities are limited. Firms, their employees, and the regions in which they operate, face not only direct economic costs such as loss of income and employment, but a range of flow on social and economic costs, arising from closure of regional infrastructure, reductions in property values, loss of self-esteem, and family dislocation" (Productivity Commission 2003: 42).
- *People are highly mobile:* The modelling is based on the assumption that "labour moves to jurisdictions in response to opportunities to earn higher wages" (Productivity Commission 2008a: 25). This assumption is contradicted by the existence of lasting disparities in wages between states and regions. What should be of more concern to policy makers, however, is that models only deal with the behaviour of individuals, and so do not have the ability to predict the behaviour of families. As the PC found in its 2003 review of the TCF industries, "labour mobility of the TCF workforce as a whole is lower than for industry in general. This is partly explained by the age profile of TCF employment and the high proportion of female and migrant workers" (Productivity Commission 2003: 46).
- *Export elasticity of demand is very high:* The model assumes that the elasticity of demand for Australia's exports is very high, whereas others assume it is much lower (Dixon & Rimmer 2008; Econtech 2008; Lateral Economics 2008). It is important to note that the choice of export demand elasticity is central to the Productivity Commission's conclusion that economic welfare is enhanced by reducing tariffs.

Technological change and innovation

It is now well established that the primary source of growth in total and per capita output is technological change (Scott-Kemmis 2008). In turn, technological change is the result of innovation in production processes, products and services. Innovation lowers input use per unit of output and expands the size of the market by increasing the scope of human wants through the development of new products and services. Innovation is embodied in improvements in the efficiency and performance characteristics of capital, intermediate and consumer goods. Diffusing the stock of existing knowledge across the workforce and developing new productive knowledge are essential for implementation of new production methods and for problem solving.

Just as conventional economic analysis is counter-factual when confronted with the reality of international trade, so too its contribution to the understanding of innovation is very limited. The standard economic model assumes that the rate of technological change is exogenous (not determined within the economy); acquiring new knowledge is cost free; and all possible technologies are known and can be represented simply as production functions, which relate different proportions of capital and labour to produce a given level of output. Identifying an optimal proportion of capital and labour for a given level of output simply depends on the ratio of their prices. There are, however, several constraints facing firms and the public sector in generating and diffusing productive knowledge. These constraints arise from the inherent properties of innovation and market economies, and some are outlined below.

Acquiring and assessing knowledge

Any change in production methods—or the development of new products and services—by a firm involves potentially costly search and experimentation. Acquiring, evaluating and implementing knowledge, even knowledge is already widely disseminated, involves significant costs. The linear model assumes that there is a straightforward transfer of codified scientific knowledge to industry. The overwhelming result in the field of innovation studies is that it typically requires the input of enormous resources by firms, and many incremental improvements over several decades, for radical innovations that emerge from scientific inquiry to be translated into new marketable products and services (Rosenberg 1994).

These costs are especially a constraint for SMEs, who lack sufficient scale to either develop an internal division of labour (different types of management expertise to acquire and evaluate information) or to buy these services in, by engaging external consultants. There are also significant costs in protecting the intellectual property that is developed by a small enterprise. In contrast, not only are larger firms less constrained by these problems, they also benefit from scale economies such as lower cost access to capital. These factors contribute to explaining the well-established finding that small firms have a far lower propensity than larger firms to engage in product and process innovation.

Risk and uncertainty

It has long been recognised that, because the outcomes of activities such as R&D are inherently uncertain, and consequently the rewards from investing in such activities are risky, either subsidies to firms or direct public expenditure on scientific and technological activity are appropriate responses. In the absence of these interventions, there is a strong bias towards less risky innovation. In other words, as was recognised by the Productivity Commission (2007) in their report on *Public Support for Science and Innovation*, the level of private investment in innovation will be lower than is warranted, from society's point of view. It is important to note, however, that while only around one-third of the business sector's total innovation expenditure in Australia is for R&D, firms undertaking non-R&D innovations also report that cost and risk remain the principal constraints on these activities (ABS 2006a).

External economies

External economies are benefits rendered by one firm to another without recompense. The most important current example is the idea of "knowledge spillover" from one firm to another. Knowledge spillovers involve the inter-firm transmission of productive knowledge that results from factors such as labour mobility and imperfections in securing all property rights over inventions. Like risk and uncertainty, external economies cause a divergence between the private and social returns on private investment, resulting in a lower level of private investment than is achievable and desirable from society's point of view. By subsidising specific private investments in the development of innovative capability, knowledge diffusion and inter-firm linkages and networks, including those which include research and educational institutions, the state can seek to reconcile private and social returns.

Failures in innovation systems

Modern studies of technical change find that the capacity of firms to identify and implement product and process improvement depends on a set of complex interactions between equipment suppliers, customers, industry associations, consultants, universities, and public and private research, standards and testing facilities. These interactions form regional, national and even international "innovation systems" (Nelson 1993). Innovation systems are subject to a variety of problems, which can impede the flow of productive knowledge (Smith 1998). Just as individual firms face the problem of identifying and processing an ever-rising volume of market and technical information, so too innovation systems require efficient coordination to avoid duplication of effort and ensure a ready flow of information.

There are three commonly recognised examples of such coordination failures:

- poor communication of the results of university and public sector scientific research to firms, and the difficulty firms have in finding researchers who can assist in resolving technical problems;.
- failures in provision of infrastructure and investment, including those vital for innovation (for example, in high-speed communications), but without adequate investment in their development. There may be a key role for public policy in such investment appraisal and investment support;
- lack of specialised skills, equipment and market knowledge, which can take many decades to develop. The specialisation of firms and supporting innovation systems can result in "technological lock-in", inhibiting firms from exploiting market opportunities that arise from a major shift in technology or market demand.

It has been shown that government can play a "crucial coordinating and facilitating role" by enabling the necessary network connections within the complex systems of production that deliver new products and services:

> [G]overnment has to be actively engaged in the broader system of which the 'market' is only part and it is not market failure that is the concern but system failure. In the complex-evolutionary approach, government does not just leave things to the 'free market' yet it does not 'pick winners' either. From its pre-eminent position it plays the role of connector by its support of national institutions and infrastructure, and through its programmes encouraging organizational skills and

> capabilities. It views entrepreneurship and associated innovation as an experiment and accepts that to win successes, failures must be accepted. It recognizes that the system it is dealing with is complex-evolutionary and, therefore, does not attempt to implement simplistic, one-size-fits-all, policies but works in many different settings in close consultation with industry players and stakeholders. (Dodgson et al. 2010: 34)

Absorptive capacity in SMEs

The capacity of firms to perceive and respond to problems and opportunities, and the ways in which they respond, are strongly shaped by their internal capacities and their access to external resources—including the capacities of other firms. Limitations in capability are greatest in smaller firms, which are more dependent on their interactions with suppliers, customers and other firms for new knowledge. As the pace of change increases and activity becomes both more knowledge-intensive and more interactive, weaknesses in the capacity to absorb new knowledge reduce the competitiveness of firms and lower the dynamism of the overall sector and innovation system. A summary of the particular problems confronting SMEs is provided in the table below

Function	Disadvantages for SMEs
Marketing	Market start-up abroad can be prohibitively costly.
Management	Often lack management specialists, e.g. business strategists, marketing managers, financial managers.
Qualified technical manpower	Often lack suitable qualified technical specialists. Often unable to support a formal R&D effort on an appreciable scale.
External communications	Often lack the time or resources to identify and use important external sources of scientific and technological expertise.
Finance	Can experience great difficulty in attracting capital, especially risk capital. Innovation can represent a disproportionately large financial risk. Inability to spread risk over a portfolio of projects.
Economies of scale and scope	Face substantial entry barriers in some areas, due to economies of scale. Inability to offer integrated product lines or systems.
Growth	Can experience difficulty in acquiring external capital necessary for rapid growth. Entrepreneurial managers sometimes unable to cope with increasingly complex organisations.
Legal	Lack of ability to cope effectively with the patent system. Cannot afford time or costs involved in patent litigation.
Government regulation	Often cannot cope with complex regulations. Unit cost of compliance often high.

Table 9: SME disadvantages in innovation (Source: Dodgson & Rothwell, 1994)

Many assessments of innovation policies have concluded that, in promoting innovation in SMEs, there is a key role for government in supporting the availability of knowledge and information: "[T]he costs of searching for and translating even freely available information into terms useful to local firms are not trivial. And there are great economies in centralizing these activities in organisations with special capabilities to carry them out. Efficiency requires that these costs, separate from the vastly lesser variable costs of dissemination, be borne but once. Otherwise each potential beneficiary of the same information would have to replicate the search and translation costs that would far better be shared, as fixed costs,

in some way among all the potential beneficiaries" (United Nations Industrial Development Organisation 2004: 117).

Many governments have been pursuing pragmatic policy measures to address these issues, and policy approaches are increasingly influenced by innovation systems perspectives. A summary of the measures used internationally to promote technology diffusion, especially to SMEs, is provided in the table below. Further analysis of institutional examples around the world has also recently been undertaken by the US Information Technology and Innovation Foundation (ITIF 2011).

Focus of program	Instruments	International examples
Awareness-building and technology demonstration	Raising awareness of potential uses of new technology through demonstration projects, training, pilot plants, performance benchmarking, web pages or electronic information.	Regional Technology Centres (Japan)
Information search and referral services	Providing technical information to lower the search costs for potential users, via regional centres or the internet.	Technical Information Centres (Denmark; many US states)
Technical assistance and consultancy	Providing of experts to assess problems and identify technological options for upgrading.	Usually located in regional technology centres (US Manufacturing Extension Partnerships)
Training	Promoting investment in human capital, by identifying training needs, improving the supply of appropriate training and providing training services.	UK Learning and Skills Council
Collaborative research and technology projects	Increasing industry involvement in applied research.	Applied Research Centres – Steinbeis and Fraunhofer Centres (Germany), TNO (Netherlands), VTT (Finland)
Personnel exchange and the support of R&D personnel	Seconding staff to technology centres or other firms, subsidising the employment of qualified staff in SMEs.	Regional Technology Centres (Japan)
Standardisation	Facilitating the development of standards to promote application, eg in ecommerce, ISO 9000 series.	
Financial support	Providing subsidies, low-cost loans and grants for the use of consultants or purchase of new equipment.	US SBIR Program Regional Technology Centres (eg Minnesota)
Procurement	Creating policies that require offsets to (and support for) SMEs, which can promote technology support.	US & UK SBIR Program EU Lead User Program
Interfirm cooperation	Sponsoring collaborative industry groups (vertical, horizontal, sectoral) for information sharing, joint production and joint problem-solving.	EU Sprint Program
Facilities for technology transfer	Linking facilities to research centres and combining demonstration, information provision and other local support.	Advanced Technology Development Centre, University of Georgia; centres in many science parks
Regional or sectoral cluster measures	Developing "social capital" through interfirm and interorganisational links	Many regional and national cluster development programs
Macro policy measures	Creating overall framework conditions that influence, for example, cost of capital, protection of intellectual property, labour-market policy or tax policy (eg depreciation for investment in new technology).	

Table 10: Technology diffusion programs: a characterisation of objectives and instruments (Based on Shapira & Rosenfeld, 1996)

Industry policy framework

While the theoretical justification for industry policy interventions is strong, the empirical evidence on whether industry policy works "on average", or what kind of policy works, is inconclusive. Industry policy remains controversial. As an attempt by government and public

agencies to promote the growth of specific sectors and companies, industry policy has had successes, but also expensive failures. The literature raises a number of concerns about the likely shortcomings of industry policy in practice. None of this makes it area of policy very different from other areas of government responsibility, such as education, health, social insurance and safety nets, infrastructure or stabilisation. In each of these areas, it is recognised that the market failure arguments for intervention can be exploited by powerful insiders and overwhelmed by informational asymmetries (Roos, 2012).

To the extent that the notion of market failure underpins the conventional case for industry policy intervention, it can equally be argued that market failures are endemic and pervasive, and that consequently they provide an inadequate basis for decision-making. It has been observed that "an analyst in search of externalities and market failures can find them anywhere he or she looks, providing a universal justification for any sort of government intervention that one might want to undertake. Supporters of the market failure concept avoid this problem by focusing on failures that are "big". In its worst form, this amounts to little more than the substitution of the ideological biases of the analyst" (Zerbe & McCurdy 1999: 564). Moreover, the underlying assumption of market failure implicitly biases the analysis of causes of the "failure" and the selection of interventions:

> The theory provides only general policy implications and tends to support horizontal economy-wide interventions and to focus on the research and invention aspects of innovation. The foundations of the theory rest on assumptions that are unrealistic and as a result give rise to policy interventions that are often ineffective. In particular, the assumptions that knowledge is information and that all economic agents have perfect information is at odds with the central dynamic of innovation and competition in a market based economy—competence in all of its forms is clearly unevenly distributed among firms. Where knowledge is the most important resource and learning the most important process, a theory that assumes away such resources and processes is an inappropriate base for policy.
> (Scott-Kemmis 2008: 23; also Dodgson et al. 2010)

Historically, nations have devised and implemented industry policy as a pragmatic response to the realities of industry and enterprise development in market economies. Some of these characteristics of market economies were identified above as: endemic external imbalances, the non-neutrality of government activity, the oligopolistic structure of many industrial sectors, the dominance of created competitive advantage over comparative advantage, the dominance of technical change in economic growth, and the particular properties of productive knowledge, such as uncertainty, risk, the potentially high cost of identifying, adapting and implementing new technologies, and failures in systems that generate and propagate innovation. These are not market failures in any conventional sense but a description of some important realities of market economies, which leads to a rejection of the "crude dichotomies… between free trade and protection" and the necessity for a pragmatic approach to "sophisticated, sector- and country specific-trade and industry policy" (Deraniyagala & Fine 2001: 821).

Discussion and debate in most areas of policy typically focus on how to make the policy work, *not on whether the government should have such a policy in the first place.* To ensure progress in the debate around innovation and industry policy will require a similar shift. Only then can we provide useful guidance for effective and coherent policy development. The poverty of the economic analysis of these issues is striking, and, as Rodrik has pointed

out, can be overcome only by going beyond stale "existential" debates (Rodrik 2008). Rodrik has shown that the requisite knowledge about the existence and location of the spillovers, market failures and constraints that block structural change is diffused widely within society (Rodrik 2007), and that this necessitates the following:

- Industry policy must be "embedded" within society. Government has only a vague idea at the outset about whether a set of activities is deserving of support or not, what instruments to use, or of the private sector behaviour with which to align these instruments. The information that needs to flow from the private sector to the government in order to make appropriate decisions are multi-dimensional and cannot be communicated transparently through firms' actions alone. A thicker bandwidth is needed.
- An industry policy that recognises government's inevitable lack of knowledge and information has to be constructed as a system of discovery about all those sources of uncertainty. It requires mechanisms for eliciting information about the constraints markets face, and hence closer collaboration between the government and the private sector. However, the capacity to design and implement industrial policy requires both autonomy from vested interests as well as "embeddedness" in the environment where the policies are implemented.
- Strategic collaboration and coordination between the private sector and the government is required to uncover where the most significant bottlenecks are, design the most effective interventions, periodically evaluate the outcomes, and learn from the mistakes being made in the process. The appropriate way to judge success is to ask: have we set up the institutions that engage government and its agencies in an ongoing conversation with the private sector and do we have the capacity to respond selectively, quickly and using a range of policies appropriate to the economic opportunities these conversations are helping identify?
- Industry policy needs to encourage investments in non-traditional areas and weed out projects and investments that fail. Conditionality, sunset clauses, built-in program reviews, monitoring, benchmarking and periodic evaluation are desirable features of incentive programs. Bringing discipline to bear on incentive programs does not require a big stick – relatively minor details of how programs are designed can make a difference in practice. Requiring that an incentive expires unless a review recommends that it be continued is much more likely to generate phase-out than simply promising a review x years from now. Being very explicit about the criteria by which a program will be judged a success—so many jobs and so many export $ or units in y years—is helpful to distinguish between hits and misses and guards against the tendency to scale down expectations when things do not work out. Bringing the discipline of the market to bear on incentive programs is always a good idea, whenever practical.
- The argument is not about whether government can pick winners—it shouldn't even try—but whether it has the capacity to let the losers go. The point is to have mechanisms that can recognize when things are turning sour and the ability to phase out the support. This is still hard to do, but in orders of magnitude less demanding of the government than full omniscience. Clearly, businesses have strong incentives to "game" the government and this call for strong safeguards against bureaucratic capture. The intended beneficiary of policy is neither bureaucrats nor business, but society at large. This necessitates accountability, including raising the political profile of industry policy activities and possibly associating a high-level champion with them. The virtue of this is

that it identifies a person who has the job of explaining why the agenda looks as it does, and who can be held responsible for things going right or wrong. Accountability can also be fostered at the level of individual agencies by giving them clear mandates and then asking them to report and explain any deviations that occur from targets.

- Another fundamental tool for accountability is transparency. Publication of the activities of the agencies and advisory councils and periodic accounting of the expenditures made under industry programs would greatly help. Any request made by firms for government assistance should in principle be public information. Ensuring that government-business dialogues remain open to new entrants would assuage concerns about the process being monopolised by incumbents.

Clearly, significant resources may be engaged in the design and implementation of industry policy. In this context, it is argued that the following elements, including a greater role for the competition authorities, are critical to the success of the policy framework:

- Competition authorities should be able to overrule rent-seeking leniency on the part of governments. It is not by favouring incumbents that an economy will retain or regain a competitive edge, but by stimulating entry and exit, and this is precisely one of the roles of competition authorities. These authorities should have a more evidence-based approach, with clear and uniform legal rules and principles, but they should also ensure that decisions are based on an economic rather than a purely legalistic approach. In other words, competition policy should take better account of the economic situation of sectors and the contribution that more vibrant competition can make to productivity, innovation and growth and take into account the justification and potential role of state aid when assessing if aid should be tolerated.
- There should be less bias against the use of public intervention while at the same time setting new and clear guidelines for the allocation and governance of that intervention. In particular, sectoral intervention should target skill intensive and competitive sectors and be allocated evenly within the sector, rather than to one or several preselected firms. Such intervention should promote competition between firms for access to public support, and should not involve clauses that automatically favour incumbents. Depending on the sector and fixed costs involved, and in order to preserve competition, sectoral intervention may need to be carried out at national or regional level, with firms benefiting from such intervention being innovative start-ups, expanding SMEs or firms involved in growing new markets in emerging economies.
- Governments underestimate the danger of a specialisation whereby the most advanced countries focus on upstream R&D and services, while outsourcing everything else to emerging economies. This has been highlighted by observers of the German model, in which public support is given not only to upstream (laboratory) research, but also to research down to the stage of industrial prototype. Indeed, it is often in the transition from laboratory to factory that critical skills for competitive advantage are developed, and the development of these skills also involves significant knowledge externalities. Maintaining a restrictive view of where to allocate research subsidies might prevent industry from competing with other regions or countries that engage more openly in sectoral support to manufacturing.[6]

[6] The challenges in crafting an effective and efficient policy in an increasingly globalised and networked world are outlined in Waluszewski (2011) for the Swedish Governmental Agency for Innovation Systems.

Design principles

While successful industry policy in countries comparable with Australia tends to be pragmatic in accordance with "what works", it can and should be informed by broad design principles, as we have indicated above. It is proposed, drawing to some extent on the PC's own published guidelines, that these should include the following:

- **Clearly specify the problem to be addressed by the policy:** Describe the causes of the problem and its duration and identify the precise beneficiaries of any government action. "Is there potential for leakage of assistance to unintended beneficiaries (such as foreign shareholders and/or local service providers)?... Should the assistance be selective (merit based) or open to all?" (Productivity Commission 2008c: 6–11).
- **State the intended effect of the policy and establish performance benchmarks:** How will an intervention address the identified constraint? Is the proposed intervention proportional to the problem? Provide a detailed discussion of policy alternatives, including taking no action, to arrive a "first best solution". Only by clearly specifying a policy outcome can the effectiveness of the policy subsequently be determined. A critical consideration for the design and effectiveness of industry policy is "how to induce an increase in the level of the targeted activity, rather than just transferring taxpayers" dollars to firms for little or no public benefit" (Productivity Commission 2008c: 6.12). Establishing performance benchmarks for recipients of assistance is a common tool in assessing policy effectiveness. Examples of performance benchmarks include: those based on well-established national and/or international criteria (such as best practice productivity rates); customised benchmarks, where a firm undertakes to do X in return for Y; or incremental assistance, where firms exceed some already established benchmark (such as increasing their known rate of investment, training or productivity) by some agreed factor. It may even be possible to experiment with contingent repayable assistance, where any profits arising from assistance are split between the firm and the state (Productivity Commission 2008c: 6.14; Chapman 2006)).
- **Quantify scope and scale of the constraint to be addressed and potential benefits of intervention:** Ideally the case for a particular measure should be based on a rigorous analysis of cost and benefits. However, in many cases, information to make these assessments is not readily available or may be impossible to acquire, because of expense or methodological problems that preclude isolating and weighting independent and dependent variables. For example, one of the major arguments in favour of public support for innovation and R&D is the idea of spillover benefits to the economy in general from a higher level of investment in these activities. The PC (2007: xx) has observed that "aggregate time series studies – often the basis for estimates of productivity effects of R&D – cannot realistically measure spillover rates of return accurately. This reflects the complex causal pathways through which R&D affects productivity growth, an inadequately short span of data, measurement errors, the potentially long lags from the conduct of R&D to ultimate benefit, and difficulties in controlling for other factors that also influence productivity". Despite these justifiable reservations, the PC found in favour of continued public support of private R&D and direct public research, albeit with suggestions for significant change in both.
- **Minimise adverse consequences:** Almost any industry policy intervention will have unforeseen and unintended positive and negative consequences for parties directly targeted by the intervention and those indirectly affected. To minimise unforeseen

negative outcomes, there should be wide consultation with potential recipients of assistance, and firms and institutions which contract with or regulate recipients.

- **Make assistance temporary and subject to periodic review:** There is a fine balance between the need to sustain an intervention to elicit a potential change in a firm's behaviour and to minimise the time before an intervention is evaluated. Planned periodic reviews are critical to ensuring taxpayers receive value for money and that interventions are cost-effective and efficient.

Given the challenges for Australian manufacturing, the policy context must recognise the multi-element nature of advanced technologies and innovation. Adopting these design principles, it must tackle early phase R&D investment inefficiencies, subsequent supply-chain integration and technology life-cycle management requirements. The following is a schematic representation of supply-side and demand-side policy tools for the development of industry, innovation and research capacity and performance:

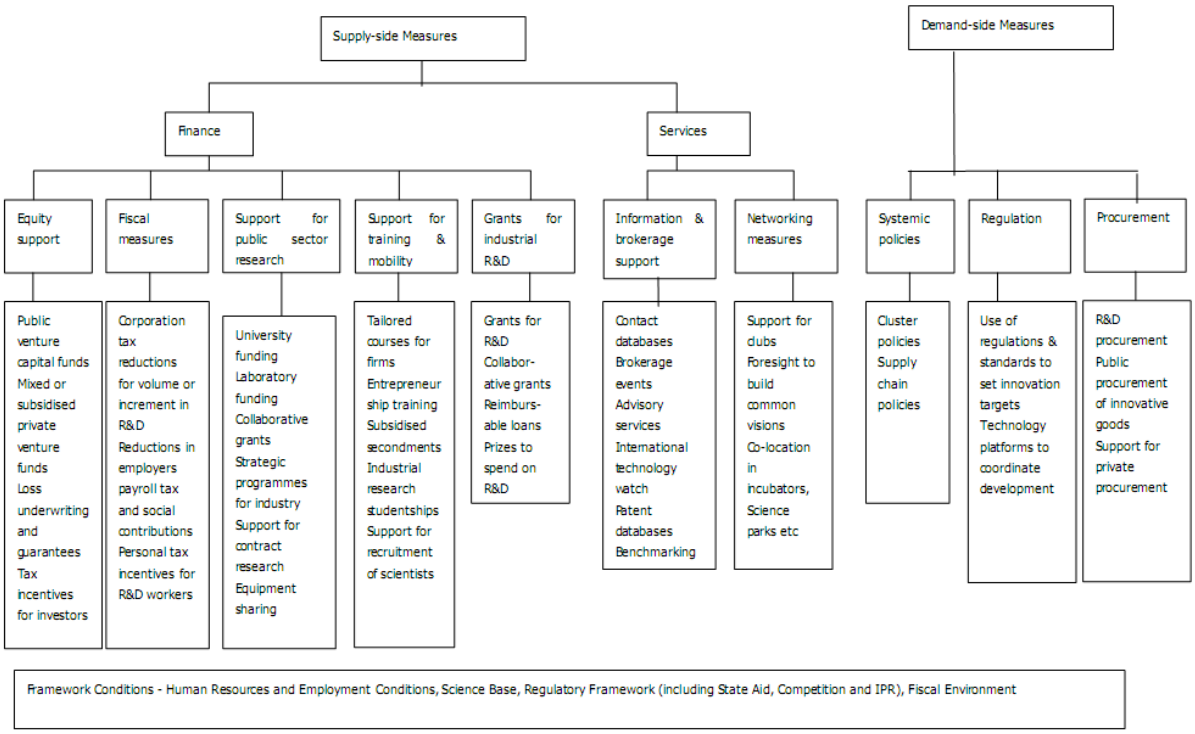

Figure 34: Policy tools for the industry, innovation and research domain (Georghiou 2008)

The fundamental difference between supply-side and demand-side policy tools is that the supply-side tends to drive activity and tends to be preferred by policy-makers grounded in the neoclassical view. Demand-side policy tools tend to drive outcomes and tend to be preferred by policy-makers grounded in the innovation economic view.

Public Procurement	• Public sector as a first user and pioneer in purchasing, piloting and using innovations • Public procurement policies • Pre-commercial procurement
Regulation	• Standards to create stimulus for innovative products and processes • Coherent regulation by coordinating standardisation and labelling • Regulatory measures directed towards steering innovation • Labelling for consumer and user information • Norms on usage to create demand for novelties
Policies supporting private demand	• Consumer awareness and competence building • Foresight activities to identify social and economic trends • Research on societal challenges, e.g. the ageing population or climate change
Financing and tax incentive policies	• Financing of R&D and innovation projects • Tax incentives and tax subsidies to create demand for innovations
Systemic policies	• Systemic coordinated demand-side innovation policies coordinating and combining several demand-driven policy instruments • Public-private partnerships for exploration activities as well as product or process specification and development

Table 11: Demand-side policy tools by category (Kaiser & Kripp, 2010)

Research for the European Commission (2009) has found that 48 per cent of the surveyed firms indicated that demand-side policies without public procurement had positively affected their innovation activities and only 33 per cent claimed the same for supply-side policies. Demand and supply-side policies were considered equally important for innovation activity by 23 per cent of the firms. Demand-side policies influenced innovation significantly in the high-tech sector (54 per cent) and in the large enterprise segment (61 per cent). Furthermore, companies in innovation-follower countries (55 per cent) and innovation-leader countries (52 per cent) were positively affected by demand-side policies. Demand-side policies supported an increase in expenditures on innovation by firms (29 per cent) in comparison to only 12 per cent for supply-side measures (Kaiser & Kripp. 2010).

Public procurement in the research intensive areas of defence, aviation, health care, infrastructure and other aspects of public administration is often more demanding than for industrial or private consumers and hence, governments can act as lead users for innovations (Dalpé et al. 1992). Governments follow missions and geostrategic considerations in certain fields of business activities, for which they are willing and able to pay higher prices at the beginning of the innovation's life cycle (Edler & Georghiou 2007). Public procurement in its present (and as yet rather unstructured) form is an important driver of innovation for 16 per cent of firms in the EU. Summarising, we can see that demand-side policy tools are between 50 per cent and 100 per cent more effective as drivers of innovation than the supply-side (Roos, 2012).

Policy recommendations

To the extent that Australia already operates an industry policy, it is largely compliant with the Productivity Commission's design principles set out above. Whether the same can be said for subsidies operating in the mining sector (diesel fuel rebate, exploration allowances, etc) is questionable as these clearly have "adverse consequences" for other trade-exposed areas of the economy. A recent paper concludes that "the most obvious way to manage the

speed of the mining construction boom is to remove the large tax concessions and subsidies which are currently serving to encourage the development of marginal mines that, by definition, deliver little to the broader economy while imposing substantial macroeconomic externalities" (Denniss 2012b: 12).

The challenge for manufacturing lies more in the scope of the policy, the resources available for its implementation and the overall coordination of priorities in the use of these resources. While currently there are a number of departments and agencies with an innovation and industry policy role, there is no central focus in government for determining national and sectoral priorities and for overseeing their implementation. For example, the effectiveness of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) is compromised by its being disconnected from policy structures and even from other advisory bodies such as the Industry Innovation Councils. There is insufficient "joined up" thinking across government, though aligning the skills and productivity agendas with research and innovation programs in the expanded Department of Innovation, Industry, Science, Research and Tertiary Education is a positive step in this direction.

National priorities and coordination: A restructured and broader PMSEIC with key stakeholder representatives, or possibly a separate entity given the recent refocusing of PMSEIC on science[7], might be well placed to play a more central coordination and advisory role in the innovation system, with links to sectoral bodies such as the Industry Innovation Councils and "delivery" agencies such as Enterprise Connect, Commercialisation Australia (CA), the Industry Capability Network (ICN) and the proposed Skills Connect. It could foster collaboration across the system, including with research and education institutions, reduce duplication, monitor the allocation of resources between policy priorities and, above all, it could build momentum for technological change and innovation as an essential element of industry policy[8]. One way to respond to the challenge of economic complexity and structural change is to subject it to the operation of the market, but even if this approach has validity it is compromised by substantial agricultural and mining subsidies which seem to escape scrutiny and which compound the problems for manufacturing. Another approach is to recognise complexity and address it in the context of a shared vision of the future, which promotes a consensus around innovation as a means to long-term growth and jobs, sustainability and social inclusion. President Obama's Advanced Manufacturing Partnership is an example of how to develop such a vision and execute it with some measureable success.

Enterprise development services: Consideration should also be given to the more comprehensive and more agile delivery of development and support services to manufacturing as a key part of technology diffusion and capability-building. From a standing start, Enterprise Connect has been an unqualified success within tight resource constraints in providing basic diagnostic and improvement services for SMEs, as well as some specialised support through its network of innovation centres (EC Evaluation 2011). With over 7500 reviews or other services, it already compares favourably with its international counterparts. However, it will require additional resources to achieve scale impact and to

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[7] http://www.pm.gov.au/press-office/revitalised-prime-ministers-science-council

[8] Dow's Advanced Manufacturing Plan for Australia argues that, "In today's global economy, it is essential to develop effective collaborations to begin identifying priority industry sectors and developing strategies with a focus on propelling the most impactful future technologies into the marketplace" (Dow 2012: 31)

take firms and organisations to the next qualitative stage of repositioning and transformation in a high cost environment. Moreover, with greater scale, it will be crucial to retain agility and responsiveness, and in this context it might benefit from being grouped with other "customer-facing" programs such as CA, ICN and possibly Austrade in a semi-autonomous public agency, still reporting to a minister but being freed of some of the less relevant departmental obligations. This is the "industry activist" model most commonly adopted overseas, including by Enterprise Ireland and Finland's Tekes, with positive performance advantages in these cases when management and customer-facing staff have an industry background and experience.

Management and workplace capability: In addition, given the poor standard of management capability and performance in many manufacturing firms, as we have indicated earlier, the opportunity should be taken to develop a new program to promote a national dialogue and action plan around the "workplace of the future". This may be part of a government agency such as the one proposed above, or, perhaps more viably in the long term, an independent program with a strong stakeholder input and a mission to improve management performance and employee engagement, including through representative structures for consultation and information-sharing at the workplace. A number of countries have established such programs, usually on the basis of a comprehensive, detailed and evidence-based dialogue such as the one led in Ireland by its National Centre for Partnership and Performance, in preparation for the European Union information and consultation directive. This year-long "national forum on the workplace of the future" found "a high correlation between [high involvement] practices and job satisfaction, low staff turnover rates, high productivity and the successful adoption of new technology and innovation" (NCPP 2005: iv), which will now contribute to Ireland's economic recovery from the speculative excesses of its finance and property sectors. Nor should such programs be pursued in isolation, as competitive advantage in manufacturing is generated not just by single enterprises but by broader, often global networks and geographically concentrated industry clusters, in collaboration with public agencies, research organisations, financial institutions and venture capital.

Cluster development: International experience demonstrates that cluster activity is a powerful attraction to foreign direct investment in manufacturing and incorporation of firms into global supply chains. The EC Innovative Regions Centre, the RDAs and the proposed Industrial Transformation Research Hubs will all contribute to the development of competitive clusters, but again connectivity and scale are lacking in these programs due to limited resources. There are also significant program gaps, such as targeted support for the integration of firms and clusters into global supply chains as well as domestic ones. Other countries have made this a policy priority, particularly for manufacturing SMEs, and in doing so they make much more use of their professional expatriate communities – for example, we have a readymade network in "Advance", the organisation of 25,000 Australian professionals and managers in 80 countries, which is currently partnering with DIISRTE to connect Australian innovators with global investors and "transform our reputation in the world as a country of world-class thought leaders, innovators and a rich source of investment opportunities". It is critical that our manufacturing SMEs have realistic opportunities to become part of integrated global production systems, either on their own account or in collaboration with multinational companies, with cost effective program support (see also Appendix A).

Engagement with research institutions: Australia rates poorly in international comparative studies not just on collaboration between firms in networks and clusters but also with research and education institutions. Internationally, it has been identified that the return on investment in applied public research organisations (such as VTT, TNO, RISE, SINTEF, GTS and Fraunhofer) is ten times the return on university research institutes. It could be beneficial to learn from the firm engagement processes and strategy of these public research organisations. A number of programs have been developed in Australia which are designed to address this deficiency, in particular the Cooperative Research Centre program and Australian Research Council Linkage grants. While the emphasis of public policy is justifiably on increasing the quality of published research – funded largely but not exclusively by the taxpayer – the unintended consequence has been that this is often at the expense of impact and relevance. Additional schemes to encourage greater collaboration between business and academia are the Enterprise Connect Researchers in Business program and Industrial Transformation Research Hubs, which have great potential but are under-resourced. Programs of this kind should have a higher priority for public funding and matched funding from industry. Consideration should also be given to an "impact" factor in the Excellence in Research for Australia (ERA) measurement exercise, and to support for more informal and interactive engagement through "living labs", which foster collaborative problem-solving, knowledge exchange and entrepreneurial ventures. These signal a new area of engagement by universities, as exemplified by Stanford's d.school, University of Toronto's DesignWorks, MIT's Design Lab, University of Connecticut's edgelab, and Aalto University's Design Factory.

Public procurement and value adding: Finally, there is an important role for industry policy in public procurement, which is deployed internationally to shape whole industries (Roos 2012, ICS 2009, and Anderberg et al. 2005). A country that has used its public purchasing power most comprehensively – arguably as its key instrument of industry policy – is the US with targeted but now largely non-discriminatory policies at federal and state levels, including schemes such as DARPA and SBIR which have driven US research and technological pre-eminence over decades. There is no reason why such policies should not be implemented on a significant scale in Australia, without breaching WTO obligations. Some progress has been made in this direction, with a focus on local supplier capability building for defence contracts, along with industry participation plans to open up large mining projects to more transparent supplier tendering and clean energy programs to support the development of renewable alternatives, but less progress has been made in efforts to pursue value adding to mining production and renewable alternatives. This has dropped down the policy agenda even for straightforward activities such as aluminium products. It is a key area of emphasis for the Advanced Manufacturing Plan for Australia, which was recently launched by Andrew Liveris, global CEO of the Dow Chemical Company and co-chair of President Obama's Advanced Manufacturing Partnership (Dow 2012).

In sum, the fundamental test of industry policy is whether it raises welfare, be it economic, social or environmental, not whether it conforms to an economic theory whose assumptions are unfalsifiable and whose predictions are "directly contradicted by observation" (Kaldor 1972). While the evidence suggests that maximising welfare in a modern economy can no longer realistically be achieved by protection, which is now widely acknowledged to be an ineffective instrument for promoting innovation and productivity growth, the case for a concerted approach to the development of industry policy priorities

and their implementation, and particularly to building management and innovation capability in our manufacturing firms, organisations and networks, is compelling. Left to the market, it is highly unlikely that such capability will be developed in the areas and to the extent that is required. However, it is also clear that building innovation capability and performance must be a central "delivery mechanism" by which Australia's industry policy framework contributes to the development of a dynamic, knowledge-based manufacturing sector.

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Appendix A

Industry clustering

Economic activities tend to agglomerate in time and space. For policy purposes it is necessary to classify different types of agglomeration. One way of doing this is to look at efficiency advantage vs. innovation advantage and general agglomeration vs. knowledge domain actors (technology actors) which leads to the following conceptual scheme, comprising cities, industrial districts, creative regions and clusters (Sölvell et al. 2006):

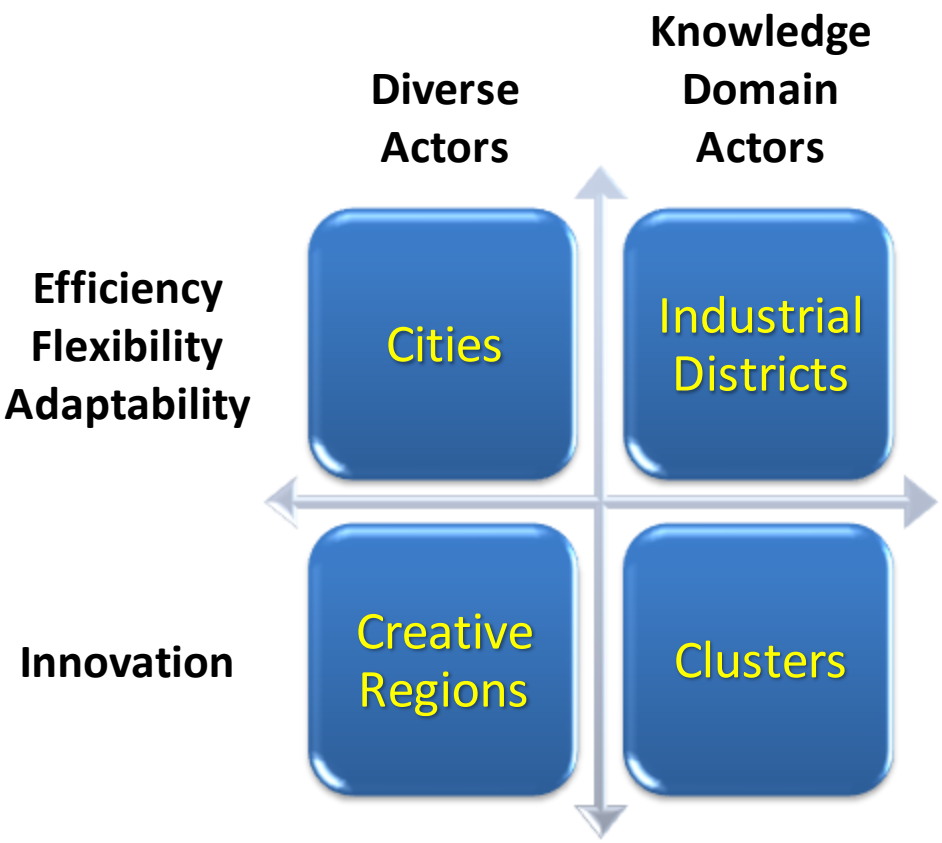

Figure 35: Types of Clusters (Sölvell et al., 2006)

In this appendix we focus on clusters. The clusters type refers to a group of linked actors (firms, financial actors, public actors, universities, organisations for collaboration, media, etc.), where the group's sustainable competitive advantage is grounded in resources (ie. monetary, physical, relational, organisational and competencies) linked to a particular location. Clusters are a dynamic agglomeration based around knowledge creation, innovation and increasing returns. This dynamic is embodied in the transformation of resources held by one or more cluster participant into resources deployable by another cluster participant (Roos et al. 2005/2006). The existence of knowledge externalities in clusters have been shown in several studies (Audretsch et al. 1996, Jaffe et al.1993). It is worth noting that these four types are not necessarily mutually exclusive, in that it is possible to have clusters within a city, etc.

There is substantial evidence that suggests that innovation and economic growth is heavily geographically concentrated. Clusters provide an environment that is conducive to

innovation and knowledge creation. Regions with strong cluster portfolios are innovative leaders, while regions with no clusters or isolated research facilities fall behind.

Globalisation has increased the benefits of strong clusters and raised the costs for regions which fail to develop some level of clustering. Strong clusters emerge in open markets where intense rivalry and cooperation within and between clusters co-exist. Clusters emerge where competition across regions enables companies, entrepreneurs and financial actors to choose a location based on the attractiveness of regions, rather than in response to artificial barriers. Globalisation has increased the need to combine strong internal dynamics within clusters with solid linkages to clusters and markets located elsewhere (Sölvell 2009).

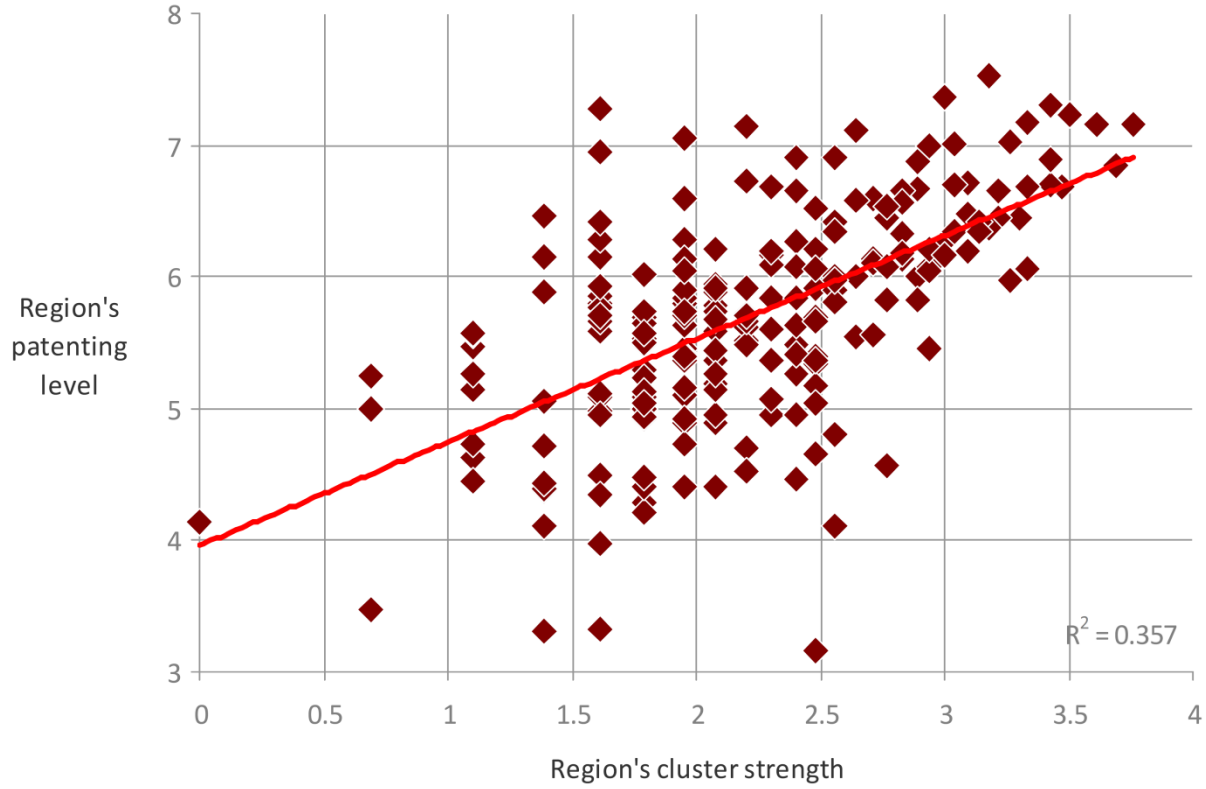

Figure 36: Cluster Strength and Patenting Levels in European Regions (Sölvell et al. 2009)

The Cluster Initiative Greenbook by Sölvell et al (2003) sets out some practical issues around supporting the formation and growth of clusters. In the following two tables from this book and from Sölvell (2009) the typical objectives of cluster initiatives and key success drivers are outlined:

Cluster Initiative Objectives
Human resources upgrading enhances the available skills pool and involves, for example, vocational training and management education. Such efforts can focus on different target groups of people. One type is intended to attract and retain students for the region – and sometimes, for selected sectors – to ensure the future supply of a skilled workforce. Another type targets managers through management training programs, typically not sector-specific. A third type is sector-specific vocational training and technical training.
Cluster expansion aims to increase the number of firms, through incubators or by promoting inward investment within the region. One way of doing this is to promote the formation of new firms, and by attracting existing firms to the region. Incubators are popular throughout Europe and are therefore a vital element of cluster policies. They often combine provision of physical facilities with assistance in setting up business plans and financial plans, and help entrepreneurs get in touch with financiers and potential customers.

Business development promotes firm operations, for example through export promotion.
Commercial cooperation encourages firms to interact with each other, for example through joint purchasing or sharing services to reduce costs.
Innovation objectives promote product, services and process innovation, for example through increased commercialisation of academic research. There are two general approaches to innovation, and they are often combined. One is to promote innovation through enhanced cooperation and networking between firms. The other is to enhance cooperation between the business sector and the research/university sector in order to commercialise academic research.
Business environment objectives, finally, aim at enhancing the microeconomic conditions for business, through improving the legal and institutional setting or improving the physical infrastructure. Improving the business environment means that conditions outside firms are improved. Business environment objectives therefore focus on issues that are in the hands of government, rather than working with firms directly. There are two main aspects of the environment that can be addressed: the physical/technical infrastructure, and the legal/institutional setting. In addition, regional branding is an objective that can be assigned to this category.
Key Success Drivers For Cluster Initiatives
The quality of the business environment, the structure and content of economic policy, and the strength of the underlying cluster have a particular influence on the cluster initiative's likelihood to succeed
Two aspects of the business environment have a particularly strong influence on the performance of the cluster initiative, measured by the successful attraction of new firms. One is strictly economic: the presence of an advanced scientific community and many strong clusters is an asset. The other is more cultural where a high level of trust between companies and between the private and public sector is positive for the cluster initiative.
Both the content of economic policy and the structure of the economic policymaking process are important for the success of a cluster initiative. Economic policies that secure high levels of competition, and promote science and technology, have a positive impact on cluster initiative success. A policy process that supports stable and predictable decisions and allocates important decisions to the regional and local level is also positive.
A strong tendency is that cluster initiatives serving strong clusters perform better, both in terms of increasing competitiveness and generating growth. Cluster initiatives for clusters that are of national or regional importance are better at attracting new firms, and the same is true for clusters with: long histories, many companies, including internationally competitive buyers and suppliers, and exhibiting tight networks of buyers and suppliers. Cluster initiatives seem to work best as "turbos" on existing clusters.
The cluster initiatives that have promotion of innovation and new technologies as an important objective are clearly more successful in improving competitiveness. Other similar objectives with a positive relationship to competitiveness are facilitating higher innovativeness, providing technical training and, to a lesser degree, analysing technical trends and establishing technical industry standards. There are also other direct or indirect approaches to increasing competitiveness: brand building and export promotion are both strongly related to improved competitiveness.
There is no evidence to suggest that a narrow or focused cluster initiative approach is better than a broad one. On the contrary, virtually every performance parameter (except the ability to meet deadlines) is positively related to having a broader range of objectives. Increased competitiveness, contribution to cluster growth and goal fulfilment all follow this pattern. Older cluster initiatives do not tend to have more objectives than younger ones, rather the contrary.
There are no significant differences in performance for cluster initiatives initiated by government, industry, or jointly. Both in terms of growth and in terms of competitiveness, these three groups have fared equally well. Nor is there any significant difference if they are grouped by main financing source. Government-financed cluster initiatives do not perform significantly better or worse than those financed primarily by industry or equally by industry and government. The only pattern emerging from the data is that the few cluster initiatives initiated primarily by the university sector have performed somewhat better in terms of improving ties between industry and academia, which is not surprising.
The findings are mixed regarding government actions on an initial stage to ensure the success of a cluster initiative. On the one hand, those cluster initiatives that went through a process of competing with other cluster initiatives to get government financing tend to perform better in terms of competitiveness, but not in terms of attracting new firms. On the other hand, if government bases its choice of which cluster to support with a cluster initiatives on research identifying "attractive" industry sectors, this is related to better performance in attracting new firms, but not to increasing competitiveness. There are other types of

government intervention, which have no significant effect at all.
Limiting the scope of the cluster initiative by aiming for a certain subgroup within the cluster as members does not help performance. Cluster initiatives with most members within one hour's travel distance, cluster initiatives with members on a particular level in the value chain and not their suppliers or customers, cluster initiatives avoiding having direct competitors as members, and cluster initiatives aiming at large companies rather than small ones have not performed better in attracting new firms or any other aspect of performance. Aiming for domestic companies rather than foreign-owned companies actually has a considerable negative effect on attracting new firms and on improving international competitiveness. Limiting the membership scope to only large companies, one level in the value chain, or only domestic companies is a recipe for failure.
Having the right set of resources to work with is important for success. A budget that allows a cluster initiative to carry out significant projects without seeking separate funding is strongly related to attracting new firms, as is having an office for the cluster initiative. Many cluster initiatives have exchange experiences with other cluster initiatives. If this involves cluster initiatives in the same industry, but in other regions, this is connected to attracting new firms.
The facilitator is another factor that has importance for the success of a cluster initiative in terms of competitiveness. Facilitators that have deep knowledge of the cluster and a strong network of contacts contribute more to increased competitiveness. Disappointing cluster initiatives often have no office or an insufficient budget for significant projects.
The framework for a cluster initiative can be built based on the specific strengths and capabilities of the cluster in question or by using a more generic framework. The former is strongly related to better performance in increasing competitiveness. It also matters how this framework is shared with the parties involved in the cluster initiative. Those cluster initiatives that spend time and effort on sharing the framework are more successful. Having achieved consensus about what actions to perform is also related to improved competitiveness. Failure is strongly related to a lack of consensus, as well as to the absence of an explicitly formulated vision for the cluster initiative and quantified targets. In failing cluster initiatives the framework is not adapted to the cluster's own strengths. Framework issues are more important to competitiveness performance than to growth performance. All the above effects have a less pronounced relationship to attracting new firms than to increasing international competitiveness.

Clusters can also fail. The key drivers of cluster demise are:

- Excessive concentration
- Heavy government involvement in saving and subsidising companies
- Radical technological shifts originating from other locations
- Radical shifts in demand at other locations
- War and other extreme circumstances.

Goverment intervention relating to clusters is justified by the market failures arising from the very local externalities that generate cluster activity (Sölvell et al 2009):

- Coordination failures exist, because individual companies consider in their decisions, be it whether to locate in a cluster or what investments to undertake being there, only the impact on themselves, not on others.
- Information asymmetries exist, because even if the incentive problems of taking account of the impact of own actions on others could be managed, the knowledge necessary to make the right "social" decision is dispersed among the many participants of the cluster.
- Path dependency exists, because decisions not only influence the present, but also the possible evolutionary path of the cluster in the future. Both coordination failures and information asymmetries thus have a dynamic dimension as well. And social and private discount rates might differ, creating an additional source of market failure.