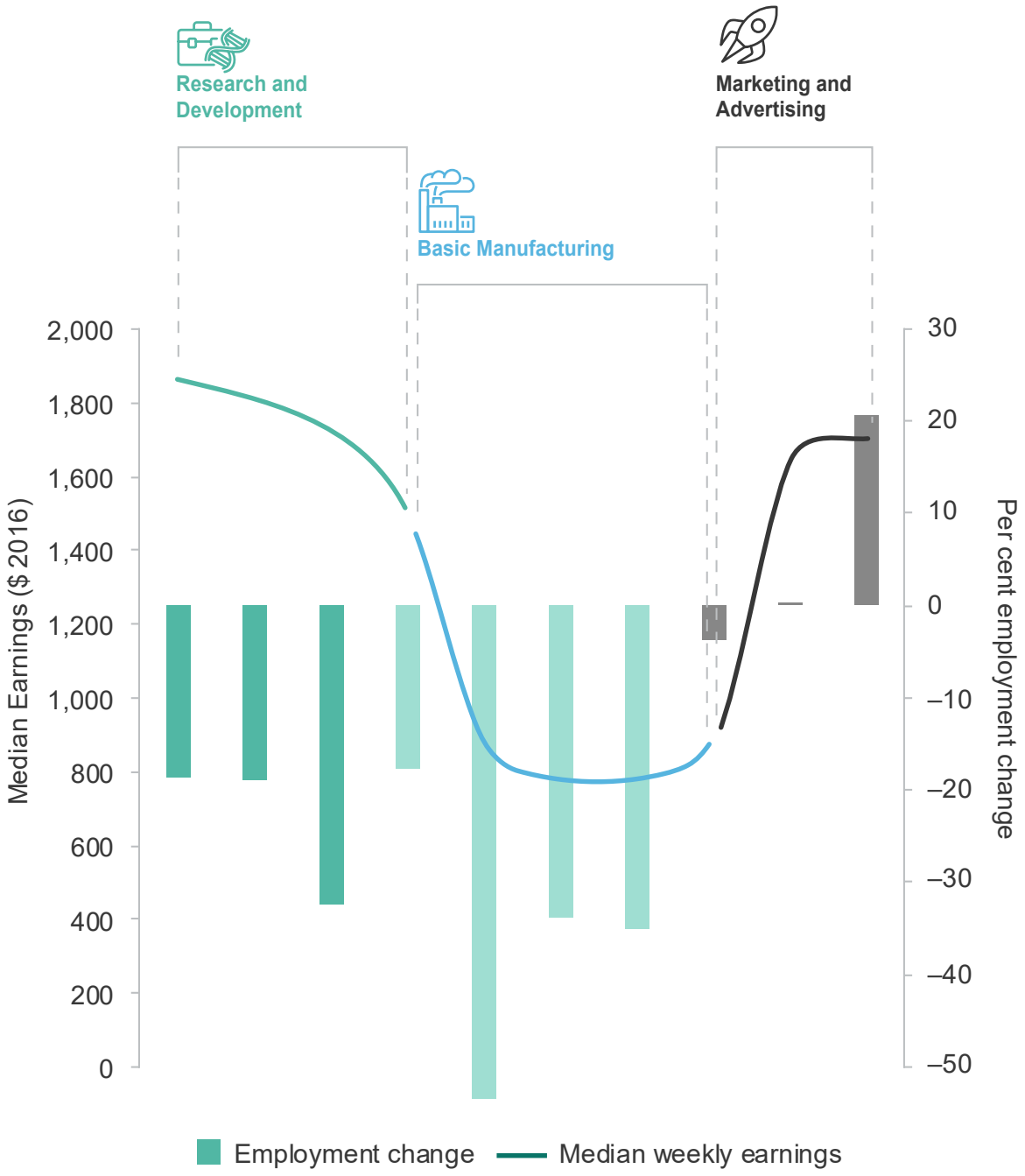
03

Manufacturing and soldiering of iron tips onto a pcb board

Manufacturing and the smile curve

Our manufacturing economy is changing

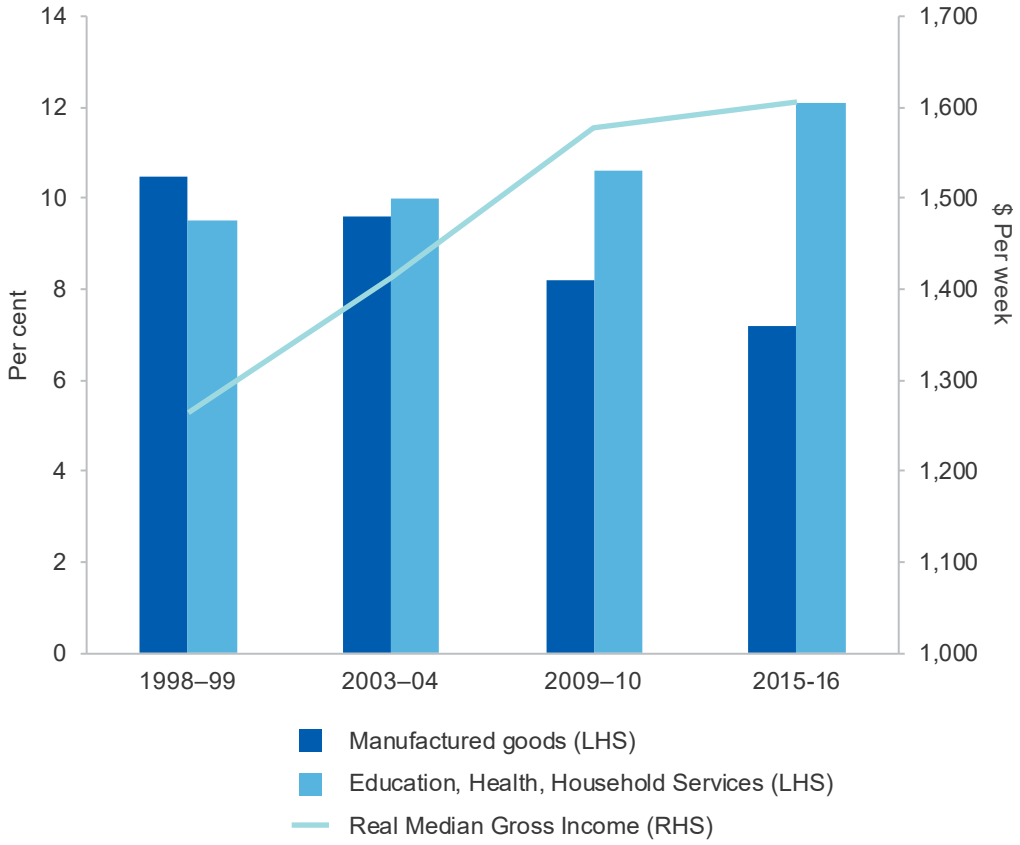
This smile curve can help visualise the changes occurring in manufacturing both locally and internationally. As Global Value Chains have increased in prominence, there has been more outsourcing of activities relating to manufacture and assembly to low cost economies. During this transition there has been a greater local focus on Research and Development, and Marketing and Advertising activities.



Since the late 1960s, Australian manufacturing industry has experienced a prolonged and steady decline in employment and share of Australian economic output. Almost all other developed countries have experienced this, but what are the reasons? One reason for the relative decline of manufacturing has been a change in consumer pending patterns. As incomes have risen, households have spent a greater share income on services, such as health, education and entertainment, and spend a smaller proportion of income on manufactured goods (Figure 3.1).[35]

Another is increased competition from China and other low-cost economies exacerbated by an extended period of relatively high Australian dollar values. In addition, local businesses have had to adapt to an international trade environment that has increased efficiency through technological improvements, decreased transaction costs and the rise of Global Value Chains (GVCs). Since 2008, overall manufacturing output has declined to 2001 output levels.[36]

Figure 3.1: Household expenditure on goods and services & income, 1998–99 to 2015–16



Notes: Left hand side is per cent of total household expenditure, values are represented in graph by bars; right hand side is median weekly gross income, values represented in graph by the line. Manufactured goods includes Clothing, Household Furnishings and Equipment.

Source: ABS Household Expenditure Survey: Summary of Results, 2015–16, cat. no. 6503.0

These challenges are not unique to manufacturing. As with other industries, success in this rapidly changing environment will be determined by how well individuals, firms and industries can adapt and take advantage of the new trading opportunities that have become available.

35 Beech A et al (2014) The Distribution of Household Spending in Australia, RBA Bulletin, March quarter, p. 15

36 Langcake S (2016) *Conditions in the Manufacturing Sector*, RBA Bulletin, June quarter, p. 27

Responding to broad economic changes can be challenging as demonstrated by the recent departure of the Australian car manufacturing industry. However, Australian manufacturers are responding positively to new trading opportunities. Despite recent declines in overall output, total manufacturing exports increased by 19.3 per cent from 2011–12 to 2014–15. This growth in exports was driven by: meat product manufacturers; basic chemicals; aircraft; and professional, scientific, computer and electronic equipment.[37]

Not only have manufacturers adapted to producing new products, they have also specialised. Australia has retained proportionally more high value added activities such as Research and Development and Marketing which are typically undertaken before and after they physical manufacture and assembly of a product. The activities occurring in the middle of the production chain, such as production and assembly, have disproportionally been performed offshore.

This chapter will present the 'smile curve' as a means to visualise the value of economic activity and the forces driving industry transition. It also examines how firms and industries are responding to the global changes in the nature of production and trade in manufactured goods.

Introducing the 'Smile Curve'

The 'smile curve', sometimes called the 'smiling curve', is a visual representation of value added along a production cycle.[38] The curve demonstrates that the greatest value across a production cycle is derived from early stage research and development, and post production activities such as sales, marketing and after-market services activities. The least valuable activities are those directly related to the production and assembly of a product, these activities are also routine in nature and have greater scope for automation and offshoring.

Many manufacturing firms, particularly within the information technology industry[39], have adjusted the structure of their businesses by outsourcing production specific activities and focusing their efforts on the high value activities in the smile curve outlined above. This isn't particularly surprising given it was the former CEO of Acer Inc., Stan Shih, who first developed the curve, and used its insights to re-allocate resources into research and development and marketing and outsourcing the actual production of their products.[40]

The basic structure of the smile curve is straightforward (Figure 3.2). Along the horizontal axis, the various production activities are ordered according to the intuitive flow of production: from research and development; to production and assembly; and ending with marketing and after-market services. The vertical axis is the value added for each of the broad production cycle activities. Within a firm, it is possible to use the rich set of information available to calculate value at precise points along each stage of the production cycle. At the broader industry level, value is usually approximated using other available data. The smile curves presented within this chapter will use employee wage information from the 2016 Census and other national surveys as an approximate measure of value added. While wages alone do not capture return on capital, another component of value, employee wages are typically the largest component within value-added and are readily available for the type of analysis within this chapter.

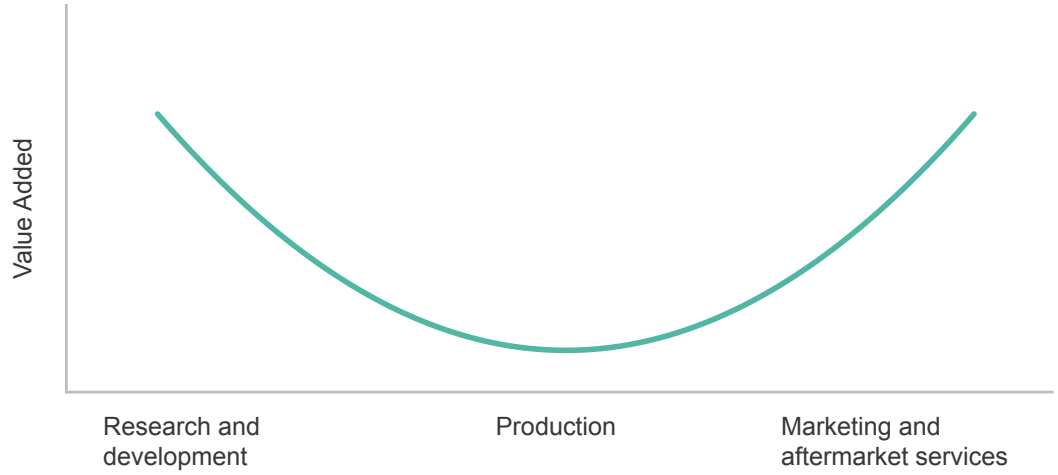
37 ABS *Australian National Accounts: Input-Output Tables*, 2014-15, cat no. 5209.0.55.001

38 Like the Phillips Curve, the Smile Curve is a stylised fact based on empirical observation

39 Clark T D, Zmud R W, & Mccray G E (1995) *The outsourcing of information services: transforming the nature of business in the information industry*. Journal of Information Technology, 10 (4), pp 221-237

40 Shih S (2010) *Millennium Transformation: Change Management for New Acer*, Aspire Academy

Figure 3.2: The traditional smile curve



Source: Stylized design as described by Baldwin R, Ito T, and Sato H (2014) Portrait of Factory Asia: Production network in Asia and its implication for growth – the 'smile curve', Institute of Developing Economies Japan External Trade Organization.

It is important to note that the traditional order of production activities on the horizontal axis may not reflect the production flow for all products within firms at all times. For instance, it is possible that new production methods can influence research and development, and that marketing and sales activities can provide information to support the development, manufacture and assembly of entirely new products.

Regardless of the order of these categories, it is the value of each component of the production cycle that provides firms with insights into where to allocate resources. The smiling shape isn't a fixed property of the curve and it is possible to derive more value from the production and assembly of products depending on factors such as the supply and productivity of labour, advances in technology and innovation, and the productivity of capital.[41]

In addition, all segments along the production cycle, regardless of their relative value-added, are necessary in order to bring a product to market. The information provided by mapping the smile curve is just one piece of the puzzle when it comes to firm-level decision making and must be balanced with the risks associated with outsourcing essential processes.

The next section will build on recent analysis from the World Bank,[42] as well as Baldwin & Evenett[43] and present global value chain production within the smile curve framework. The final section will look specifically at the Australian manufacturing industry using a method of generating within country smile curves from occupation activities.

41 For more information about how advanced economies can derive value from production and assembly activities see: The World Bank's report, Measuring and analyzing the impact of GVCs on economic development (citation below).

42 World Bank (2017) *Measuring and analyzing the impact of GVCs on economic development,* World Bank Group, p. 52

43 Baldwin R and Evenett S J (2014) *Value creation and trade in 21st century manufacturing*. Journal of Regional Science, 55(1), pp 31-50

Smiling globally

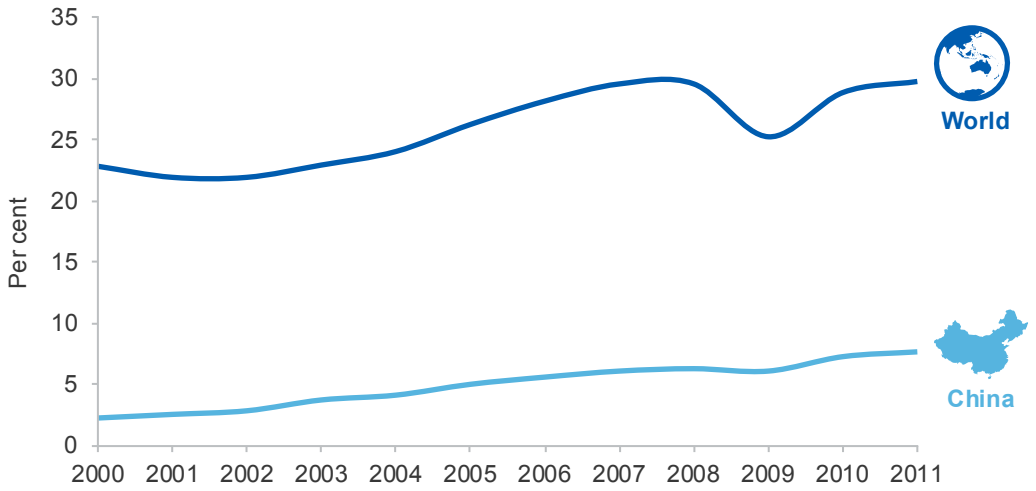
Australia has relatively high labour costs, a modest local consumer market, and large distances to major global consumer markets. These factors typically make it difficult for Australian manufacturers to compete internationally. However, since the turn of this century, there has been a major shift in how products are manufactured and assembled, from locally-integrated single manufacturers toward specialised manufacturing and services linked through GVCs.[44] This shift to GVCs has offered new opportunities to Australian manufacturers and exporters, yet Australia's contribution to GVCs remains skewed toward basic materials and energy.

Australia's contribution to GVCs

As a result of the shift in manufacturing processes, Australia's forward participation in GVCs is increasing. Forward participation occurs when goods that have been imported undergo further processing in the receiving country before being exported again. A comprehensive analysis of Australia's role in GVCs can be found in Chapter 2, however it is worth reiterating here the characteristics of the trading relationship between Australia and China.

The share of Australian value added exports to China that is being transformed and exported by China has tripled since the turn of the century (Figure 3.3) with only a small contraction during the Global Financial Crisis. An example includes iron ore, which is mined in Australia, sent to China where it can be transformed into steel for export, or transformed again into other export products such as household appliances.

Figure 3.3: Share of Australian forward participation in GVCs, by region, 2000 to 2011



Notes: Forward participation includes products which have been exported, transformed by the importing country, and subsequently exported again.

Source: OECD Trade in Value Added Database, Forward Participation in GVCs. Australian Government Department of Industry, Innovation and Science (2018).

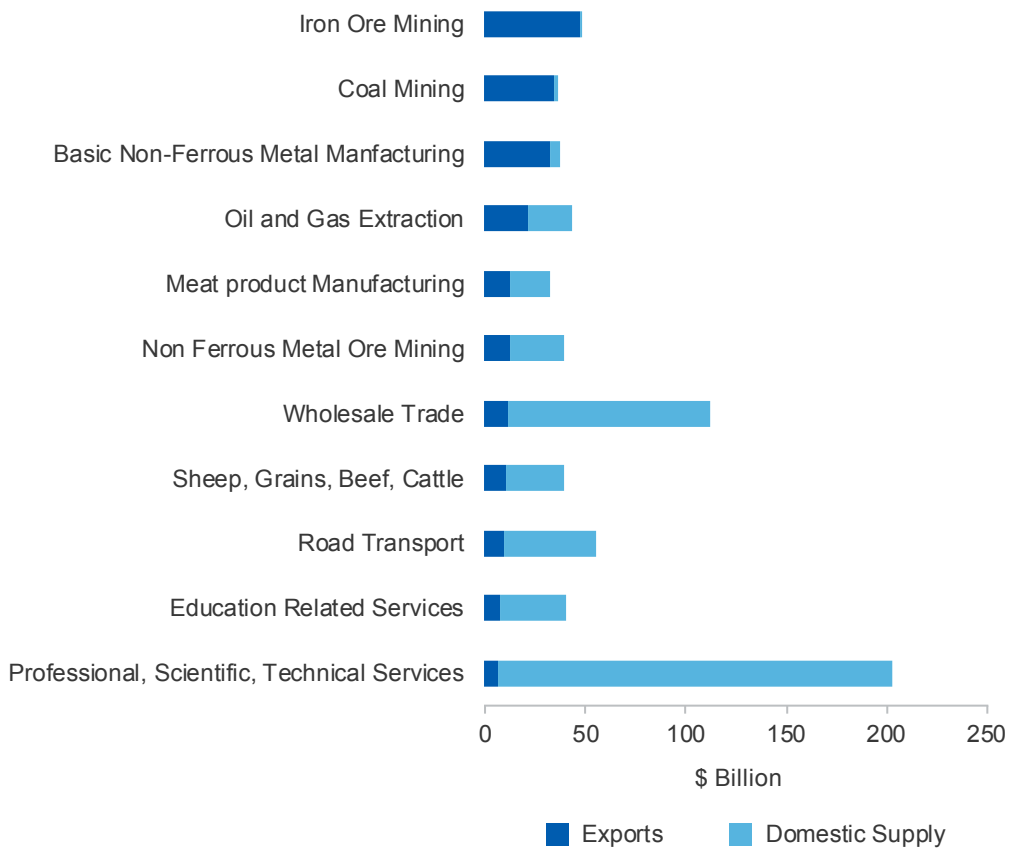
The rise in GVCs and Australia's increasing contribution to trade in primary and intermediate goods is a positive development. However, there is also potential for growth in Australia's

44 World Bank (2017) *Measuring and analyzing the impact of GVCs on economic development*, World Bank Group, p. 52

trade in activities at the edges of the smile curve, particularly the trade in professional, scientific and technical services.

As has been highlighted in Chapter 1, Australian exports are dominated by materials, energy and basic manufacturing products. Figure 3.4 below presents the top 11 Australian export product groups in 2014-15, ordered by the volume of exports. The top services export products making the list include education and training related services as well as the Professional, Scientific and Technical Services.

Figure 3.4: Exports and domestic supply by product group, 2014–15



Source: ABS Australian National Accounts: Input Output Tables, 2014–15 cat. no. 5209.0.55.001, Table 2

The production of basic metals and meat manufacturing products in this list comprises of activities that have traditionally occurred in the centre of the smile curve. The Professional, Scientific and Technical Services sector, however, is a category that includes a broad range of services, including activities that are located at the both edges of the curve, these being scientific research services, engineering design as well as advertising services and market research.

A feature of Australia's Professional, Scientific and Technical Services is the low share of exports out of overall supply.[45] Currently, 3.6 per cent of the production of these products is exported, a much lower export exposure than the equivalent product types exported by the United States (seven per cent in 2015) and the United Kingdom (23 per cent in 2015).[46] When compared to these peer economies with equivalent living standards, the low export rate of Australian Professional, Scientific and Technical Services demonstrates that if this rate increased to similar levels, this sector could be a source of future Australian export growth beyond raw materials.

Global trade is smiling

While the firm level smile curve can show the value of distinct stages of a production chain, analysis of global value chains can map the distinct regions in which each stage of global production occurs. When plotted with a measure of value, such as wages, it is possible to generate a curve that resembles the traditional smile curve.

Inspired by the work of Ming, Bo and Shang-jin,[47] Figure 3.5 plots the top five exporters of products within each smile curve category: research and development; basic manufacturing; and marketing and advertising.

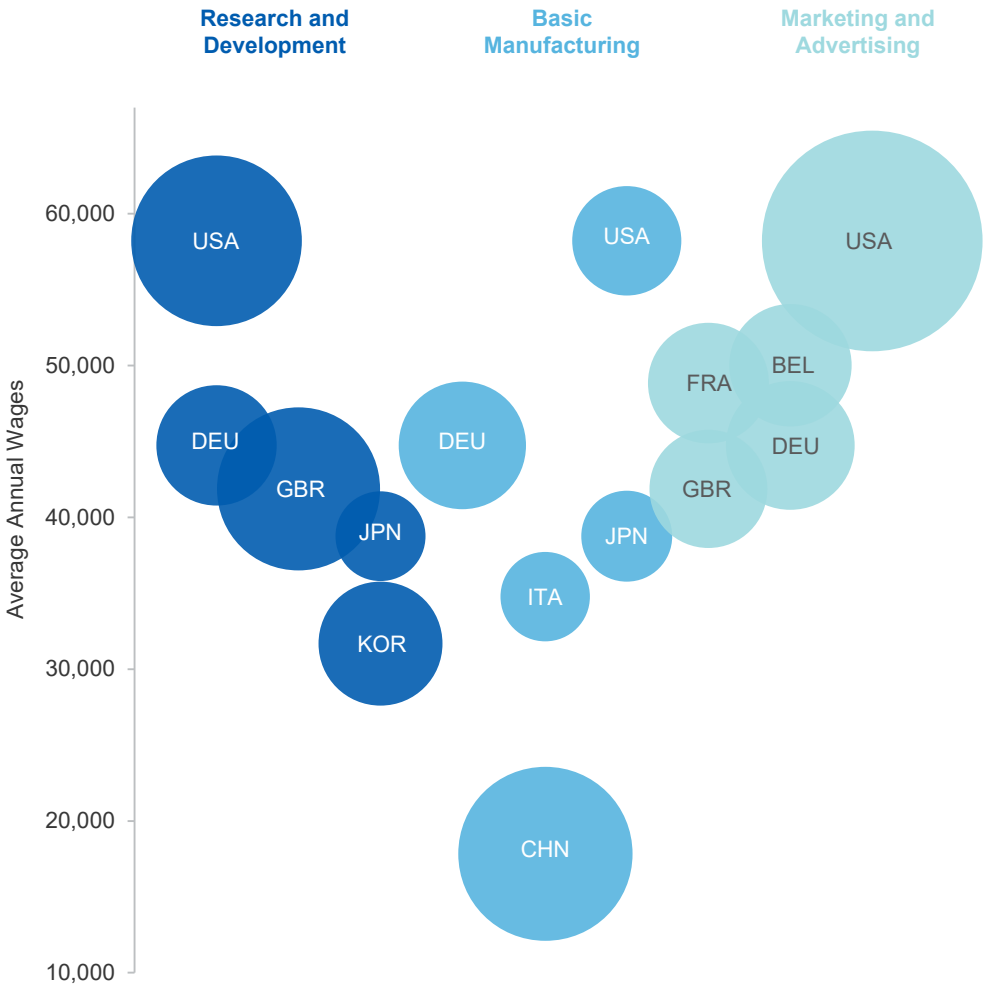
By using wages as a proxy for value an assumption is made that the share of the value of wages of total value added — including return on capital — is consistent across the broad activity categories and across regions. In addition, national average wages may not be equally distributed across activity types, or similarly distributed across regions. Nevertheless, when plotted this way with wages as a measure of value, the locations of the largest exporters of these products align with the broad understanding of global economic activity. In addition, the effect of return on capital on comparative advantage may explain how high cost regions have remained globally competitive.

45 Wholesale Trade also has low exports to local supply, however this ratio is in line with peer economies.

46 Australian Government Department of Industry, Innovation and Science (2018), analysis of Input-Output Tables produced by: Australian Bureau of Statistics National Accounts (2017) *Input Output Tables, 2014-15*, cat. no. 5209.0.55.001, Table 2; Bureau of Economic Analysis (2017) *Use of commodities by industry valued at producers' prices 1997-2016, 71 Industries*, The United States Department of Commerce; and The United Kingdom Office for National Statistics (2017) *Input-output supply and use tables, Table 2*, ONS.gov.uk. For each country, categories relating to Professional, scientific and technical services' were used, these being: "Miscellaneous professional, scientific, and technical services" for the USA; combined "Scientific research and development services", "Advertising and market research services", "Other professional, scientific and technical services"; and "Professional, Scientific and Technical Services" for Australia.

47 Ming Y, Bo M, and Shang-jin W (2015) *Measuring smile curves in global value chains*, IDE Discussion Paper, Institute of Developing Economies.

Figure 3.5: World share of exports by product type and price of labour by country, 2014



Notes: Size of each bubble represents share of world exports within each product group using World Input Output Tables. Wages information is the mean annual full time equivalent wage in 2016 US dollars (PPP) from the OECD in all cases except China, where the median annual wage for all employees was used from the ILO. The product groups on the horizontal axis were categorised using World Input Output Tables as follows: The Research and Development includes 'Scientific research and development' and the 'other professional, scientific and technical activities'; Basic manufacturing includes the manufacturing categories, 'basic metals', 'chemicals and chemicals products', 'fabricated metal products', 'furniture and other', 'other non-metallic mineral products', 'paper and paper products', 'rubber and plastic products', 'textiles, wearing apparel and leather products', 'wood, cork, straw and plaiting'; Marketing and advertising includes 'advertising and market research'.

Ordering of regions within each broad product export category has been organised aesthetically, the mean weighted positions of each category on the vertical axis are consistent with the theoretical position of activity along the smile curve.

Source: Timmer M. P et al (2015) *An illustrated user guide to the world input-output database: the case of global automotive production*, Review of International Economics, 23: pp. 575-605. OECD, 2018. Labour Earnings, Average Annual Wages. Stat.OECD.org. International Labour Organisation, 2018. Key indicators of the labour market, mean nominal monthly earnings of employees. Ilo.org/ilostat/

From this graph some compelling insights can be derived. First, the major exporters of products at the edges of the curve are located in high wage economies. In these sectors, wages are used as an approximate measure of value. These products often require labour with higher level skills and education, and firms within countries with relatively deep human and physical capital have a comparative advantage in high value added sectors. Australia's relatively low share of exports of professional and scientific services products is notable in this regard.

Second, the combined global share of exports of basic manufacturing products from the United States and Germany are similar to that of China (15.6 per cent and 16.8 per cent respectively). This demonstrates that it is possible for high labour cost economies to remain globally competitive provided that there is sufficient investment in sophisticated capital, new production technology and the availability of relevant skillsets to utilise these.

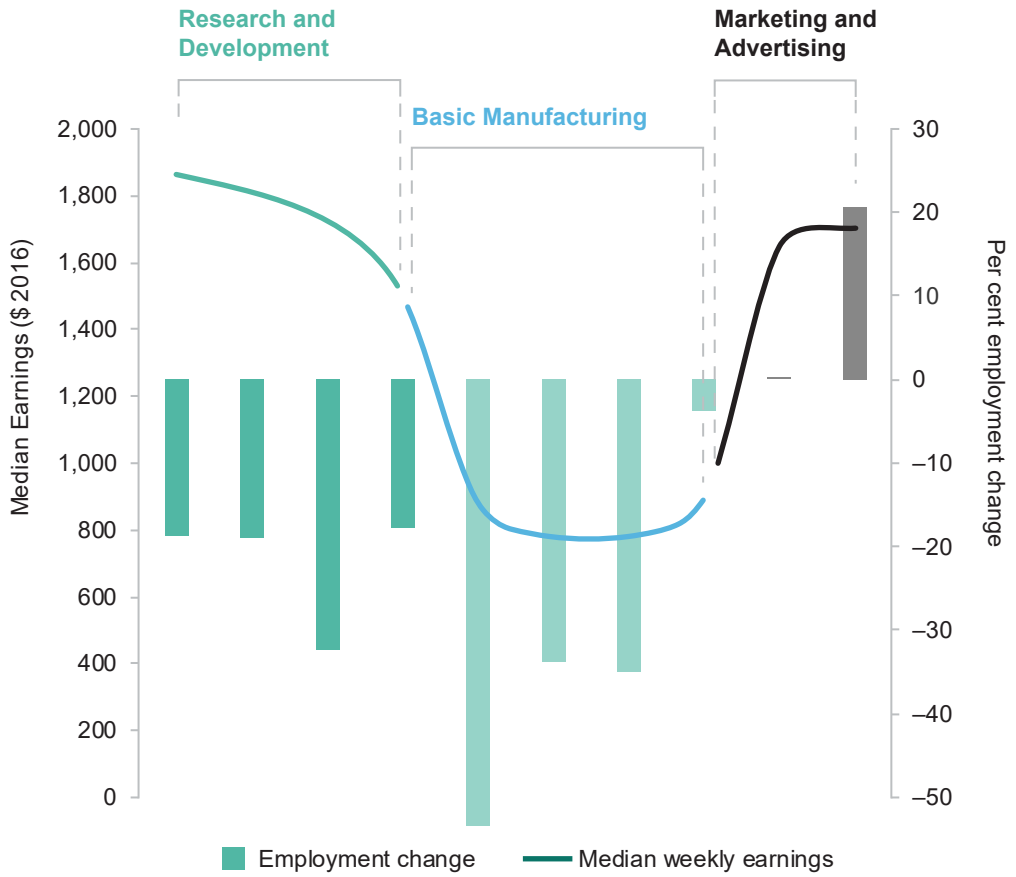
Smiling locally

Up to now, this chapter has presented the smile curve framework and applied it at a global scale by mapping export trade activity across separate sectors. This section will present a new approach to visualising smile curves within the Australian manufacturing industry, using industry and occupation information to plot the value of activities along the smile curve.

As demonstrated by Sebastien Miroudot from the OECD, occupations within the manufacturing industry can be grouped together to broadly align with the main activity categories of the traditional smile curve. When value added (in terms of employee wages), and employment growth is plotted along these same set of occupations, and the occupations within each activity type are ordered by average income, a distinct smile shape emerges (Figure 3.6).

This curve demonstrates that, within the manufacturing industry, there has been greater value added from activities that align with research and development as well as marketing and advertising, compared to the activities directly related to the production and assembly of goods.

Figure 3.6: The smile curve of Australia's manufacturing industry, 2006 – 2016



Notes: The three segments of the line are comprised of occupations (ordered from left to right) that align with R&D (1. Business and Systems Analysts, and Programmers; 2. Engineering Professionals; 3. Natural and Physical Science Professionals), Basic Manufacturing (4. Miscellaneous Factory Process Workers; 5. Packers and Product Assemblers; 6. Factory Process Workers not further defined; 7. Food Process Workers), and Marketing and Advertising (8. Sales, Marketing and 9. Public Relations; Information and Organisation Professionals). The values occupations within each category are plotted, and ordered by each occupation's average weekly earnings (FTE, $ 2016) as per the left vertical axis. The shaded bars represent employment growth (right vertical axis) for each of these same occupations between 2006 and 2016. The relative strength of food process workers employment may be reflecting the recent growth in output, exports and productivity across the broader food and agribusiness industry.

Source: ABS Census of Population and Housing 2006 and 2016

Similarly, there has also been greater demand for labour at the edges of the curve. During a period of overall declines in employment within the manufacturing industry, Figure 3.6 demonstrates that the occupations relating to research and development and marketing, experienced more modest declines and in some cases gained employment by over 10 per cent over the period. This implies that the manufacturing industry is improving its overall capacity to undertake these higher value activities, and is in a better position to capitalise on the export potential of these products.

Box 3.1: Profiles of Australian Manufacturers

Australian firms are responding to industry transition by engaging in high value research and development activities, and participating in new global market opportunities:

Astor Industries is a manufacturer of premier plastic injection moulded, electroplated, decorated and assembled components. They are an industry leader in automotive decorative badges – supplying to Holden, Mitsubishi, Ford and Toyota as an Original Equipment Manufacturer (OEM)[48] both locally and abroad. The end of car making in Australia could have closed the car badge manufacturer, but the company is thriving by branching into new markets. In addition, Astor now makes glasses frames for eyewear retailer Dresden Optics.

Scott Automation & Robotics specialises in the design and manufacture of automated production, robotics and process machinery. They are leading experts in automation and robotic solutions globally – solutions that improve productivity, reliability, yield, and safety for manufacturers and processors in industries. The world class builders of advanced automation systems are used particularly for the appliance, meat processing, mining and superconductor industries.

Source: Department of Industry Innovation and Science, Communications Branch

As the global standard of living continues to rise, the growth in demand for services is expected to outpace the growth in demand for goods. This chapter has discussed the forces that are driving change within Australia's manufacturing industry and demonstrated that in response to these forces there has been a relative shift in the types of activities being performed, from physical production and assembly to professional and scientific services and marketing.

The rise of global value chains and the corresponding increase in world trade of intermediate goods and services is a relatively new phenomena. Worldwide, the major exporters of products at the edges of the smile curve are located in advanced economies with high standards of living, sophisticated capital equipment and skilled human capital. Regions with these characteristics have a comparative advantage in high value added sectors, and Australia is in a unique position to take advantage of these opportunities

Many Australian manufacturers have already shifted investment toward research and development as well as marketing and in doing so are opening up new domestic and international business opportunities. Australia's relatively low share of exports of professional and scientific services products is a source of potential growth and continued investment in these activities will help Australia achieve its export potential.

48 An Original Equipment Manufacturer (OEM) is a supplier of parts and equipment that are installed in the production of new vehicles.

Transitioning industries

Nicholas Davis, Head of Society and Innovation, Member of the Executive Committee, World Economic Forum

The complex choreography between companies, technologies, social norms and economic conditions makes it impossible to predict the future, and difficult to make sense of the present.

Nevertheless, the rhythm and rhymes of history suggest that we are at a period where the way in which value is created, exchanged and distributed is changing around the world. At the World Economic Forum, we refer to this as “The Fourth Industrial Revolution”. One driver of this revolution is the availability of a set of powerful technologies that are converging and reinforcing one another – building on the digital infrastructure developed and constructed over the past 50 years, which most of us take for granted today.

The framework of the Fourth Industrial Revolution highlights the need for Australia to be firmly integrated into global value chains and knowledge networks, to benefit from the flows of value and accumulation of capabilities that they represent, and also in order to help lead a transition occurring on a scale far larger than Australia’s own economic transformations.

Industry, government and social leaders interested in ensuring that Australian citizens can prosper through a time of technological and economic transition therefore face two important challenges.

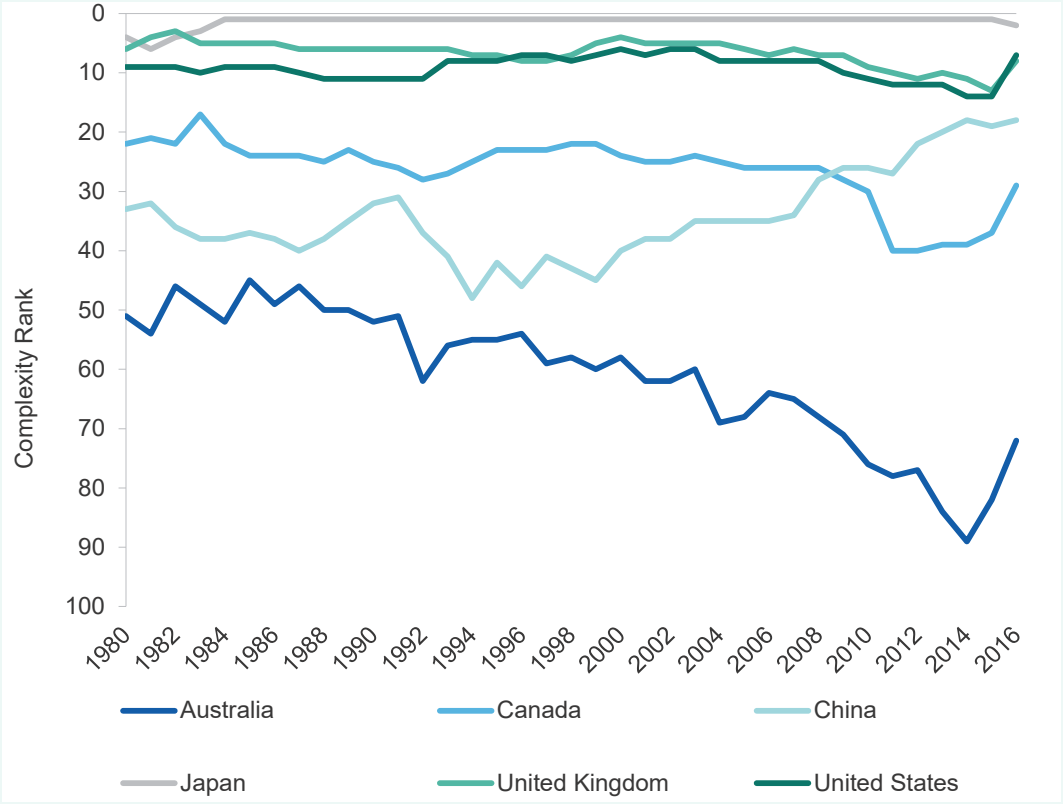
First, are Australian businesses and institutions prepared to grasp the opportunities offered by increasingly powerful emerging technologies, starting with the adoption and use of broad digital capabilities that can lead to machine learning, advanced robotics and use of new computing models?

This question is frequently asked from many different directions, but even more attention is needed. As EY’s Digital Australia report and the World Economic Forum’s data show, Australia’s digital readiness is slipping in relation to other countries, and the 2016 Australian Industry Report cited data that Australian companies are lagging in the sophisticated use of digital technologies.

One important perspective on Australia's readiness in transition is the role that networks and levels of complexity play in a country's ability to produce higher value-added goods within global value chains. Hidalgo and Hausmann's theory of economic complexity argues that products are a result of combinations of knowledge, natural resources and financial capital, influenced by both relational and organisational factors that capture cultural aspects, network effects and the policy landscape.[49] By focusing on the complementarity of value-adding activities, rather than the existence of individual factors of production, economic complexity offers opportunities to investigate the dynamic process by which new capabilities result in new products, and vice-versa.

As should be expected from an economy in transition, Australia has risen in recent years in both measures and rankings of economic complexity. Unfortunately, this comes after 34 years of declining levels of complexity: in 1980, Australia was ranked as the 51st most-complex economy in the world; in 2014, it ranked 89th. Since then, it has risen to 72nd in 2016, far below its ranking on other measures of economic output.[50]

Figure 3.7: Australia's ranking of economic complexity, 1980–2016



Source: Observatory for Economic Complexity, http://atlas.media.mit.edu/en/visualize/line/sitc/eci/show/aus/all/1980.2016/

Measuring complexity within countries is more challenging, but recent sub-regional analysis of economic complexity by Reynolds et al are more encouraging than the national picture, and reveal interstate trends useful for policy-making.[51]

49 Hidalgo C and Hausmann R (2009) 'The Building Blocks of Economic Complexity' in *Proceedings of the National Academy of Sciences of the United States of America*, 106, pp. 10570-5. 10.1073/pnas.0900943106. http://www.pnas.org/content/106/26/10570.abstract

50 Simoes AJG and Hidalgo CA (2011) *The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development.* Workshops at the Twenty-Fifth AAAI Conference on Artificial Intelligence. http://atlas.media.mit.edu/en/profile/country/aus/, accessed October 2017

51 Reynolds C et al (2017) *A sub-national economic complexity analysis of Australia's states and territories, Regional Studies*, pp. 1-12

Yet a plethora of data show that Australian organisations need to work far harder to overcome sectoral boundaries, geographic distance and barriers between disciplines to work together more often and more effectively. Australia's Industry Monitor 2016 reports that the level of collaboration among Australian firms – a key driver of knowledge accumulation and a strong indicator of profitability growth – is well below the OECD average. The percentage of Australian firms collaborating with universities and other non-commercial research organisations is among the lowest in the OECD.[52]

The second challenge is perhaps even more important: choosing what purpose, whose values and which principles will set the goals and guiderails for the transition to a new economy.

The key insight here is that technologies are neither mere tools, nor inevitable masters – two views which dominate the current, polarised discourse about the potential impact of technologies such as artificial intelligence, neuro technologies or distributed ledgers.

Every day, managers, investors, educators, developers and individual users make choices around the design, diffusion and use of technologies that shape how they affect us. And these choices matter – because our very natural human desires and biases become part of the technologies and systems that surround us. As Langdon Winner argued in 1980, technological artefacts have politics[53] – and this is perhaps even more true of an algorithm returning search results or a personalised gene therapy than Winner's examples of a weapon of mass destruction, automated agricultural machinery or a road to a beach designed to exclude people of colour.

Living at a time of transition in how we create value is a huge opportunity for Australia's entrepreneurs, business leaders, social influencers, policy-makers and citizens. Both the emerging technologies themselves and the human values being embedded in them are in flux. All around the world, regulations around self-driving vehicles are literally being written for the first time. Corporate data policies are being frantically updated as consumers call for awareness and control over the information they exchange with firms, and the entry into force of the European Union's General Data Protection Regulation (GDPR) fast approaches.

Productively engaging in these processes will require more than better consultation approaches, incentives for partnerships or more investment in lobbying – it will require CEOs and government leaders to reflect deeply on the values, purpose and principles that influence their choices of technology, the design of new systems and the resulting impact on Australian organisations and individuals.

As Simon Longstaff puts it, "We are responsible for the things we make" – and this includes our future economy as well as the technological and production systems that influence it.[54]

Grasping the industrial opportunities of an economy in transition therefore means shifting from trying to predict the future to taking every opportunity to shape it, capitalising on the very complex dynamics that make it so challenging to comprehend. And perhaps most importantly, we must ensure that we understand the role, and rising importance, of human values within global value chains.

52 Office of the Chief Economist (2016), *Industry Monitor 2016*, Canberra, ACT, Australia

53 Winner L (1980) Do Artifacts Have Politics?, *Daedalus*, Vol. 109, No. 1, Modern Technology: Problem or Opportunity? (Winter,1980), pp. 121-136

54 Longstaff S (2017), *Everyday Ethics*, Simon and Schuster

Aerial panorama of small coastal town in Australia