# 6 Productivity in Metal products

Multifactor productivity (MFP) growth in the Metal products (MP) subsector of Manufacturing declined between cycle 3 (1998-99 to 2003-04) and cycle 4 (2003‑04 to 2007-08) — with the subsector making the third largest negative contribution of any subsector to the MFP decline in total Manufacturing. The MFP decline in MP occurred despite very strong growth in output over cycle 4, because the growth in inputs was even larger.

This chapter examines the structure and characteristics of the MP subsector before detailing its pattern of MFP growth and the factors that are likely to have influenced it.

## 6.1 Metal products subsector structure and characteristics

MP consists of two *Australian and New Zealand Standard Industrial Classification* (ANZSIC06) subdivisions (table 6.1): Primary metal product manufacturing (‘Primary metals’) and Fabricated metal product manufacturing (‘Fabricated metals’).

Table 6.1 Activities within the Metal products subsector

|  |  |
| --- | --- |
| Subdivision | Primary activities |
| Primary metal product manufacturing | Includes the manufacturing of iron and steel (including casting and production of pipes and tubes), alumina refining and aluminium smelting, and smelting of other non-ferrous metals (such as copper, gold, zinc, lead, silver). Also includes casting of metals, aluminium rolling, drawing and extruding, and other manufactured products (such as wires, rods, plates, sheets and foil). |
| Fabricated metal product manufacturing | Includes iron and steel forging, structural metal products (including structural steel and architectural aluminium products), metal container manufacturing, sheet metal products, metal coatings, and other fabricated manufactures (such as cutlery, livestock yarding equipment, mattress supports and ammunition). |

*Source*: ABS (*Australian and New Zealand Standard Industrial Classification, 2006,* Cat. no. 1292.0).

The output from Primary metals is mostly exported (for example, refined metal and alumina) or used as inputs to Fabricated metals. Output from Fabricated metals is mainly used in construction and final consumption goods.

MP is a sizable share of total Manufacturing — 23 per cent of value added, 17 per cent of hours worked and 32 per cent of investment (gross fixed capital formation) in 2007-08. During cycle 4, MP’s share of investment rose particularly quickly, which had productivity implications that are discussed later in the chapter.

### Relative sizes of the Metal products subdivisions

In 2007-08 (the end of cycle 4), Primary metals was the larger of the two subdivisions in terms of value added, hours worked and investment (table 6.2). However, there is some volatility in the shares of outputs and inputs over time.[[1]](#footnote-1)

The mix of activities within the MP subdivisions is quite diverse. In Primary metals, the majority of value added comes from Basic non-ferrous metal manufacturing, of which Alumina production and Aluminium smelting are the largest components. Basic ferrous metal manufacturing — primarily the manufacture of steel — also makes up a significant share of Primary metals output.

In Fabricated metals, Structural metal product manufacturing — a product group that is mainly used in construction — makes up the largest proportion of value added. In turn, the largest parts of Structural metal product manufacturing are Structural steel fabricating and Architectural aluminium product manufacturing. Other fabricated metal product manufacturing also contributes a large proportion of value added in Fabricated metals.

Table 6.2 Composition of Metal products subsector, 2007-08**a**

Percentage shares of MP

|  |  |  |  |
| --- | --- | --- | --- |
| ANZSIC06 subdivision/group/classb | Value added | Hours worked | Investmentc |
| **21 Primary metal product manufacturing** | **61.3** | **52.9** | **76.7** |
| 211 Basic ferrous metal manufacturing | 17.6 |  |  |
| 212 Basic ferrous metal product manufacturing | 5.3 |  |  |
| 213 Basic non-ferrous metal manufacturing | 36.5 |  |  |
| *2131 Alumina production* | *16.9* |  |  |
| *2132 Aluminium smelting* | *8.4* |  |  |
| *2133 Copper, silver, lead and zinc smelting and refining* | *2.3* |  |  |
| *2139 Other basic non-ferrous metal manufacturing* | *8.9* |  |  |
| 214 Basic non-ferrous metal product manufacturing | 1.9 |  |  |
|  |  |  |  |
| **22 Fabricated metal product manufacturing** | **38.7** | **47.1** | **23.3** |
| 221 Iron and steel forging | 0.8 |  |  |
| 222 Structural metal product manufacturing | 19.5 |  |  |
| *2221 Structural steel fabricating* | *8.8* |  |  |
| *2222 Prefabricated metal building manufacturing* | *2.1* |  |  |
| *2223 Architectural aluminium product manufacturing* | *5.1* |  |  |
| *2224 Metal roof and guttering mfg (except aluminium)* | *0.6* |  |  |
| *2229 Other structural metal product manufacturing* | *2.9* |  |  |
| 223 Metal container manufacturing | 3.5 |  |  |
| 224 Sheet metal product mfgd | 2.9 |  |  |
| 229 Other fabricated metal product manufacturing | 12.0 |  |  |

a 2007-08 shares are presented because they are more representative of cycle 4, especially due to dramatic changes in prices in the following year. See figure H.1. b Detailed disaggregation not available for hours worked and investment. c Private new capital expenditure. d Except metal structural and container products.

*Sources*: ABS (*Experimental Estimates for the Manufacturing Industry,**2006-07 and 2007-08,* Cat. no. 8159.0); ABS (unpublished Labour Force Survey data);ABS (*Private New Capital Expenditure and Expected Expenditure, Australia, June 2011*, Cat. no. 5625.0).

### High capital intensity

MP is a more capital intensive activity than Manufacturing on average. MP had a higher share of its income from value added paid to capital than Manufacturing until the global financial crisis (GFC). And the extent to which MP’s net capital stock per hour worked exceeds that of Manufacturing has risen over time (figure 6.1). Explaining this strong growth in capital intensity is key to understanding this subsector’s productivity performance and is discussed in detail later in the chapter.

Figure 6.1 Measures of capital intensity for Metal products**a**

|  |  |
| --- | --- |
| *Net capital stock per hour worked*b | *Capital income share*c |
|  |  |

a Aggregate Manufacturing series presented here are those derived by the authors (appendix A). b 2009-10 dollars. c On a value added basis and includes some taxes attributable to capital (appendix A).

*Data sources*: Authors’ estimates based on ABS (*Australian Industry,* various issues*,* Cat. no 8155.0); ABS (*Australian Manufacturing,* various issues, Cat. no. 8221.0); ABS (*Australian System of National Accounts, 2010-11,* Cat. no. 5204.0); and ABS (unpublished Labour Force Survey data).

### Growth in R&D intensity

The R&D intensity of the subsector has been rising since 2000-01, although it remains lower than for Manufacturing as a whole. Within the subsector, the R&D intensity of Primary metals is higher than that of Fabricated metals (figure 6.2).

The R&D intensity of MP has been rising since the beginning of cycle 4, which suggests that changes in R&D activity are not behind the decline in MFP in MP over cycle 4.

Figure 6.2 R&D intensity**a** for Metal products

Per cent

|  |
| --- |
|  |

a Total R&D expenditure (current and capital expenditure) as a percentage of industry value added.

*Data sources*: Authors’ estimates based on ABS (*Research and Experimental Development, Businesses, Australia, 2010-11*, various issues, Cat. no. 8104.0); ABS (*Australian Manufacturing*, various issues*,* Cat. no. 8221.0); and ABS (*Australian Industry,* various issues, Cat. no. 8155.0).

## 6.2 Operating environment for Metal products

Demand for both primary and fabricated metal products has increased over the last two productivity cycles. Increased global demand for base metals led to higher commodity prices, which in turn influenced production and investment decisions in Primary metals. A boom in construction activity in Australia boosted demand for Fabricated metals, and indirectly for some Primary metals.

### Primary metal products received higher prices

#### Basic non-ferrous metals

There was strong growth in non-ferrous metal prices during the last two productivity cycles, particularly in cycle 4 (figure 6.3). This growth in prices was driven by strong demand from Asia over the period (Syed, Grafton and Kalirajan 2013; Australian Government 2012). The sustained prices encouraged investment by the producers of these metals, which explains much of the investment growth observed in the subsector as a whole.

The change in aluminium prices is particularly relevant as Australia is the world’s leading producer of bauxite ore and second largest producer of alumina (AAC 2010).

Figure 6.3 Changes in selected non-ferrous metal prices by cycle**a**

Average annual growth rate (per cent)

|  |
| --- |
|  |

a London Metals Exchange spot-market nominal prices.

*Data source*: BREE (2011).

#### Basic ferrous metals

A major shift in the operating environment for Australian manufacturers of ferrous metals (iron and steel) is the strong growth of steel output from China in recent years. During the 2000s, growth in Chinese steel production was close to 20 per cent a year, with China becoming a net exporter of steel in 2006 (Holloway, Roberts and Rush 2010). China not only increased its share of global steel production, but also changed its mix of steel production towards higher value flat products used in Manufacturing (Holloway, Roberts and Rush 2010). As shown in figure 6.4, China has recently become the largest producer of these steel products by a wide margin. Despite this increase in world supply, steel prices rose steadily through the 2000s (figure 6.5).

Figure 6.4 Country/region share of world steel production**a**

‘000 tonnes

|  |  |
| --- | --- |
| *Hot-rolled flat products* | *Hot-rolled long products* |
|  |  |
|  | |

a For selected steel products (hot rolled flat and hot rolled long only).

*Data source*: World Steel Association (2011).

Figure 6.5 Steel prices**a**

US$/mt

|  |
| --- |
|  |

a Current prices.

*Data source*: World Bank (2013).

##### Responses to greater imports of steel

The domestic producers of steel faced a higher price for both inputs and outputs, as well as greater competition in domestic and overseas markets. Responses of the major steelmakers in Australia have varied. For example, BlueScope Steel responded to the increased competition in the domestic market by becoming more focused on exports of higher value products (BlueScope Steel 2006). In contrast, Arrium (previously OneSteel) responded through diversification — altering its steel production process to use lower-quality iron ore and export the higher-quality iron ore from its mines (Onesteel 2005). Figure 6.6 shows the movements in trade in iron and steel.[[2]](#footnote-2)

Figure 6.6 Australian trade in Iron and Steel**a**

2009-10 $m

|  |
| --- |
|  |

a Based on Standard International Trade Classification (SITC) division 67: Iron and Steel.

*Data sources*: Authors’ estimates based on ABS (*International Merchandise Exports, February 2013*, Cat. no. 5432); ABS (*International Merchandise Imports, February 2013,* Cat. no. 5439.0); and ABS (*International Trade Price Indexes, March 2013,* Cat. no. 6457.0).

### Changing use of Metal products: from Manufacturing to Construction and Mining

Strong growth in construction activity in Australia over cycles 3 and 4 meant that there was additional demand for construction materials (figure 6.7).

Figure 6.7 Real value added of Metal products and Construction

2009-10 $m (chain volume measure)

|  |
| --- |
|  |

*Data source*: ABS (*Australian System of National Accounts, 2010-11,* Cat. no. 5204.0).

Increased non‑residential building and engineering construction led to increased demand for steel products over cycle 4. The resources boom also helped encourage greater urban infrastructure development and residential construction in mining regions (BlueScope Steel 2006). The commissioning of new mining and petroleum projects has presented opportunities for steel and fabricated metals producers, although the scope of these opportunities may have been more limited since the end of cycle 4.[[3]](#footnote-3)

The proportion of MP output going as inputs to the Construction and Mining industries increased accordingly over the 2000s — particularly fabricated metal products and ‘basic ferrous metal and metal products’ (figure 6.8).[[4]](#footnote-4)

Figure 6.8 Changing use of the output of Metal products**a**

Share of nominal output

|  |  |
| --- | --- |
| *Fabricated metals* | |
| 2001-02 | 2008-09 |
|  |  |
| *Basic ferrous metal and metal products*b | |
| 2001-02 | 2008-09 |
|  |  |

a Total supply is the sum of all final uses (including export) and total industry use. Based on the input-output table with direct allocation of imports. More input-output data are presented in appendix H. b Includes ANZSIC06 groups 211 and 212 for 2008-09 and ANZSIC93 group 271 for 2001-02. Other manufacturing includes all manufacturing uses other than that of Fabricated metals.

*Data source*: Authors’ estimates based on ABS (*Australian National Accounts: Input-Output Tables,* various issues, Cat. no. 5209.0.55.001, table 5).

Between 2000-01 and 2008-09:

* the proportion of fabricated metal products output used as inputs by Manufacturing fell from 30 to 24 per cent, while the proportions used in Mining and Construction rose (from 3 to 7 per cent, and 25 to 34 per cent, respectively)
* the proportion of basic ferrous metal and metal products output used as inputs by Manufacturing (other than Fabricated metals manufacturing) fell from 49 per cent to 40 per cent, while the proportion used by Construction rose from 13 to 20 per cent.

Over the period of cycles 3 and 4, the value of Fabricated metals and Basic ferrous metals and products supplied to the Construction sector rose much more quickly than the value of products supplied to Manufacturing. BlueScope Steel (2006) posited that local steel-intensive manufacturing, such as in white goods, hardware, appliances and food packing, was contracting. They noted a drop in the volume of sales to downstream manufacturers between 1997-98 and 2005-06. In particular, drying up of downstream users in Manufacturing and import competition had led to plant closures in tin plate steel and electrical steel (BlueScope Steel 2006).

## 6.3 MFP growth and its proximate causes in Metal products

MP’s average MFP growth was 2 per cent a year between 1985-86 and 2010-11. MFP in MP generally had an upward trend up to the early 2000s, before declining considerably to the mid-2000s, after which it picked up again (figure 6.9). This trend was fairly similar to that for Manufacturing in total, except for the drop in 2005-06.

Figure 6.9 MFP in Metal products and Manufacturing

Index 2009-10 = 100

|  |
| --- |
|  |

*Data sources*: Authors’ estimates; ABS (*Experimental Estimates of Industry Multifactor Productivity, 2010‑11,* Cat. no. 5260.0.55.002).

For the purposes of identifying the contributions of a subsector to MFP for Manufacturing as a whole, the cycles for Manufacturing in aggregate are used.[[5]](#footnote-5) Figure 6.10 presents MFP growth and growth in its proximate causes — the volumes of value added, hours worked and capital services — over the productivity cycles since 1988-89. MP’s average MFP growth was positive and fairly stable in the first three cycles — with value added growth exceeding combined growth in capital and labour. The negative MFP growth in cycle 4 (2003-04 to 2007-08) was exceptional. Despite very strong growth in value added, this was exceeded by even stronger growth in combined inputs, particularly capital.

Figure 6.10 MFP growth and its proximate causes**a** in Metal products by cycle

Average annual growth rate (per cent)

|  |
| --- |
|  |

a Capital services and hours worked weighted by income shares.

*Data source*: Authors’ estimates.

Growth of capital services has been consistently positive (up to 1 per cent a year for the first three cycles), but it was particularly strong in cycle 4 (up to 4.6 per cent a year). At the same time, hours worked generally declined — except in cycle 4, where they increased, but not to the same extent as capital services and value added. The growth of capital services relative to hours worked implies an increase in the capital-labour ratio, suggesting that MP has become more capital-intensive (as shown in figure 6.1).

There has been some improvement in MFP growth in the incomplete cycle. Input growth slowed by more than value added growth — with a return to reductions in hours worked and a more typical rate of capital services growth. (However, as noted in chapter 2, some care is needed in the interpretation of the incomplete cycle since it may be influenced by temporary factors, including the global financial crisis.)

As discussed in chapter 3, the principal focus of this paper is on explaining the decline in Manufacturing MFP growth between cycles 3 and 4 when MP made a large contribution to this decline. Figure 6.11 highlights the extent of the decline in MP’s MFP growth — with the large increase in value added growth being offset by an even larger increase in input growth, particularly capital services. The remainder of the chapter discusses influences that might underlie these large changes in MP between cycles 3 and 4.

Figure 6.11 MFP growth and its proximate causes**a** in Metal products, cycles 3 and 4

Average annual growth rate (per cent)

|  |
| --- |
|  |

a Capital services and hours worked weighted by income shares.

*Data source*: Authors’ estimates.

## 6.4 Influences on MFP growth in Metal products

Fabricated metals appears to have been driving MP value added growth and the bulk of the hours worked growth, while Primary metals appears to have been largely responsible for the rapid growth in capital services.

### Strong value added growth in Fabricated metals

Real value added growth for the MP subsector as a whole was 4.5 per cent a year over cycle 4 — 3.2 percentage points higher than the previous cycle (figure 6.11). Data for real value added in each of the subdivisions (Primary metals and Fabricated metals) are not available. However, other indicators suggest that Fabricated metals, rather than Primary metals, was the source of value added growth in the MP subsector.[[6]](#footnote-6)

One available measure of output volumes (*real* ‘sales and service income’) shows an increase for Fabricated metals over cycle 4 and a decline for Primary metals (figure 6.12).[[7]](#footnote-7) *Nominal* sales and service income of Primary metals rose as prices for the subdivision’s output increased in response to greater demand for those products.[[8]](#footnote-8) However, *real* sales and service income (which nets out this price change) indicates that the volume of Primary metals output fell. Fabricated metals, which had real sales growth, was more likely to have contributed to the strong value added growth in MP over cycle 4.

The remainder of this subsection examines more disaggregated data from alternative sources to help identify possible drivers of output in each MP subdivision.

Figure 6.12 Sales**a** in Metal products subdivisions

Nominal ($m) and real (chain volume measure 2009-10 $m)

|  |  |
| --- | --- |
|  |  |

aSales and service income.

*Data source*: ABS (*Business Indicators*, *September 2012,* Cat. no. 5676.0).

#### Primary metal products

Output data published by the Bureau of Resource and Energy Economics (BREE) confirms that the physical volume of output of most primary metal products did not grow faster in cycle 4 than cycle 3 (table 6.3).[[9]](#footnote-9)

Volumes for most primary metal products declined during cycle 4 with a total decline of -0.2 per cent a year, which was 2.8 percentage points lower than the cycle 3 growth rate of 2.6 per cent a year. Product‑specific factors were at play in explaining many of the declines in output volumes. For example, refined gold output fell in line with declining mine output. Iron and steel output dropped due to the closure of the Boodarie iron briquette plant (BHP Billiton 2005; ABARE 2004b, p. 447).

Table 6.3 Estimated growth in output volumes of primary metal products

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Cycle 3: 1998-99 to 2003-04 | |  | Cycle 4: 2003-04 to 2007-08 | |  | Difference between  the cycles | |
|  | *Change in volume*a | *Contribution to total*b |  | *Change in volume*a | *Contribution to total*b |  | *Change in volume*a | *Contribution to total*b |
|  | % py | % pts |  | % py | % pts |  | % py | % pts |
| Alumina | 3.3 | 0.6 |  | 3.8 | 0.7 |  | 0.5 | 0.1 |
| Tin | -1.5 | 0.0 |  | -16.6 | 0.0 |  | -15.1 | -0.0 |
| Silver | 8.6 | 0.1 |  | -0.6 | 0.0 |  | -9.1 | -0.1 |
| Lead | 1.8 | 0.0 |  | -5.4 | -0.1 |  | -7.2 | -0.1 |
| Aluminium | 2.2 | 0.4 |  | 1.1 | 0.2 |  | -1.0 | -0.2 |
| Gold | -1.1 | -0.3 |  | -2.1 | -0.5 |  | -1.1 | -0.2 |
| Zinc | 6.6 | 0.2 |  | 0.4 | 0.0 |  | -6.2 | -0.2 |
| Copper | 8.4 | 0.5 |  | -0.7 | -0.1 |  | -9.1 | -0.5 |
| Iron and steelc | 2.0 | 0.4 |  | -3.6 | -0.4 |  | -5.6 | -0.8 |
| Nickeld | 9.8 | 0.8 |  | -0.5 | -0.1 |  | -10.4 | -0.9 |
| **Total** |  | **2.6** |  |  | **-0.2** |  |  | **-2.8** |

a Production volumes — average annual growth rates. b Size times growth. Estimated relative contributions to growth of all of the BREE-listed metal products commodities. Contribution based on value weights, calculated from export price or London Metal Exchange price. c Consists of manufactured ferrous products. d Nickel is the sum of class I and II products.

*Source*: Authors’ estimates based on BREE (2012b).

The primary metal products that experienced positive growth in cycle 4 were alumina (3.8 per cent a year), aluminium (1.1 per cent a year) and zinc (0.4 per cent a year). Of these, only alumina output grew at a rate faster than in cycle 3.

Growth in the volume of output of alumina, aluminium and zinc does not seem to be sufficient to explain the strong growth in value added for the MP subsector as a whole.

#### Fabricated metals

Practically all of the value added growth in Fabricated metals seems to have occurred in construction-related products, which tallies well with the changes in the operating environment.

While there are some difficulties in calculating real value added (box 6.1), there is strong evidence to indicate that those parts of the subdivision associated with construction — particularly structural steel manufacturing — were responsible for the bulk of nominal value added growth in MP, between cycles 3 and 4.

|  |
| --- |
| Box 6.1 Difficulties in measuring value added in Fabricated metals |
| Value added data are available only in nominal terms for ANZSIC groups within the MP subsector. Because changes in nominal value added reflect both price and volume changes, at best they provide a broad indication of the relative growth the volume of value added in different parts of Fabricated metals manufacturing. There is no source of data analogous to that used for Primary metal manufacturing to look at physical volumes of production.  ANZSIC changes  There are also several differences in the definition of Fabricated metal products manufacturing between the 1993 and 2006 editions of ANZSIC. This makes it difficult to construct a long enough time series to fully describe movement within the subdivision over cycles 3 and 4. The main problem is that parts of several ANZSIC93 classes were divided up into a greater number of overlapping ANZSIC06 classes and some activities were moved from the MP manufacturing subsector to other parts of Manufacturing (for example, Machinery and equipment manufacturing and Other manufacturing) or to Construction.  There are, however, a handful of classes that concord exactly from ANZSIC93 to ANZSIC06 (by ANZSIC06 code):   * 2221 *Structural steel fabricating* (23 per cent of Fabricated metals value added in 2007-08) * 2229 *Other structural metal product manufacturing* (13 per cent) * 2291 *Spring and wire product manufacturing* (7 per cent) * 2292 *Nut, bolt, screw and rivet manufacturing* (4 per cent) * 2293 *Metal coating and finishing* (2 per cent)   In addition, there is another category that concords closely, based on the descriptions given in both editions of the relevant ANZSIC manual:   * 2223 *Architectural aluminium product manufacturing* (8 per cent)   Thus, it is possible to examine movements in the above series (which comprise around 57 per cent of the subdivision value added, and almost three-quarters of the growth, in cycle 4) as well as an amalgamated group of all other fabricated metal products activities that comprise the remainder of the subdivision. |
| *Sources*: ABS (*Australian and New Zealand Standard Industrial Classification, 2006,* Cat. no. 1292.0); authors estimates’ based on ABS (*Experimental Estimates for the Manufacturing Industry, 2006-07 and 2007-08,* Cat. no. 8159.0). |
|  |
|  |

Table 6.4 details the growth in selected industry classes within the Fabricated metals subdivision, together with a ‘catch-all’ category for the part of the subdivision that cannot be easily tracked over time due to industry classification changes.

Table 6.4 Estimated contributions to growth in nominal value added of Fabricated metals

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Cycle 3: 1998-99 to 2003-04 | |  | Cycle 4: 2003-04 to 2007-08 | |  | Difference  between the cycles | |
|  | *Change* | *Share of growth* |  | *Change* | *Share of growth* |  | *Change* | *Share of growth* |
|  | $m | % |  | $m | % |  | $m | % |
| 2221 Structural steel fabricating | -142 | -8.3 |  | 1 151 | 40.5 |  | 1 293 | 115.1 |
| 2223 Architectural aluminium product mfg | 270 | 15.7 |  | 356 | 12.5 |  | 86 | 7.6 |
| 2229 Other structural metal product mfg | 128 | 7.4 |  | 279 | 9.8 |  | 152 | 13.5 |
| 2291 Spring and wire product mfg | 4 | 0.2 |  | 20 | 0.7 |  | 16 | 1.4 |
| 2292 Nut, bolt, screw and rivet mfg | 62 | 3.6 |  | 32 | 1.1 |  | -30 | -2.6 |
| 2293 Metal coating and finishing | 112 | 6.5 |  | 284 | 10.0 |  | 172 | 15.3 |
| *Selected classes*a | *434* | *25.2* |  | *2 122* | *74.6* |  | *1 688* | *150.3* |
| *All other fabricated metal prod.*b | *1 286* | *74.8* |  | *721* | *25.4* |  | *-565* | *-50.3* |
| **22 Fabricated metals** | **1 720** | **100.0** |  | **2 843** | **100.0** |  | **1 123** | **100.0** |

a Includes ANZSIC classes listed above. b See box 6.1 for definition.

*Sources*: Authors’ estimates based on ABS (*Australian Manufacturing*, various issues, Cat. no, 8221.0); ABS (*Australian Industry*, various issues, Cat. no. 8155.0); and ABS *(Experimental Estimates for the Manufacturing Industry,* various issues, Cat. no. 8159.0).

Much of the growth over cycle 3 was contributed by this catch-all category, but the classes responsible for growth in cycle 4 are more easily identified. Nearly three-quarters of the growth in cycle 4 in the nominal value added of Fabricated metals was in ‘Structural steel fabricating’ (over 40 per cent), ‘Architectural aluminium product manufacturing’ (12.5 per cent), ‘Metal coating and finishing’ (10 per cent) and ‘Other structural metal product manufacturing’ (9.8 per cent).

Structural steel products, therefore, more than accounts for the total increase in nominal value added growth in Fabricated metals *between* cycles 3 and 4. This was partially offset by a decline in the value added of the other Fabricated metals category. Metal coating and finishing and Other structural metal product manufacturing also registered strong growth between the cycles.

#### Summary of value added trends

While data are limited at more disaggregated levels within MP manufacturing, all the available evidence indicates that the majority of growth observed between cycles 3 and 4 occurred in structural steel products. Much of that growth appears related to activities associated with construction — which suggests that the construction ‘boom’ in the lead-up to the global financial crisis may have benefited Fabricated metals and explains the growth in nominal value added for the subdivision over the period (appendix H).

### Capital

Much of the decline in MFP for MP between the last two complete productivity cycles was driven by the strong capital services growth of the subsector. There was a rapid rise in capital investment by MP in cycle 4, during which the subsector contributed about 40 per cent of the capital services growth in Manufacturing as a whole.

Capital services growth in MP was driven by the strong investment in Primary metals, particularly in projects designed to increase the capacity (and in some cases efficiency) of alumina refining. There were also some smaller investments made in nickel refining and copper smelting. Investments were also made in Fabricated metal production, but on a much smaller scale.

#### Investment by asset and industry

Growth in capital services for MP more than quadrupled in cycle 4 relative to cycle 3. A starting point for examining the reasons for the increase in capital services is to look at the type of investment undertaken.

Figure 6.13 shows the real value of MP investment by asset type — namely machinery and equipment, non-dwelling construction, research & development and software. Machinery and equipment and non-dwelling construction were the largest components of investment, with very strong growth in non-dwelling construction in cycle 4. While the level of R&D investment is much smaller, it also grew substantially over cycle 4 in MP, although there has now been some decline over the incomplete cycle.

Figure 6.13 Metal products gross fixed capital formation by asset type**a**

2009-10 $m

|  |
| --- |
|  |

a The estimation of capital services for each subsector of Manufacturing (as discussed in chapter 3), involved apportioning Manufacturing investment (gross fixed capital formation from the ABS National Accounts) across the different subsectors. This allowed for the construction of a time series for MP investment in different capital asset types (see appendix A for details).

*Data sources*: Authors’ estimates based on ABS (*Australian System of National Accounts, 2010-11*, Cat. no. 5204.0); ABS (unpublished Survey of New Capital Expenditure data); and ABS (*Research and Experimental Development, Businesses, Australia,* various issues, Cat. no. 8104.0).

Nearly all of the growth in MP investment over cycle 4 was driven by Primary metals (figure 6.14).

Figure 6.14 Metal products gross fixed capital formation by subdivision and asset type

2009-10 $m

|  |
| --- |
| *Machinery & equipment* |
|  |
| *Non-dwelling construction* |
|  |
|  |

*Data sources*: Authors’ estimates based on ABS (*Australian System of National Accounts, 2010-11,* Cat. no. 5204.0); and ABS (unpublished Survey of New Capital Expenditure data).

#### Primary metals

As discussed in section 6.2, capital expenditure to expand production capacity in mining and in metals processing is likely to be in response to rising commodity prices throughout cycles 3 and 4. Most of the investment in MP between the last two complete productivity cycles occurred in Primary metals and, of that, most occurred in expanding alumina production capacity.

Table 6.5 shows the growth in net capital expenditure between 2001-02 and 2006‑07 by selected groups and classes in Primary metals.[[10]](#footnote-10) It indicates that Primary metals contributed around 88 per cent of the growth in net capital expenditure for MP as a whole (or 11.3 percentage points of the 12.8 per cent a year). Of this, most occurred in alumina refining (8.5 percentage points) and other non-ferrous metal manufacturing (3.2 percentage points).

Table 6.5 Breakdown of net capital expenditure of Metal products subsector**a**

2001-02 to 2006-07

|  |  |  |  |
| --- | --- | --- | --- |
|  | Change | Growth rate | Contribution  to growth |
|  | $m | % py | % pts |
| **Total Metal product manufacturing** | **1 909** | **12.8** | **12.8** |
|  |  |  |  |
| **Primary metal product manufacturing** | **1 681** | **13.9** | **11.3** |
| Iron & steel | 229 | 8.2 | 1.5 |
| Basic non-ferrous metal | 1 330 | 14.9 | 8.9 |
| *Alumina production* | *1 265* | *51.7* | *8.5* |
| *Aluminium smelting* | *-407* | *-15.1* | *-2.7* |
| *Other non-ferrous*b | *472* | *16.3* | *3.2* |
| Basic non-ferrous metal products | 122 | 36.3 | 0.8 |
| *Aluminium drawing, rolling and extruding* | *123* | *49.5* | *0.8* |
|  |  |  |  |
| **Fabricated metal product manufacturing**c | **228** | **8.2** | **1.5** |

a Current prices. Data for 2006-07 are based on ANZSIC06 adjusted to match ANZSIC93. There are minor concordance issues with ‘Aluminium smelting’ and with ‘Non-ferrous basic metal products’ in 2006-07. The concordance issues for Fabricated metals are significant (box 6.1). b For ‘Other non-ferrous’, average annual growth is for 2001-02 to 2004-05. Other non-ferrous’ is a catch-all category which includes classes 2723 Copper, silver, lead and zinc smelting, refining and 2729 Basic non-ferrous metal manufacturing nec. c Fabricated metals includes 274 Structural Metal Product Manufacturing, 276 Sheet Metal Product Manufacturing and 275 Fabricated Metal Product Manufacturing in 2001-02.

*Source*: Authors’ estimates based on ABS (*Manufacturing Industry, Australia*, various issues, Cat. no. 8221.0).

Around 70 per cent of the growth in investment in MP between cycles 3 and 4 can be attributed to new metal processing investments. Most of these projects were alumina-related (around 80 per cent of the capital expenditure identified in the ABARE ‘minerals and energy major development projects’ list),[[11]](#footnote-11) while steel (8 per cent) and nickel (5.6 per cent) were also important.

The rest of this section examines these specific investments and the likely motivations behind the investment in the alumina, aluminium and other primary metal product industries.

##### Alumina investment to expand capacity

Alumina projects drove most of the capital expenditure in Basic non-ferrous metals, particularly in cycle 4. While there were several aluminium brownfields projects that took place during the last two complete productivity cycles, they were far exceeded in value by alumina projects in cycle 4, some of which were worth multibillions of dollars. Alumina significantly increased its share of net capital expenditure by MP, while aluminium smelting reduced its share in the period for which class data are available (figure 6.15).

Figure 6.15 Net capital expenditure of Metal products subsector**a**

$m

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| --- |
|  |

a Current prices. Data for 2006-07 are based on ANZSIC06 adjusted to match ANZSIC93. ‘Other non-ferrous metals’ which includes the classes ‘2723 copper, silver, lead and zinc smelting and refining’ and ‘2729 Basic non-ferrous metal mfg nec’, also include group ’273 Non-ferrous basic metal product manufacturing’.

*Data source*: ABS (*Manufacturing Industry, Australia,* various issues, Cat. no. 8221.0).

These investments were aimed at expanding production capacity in response to expectations that commodity prices would remain high. ABARE (2004a, pp. 126–7) forecast strong growth in alumina output associated with these new investments to meet greater overseas demand for alumina to meet aluminium smelting requirements.

Other data also indicate that Australia’s refining capacity increased significantly over the 2000s: from 13 Mt in 2000 to 20 Mt in 2010 (Prosser 2013, pers. comm., 8 October). Indeed, in 2005 the Australian Aluminium Council noted:

While both alumina and aluminium production levels in 2005 remained similar to 2004 results, alumina capacity is currently being increased through both debottlenecking of existing plant and the construction of additional capacity. Further production growth is anticipated as recent developments ramp up to full capacity. (AAC 2005, p. 2)

The Australian Aluminium Council (2006, 2007) also indicated that there was likely to be growth in production of alumina (and aluminium) as expansion projects began to utilise their additional capacity. However, there may have been some underutilised capacity within the industry over cycle 4 (and to an even greater extent following the GFC). While there was an increase in the production of alumina over cycle 4 (table 6.3), growth in output volumes fell short of expectations. For example, alumina output generally fell short of ABARE forecasts over the 2005-06 to 2009-10 period.

As well as increasing capacity, investment may also have been aimed at improving cost-competitiveness by taking advantage of lower cost energy sources, such as natural gas. While the technical process of alumina refining has largely remained unchanged in the past twenty years, there have been changes in energy sources used. There has been a shift towards adopting cogeneration as a more efficient and less greenhouse gas-intensive source of energy (AAC 2004). Investment undertaken during cycle 4 and the current incomplete productivity cycle included the construction of co-generation facilities (box 6.2).

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| Box 6.2 Cogeneration |
| Cogeneration is a process of generating electricity while using or recovering the waste heat in addition to the primary power source. Alumina production requires steam, and cogeneration uses waste heat from the production of electricity to generate high-pressure steam more efficiently. Investment in cogeneration is driven by cost-reduction and is dependent on alumina refineries being able to secure a supply of energy source, usually gas.  **Alcoa Pinjarra Alumina Refinery upgrade ($440 million, commissioned April 2006)**   * This project involved an efficiency upgrade to the refinery as well as installation of two cogeneration plants, bringing total capacity to 4.2 mt per year. The cogeneration facilities are not owned by Alcoa, but by Alinta. They run on natural gas and provide electricity and high-pressure steam for the refinery, while also supplying electricity to the grid. The steam produced by cogeneration replaces the 240 tonnes per hour of steam that was previously generated by the refinery’s own boilers, which is just less than half of the refinery’s steam requirements (Power-technology.com 2012).   **Rio Tinto Alcan Yarwun 2 ($2.5 billion, completed 2012)**   * The Yarwun 2 project involved installing a new cogeneration plant run on coal seam gas, which was commissioned in August 2011. The cogeneration plant makes Yarwun self-sufficient in electricity and steam requirements, and also provides surplus power to the grid (Sizer 2011).   The effect of a move to cogeneration on *measured* productivity in MP manufacturing is complex and will depend on the relative efficiency of the electricity production and ownership of the cogeneration facilities. For example, such a shift could raise value added as intermediate inputs in the form of purchased electricity are reduced, but it would also involve additional capital investment, hours worked and other intermediate inputs. |
|  |

Given the sudden and pronounced increase in investment, particularly in alumina refining over cycle 4, this raises the question of whether the poor productivity performance in the MP subsector was partly driven by a lag between when this new investment was recorded and when output associated with the investment came on stream (a ‘capital lag’). For example, some of the alumina investment projects took several years to complete and there was also a process of ramping up production following expansions (AAC 2006).

Analysis of possible capital lags (box 6.3) tends to indicate that, even after allowing for lag between investment in cycle 4 and new capacity becoming available for production in the incomplete cycle, output growth has been relatively low. This suggests that, in the incomplete cycle, some of the new capacity within the MP subsector may have been underutilised, but could be employed if the operating environment improved.

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| --- |
| Box 6.3 Testing for capital lags |
| MFP is calculated on the basis that investment is immediately productive, but this may not be the case for projects that take a long time to complete. This introduces a lag between the measured increase in capital inputs and any associated increase in output. The length of time between investment and output is called a ‘capital-lag’.  One technique to gauge the magnitude of the effect that capital-lags could have on measured MFP is to lag capital expenditure in order to better reflect capital inputs coming on-stream and any growth in output that may ensue. Lagging capital is most likely to produce the greatest effect on MFP growth in periods where there is a surge in capital inputs, and may smooth out MFP fluctuation in the short run. It is expected to have little effect on MFP in the long run.  On average, the time between investment and completion in MP is between two and three years. The effect, then, of lagging capital inputs is very apparent in the 2003-04 to 2007-08 productivity cycle — the period of strong capital inputs growth. Allowing for a two-year lag of capital services (so that they are matched with output produced two years after capital installation), annual average MFP growth in cycle 4 improves by 0.6 of a percentage point but is still negative (-0.3 per cent) and MFP growth in the next (incomplete) cycle becomes negative. With a three-year lag, MFP improves by 1.8 percentage points and actually becomes positive (1.0 per cent) in cycle 4, but the MFP in the incomplete cycle becomes even more negative.  **Effect of two- and three-year capital lags on Metal products MFP**   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | Average annual MFP growth | | |  | Effect of the lag on MFPa | | | *Cycle* | *no lags* | *2 year lag* | *3 year lag* |  | *2 year lag* | *3 year lag* | |  | % | % | % |  | % pts | % pts | | Cycle 1: 1988-89 to 1993-94 | 1.0 | 0.3 | 0.2 |  | -0.7 | -0.8 | | Cycle 2: 1993-94 to 1998-99 | 1.1 | 1.3 | 0.8 |  | 0.2 | -0.3 | | Cycle 3: 1998-99 to 2003-04 | 1.4 | 2.3 | 2.5 |  | 0.9 | 1.1 | | Cycle 4: 2003-04 to 2007-08 | -0.9 | -0.3 | 1.0 |  | 0.6 | 1.8 | | 2007-08 to 2010-11b | 0.1 | -1.7 | -2.4 |  | -1.8 | -2.5 |   a Relative to the case with no lags. b Incomplete cycle.  *Source*: Authors’ estimates.  In effect, as output growth has been relatively low during the incomplete cycle despite the increased capacity, allowing for capital lags has only ‘pushed out’ the period of the poor productivity performance to a later period. While these investments in alumina refining have been completed, output has remained roughly equal to the level reached at the end of cycle 4. For example, the production of alumina in 2011 was 19.6 Mt, while total capacity is quoted as 21.95Mt (AAC 2012), which suggests there is underutilised capacity. (A further discussion on capital lags for MP is provided in appendix H.) |
|  |

##### Aluminium investment

While there has been an increase in the level of alumina investment over cycles 3 and 4, there has been a decline in the amount of investment in aluminium. Nonetheless, there were a few projects that were completed over cycle 4.

* In 2006, Hydro Aluminium completed two upgrades worth a total of $130 million at the Kurri Kurri facility (ABARE 2006b).
* In 2006, the Boyne Island Smelter completed a $56 million project to increase capacity (ABARE 2006b).
* In 2007, Tomago Aluminium also completed upgrades worth $200 million to expand capacity and improve energy efficiency (Tomago Aluminium 2013).

Collectively, these investments amounted to $386 million during cycle 4, which would have contributed to the growth in capital services in MP observed over the period. However, aluminium investments above account for only a small proportion of investment over cycle 4 compared with alumina investment (table 6.5).

##### Other non-ferrous metals investment in response to higher prices

There have been other investments in Basic non-ferrous metals manufacturing, particularly nickel and copper metal manufacturing.

Investment in nickel refining appears to be driven by a single large investment of $731 million, associated with the Yabulu nickel refinery upgrade, in order to process ore from the new mine at Ravensthorpe (Gleeson et al. 2008). The motivation behind this upgrade was the particularly strong increase in prices for nickel driven by increased demand from China, particularly for use in stainless steel (Oututec 2005).[[12]](#footnote-12)

Xstrata also invested over cycle 4 to expand its copper smelter at Mt Isa and upgrade its refinery in Townsville — an investment of $100 million which was completed in 2007. The purpose of the expansion was to increase the smelter’s capacity by about 16 per cent to 280 kilotons per year (ABARE 2005, p. 137).[[13]](#footnote-13)

Collectively these account for around $830 million of investment, much of which occurred over cycle 4. While not as large as the investments in alumina (table 6.5), these other non-ferrous metal investments still made a significant contribution to the growth in capital services observed in MP.

##### Basic ferrous metals investment in response to changing conditions

There have been two investment projects of particular note with respect to steelmaking over cycle 4.

One project was undertaken by Arrium (formerly OneSteel), which has a relatively vertically integrated chain of production to make steel, ranging from iron ore mines to steelworks. It responded to the higher iron ore prices by investing in measures to allow a lower grade of ore (magnetite) to be used so that it could export its supply of higher grade ore (hematite). This ‘project Magnet’ was completed in 2007 and cost $395 million. In addition to changing the type of ore used, it also extended the life of the steelworks from 2020 to 2027, since the surrounding Middleback mines had limited hematite reserves (OneSteel 2005).

The other project was the ‘HIsmelt’ plant commissioned by Rio Tinto in 2005 at a cost of $400 million. This plant was considered a breakthrough in smelting technology, as a means of directly smelting iron ore into high grade molten iron for use in steel products. It was designed to process high phosphorous iron ore and to use non-coking coals, thus reducing environmental impact (Goodman 2007). However, after the GFC, the smelter ceased production and in 2011 the plant was dismantled and relocated to India (Rio Tinto 2011).

#### Fabricated metals

Fabricated metals made a significantly smaller contribution to the capital services growth in MP than Primary metals, but still had increasing investment over cycle 4.

Figure 6.16 shows net capital expenditure by selected Fabricated metals product groups, as well the remainder of the subdivision. The data indicate that the strongest growth in net capital investment occurred in those categories that cannot be separately identified, but there was also noticeable investment growth in Structural steel product manufacturing and Metal and coatings manufacturing. There is some evidence to indicate that some investment in the fabricated sector was associated with expansion and automation of the steel industry (McDonald 2009).[[14]](#footnote-14)

Figure 6.16 Net capital expenditure of Fabricated metals subdivision**a**

Sum of net capital expenditure 2001-02 to 2006-07, $m (current prices)

|  |
| --- |
|  |

a There exists a break series between 2005-06 and 2006-07 due to changes in ANZSIC. Those industry classes shown have been concorded between classifications, but some are unable to be concorded — these are grouped together in the ‘all other fabricated metal products’ (which should not be confused with ANZSIC06 group 229 or ANZSIC06 class 2299). See box 6.1 for more details regarding Fabricated metals concordance.

*Data source*: Authors’ estimates based on ABS (*Manufacturing Industry, Australia,* various issues,Cat. no. 8221.0).

Investments in Fabricated metals may have been made in association with the construction boom and in anticipation of additional future demand for construction materials. In addition, there is also evidence to suggest that investment was designed to allow the manufacturing of different sorts of construction goods. Examples of innovation for steel in residential construction goods cited by BlueScope Steel (2006) include blue resin for coated steel and complete roofing, truss and guttering systems. The construction boom also coincided with a push by the fabricated metals industry to incorporate a ‘design and construct’ trend (as had occurred in the United Kingdom) (The Warren Centre 2007). This involves providing more tailored products to meet changing downstream demand.

### Labour

There was growth in hours worked in MP over cycle 4, after a decline over cycle 3 (table 6.6). It is difficult to establish definitively which of the subdivisions within MP contributed to this growth in hours worked. One source of disaggregated data suggests that employment in Fabricated metals grew over cycle 4. This is consistent with value added growth in Fabricated metals — particularly those parts related to construction. (For a comparison of the alternative data sources see appendix H.)

Table 6.6 Metal products hours worked

Average annual growth rate (per cent)

|  |  |
| --- | --- |
|  | Growth |
| Cycle 3: 1998-99 to 2003-04 | -2.6 |
| Cycle 4: 2003-04 to 2007-08 | 1.5 |
| Incomplete cycle: 2007-08 to 2010-11 | -2.7 |

*Sources*: Authors’ estimates based on ABS (unpublished Labour Force Survey data).

## 6.5 Drawing together the implications for productivity

Metal product manufacturing made the third largest contribution to the slowdown in MFP growth within Manufacturing between productivity cycles 3 and 4. This negative growth in the subsector’s MFP was driven by very strong growth in inputs, which outpaced particularly strong growth in outputs. However, growth in inputs and outputs were very different across the two subdivisions within the subsector. The strong value added growth observed in the subsector appears to have been driven by growth in Fabricated metals, motivated by stronger demand from the domestic construction and mining sectors. There was also some value added growth in parts of Primary metals — primarily in alumina refining.

Growth in capital inputs accounted for around 63 per cent of the growth in combined inputs between cycles 3 and 4, with practically all of the investment growth taking place in Primary metals. This investment — the bulk of which was in alumina refining — was associated with building new metal refining assets and upgrading existing ones. This expansion was in response to the higher commodity prices observed over 2003-04 to 2007-08 and in anticipation of strong demand in the future.

Growth in hours worked between the cycles accounted for the remaining 37 per cent of growth in total inputs, with Fabricated metals likely to have contributed most of this growth. This rise in the number of hours worked during cycle 4 was significant as it reversed a trend of declining hours worked for the subsector, which had reduced hours worked in every cycle since 1988-89.

Fabricated metals appears likely to have experienced positive MFP growth over cycle 4 — a result of having the bulk of the output growth over the period, although it also had most of the labour input growth.

In contrast, Primary metals is likely to have contributed nearly all the decline in MFP, due to extraordinary growth in capital inputs without any evidence of growth in the real volume of output for the subdivision in total. There may be an element of ‘capital-lag’ to this result, although the length of such a lag may be longer than expected, as falling demand in the incomplete cycle means that the investment in capital is yet to be fully utilised.

In summary, Primary and Fabricated metals appear to have been pulling MFP in the MP subsector in different directions between cycles 3 and 4, with Primary metals playing the main role in the decline and Fabricated metals offsetting the scale of the decline to some extent.

It appears likely that the decline in MFP in MP over cycle 4 was exceptional. Average MFP growth in MP was just above zero in the incomplete cycle (0.1 per cent a year). While value added growth fell to 0.3 per cent a year, combined input growth was also very low. Hours worked fell, almost offsetting growth in capital services, which has slowed relative to the exceptional growth of cycle 4.

1. During cycle 4, the share of hours worked and investment growth comprised by Primary metals rose quickly. And since 2007-08, Primary metals has had a smaller share of value added than Fabricated metals, since value added in Primary metals has declined. More details are provided in appendix H. [↑](#footnote-ref-1)
2. Trade in all metal products is discussed in greater detail in appendix H. [↑](#footnote-ref-2)
3. The steel industry has raised concerns that Australian suppliers are increasingly overlooked when it comes to supplying major mining and construction projects (McDonald 2009). Other research indicates that Metal products continues to supply a significant proportion to the mining industry and that changes in source of supply reflect the changing composition of mining projects (especially in regards to constructing new liquefied natural gas capacity) (Connolly and Orsmond 2011). [↑](#footnote-ref-3)
4. Proportions based on input-output tables are in nominal terms. Accordingly, changes in shares could reflect changes in volume and/or price. [↑](#footnote-ref-4)
5. The cycles for MP do not exactly match those of Manufacturing (appendix C), but the change in timing does not detract from the overall finding that MP has had a significant decline in MFP over the mid- to late-2000s and contributed to the overall decline in Manufacturing MFP. As a result, MP-specific cycles are not shown here. [↑](#footnote-ref-5)
6. Value added is gross output less intermediate inputs used in producing that output. Intermediate inputs are the inputs used by the business other than capital and labour — for example, energy, raw materials and services. The volume of value added refers to value added with the effect of price changes removed.

   In the case of MP, there is little evidence to suggest a change in the proportion of intermediate inputs being used, thus changes in value added are being primarily driven by changes in gross output. [↑](#footnote-ref-6)
7. Comparability of data for MP from the National Accounts and from other ABS surveys is discussed in appendix H. [↑](#footnote-ref-7)
8. This is borne out by an examination of the implicit price deflators for Primary metals based on the sales and service income, as well as the producer price indexes of output for the subdivision. Specifically, growth in the output producer price index for Primary metals was 1.6 and 13.5 per cent a year for cycles 3 and 4, respectively — an acceleration of 11.9 percentage points. The implicit price deflator for sales and service income for Primary metals grew at a rate of 5.3 and 15.6 per cent a year for cycles 3 and 4, respectively — an acceleration of 10.3 percentage points. See appendix H for further details. [↑](#footnote-ref-8)
9. The value of production (inferred from BREE data) captures, on average, around 70 per cent of the sales and service income in Primary metals (from ABS Cat. no. 8155.0) for the years 2000‑01 to 2010-11. [↑](#footnote-ref-9)
10. Net capital expenditure is another measure of investment, which differs from ‘gross fixed capital formation’ and ‘private new capital expenditure’. Net capital expenditure is used here because it is the only measure of investment available below the subdivision level of disaggregation. However, these data were only published for the 2001-02 to 2006-07 period. [↑](#footnote-ref-10)
11. The list details many mineral processing investments that fall under Primary metal product manufacturing and includes data regarding expected completion dates and value of capital expenditure (Gleeson et al. 2008). [↑](#footnote-ref-11)
12. It is worth noting that during the incomplete cycle, the price of nickel fell and the Ravensthorpe nickel mine was mothballed. The Yabulu refinery was sold, but continued to produce refined nickel from other sources. In 2013, it was refining nickel at record levels. [↑](#footnote-ref-12)
13. This project was also adversely affected by plummeting prices after the GFC. In the face of competition from Chinese refineries, Xstrata decided to dismantle both the Mt Isa smelter and Townsville refinery by 2016, but to continue to acquire and invest in copper mining. Investment measures are typically adjusted to take account of disposals of assets in order to derive capital services inputs, but in the case where the write-off of an asset occurs below that of its previous value (that is, the replacement value at the time the investment was made), then there is some scope for part of the capital asset to remain in the capital services measure. [↑](#footnote-ref-13)
14. Information from the Australian Steel Institute, presented in a consultancy report to the then Steel Industry Innovation Council, indicates that the scale of investment in automation and expansion of capacity between 2006 and 2008 was in the order of $400 million (Howard Partners 2012). The report noted that ‘These investments preceded the GFC in 2009 and many businesses were subjected to significant financial pressure, with many going out of business over the last two years as demand has failed to recover.’ (Howard Partners 2012, p. 53). [↑](#footnote-ref-14)