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Overview

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| Key points |
| * Multifactor productivity (MFP) growth in Manufacturing was negative over the most recent complete productivity cycle (2003-04 to 2007-08), in contrast to the positive growth in the previous cycle. This large decline was atypical for Manufacturing, and since then MFP has continued to decline (although more slowly). * Manufacturing’s MFP decline was a major contributor to flat market sector MFP. * There is no overarching systemic reason for the large decline. Rather, various subsector-specific factors, such as lags between investment and output; unmeasured increases in quality; and lower capacity utilisation all contributed. Some factors reflect temporary responses to changing competitive conditions. * Faster rates of input growth (capital and hours worked) and slower output (value added) growth were the ‘proximate causes’ of this Manufacturing MFP decline. * Petroleum, coal, chemical and rubber products (PCCR), Food, beverage and tobacco products (FBT), and Metal products (MP) collectively accounted for two-thirds of the decline between cycles. Influences on each subsector were diverse. * PCCR output declined in absolute terms over the most recent cycle (after growing over the previous cycle), and yet there was a large increase in capital investment. * Petroleum refineries invested to meet new environmental standards, but the improved fuel quality is not fully reflected in the output measure, and thus in MFP.  Value added per unit of output also declined, as greater volumes of feedstock and refined fuel were imported in response to reduced output from domestic oilfields. * For plastic products, increased production by overseas firms with lower input costs and the appreciation of the Australian dollar led to strong import competition. Domestic production declined, leading to underutilised capacity. Higher demand for fertilisers and explosives led to very large investments to expand chemical production, but there was a lag before output increased. * Food and beverages output growth slowed, yet hours worked increased significantly. * Slower output growth was associated with a decline in exports and a loss of domestic market share for some products — reflecting input cost pressures, appreciation of the Australian dollar, and, in cases such as wine, drought. * Consumer preferences also drove changes in the composition of output that increased the input intensity of production — for example, there was growth in smaller scale, more labour intensive, non-factory bakeries. * But the decline in MFP in FBT may have been overstated due to challenges in measuring improved output quality and reductions in the capital stock. * Metal products was different, with faster output growth and even faster input growth. * Fabricated metals output grew strongly to meet increased demand from the Construction and Mining sectors. * Metal products was responsible for most of the capital growth in Manufacturing, largely to expand alumina refining capacity. However, the inevitable lag between investment and ensuing output led to lower measured productivity. * The MFP decline in Manufacturing has slowed in the current incomplete cycle. MFP growth in PCCR and FBT remains negative and it is marginally positive in MP. |
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# Overview

During the 1980s and 1990s, Manufacturing in Australia exhibited a rising trend for both real value added and multifactor productivity (MFP). In particular, real value added grew strongly over the 1990s. And although it has plateaued since, real value added is still larger now than it was at the turn of the century. Over the long term, hours worked (and therefore, broadly, jobs) have declined but Manufacturing investment has risen. Real investment rose strongly over the 2000s, before slowing since the global financial crisis.

Despite Manufacturing’s value added growth performance, MFP has been declining since 2003-04. This has been one of the main contributors to the recent flat to declining productivity of the whole market sector of the Australian economy.

Manufacturing includes a wide range of activities, and thus an examination of its subsectors is key to understanding the drivers of its productivity decline. There have been changes in each of the subsectors over time, and thus this study examines the last four productivity cycles, starting from 1988-89. In particular, it focuses on changes over the last two complete cycles — ‘cycle 3’ (1998-99 to 2003-04) and ‘cycle 4’ (2003-04 to 2007-08). This study finds that almost two‑thirds of the decline in Manufacturing’s MFP growth, from its average rate in cycle 3 to its average rate in cycle 4, is accounted for by three of the eight subsectors: Petroleum and chemicals; Food and beverages; and Metal products.[[1]](#footnote-1)

The influences on the productivity of manufacturers are diverse and vary over time. There is no single factor that explains the decline in Manufacturing MFP. In the subsectors examined in detail some of the varying factors were: the lead time between investment in new capital and associated output; unmeasured increases in output quality, in some cases in response to regulation; lower rates of capacity utilisation; and change in the composition of output demanded by consumers into products with higher labour-intensity and lower levels of measured productivity. Some of these factors are temporary in nature and the result of adjustment to changing competitive conditions and no simple policy inference can be drawn.

### The long-term performance of Manufacturing in Australia

There was a shift in Manufacturing MFP and its proximate causes in the most recent complete productivity cycle (cycle 4), compared with trends going back to 1985‑86 (figure 1).[[2]](#footnote-2)

Figure 1 Manufacturing MFP and its proximate causes**a** over the longer term

Index 2009-10 = 100

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a 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, as well as semi-finished goods for assembly and transformation. The volume of value added refers to value added with the effect of price changes removed.

Manufacturing’s trend of positive MFP growth turned negative in cycle 4.

* The long-term upward trend in value added became relatively flat during cycle 4 (and the current incomplete cycle[[3]](#footnote-3)).
* The ongoing growth in capital inputs accelerated over cycle 4, before slowing more recently.
* Hours worked stabilised over cycle 4, after a downward trend, but the decline resumed more recently.

### Decline in Manufacturing MFP since 2003-04

ABS estimates show a decline in Manufacturing MFP from 2003-04, and at a faster rate than for the market sector as a whole. While there was positive growth of 1.3 per cent a year over cycle 3 (1998-99 to 2003-04), Manufacturing MFP declined in absolute terms by 1.4 per cent a year over cycle 4 (2003-04 to 2007-08) (figure 2). This absolute decline has continued in the incomplete cycle (2007‑08 to 2010-11), although at a slower rate of 0.8 per cent a year.[[4]](#footnote-4)

Figure 2 MFP in Manufacturing and market sectora, by cycle

Index 2009-10 = 100 and average annual growth rate (per cent)

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**a** The term ‘market sector’ refers to 12 industry sectors under the ABS industrial classification (table 2.1).

Manufacturing is a significant part of the market sector (averaging 18 per cent of market sector value added over cycle 4). Accordingly, the turnaround in Manufacturing’s MFP growth rate by 2.7 percentage points between cycles 3 and 4 (figure 2) had a considerable influence on the slowdown of MFP growth for the market sector overall.

#### The fall in MFP was associated with slowing value added growth and rising input growth

The decline of 2.7 percentage points in the average annual rate of MFP growth between cycles 3 and 4 was associated with nearly equal parts of: a decline in value added growth; an increase in growth in capital services; and a reversal in the decline of hours worked (figure 3).

Figure 3 Proximate causes of Manufacturing MFP growth**a** in cycles 3 and 4

Average annual growth rate (per cent)

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a Capital services and hours worked weighted by income shares. This means the sum of these growth rates is equal to the growth in combined inputs (effectively a weighted average of the growth rates in the two inputs).

##### What is meant by ‘negative’ MFP growth?

Just as MFP growth cannot be automatically interpreted as technical progress (measured as a residual it captures much more than this), negative MFP growth cannot be interpreted as technical regress. MFP growth can be negative for a range of reasons. These include changes in the composition of activities within a sector or industry, differences in the timing of input and output responses to particular changes in the economy, and measurement challenges that can lead to the understatement of outputs (where, for example, quality improvements are not measured as an increase in outputs, but require greater levels of inputs), or even the overstatement of inputs.

Some of these factors are likely to be more pronounced during periods of structural change in the economy. For example, an increased rate of business creation and destruction can temporarily lower measured productivity — through decreases in capacity utilisation. Similarly, shifts to new technologies and organisational structures, which are aimed at increasing future productivity, may temporarily disrupt output or lead to an increase in inputs ahead of any increase in output.

There are many forces driving structural change in Manufacturing — such as changing consumer preferences, domestic costs, international prices and the exchange rate — which have different implications for measured productivity, particularly in the adjustment phase.

Given the diverse range of activities within Manufacturing, this study estimates MFP for the subsectors within Manufacturing — a level of disaggregation for which ABS MFP estimates are not available. (The details of how these subsector estimates were derived, and steps taken to make them as consistent as possible with the ABS estimates for Manufacturing as a whole, are explained in a technical appendix.)

### MFP growth varies across Manufacturing subsectors

Most subsectors of Manufacturing had positive MFP growth over cycle 3, and negative MFP growth over cycle 4, but there was considerable variation across the eight subsectors (figure 4).

Figure 4 Subsector MFP growth in cycles 3 and 4**a**

Average annual growth rate (per cent)

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|  | *Cycle 3:  1998-99 to 2003-04* | *Cycle 4:  2003-04 to 2007-08* |
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a Subsector estimates are of lesser quality than the ABS estimates for Manufacturing as a whole (due to data and methodological limitations) and will not necessarily aggregate to those ABS estimates. Therefore, the subsector estimates should be regarded as indicators of differences within the Manufacturing sector, rather than precise estimates. Some subsector estimates (such as Printing and recorded media, and Textiles, clothing and other manufacturing) are less well estimated because of changes in industry classification.

When the relative sizes of the subsectors are taken into account, three subsectors made the largest contributions to the total decline in Manufacturing MFP growth between cycles 3 and 4:

* Petroleum and chemicals
* Food and beverages
* Metal products.

These subsectors made a combined contribution of around two-thirds of the total decline (right panel, figure 5).

Figure 5 Change in subsector MFP growth between cycles 3 and 4 and contributions to Manufacturing MFP growth in total**a**

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a FBT, MP, PCCR, and ME are of similar size (around 17-22 per cent each of Manufacturing value added on average in cycle 4). The other four subsectors are much smaller (around 4-8 per cent). Due to approximation errors and data limitations, there is a discrepancy between the sum of the subsector MFP contributions (‑3.1 per cent a year) and the ABS aggregate Manufacturing estimate (-2.7 per cent a year). The combined contribution of PCCR, FBT and MP is based on the sum of the subsector contributions. The MFP decline for PRM is large, but this subsector is relatively small in size and is less well estimated than other subsectors due to major changes in industry classification over time.

#### Proximate causes of the decline in MFP growth also differ across subsectors

Most subsectors — with the exception of Metal products and Non-metallic mineral products — contributed to the decline in aggregate Manufacturing MFP growth between cycles 3 and 4 through declines in value added growth. On the input side, the three subsectors of Petroleum and chemicals, Food and beverages and Metal products made the largest contributions to the increases in labour and capital (figure 6).

* There was a large increase in value added in Metal products (0.7 of a percentage point). But this was more than offset by the declines in Petroleum and chemicals and Food and beverages (which contributed 0.4 and 0.2 of a percentage point to the decline in value added growth) and the rest of Manufacturing (which contributed a further 1.2 percentage points to the decline).
* Labour input growth was dominated by the large positive contributions from Food and beverages and Metal products. The rest of Manufacturing overall made a partially offsetting negative contribution (with a large negative contribution from Wood and paper products in particular).
* Metal products, followed by Petroleum and chemicals, made by far the largest contributions to the capital input surge between cycles 3 and 4. Food and beverages made a small negative contribution, broadly offsetting the small positive contribution from the rest of Manufacturing.

Figure 6 Main subsectors contributing to change in total Manufacturing MFP growth and its proximate causes between cycles 3 and 4

Percentage point change

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### Influences on MFP varied across Petroleum and chemicals, Food and beverages, and Metal products

A closer examination of the influences on these subsectors is needed to explain changes in the proximate causes of the decline in MFP growth.

#### Petroleum and chemicals subsector was the largest contributor to the decline in Manufacturing MFP

A wide range of different activities fall within this subsector, including petroleum refining, pharmaceutical manufacturing, fertiliser production and manufacturing of plastics, amongst others. Formally, it is divided into three subdivisions — Petroleum refining, Chemical manufacturing and Polymer manufacturing.

The subsector had a low but positive rate of MFP growth over cycle 3 (0.6 per cent a year on average) — associated with value added growth in excess of combined input growth (figure 7). There was a reversal to strong negative MFP growth over cycle 4 (‑4.1 per cent a year) — driven principally by a decline in value added growth and very strong growth in capital services.

Figure 7 Petroleum and chemicals: proximate causes of MFP growth in cycles 3 and 4

Average annual growth rate (per cent)

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##### Value added decline driven by changes in petroleum refining and plastics

Most of the decline in value added growth from cycle 3 to cycle 4 occurred in the Petroleum refining and Polymer products subdivisions.

Value added of the domestic Petroleum refining industry fell for several reasons — even though the overall volume of domestic refined output remained relatively stable and domestic consumption grew.

* The greatest value added per unit of refined output comes from refining domestically-sourced crude oil. But the supply of crude oil available from domestic oilfields has been declining, necessitating increased imports of crude oil and refined petroleum.
* Less value added per unit of output comes from refining imported crude oil, as more intermediate inputs are required to process the different type of crude oil that is available from overseas.
* The least value added per unit of output comes from blending imported refined fuel to meet Australian standards, and the volume of refined fuel imports has been rising.

There has been increased demand for diesel fuel over cycle 4, as a result of the mining boom and changing consumer preferences. However, the increase in demand has been met mainly from imports of refined diesel as domestic refineries are better suited to producing petrol rather than diesel.

In the case of Polymers, domestic production declined. Finished plastic products faced stronger import competition as the result of increased production volumes of overseas firms with lower input costs and the appreciation of the Australian dollar. As firms adjust, *measured* productivity may fall, even though their productive efficiency may not. For example, where firms reduce output in response to decreased demand for their output, this can lead to unutilised capacity, which depresses measured productivity*.* More broadly, import competition should provide incentives for firms to improve their efficiency, but its impact on productivity, particularly in the short term, will also be influenced by industry-specific factors.

##### Rapid investment growth in Petroleum refining and Chemical manufacturing

The faster growth in capital services over cycle 4 is a product of very strong investment, particularly in the Petroleum and Chemicals subdivisions, but for different reasons. In the case of Petroleum refining, significant investments were required to upgrade refineries to meet new environmental standards relating to fuels. These investments appear as additional inputs, but the improvements in fuel quality are not completely accounted for in the measure of value added, thus depressing measured productivity.

In Chemicals, there was significant investment in expanding the production capacity of ammonia and ammonium nitrate — key inputs to fertilisers and explosives, which experienced heightened demand over cycle 4. The investment was made in that cycle, but some of the additional output was not realised until after 2007-08. As new capacity has come on stream since the end of cycle 4, the additional output has reversed some of the measured productivity decline.

#### Food and beverages subsector made a considerable contribution to the decline in Manufacturing MFP

The Food and beverages subsector has two subdivisions: Food manufacturing, and Beverages and tobacco product manufacturing. There is a diverse range of manufacturing activities within each subdivision — from simple processing of agricultural products to the production of more complex products.

Food and beverages had a slightly negative rate of MFP growth over cycle 3 (‑0.5 per cent a year on average) — associated with value added growth being lower than capital services growth (which was only partially offset by a small decline in hours worked) (figure 8). But, over cycle 4, the rate of MFP decline accelerated (‑4.2 per cent a year). This was driven by value added growth slowing to almost zero and strong growth in hours worked (more than reversing the small fall over cycle 3).

Figure 8 Food and beverages: proximate causes of MFP growth in cycles 3 and 4

Average annual growth rate (per cent)

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##### Slower value added growth, with declining net exports of food and beverage products and change in the composition of value added

During cycle 4, there was a slowdown in value added growth for Food and beverages in total and absolute declines for some products. There was a decline in exports and loss of domestic market share for some food and beverage products, reflecting input cost pressures, the appreciation of the Australian dollar and, in some cases, severe weather events including drought. As noted above for Polymers, in the short run, the effect on *measured* productivity of adjusting to lower levels of output of some products may be negative.

The slowdown in value added growth was most noticeable in Beverages and tobacco manufacturing — which grew over cycle 3 but declined in absolute terms over cycle 4. Wine manufacturing, in particular, appears likely to have been a significant contributor to this change. The amount of value adding per unit of output may have declined with a shift to a greater volume of bulk (rather than bottled) production in response to global market conditions. The drought in 2006 also led to some decline in grape production and wine output.

There have also been changes in the composition of output produced by Australian food and beverage manufacturers in response to changing consumer preferences. Those preferences relate to such factors as health considerations, quality, value, diversity and convenience. Estimates of value added growth may be understated given the challenges of measuring improvements in such factors as the quality and convenience of some outputs.

##### Different processes and higher input intensity

Change in the composition of output of Food and beverages may also affect the scale of production, the type of capital required and the labour intensity of production. For example, ‘boutique’ production, such as for artisan bakery products and craft beer, does not have the economies of scale of large factory production.

Within Bakery product manufacturing, for example, the growth of non-factory bakeries (such as hot bread shops) appears to have led to more labour intensive, smaller scale production with different capital requirements. The strong growth in hours worked in Bakery product manufacturing (which made a significant contribution to hours worked growth for the subsector as a whole) is consistent with such a shift in the composition of Bakery output.

The limitations of available data make it difficult to be more definitive about the extent to which changes in the composition of output may have reduced MFP growth in the Food and beverages subsector over cycle 4, compared with cycle 3.

##### Broader input measurement challenges

The decline in MFP for this subsector may also be overstated because of the challenges in measuring inputs. The comparability over time of labour input measures for Food and beverages may have been reduced by changes in survey methodology and industry classifications. In addition, changes in the composition of production that have altered capital requirements may have led to the early retirement of existing capital (that remains ‘on the books’ in statistical terms) or increased underutilised capacity. This may be part of the explanation for a larger decline in output growth than in capital growth between cycles 3 and 4.

#### Metal products subsector contributed to the decline in Manufacturing MFP even though its value added growth strengthened

The Metal products subsector has two subdivisions — Primary metals (which includes the manufacture of basic steel, alumina, aluminium processing, and the smelting of other non-ferrous metals) and Fabricated metals (which includes the manufacture of structural metal products, metal coatings and other fabricated products).

Metal products had a positive rate of MFP growth over cycle 3 (1.4 per cent a year on average) which turned negative over cycle 4 (-0.9 per cent a year) (figure 9). This decline in MFP was driven by very strong growth in capital inputs over cycle 4 and a reversal of the decline in hours worked that had occurred in cycle 3. Value added growth was also stronger over cycle 4 than cycle 3, but it did not increase enough to offset the pace of input growth.

Figure 9 Metal products: proximate causes of MFP growth in cycles 3 and 4

Average annual growth rate (per cent)

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Metal products was the third largest contributor to the decline in Manufacturing MFP between cycles 3 and 4. While its contribution was not much larger than some of the remaining subsectors, it is notable that, unlike most of the other subsectors, its value added growth strengthened between cycles. It was also responsible for most of the capital services growth for Manufacturing in total.

The productivity performance of the Metal products subsector can be explained by examining those parts of the subsector that experienced the strong value added growth and those that experienced the strong capital services growth.

##### Fabricated metal products and alumina smelting experienced value added growth

Most of the strong value added growth in cycle 4 occurred in Fabricated metals, particularly those metal fabricators associated with supplying materials to the Construction and Mining sectors. Stronger demand from these sectors saw Fabricated metal manufacturers expand output and supply a greater share of their output to these sectors. There was also faster growth of alumina production during cycle 4, as growth in world demand for aluminium was strong prior to the global financial crisis.

##### Large investment to expand alumina production capacity

Growth in capital services accounted for around two-thirds of Metal products’ total input growth between cycles 3 and 4. Practically all of the investment growth was in Primary metals (and the bulk of that was in alumina refining). This investment was associated with building new metal refining assets and upgrading existing ones — in response to higher commodity prices during cycle 4 and in anticipation of strong demand in the future. There was also some investment growth in other parts of the subsector, including other metal refining and some fabricated metal products. The lag between investment and output associated with that investment led to lower measured productivity.

##### Hours worked growth in Fabricated metals

Growth in hours worked between the cycles accounted for the remaining third of the growth in total inputs. Fabricated metals, which also had value added growth, is likely to have contributed most of this growth. This rise in the number of hours worked during cycle 4 is significant as it reverses a trend of declining hours worked for the subsector.

##### Different parts of Metal products had different effects on MFP

Available evidence is consistent with Primary metals and Fabricated metals pulling MFP in Metal products in different directions between cycles 3 and 4. Primary metals played the main role in the decline in MFP and Fabricated metals offset the scale of the decline to some extent.

### Manufacturing since the last complete productivity cycle

The decline in MFP in Manufacturing has continued since the last complete productivity cycle, with Textiles, clothing and other manufacturing making the largest contribution, followed by Printing and recorded media and Petroleum and chemicals. However, the rate of MFP decline has been slower than over cycle 4.

MFP growth in Petroleum and chemicals remained negative on average in the incomplete cycle, but the decline in MFP was slower (-1.1 per cent a year) than in cycle 4 (-4.1 per cent a year). While the decline in value added accelerated in the incomplete cycle, there was also some decline in combined inputs — a steep decline in hours worked and slower capital services growth.

Similarly, the rate of MFP decline in Food and beverages slowed in the incomplete cycle (from -4.2 to -1.1 per cent a year). But in that case, the rate of value added growth increased and the rate of combined input growth slowed. After the strong growth in hours worked in cycle 4, there was no growth in the incomplete cycle. And capital services growth also slowed.

Average MFP growth in Metal products 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 slowed relative to the exceptional growth of cycle 4.

Food and beverages and Metal products made much smaller contributions to the decline in Manufacturing MFP in the incomplete cycle than over cycle 4 — reflecting a return to MFP growth rates closer to, but still below, their longer-term averages. Notwithstanding possible measurement issues, it appears likely that the significant declines in MFP growth in these two subsectors over cycle 4 were atypical.

1. ‘Petroleum and chemicals’ refers to Petroleum, coal, chemicals and rubber product manufacturing and ‘Food and beverages’ to Food, beverage and tobacco product manufacturing. [↑](#footnote-ref-1)
2. MFP growth is derived as the difference, in volume terms, between growth in value added and growth in combined factor inputs (hours worked and capital services). These components of MFP growth are known as its proximate causes. [↑](#footnote-ref-2)
3. There was variability in year-to-year growth over the incomplete cycle, including higher growth in 2007-08, followed by contraction in 2008-09 (a year affected by the global financial crisis). [↑](#footnote-ref-3)
4. As this cycle is incomplete, this growth rate should be interpreted with caution because it may be the product of temporary factors. It should be noted that this paper examines Manufacturing MFP up to 2010-11, based on the 2010-11 ABS National Accounts (the latest available when the MFP estimates for the Manufacturing subsectors were derived for this study). [↑](#footnote-ref-4)