KPMG ECONTECH

Economic Contribution of the Australian Refining Industry

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Executive Summary

Introduction

The Australian Institute of Petroleum (AIP) has engaged KPMG Econtech to examine the economic contribution of the Australian refining industry. This report uses economic modelling to explain the petroleum refining industry's contribution to the Australian national and state economies. The report also examines externalities created by the refining industry, which are not captured by economic modelling.

Key Results

Economic contributions of the refining industry

The Australian refining industry contributes 0.5[1] per cent of GDP ($6.2 bn in 2007/08 terms) to the Australian economy. This estimate includes the industry's direct contribution to GDP, which is 0.2 per cent of GDP ($2.4 bn in 2007/08)[2], plus an indirect contribution, of additional activity that the industry provides to other areas of the economy. The economic contribution has been estimated using KPMG Econtech's long-term economic model by estimating the size of the Australian economy with and without the presence of the domestic refining industry.

The following statements demonstrate the relationship between the domestic refining industry and the Australian economy.

- Australian refineries currently supply around 70 per cent of Australia's liquid fuel needs.
- Refinery products are inputs for other Australian industries. Approximately 48 per cent of the total value of Australian liquid fuel consumption is in the agriculture, manufacturing, mining and transport industries.
- Annual refining industry turnover is around $42 billion and annual investment is around $1 billion (AIP 2007 b).
- In 2007/08 Australia's refineries produced 39,575 megalitres of refined products. Petrol and diesel accounted for approximately 77 per cent of production[3].
- The refining industry's direct contribution to GDP at 0.2 per cent is comparable to other significant industries. For example, the Textile Clothing and Footwear industry contributes 0.3 per cent directly to GDP, and the Forestry and Fishing industries together contribute 0.1 per cent.

[1] This estimate is indicative only. See footnote 27 on page 39 for more information
[2] This estimate has been made using ABS data, Cat no. 82210DO002_200607 Manufacturing Industry, Australia, 2006-07 and Cat no. 5206.0 Australian National Accounts: National Income, Expenditure and Product, Table 1 and is not part of the economic modelling.
[3] This does not add to the figures shown in Chart 3.1 due to rounding.

National and State contributions

KPMG Econtech simulations show that refineries contribute to the level of economic activity at the state and national level. This is shown by simulating the effects of closing a small and then a large refinery. Refineries' contributions include broad impacts across the national economy, including price and exchange rate impacts. Refineries also contribute to the economy through their links with other industries. Households are also affected by changes in the refining industry, because they are a major consumer of refinery products. Below are some examples of the economic impact of closing small and large refineries.

Small refinery closure –

- It is estimated that if a typical small refinery closed, then Gross Domestic Product (GDP) would be lower by 0.05 per cent. In 2007/08 this was equivalent to $0.6 billion in national economic activity. This includes the direct loss of refinery value added, which is around 0.02 per cent of GDP, plus the flow-on effects to other industries.

- If this typical small refinery were located in New South Wales, a state with a large proportion of domestically-oriented industries, when it closed, production in NSW would be 0.2 per cent lower. This is equivalent to $0.5 billion in 2007/08 terms. (The remaining $0.1 billion loss in economic activity from the closure of the small refinery is spread throughout the other states).

- The closure of this small refinery in NSW, and the flow-on effects to other industries in NSW, mean that employment in NSW is estimated to be lower by 3,580 people than would otherwise be the case (and higher by the same amount in the rest of the country, because the modelling assumes labour market equilibrium[4]).

Large refinery closure –

- It is estimated that if a typical large refinery closed, then GDP would be lower by 0.09 per cent. In 2007/08 this was equivalent to $1.0 billion in national activity. This includes the direct loss of value added from the large refinery, which is around 0.04 per cent of GDP, plus the flow-on impacts to other industries.

- If this typical large refinery were located in Queensland, a state with a high proportion of export-oriented industries compared to other states, then Queensland's production would fall by around 0.2 per cent if it closed.

- The closure of this large refinery in Queensland, and the flow-on effects to other industries in Queensland mean that employment in Queensland is estimated to be lower by around 3,890 people than would otherwise be the case (and higher by the same amount in the rest of the country, because the modelling assumes labour market equilibrium[5]).

[4] See section 5.1 of the report for a discussion about labour market assumptions in the model.
[5] See section 5.1 of the report for a discussion about labour market assumptions in the model.

Broad economic impacts of refinery closures –

- When a refinery is closed, petroleum product imports increase which leads to a depreciation of the exchange rate, although this will be partly offset by a decrease in crude oil imports. The exchange rate falls by 0.55 per cent if a small refinery closes, and by 0.85 per cent if a large refinery closes.

- The depreciation has a positive impact on producers involved in international trade, because the price of Australian produced goods and services becomes cheaper relative to those produced in other countries. The increase in output from some industries has a partially offsetting effect, but overall GDP falls. (See Chart B, on page 7.)

- This depreciation of the exchange rate leads to higher import prices across all imported goods and services. This raises the general price level (CPI), and lowers the purchasing power of consumers. Thus, the welfare of consumers falls as their overall real consumption is reduced. Consumption falls by 0.06 per cent if a small refinery closes, and by 0.11 per cent if a large refinery closes.

Qualitative findings

It is often not well understood that there are also positive benefits generated within the sector that are not quantifiable. These are not quantified using economic modelling, but are listed below.

- The Australian refining industry enhances the supply security of liquid fuels in ways that other points in the supply chain are unable to. This is because it provides greater flexibility to respond to short-term product shortfalls, compared to imported supplies. As noted by ACIL Tasman "the closure of domestic refineries will not improve Australia's energy security in liquid fuels." (2008) In particular, since fuels are important inputs for the transport, mining, manufacturing and agriculture sectors, security of supply is important to these industries. (See Chart A, on page 4.)
- The Australian refining industry contributes to the development of other industries by adding to the demand for certain inputs that are used by other industries, such as engineering contract services. This helps to achieve economies of scale and lower costs in industry supply chains. This contributes to other sectors of the economy by lowering costs of commonly consumed products.
- The Australian refining industry provides technology and knowledge spillovers. This contributes to the skills of the Australian workforce and the productive capacity of other industries.
- The Australian refining industry takes part in community development and environmental impact reduction activities.

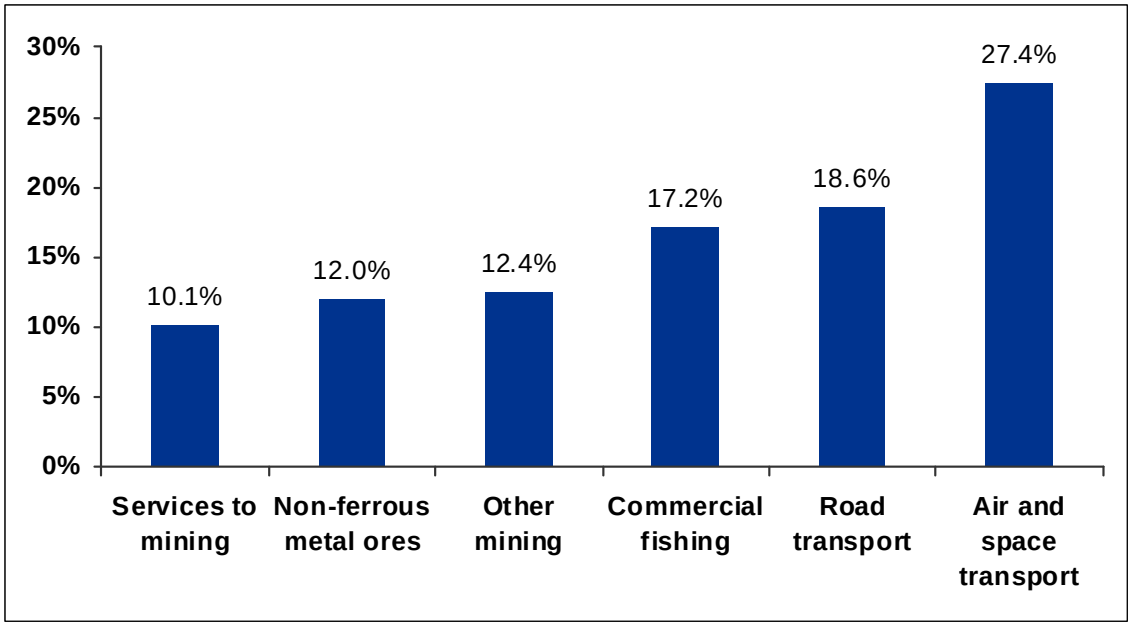
The following is a more detailed summary of the key results described above. To provide a context for the findings, the structure of the industry is first described, including consumption, production and trade patterns. The qualitative benefits and modelling results are then explained in greater detail.

Intrinsic industry links

Approximately 48 per cent (in value terms) of all petroleum products used in Australia are used by four industries: Agriculture, Forestry and Fishing; Manufacturing; Mining; and Transport industries. Outputs from these industries are inputs to many other economic activities. Therefore, any shock to the petroleum refining sector has flow-on impacts to other sectors through these four industries.

Refinery output accounts for a large proportion of the input costs in many other Australian industries. The dependence of selected industries on petroleum products is shown in Chart A, which gives the proportion of intermediate input costs[6] made up by petroleum products. For example, the chart shows that liquid fuels make up 27.4 per cent of intermediate input costs in the Air and Space Transport Industry.

Chart A: Industry dependence on refinery products, per cent of intermediate input costs



Source: ABS, Input Output Tables, 2004/05, cat. no. 5209.0.55.001
Note: 'Other mining' refers to all mining activity except those extracting coal, oil and gas, iron ores and non-ferrous metal ores
Note: 'Dependence' is defined as the proportion of intermediate costs represented by petroleum products, where intermediate inputs costs are the costs of inputs into the production process, other than labour and capital input costs.

[6] Intermediate input costs are the costs of inputs into the production process, other than labour and capital input costs.

Imports and exports

Australia's refining industry is an import-competing industry. Domestic production of liquid fuels is geared towards Australian consumption, and exports make up only a small proportion of domestic refining industry output. However, the use of imported fuels has been growing, particularly since 2003. In 2007/08 imports made up 33 per cent of total domestic consumption of refinery products (DRET 2009b).

Australia is a small international player, importing both inputs to the refining sector, as well as refined products that compete with Australian refinery outputs. Australian refining capacity makes up less than 2 per cent of total capacity in the Asia Pacific region in 2008 (BP Statistical Review, 2009).

Estimated contribution of the refining industry

KPMG Econtech's economic model, MM600+, is well placed to illustrate the refining industry's economic contributions. MM600+ is a computable general equilibrium (CGE) model of the Australian economy that is highly detailed, distinguishing between 672 products produced by 108 Australian industries. It takes account of substitution effects triggered by changes in the prices of these goods and services.

In baseline simulations, KPMG Econtech used data collected from the industry to adjust MM600+ so that it properly reflects the current industry structure. That is, simulations have been run so that the model reflects the most up-to-date picture of the industry's actual product mix in outputs, exports, imports and consumption. From this position, KPMG Econtech used MM600+ to trace the likely economy-wide impacts of two scenarios involving refinery closures. These scenarios demonstrate the refining industry's economic contribution by showing the likely impacts of reducing the size of the industry. These scenarios relate to the following two questions:

- *Scenario 1 - Small refinery closure*
  - "What happens to the national and state economies if a small refinery in a domestically-oriented state permanently shuts down?"

- *Scenario 2 - Large refinery closure*
  - "What happens to the national and state economies if a large refinery in an export-oriented state permanently shuts down?"

Contributions of small and large Australian refineries

Refineries contribute directly to Australian GDP through the value of their own production. For this study, small refineries are defined as those producing on average around 5,000 ML per annum or less. Four domestic refineries fit this definition, and value added from a typical small refinery makes up approximately 0.02 per cent of GDP. Large refineries are defined as those

producing on average around 6,000ML per annum or more. The remaining three domestic refineries fit this definition, and a typical large refinery makes up 0.04 per cent of GDP[7].

However, if a refinery closes, GDP falls by more than the share of GDP than the refinery directly contributed. This is because of the flow-on impacts that refineries have to the rest of the economy. Our modelling indicates that GDP would be 0.05 (or $0.6 billion in 2007/08[8] values) per cent smaller than would otherwise be the case if a typical small refinery closed. If a typical large refinery closed GDP would be 0.09 per cent (or $1.0 billion in 2007/08[9]) smaller.

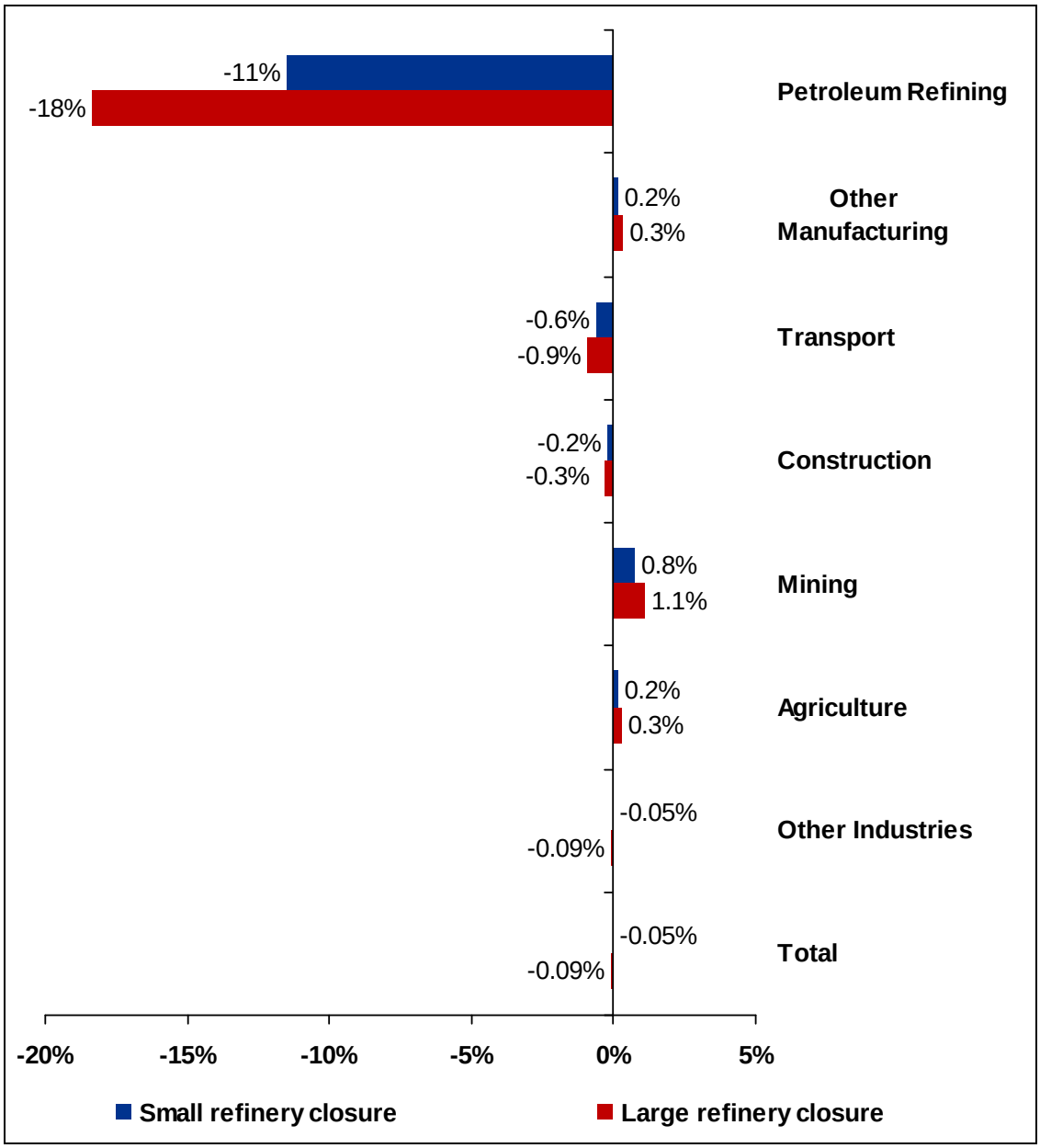
If a domestic refinery closes, imports of petroleum products must be higher to fill the wider gap between consumption and domestic production. The higher level of imports will cause the Australian dollar to depreciate. This lowers the relative price of Australian produced goods and services. Export-oriented industries, such as the Mining and Agriculture industries, benefit from the depreciation, because their outputs can be priced more competitively on international markets. Industries which compete with imports also benefit from the depreciation, because it raises the price of imports.

Households are also worse off if a refinery closes. The depreciation of the Australian dollar puts upward pressure on price levels, which lowers the purchasing power of consumers. This reduces their overall consumption by 0.06 per cent with the closure of a small refinery, and by 0.1 per cent with the closure of a large refinery.[10] This has flow on-effects to the demand for Australian production, and means that industries which depend on domestic demand are smaller than would otherwise be the case.

Chart B overleaf shows the impact of refinery closures on Australian industries. As discussed, some industries benefit from the closures, mostly through exchange rate effects. Others suffer because of reduced domestic demand, from businesses and households, for their outputs.

[7] These estimates have been made using ABS data, Cat no. 82210DO002_200607 Manufacturing Industry, Australia, 2006-07 and Cat no. 5206.0 Australian National Accounts: National Income, Expenditure and Product, Table 1 and is not part of the economic modelling.
[8] Estimate uses current price GDP from ABS Cat. No. 5260 Table 1, Macro Indicators
[9] Estimate uses current price GDP from ABS Cat. No. 5260 Table 1, Macro Indicators
[10] In general, we would expect the change in total consumption (which is an indicator of household welfare) to be smaller than the change in GDP. However, the modelling of refinery closures shows that the change in consumption is *larger* than the change in GDP. This is because the refining industry is taxed through the application of fuel excises. Fuel excises result in artificially high prices that inhibit demand and lead to sub-optimally low production levels. Therefore, in the presence of taxes, consumers' value of production exceeds production costs, making consumers worse off. Reducing production further has a large welfare cost, as indicated by the large change in total consumption.

Chart B: Changes in industry production stemming from refinery closures, per cent



Source: KPMG Econtech simulations, MM600+
Notes: 'Other Manufacturing' refers to all manufacturing except the refining industry
'Other Industries' refers to all industries not separately identified. That is, it includes the Electricity, Gas and Water industry along with the service industries.

Benefits of the petroleum refining industry

The domestic industry also contributes to the Australian economy and community in positive ways that often are not well recognised. These benefits are outlined below.

Supply security

The International Energy Agency defines energy security broadly as the provision of adequate, affordable and reliable supplies of energy (IEA 2007). A secure supply of liquid fuels enables firms and consumers to easily access goods and services and aids efficient production. Moreover, there is upward pressure on prices during periods of supply disruption, putting extra costs on households and firms.

The Australian refining industry enhances the supply security of liquid fuels in ways that other points in the supply chain are unable to. Specifically, domestic refineries provide greater flexibility to respond to short term supply disruptions because they are able to respond in a shorter time frame compared to imported supplies. Thus, "the closure of domestic refineries will not improve Australia's energy security in liquid fuels." (ACIL Tasman 2008)

In particular, since fuels are important inputs for sectors of transport, mining, manufacturing and agriculture, security of supply is important to these industries. (See Chart A, on page 4.)

Input sharing

The refining industry uses some of the same inputs as other Australian industries. Examples of these inputs include engineering services, chemicals, electronic equipment and mechanical components. The refining industry may be contributing to the development of other industries using these common inputs. If the refining industry's use of certain inputs adds to the economies of scale in input industries, then those input industries can lower their prices. This assists other sectors which use the same inputs as the refining sector, by lowering their costs.

Moreover, related industries tend to congregate around refineries to take advantage of the inputs available from the companies established to service the refinery. This phenomena is known as *external economies of scale* or *agglomeration economies*, where there are benefits derived from similar industries congregating in one area (Rosenthal, 2003).

Technology and knowledge spillovers

Petroleum refining is a highly capital intensive and technologically advanced industry. This gives it the opportunity to contribute to the development of new technologies which can be used elsewhere in the Australian economy. The major technological investments made by the refining industry include: improvements in safety; new product development; and improvement and smoothing bottlenecks in production processes.

Technological innovations in the refining industry have positive spillover effects on the rest of the Australian economy. This occurs when other industries incorporate the technologies developed in the refining industry into their own production processes. The main vehicles for

such technological spillovers are movements in labour, in particular, through employees moving between industries or through contract workers.

The refining industry also contributes to the skills of the Australian workforce. When trained workers move to other industries, they take their skills with them and contribute to the value added from those industries. This occurred during the mining boom when many highly skilled workers left the refining industry to take part in the expansion of the mining sector[11].

Community development – Shell Geelong refinery case study

Corporate sustainability[12] is a concept taken on by the refining industry, which is involved in numerous community development activities. This report takes the Shell Geelong refinery as a case study, and describes some of the community development activities undertaken by this refinery. These include interaction with local community groups seeking to enhance the education, environment and health outcomes of the local area.

This can be expected to have benefits for the wider economy. A report by Finsia concluded that the "voluntary adoption of sustainability risk reporting by more Australian businesses appears to be a worthwhile investment for them, as well as having wider economic benefits" (Finsia, 2007).

Australia in the Asia Pacific liquid fuels market

Australia's domestic refineries are in direct competition with the refineries located in the Asia Pacific region. The industry faces competition from imports from the region, and is therefore a price taker on international markets. Moreover, parts of the Australian industry compete with Asian locations as an investment destination. Therefore, regional demand and supply developments are important for determining the petroleum product prices that can be achieved in Australia as well as the Australian industry's profitability and performance.

The Australian industry faces cost disadvantages compared to some of their Asia Pacific competitors. Examples of these cost disadvantages include relatively high labour costs and more strict environmental regulations in Australia. Refining technology is also subject to increasing economies of scale. Thus, the relatively small size of Australian refineries also means that production is generally at a competitive disadvantage compared to production from other refineries in the region, which tend to be larger. For example, the newly-built Jamnagar refinery in India has capacity double that of Australia's total refining industry (IES 2009). Taking into account these constraints, Australian refineries optimise their production process, choosing the optimal crude mix and other inputs.

[11] Interviews with refinery representatives.

[12] *Corporate sustainability* is a management paradigm where companies incorporate the idea that community development activities can have benefits to the companies themselves. These include better risk management, cost savings and management of intangible assets such as brand and human capital.

On the other hand, Australian refineries enjoy some competitive advantages compared to their Asia Pacific counterparts. Freight costs must be added to the price of imported petroleum products. Therefore, the large geographical distance between Australia and sources of imports, such as Singapore, affords Australian refiners some ability to price competitively.

Moreover, some price premiums are available in the market for fuels meeting tighter Australian regulatory specifications has helped domestic refiners to defray the higher costs of production in Australia.

The environment and regional climate change policies

Australian refineries are involved in reducing their environmental impact though meeting regulatory standards set by the Commonwealth, State and Local governments.

Cleaner fuel standards in Australia have made the fuels production process more energy intensive. Therefore, the refining industry is more directly exposed to the impacts of the proposed Carbon Pollution Reduction Scheme (CPRS). The CPRS will put a price on carbon emissions, which will be paid by the companies that emit carbon (including the refining industry), and will also increase the cost of electricity and other forms of energy. However, it is likely that comparable schemes will not be introduced by regional competitors in the near future. Therefore, the introduction of the CPRS in 2011 has the potential to reduce the competitiveness of Australian refineries compared to their counterparts in the Asia Pacific region. However, the Government proposes to partially ameliorate this effect on competitiveness by classifying the petroleum refining industry as an Energy Intensive Trade Exposed (EITE) industry so that it may be entitled to assistance.

1 Introduction

The Australian Institute of Petroleum (AIP) has engaged KPMG Econtech to examine the economic contribution of the Australian refining industry. This report uses economic modelling to explain the petroleum refining industry's contribution to the Australian state and national economies. The report also examines externalities created by the refining industry, which are not captured by economic modelling.

The Australian petroleum refining industry refines crude oil and condensate to produce a range of petroleum products including petrol, diesel, jet fuel, LPG and other products. Petroleum production in Australia is a capital-intensive process, involving the use of a highly skilled workforce and the development and adoption of technological innovations.

Refinery output links with the rest of the Australian economy, because many industries use petroleum products as inputs. KPMG Econtech has run a number of scenarios to model the economic contribution of the petroleum refining industry to the Australian national and state economies. These are: a base case, which ensures that the model reflects the current structure of the refining industry; the closure of a small refinery in a state with domestic-oriented, labour-intensive industries; and, the closure of a large refinery in a state with export-oriented, capital-intensive industries. The modelling picks up the links between Australian industries and the refining sector, as well as impacts on macroeconomic variables at the national and state levels.

The report uses data and information gathered through research of publicly available resources and data provided by the AIP. This report also draws on interviews with industry members.

1.1 Report structure

This report is structured as follows.

- Section 2 describes trends in Australian consumption of liquid fuels.
- Section 3 outlines trends in the production of the Australian refining industry.
- Section 4 presents trends in Australia's international trade of petroleum products.
- Section 5 outlines our modelling approach.
- Section 6 presents estimates of the economic impact of refinery closures and import curtailments.
- Section 7 describes the benefits to the Australian economy from the refining industry that cannot be captured in economic modelling.
- Section 8 details Australia's place in the regional market, and the impact of refining industry developments in other countries.

- Section 9 compares Australia's climate change policies with those of our trading partners.
- Section 10 concludes with final remarks.
- Appendix A lists the petroleum product categories used in the analysis.

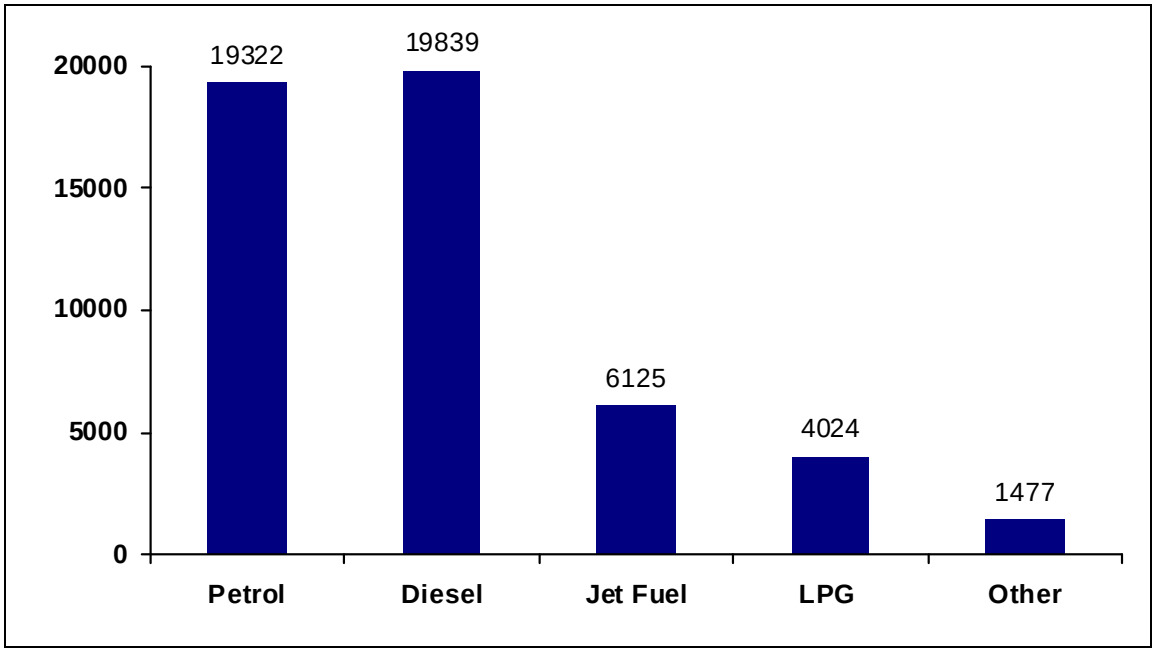
2 Australian consumption

This section describes the relationship between the refining industry and the rest of the economy. It includes a description of trends in refinery product consumption and industry use. This section also gives a background to understanding the modelling results.

2.1 Australian consumption patterns

Petroleum products supply a large proportion of Australia's energy needs, with consumption of petroleum products making up 24 per cent of total primary energy consumption[13] in 2006/07 (DRET 2008 b). Chart 2.1 gives Australian consumption of different petroleum product categories in 2007/08. It shows that, petrol and diesel dominated total petroleum consumption in 2007/08. These products made up 38 and 39 per cent of the volume of petroleum product consumption respectively.

Chart 2.1: Australian consumption of petroleum products 2007/08 (ML)



Source: DRET, *Australian Petroleum Statistics*, ABARE, 2009
Note: 'Other' includes the categories: 'Miscellaneous other petroleum & coal products' and 'Refinery produces n.e.c.' as defined in the Appendix.

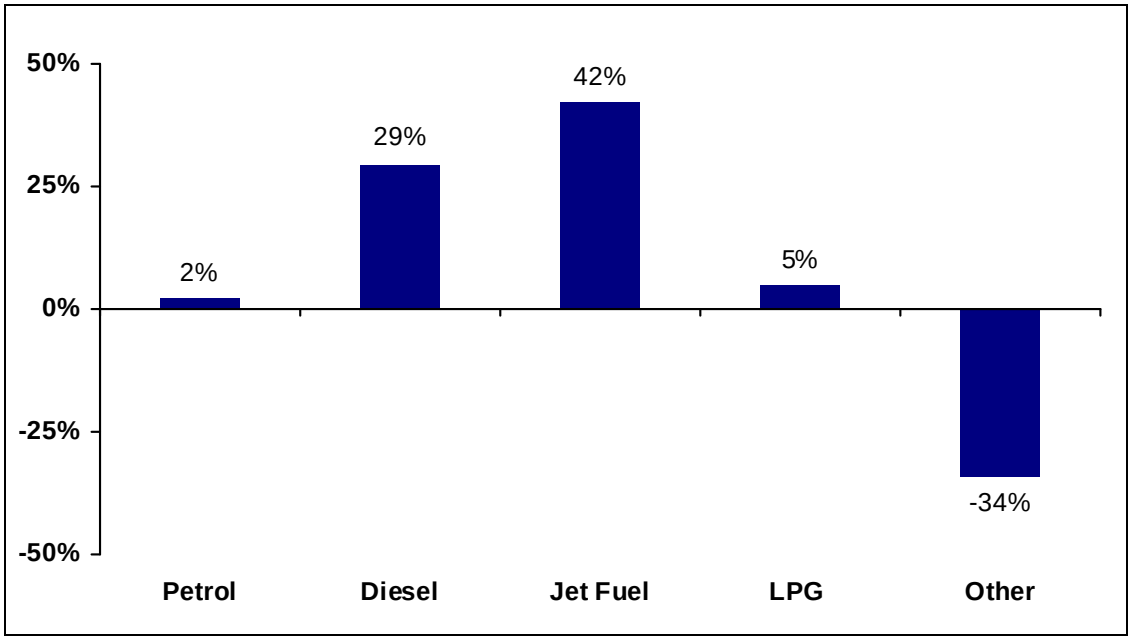
The product categories shown in Chart 2.1 are defined in Appendix A. These are the categories that will be used throughout this report, and are the categories that are identified in the modelling analysis. Most of the petrol category is automotive gasoline[14] (DRET 2009 a).

[13] This is measured in energy units.
[14] Automotive gasoline made up 99.5 per cent of the category in 2007/08 and remainder was aviation gasoline.

Similarly, automotive diesel oil made up most of the diesel category[15]. The jet fuel category consists almost entirely of aviation turbine fuel[16].

It is interesting to look at the changes in consumption of different petroleum products over recent years. Chart 2.2 shows that there has been a 29 per cent increase in diesel consumption and a 42 per cent increase in jet fuel consumption between 2002/03 and 2007/08. There has also been a 34 per cent fall in consumption of other products, but since this is a small category, the absolute change represented here is small.

Chart 2.2: Change in Australian consumption of petroleum products 2002/03 to 2007/08 (ML)



Source: DRET, *Australian Petroleum Statistics,* ABARE, 2009 b and 2006

The large increase in jet fuel consumption between 2002/03 and 2007/08 shown in Chart 2.2 stems from the increase in Australian demand for air travel.

The major factor driving the increase in diesel consumption has been the boom in the mining industry between 2002/03 and 2007/08. Increasing activity in the transport sector in association with solid economic growth has also been important. As the following sections point out, both of these industries are major users of petroleum products, particularly diesel.

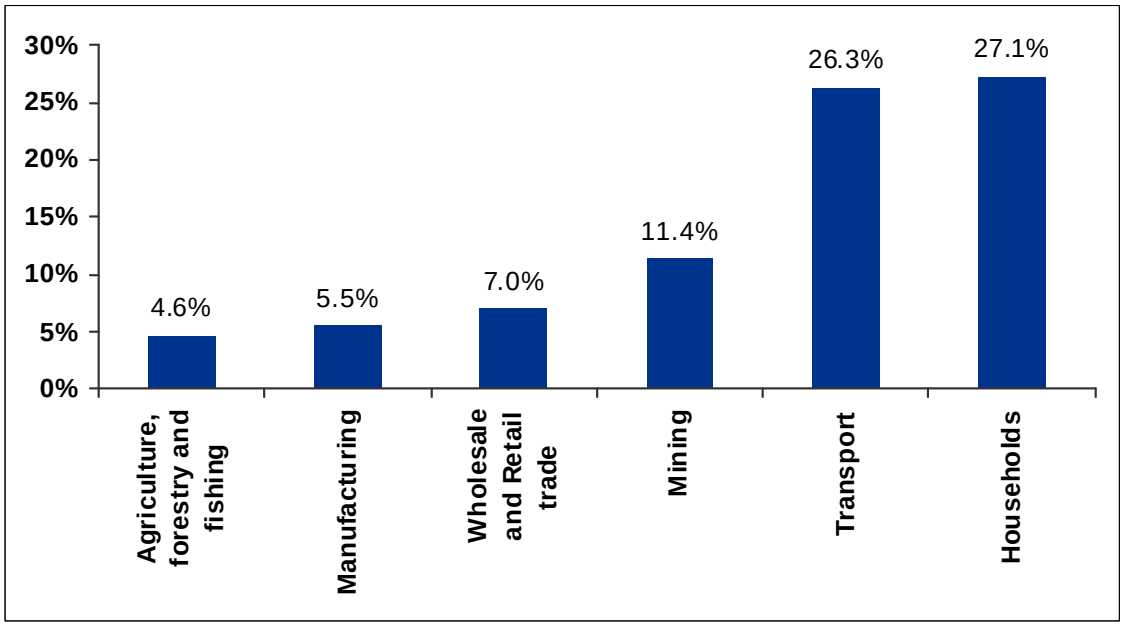
[15] Approximately 92 per cent of the diesel category was automotive diesel.
[16] Aviation turbine fuel makes up 99 per cent of the category, with the remainder being kerosene.

2.2 Intrinsic industry links

Many industries use petroleum products, and for some industries they make up a large share of intermediate input costs. This means that the petroleum refining industry's products have intrinsic links with the rest of the Australian economy. According to ABS data, the petroleum refining industry accounted for 0.2 per cent of GDP (or $2.4 billion) in 2007/08.[17] The industry directly employed approximately 2,500 people in 2008. [18] Due to the flow-on impacts to other industries, KPMG Econtech's modelling shows that the economic contribution of the industry is larger than 0.2 per cent of GDP.

Households account for around 27 per cent [19] of the value of domestic petroleum product use. This makes them the largest user group in Australia. Industries make up the remaining 73 per cent of petroleum product use. Chart 2.3 shows the use of petroleum products in industries where refinery products are particularly important inputs. Use in each industry is reported as a share of total use of petroleum products in Australia.

Chart 2.3: Use of refinery products as a share of total Australian use, 2004/05



Source: ABS, Input Output Tables, 2004/05, cat. no. 5209.0.55.001 (most recent issue)
Notes: Manufacturing use excludes that used by the petroleum and coal products industry itself.
The remainder of petroleum product use is in other industries which make up only a small proportion of total use (less than 4.6 per cent).

[17] This estimate has been made using ABS data, Catalogue no. 82210DO002_200607 Manufacturing Industry, Australia, 2006-07 and Catalogue no. 5206.0 Australian National Accounts: National Income, Expenditure and Product, Table 1 and is not part of the economic modelling.

[18] This estimate has been made by KPMG Econtech using data supplied by the AIP.

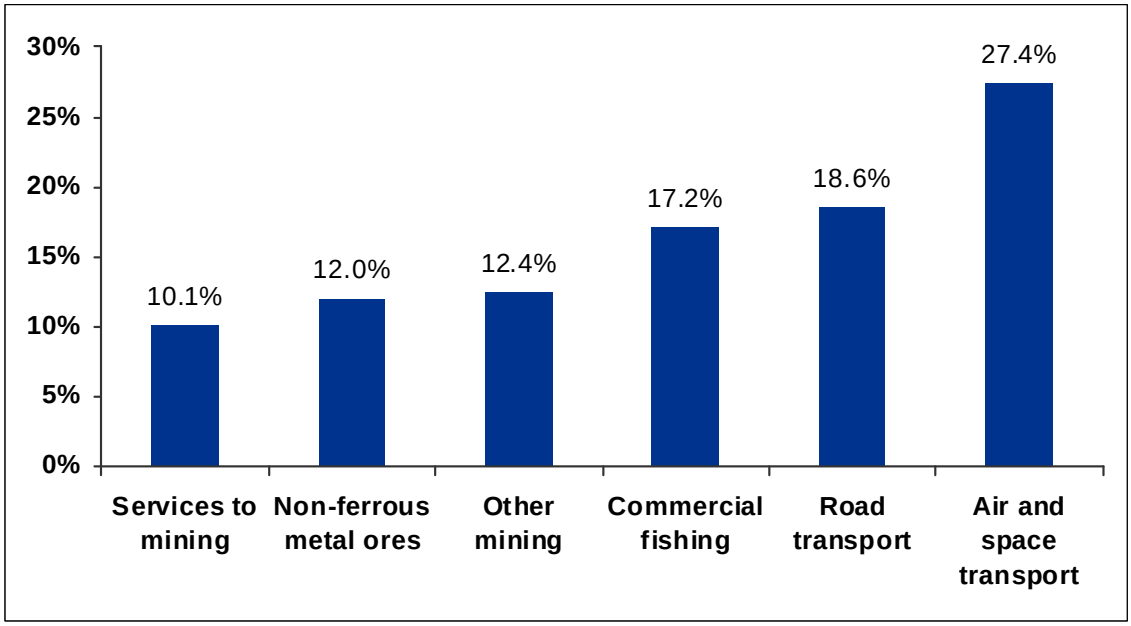
[19] This estimate has been made using ABS input-output tables, Catalogue no. 5209., reference year 2004/05.

Major industrial users of petroleum products include the agriculture, manufacturing, mining and transport industries. Some outputs from these industries are, in turn, important inputs for other Australian industries. Therefore, any shocks (such as the closure of a refinery) to the petroleum refining sector will flow though all sectors of the economy via links with the agriculture, manufacturing, mining and transport industries.

Chart 2.3 above shows that approximately 47.8 per cent of petroleum product use in Australia is concentrated in the four major petroleum-using industries. Transport is the largest industry user of petroleum products, making up around 26.3 per cent of total Australian use.

Looking at a breakdown of industry inputs, Chart 2.4 shows the industries which rely heavily on petroleum products as inputs to their production processes. The chart shows the proportion of intermediate input costs[20] which are attributed to petroleum products.

Chart 2.4: Industry dependence on petroleum products, per cent of input costs 2004/05



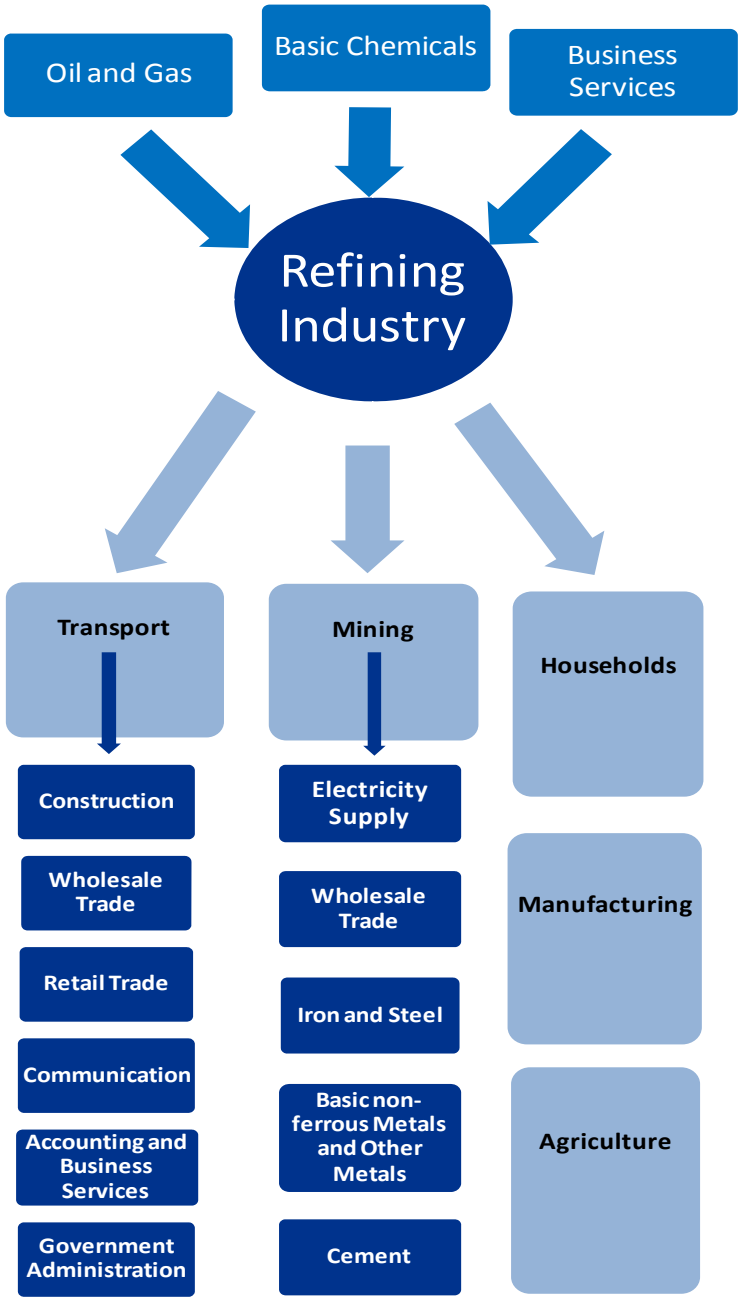
Source: ABS, Input Output Tables, 2004/05, cat. no. 5209.0.55.001
Notes: 'Dependence' is defined as the proportion of intermediate costs represented by petroleum and coal products
'Other mining' refers to all mining activity except those extracting coal, oil and gas, iron ores and non-ferrous metal ores

As expected, transport sectors have a particularly high dependence on petroleum products. In 2004/05, petroleum products made up 27.4 per cent of intermediate input costs for air and space transport, and 18.6 per cent of road transport. Commercial fishing activities also have a high reliance on refinery products, which accounted for 17.2 per cent of industry costs in 2004/05. Since 2004/05, petroleum products may have increased as a proportion of industry costs, due to increases in their price.

[20] Intermediate input costs are the costs of inputs into the production process, other than labour and capital input costs.

Figure 2.1 below presents a simplified picture of the relationship between the refining industry and the rest of the Australian economy. It shows that the refining industry is an important input for other industries which themselves play an important role in the economy.

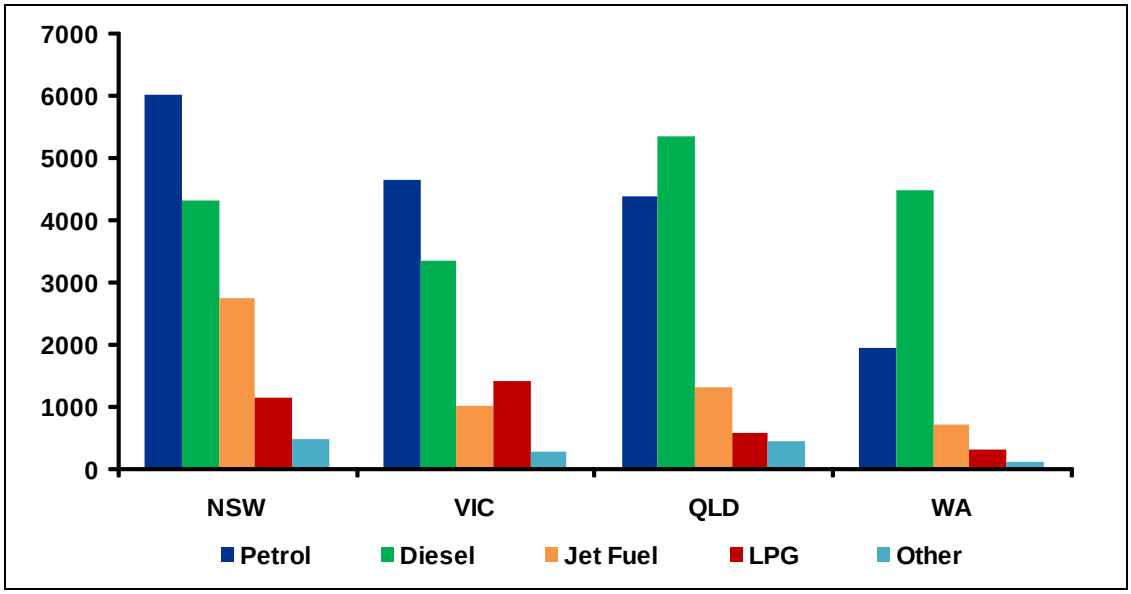
Figure 2.1 The Refining Industry and the Australian Economy



2.3 State consumption

In each of the larger states shown in Chart 2.5, consumption of the different fuels follows a similar pattern. Petrol and diesel are the dominant fuel types in all large states. Queensland and Western Australia, both have large mining industries, and therefore consume more diesel than petrol. Chart 2.5 shows monthly consumption levels for January 2009 by state.

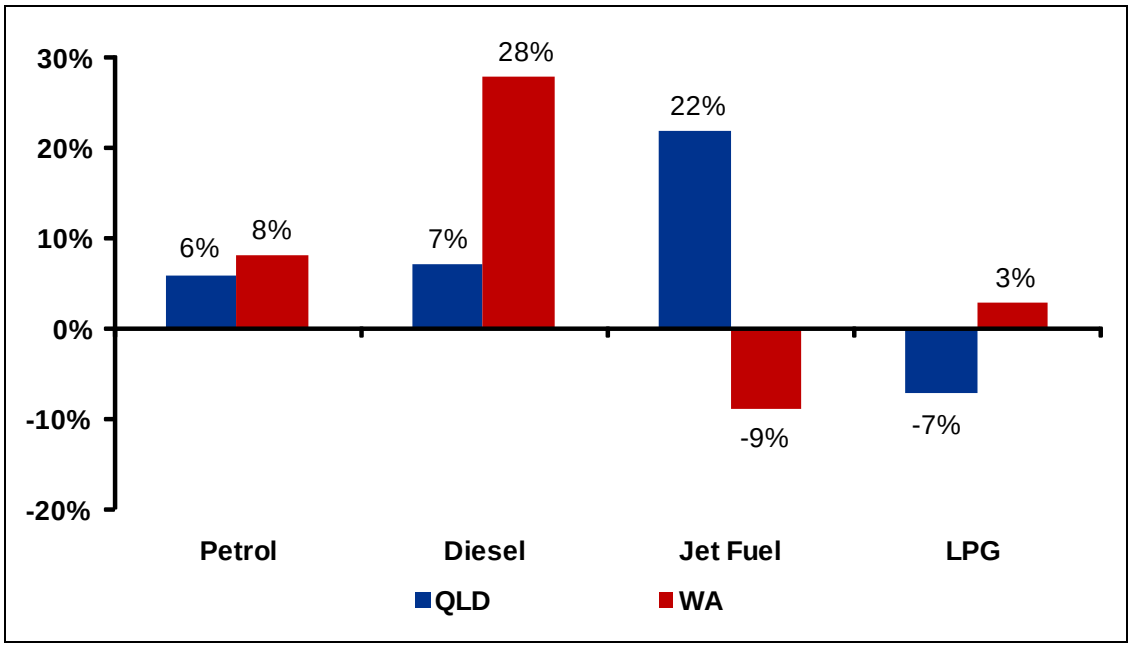
Chart 2.5: Liquid fuel consumption by state, January 2009 (ML)



Source: DRET, *Australian Petroleum Statistics*, ABARE

The growth in fuel consumption between 2002/03 and 2006/07 is shown for Queensland and Western Australia in Chart 2.6 overleaf. Changes in consumption in these states reflect the high economic and population growth rates as a result of the mining boom in those states. Jet fuel consumption in Queensland grew by 21.8 per cent between January 2002/03 and January 2006/07. Diesel use in both mining states has also grown, recording growth of 27.8 and 7.1 per cent for Western Australia and Queensland respectively.

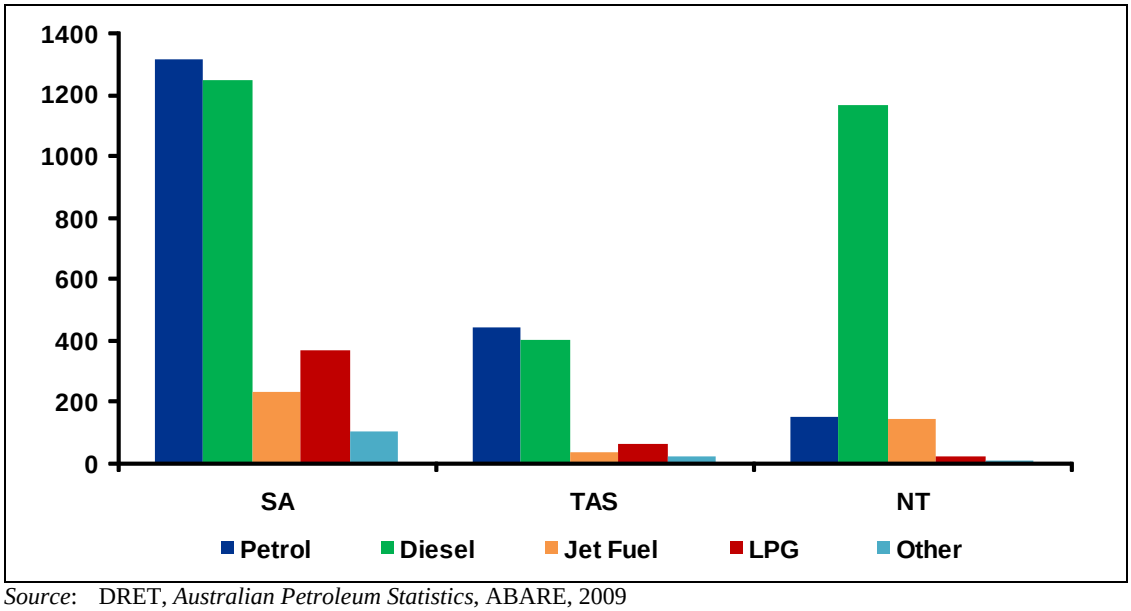
Chart 2.6: Change in liquid fuel consumption by state, 2002/03 to 2006/07 (per cent)



Source: DRET, Australian Petroleum Statistics, ABARE, 2009

The level of liquid fuel consumption in smaller states follows a similar pattern to the larger states. However, the Northern Territory consumes a different fuel mix to the other states, with diesel being by far the most important fuel.

Chart 2.7: Liquid fuel consumption by state, January 2009 (ML)



Source: DRET, *Australian Petroleum Statistics*, ABARE, 2009

3 Australian production of liquid fuels

As noted above, the refining industry makes up around 0.2 per cent of GDP, which in 2007/08 was equivalent to $2.4 billion. [21]

Petroleum refineries process crude oil, condensate and intermediate feedstocks to produce liquid fuels for distribution. The fuel mix produced at a refinery depends on the configuration of the refinery (the equipment) and the chemical composition of crude oils and other inputs that are used. The production process itself involves choosing the right mix of crude oils, and then distilling them to separate the different components. Once separated, each component then goes through different treatments, before the intermediate outputs are blended. The process corrects the quality, quantity and timing of different products so that the outputs are produced close to the proportions required by market demand, and are fit for industry and household use. Sulfur and benzene are also removed from petrol and sulfur from diesel to meet Australian cleaner fuels standards.

Like any other industry, production at refineries is the result of a complex optimisation exercise given the prevailing market demand conditions. Refineries use sophisticated decision making tools to devise the best product mix. They take into account constraints stemming from the availability of different types of crude oil, storage capacity, refining technology, global prices for crude oil and finished petroleum products, government regulations and historical investments.

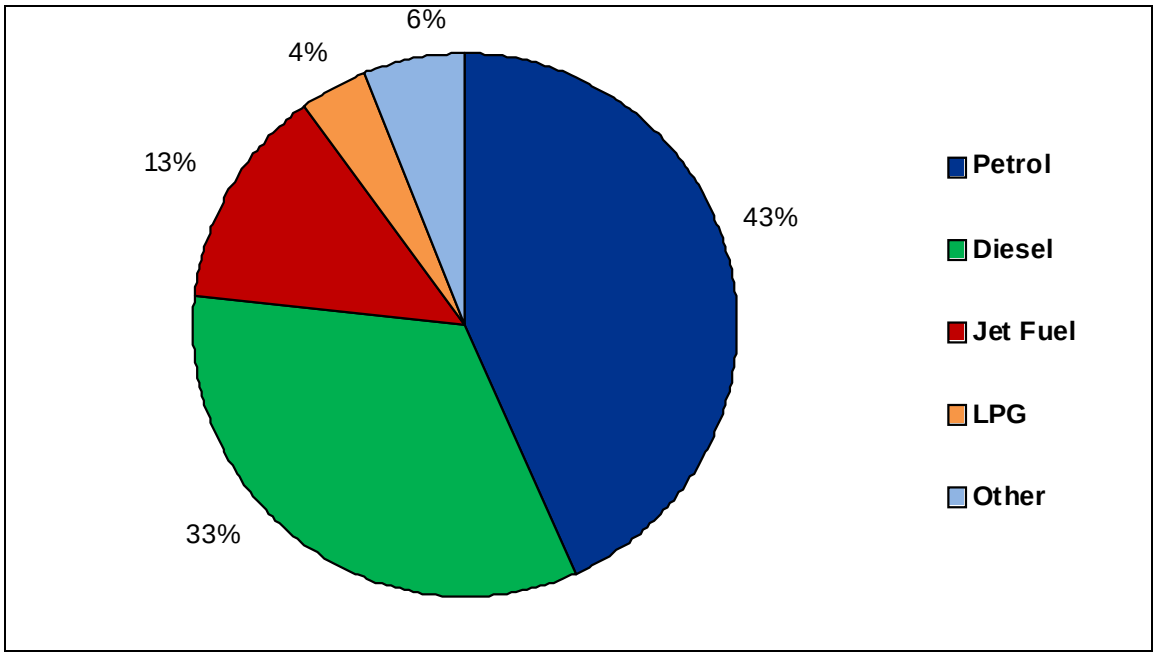
This section describes the production trends of the Australian petroleum refining industry. First, production trends are presented at an industry level. Next, the configuration of refineries working within the Australian context is detailed, and a brief description of each refinery is given. Lastly, employment patterns in the industry are described.

[21] This estimate has been made using ABS data, Catalogue no. 82210DO002_200607 Manufacturing Industry, Australia, 2006-07 and Cat no. 5206.0 Australian National Accounts: National Income, Expenditure and Product, Table 1 and is not part of the economic modelling.

3.1 Production

In Australia there are seven major petroleum refineries operated by four companies: BP, Caltex, Mobil and Shell. Their 2007/08 production mix is shown in Chart 3.1.

Chart 3.1: Australian refinery production, 2007/08, per cent



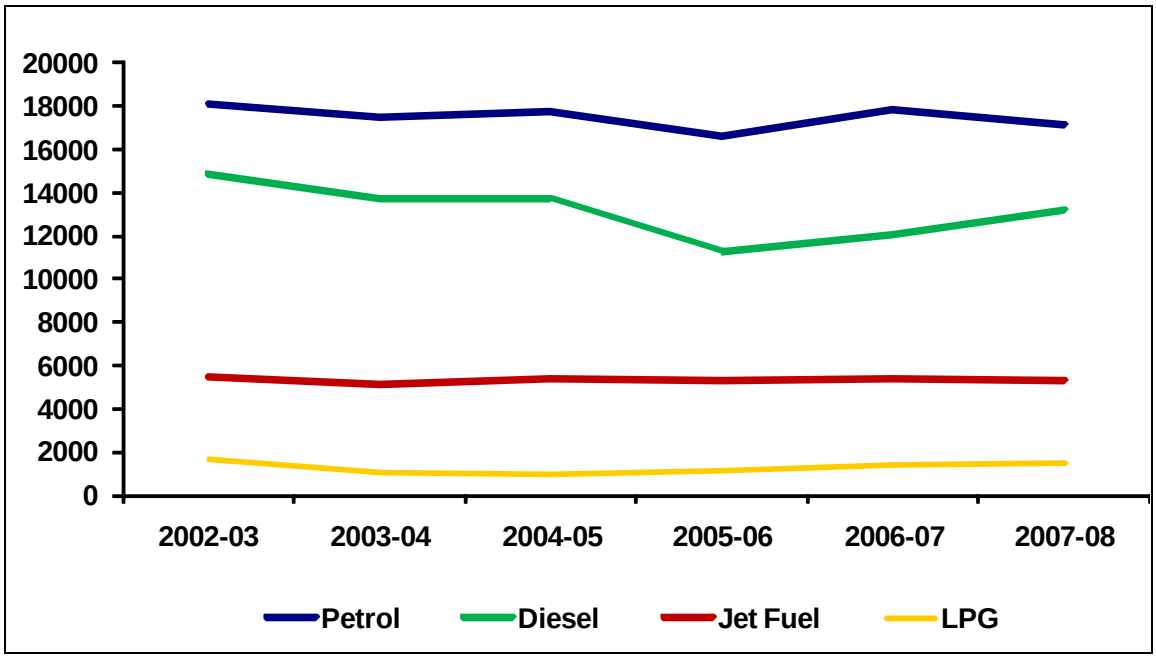
Source: DRET, Australian Petroleum Statistics, ABARE, 2009
Note: Numbers do not sum to 100 per cent due to rounding.

In 2007/08 Australia's refineries produced 39,575 megalitres of refined products. Petrol and diesel accounted for approximately 77 per cent of production[22], as shown in Chart 3.1 (DRET 2009).

Chart 3.2 shows the production of various refinery outputs over time. There was a decline in production of petrol and diesel in 2005/06. This was associated with the introduction of cleaner fuel standards, which led to a reduction in capacity and production from Australian refineries.

[22] This does not add to the figures shown in Chart 3.1 due to rounding.

Chart 3.2: Australian refinery production, ML



Source: DRET, Australian Petroleum Statistics, ABARE

3.2 Australia's refineries

By international comparison, the capacity of Australia's refineries is quite small. This means that they have less opportunity to obtain the economies of scale available to refineries in other countries. Constraints imposed by infrastructure and geography play a large role in determining refinery size and configuration. Historical decisions are also an important factor influencing the current location of refineries and mix of fuels produced. High fixed costs inherent in the industry mean that large amounts of up-front investment are required to build a new refinery, limiting flexibility to adapt to change and creating barriers to new firms entering the market.

Australian refineries tend to be located in close proximity to port facilities and to urban and industrial areas. Close proximity to port facilities means that logistic costs are minimised, reducing the overall costs of production. Location in urban environments means that refineries have easy access to a market of consumers, as well as a source of labour resources and other inputs. The location of refineries is important for their viability because Australian refineries tend to supply their local supply footprint, which includes the area immediately surrounding the refinery plus any other areas the refinery is able to supply. Only when market conditions permit, such as when shortages drive prices up in a particular area, will refineries supply outside their local supply footprint.

The size of Australian refineries is small due to the relatively small size of the Australian market and its geographical dispersion. The Australian industry and population are concentrated in urban centres that are scattered across the country. Refineries distribute product to regional areas by truck, pipeline or ship. The cost of this distribution rises with the distance travelled. Therefore, a refinery's ability to expand is constrained by the geographical layout of its

potential customer base. For example, although the Northern Territory is supplied solely through imports (ACIL Tasman 2008), it is not likely to be commercially viable for the domestic industry to supply petroleum products to the Northern Territory market. Firstly, Darwin is too small a market to support the production from any newly established refinery. Secondly, it is also costly to supply the Northern Territory with petroleum produced at other domestic refineries, because it is far from any other population centre. High domestic freight costs make imports from Singapore more attractive than domestically produced products. Therefore, the vast distances between some consumers and domestic refineries is to some extent constraining the expansion of production in the refining industry.

Another factor constraining the expansion of refinery production in Australia is the costs of production itself. It is more costly to construct new refining capacity in Australia, than in Asia Pacific countries. This is because labour costs and construction costs are higher in Australia than in many Asia Pacific countries. In addition, Australia has tighter environmental regulations than many other Asia Pacific countries. These costs are discussed in section 8.2.

There are also a number of costs associated with closing a refinery in Australia, which mean that the number of refineries in the Australian industry is unlikely to shrink without significant pressure to do so. Describing the Australian refining industry, Hogget (2003) notes that the costs to any one refinery of ceasing production and leaving the industry are very high. The capital-intensive nature of the industry means that a high level of associated investment and sunk costs are involved, and any refinery leaving the industry would forego the value of their existing assets. Moreover, a refinery exiting the Australian industry would also face site remediation costs. There are also opportunity costs of leaving the industry. When one refiner leaves the industry, there may be opportunity for other refiners to gain by expanding their market share. This creates an incentive for each refinery to wait until others exit.

Table 3.1 shows the capacity of the seven major refineries currently operating in Australia. The largest Australian refinery has capacity of 8,000 megalitres (ML) per annum. In comparison, the four largest refineries in Asia have capacity of between 30,000 and 70,000 ML per annum. The implications of this relatively small size will be discussed in section 7, which describes the Asian liquid fuels market.

Table 3.1: Australian refineries

Refinery	City/Operator	Capacity (ML pa)
Altona	Melbourne/ Mobil	4530
Clyde	Sydney/ Shell	4930
Bulwer Island	Brisbane / BP	5110
Lytton	Brisbane / Caltex	6270
Geelong	Geelong/ Shell	6380
Kurnell	Sydney/ Caltex	7540
Kwinana	Kwinana, WA/ BP	7960

Source: AIP, Downstream Petroleum, 2007

The following is a brief description of each of Australia's seven refineries.

Kwinana

The BP Kwinana refinery (commissioned in 1955) is the largest in Australia, and the only refinery in Western Australia. It supplies most of Western Australia's fuel needs, producing a wide range of products including LPG, petrol, jet fuel, diesel, bitumen and fuel oil. It loads petrol, diesel and other products from its jetty at the refinery. It also supplies these and other products, such as ship's bunker fuel, by pipeline to BP's North Fremantle terminal.

Petrol, diesel and jet fuel are pumped by pipeline to BP's Kewdale terminal where road trains, rail tankers and semi-trailers are loaded with fuel for distribution throughout WA. This includes BP's terminal at Kalgoorlie, which is a key distribution point for fuels and lubricants for the mining sector such as the gold and nickel industries (BP Australia, 2009).

Kurnell

The Caltex Kurnell refinery is located on the southern shore of Botany Bay in Sydney's southeast. Commissioned in 1956, it is the second largest of the Australian refineries based on crude run capacity.

Caltex upgraded its Kurnell refinery to meet the fuel standards introduced in 1 January 2006 as part of the Government's cleaner fuels program. This investment has also enabled the refinery to comply with the new 2009 standards for diesel. Upgrades include increasing Kurnell's diesel hydrotreater capacity, which has allowed a reduction in sulfur content in diesel to 10ppm and sulfur content in premium unleaded petrol to 50ppm.

The refinery distributes its output by ship and pipeline. Pipelines connect the refinery's tanks to the three berths, the Banksmeadow terminal and, via the Sydney-Newcastle Pipeline, to the Silverwater and Newcastle terminals. The Kurnell refinery also has a jet line supplying 50 per cent of the airline fuel needed by Sydney Airport. The refinery also directly supplies the chemicals industry located around the bay (Caltex Australia, 2009).

Geelong

The Shell Geelong refinery was commissioned in 1954 and is located at Corio Bay.

Shell has invested approximately $210 million in its Geelong refinery in recent years, in order to produce cleaner fuels with lower sulfur and benzene levels in compliance with government regulations.

The Shell Geelong refinery produces petrol, jet fuel and diesel as well as other petroleum products. In 2006, it produced 50 per cent of the fuel used in Victoria and 75 per cent of the fuel used in Tasmania. This included 2.2 billion litres of low benzene fuel. The refinery also supplies fuel to New South Wales, Queensland, South Australia, Western Australia and New Zealand (Shell Australia, 2009).

Lytton

The Caltex Lytton refinery, commissioned in 1965, is one of the two refineries in Queensland, located at the mouth of the Brisbane River, south of the Brisbane CBD.

Caltex commenced its $250 million Clean Fuels Project at Lytton refinery in 2006. The project reduced the benzene content in petrol and the sulfur content in diesel to standards required by the Australian Government. For example, Lytton's diesel hydrotreater unit is producing diesel to the new standards of a maximum 10ppm of sulfur.

Almost 70 per cent of finished petroleum products from this refinery are transported via pipeline to South East Queensland to supply the industry activity there. The remainder goes by ship to ports as far north as Cairns. From terminals, the product is trucked to service stations and final consumers (Caltex Australia, 2009).

Bulwer Island

BP's smaller refinery, Bulwer Island refinery, is located on reclaimed land in Queensland, bounded by the Brisbane River and Boggy Creek. It was built in 1965 by Amoco, but acquired by BP in 1984.

The Bulwer Island refinery utilises a technologically advanced hydrocracker to produce low sulfur diesel fuel, and it is the only refinery in Australia possessing such a technology. Hydrocracked diesel has a lower density, higher hydrogen content, lower sulfur for an equivalent energy content when compared with equivalent straight-run diesel (Department of the Environment, Water, Heritage and the Arts, 2004).

Products from Bulwer Island are distributed mainly via pipeline to the nearby marketing terminal at Whinstanes, and to other product terminals in Brisbane where they are then distributed by road tankers. Jet fuel from Bulwer Island is supplied via a direct pipeline to the Brisbane airport and LPG is delivered to a local terminal for onward distribution by truck. The remainder of the products are sent via the product wharf to terminals in Gladstone, Mackay and Townsville. Occasionally, shipments go to other locations such as Sydney and Newcastle (BP Australia, 2009).

Clyde

Shell's Clyde Refinery was built in the early 1920s and operated by Shell since 1928. It is located where the Parramatta and Duck Rivers join, 16km west of Sydney's CDB. It is one of the most complex of the seven refineries operating in Australia.

The refinery produces petrol (with approximately 20 per cent being high octane grades), diesel fuel, jet fuel, bitumen, and LPG. These petroleum products are delivered to customers through Shell's Parramatta distribution terminal by road tankers and by rail. The refinery is also connected by pipeline to Sydney Airport, oil company distribution terminals in Newcastle and other oil companies at Silverwater. The refinery supplies about 40 per cent of

Sydney's petroleum requirements and about 50 per cent of New South Wales needs (Shell Australia, 2009).

Altona

The Mobil Altona refinery is located 13 kilometres west of Melbourne. The original refining operation on the site (producing bitumen and lubes) was established in 1949. The refinery was upgraded and expanded to produce petroleum fuels in 1954. In 1956 Altona was the first refinery to produce aviation fuel in Australia.

The refinery produces petrol, diesel, jet fuel, bitumen and LPG. Petrol represents approximately 50 per cent of production, with diesel making up a further 25 per cent and jet fuel around 15 per cent. The refinery supplies around half of Victoria's fuel needs.

Around 90 per cent of products are distributed to local oil company terminals. Bitumen is transported directly from the refinery by road or rail. The refinery also supplies the nearby Altona chemical complex with LPG, which in turn supplies feedstocks to a number of petrochemical manufacturing plants at Altona. These plants produce the raw materials from which a number of consumer products are manufactured (ExxonMobil Australia, 2009).

Port Stanvac

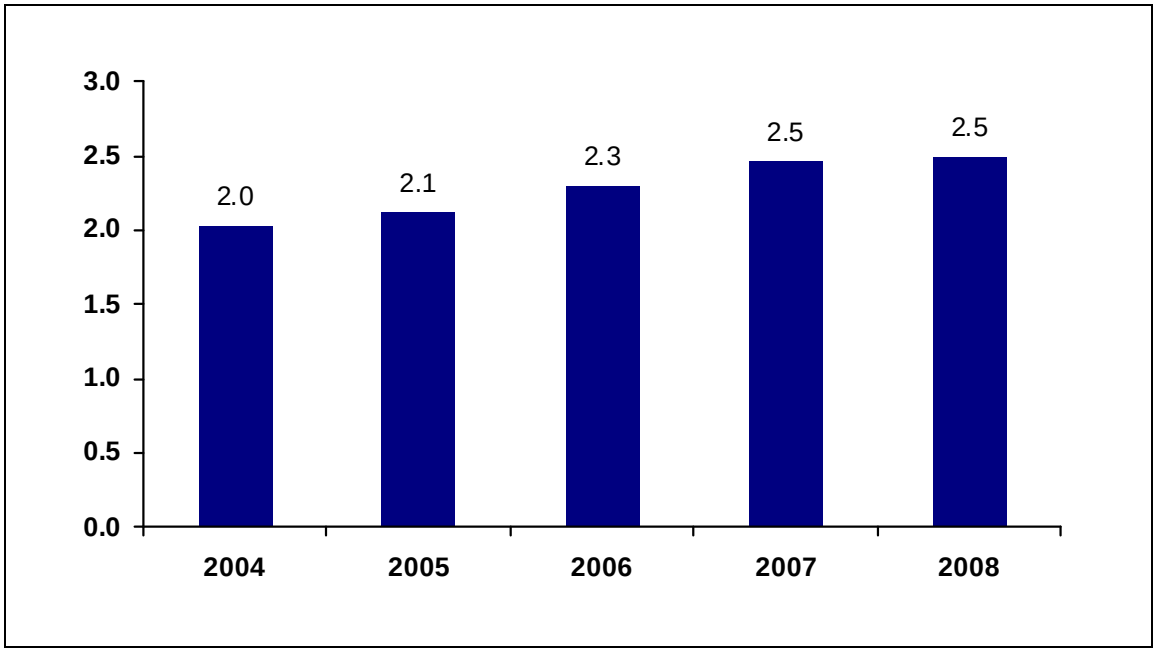
In 2003, ExxonMobil mothballed the Port Stanvac Refinery in Adelaide. It has since reviewed, a number of times, whether restarting the refinery would be financially viable. In June 2009, ExxonMobil announced that it does not plan to restart the refinery and that it intends to proceed with plans to demolish the refinery facilities and remediate the site (ExxonMobil Australia, 2009).

3.3 Employment

Employment in Australia's petroleum refining sector currently stands at around 2500[23] permanent employees. The industry also uses significant numbers of contractors.

Chart 3.3 shows the number of employees in the refining industry between the years 2004 to 2008. The employment numbers shown in Chart 3.3 only includes those workers directly employed by refineries. Actual labour use will be larger than these numbers show because the petroleum refining sector also employs contractors on a non-permanent basis.

Chart 3.3: Direct employment in Australia's petroleum refining industry, persons ('000)



Source: KPMG Econtech estimates using data supplied by the AIP
Note: Employment numbers only includes direct employment, does not include contractors.

The number of contractors employed in the refining industry varies throughout the year, especially during periods when some production units are shut down to allow for major maintenance. During these periods, refinery labour requirements increase temporarily and contractors generally fill the extra demand. According to some refineries, during ordinary periods of operation refineries employ almost as many contractors as permanent employees, implying that employment levels could be as much as twice as large as those shown in Chart 3.3 during normal periods of operation. During these periods, the main tasks of contractors include maintenance, engineering, inspection, water treatment and security. However, the number of contractors could as much as double during periods of major maintenance compared to an ordinary period of operation.

[23] This estimate has been made by KPMG Econtech using data supplied by the AIP.

As with the rest of the economy, the availability of workers to the refining sector tends to exhibit cyclical patterns. Refineries employ skilled labour, such as engineers and trades-people and thus have to compete with many other employers who employ workers with similar skills. According to refineries, in general, niche roles such as risk engineers and process control engineers are in relatively short supply. Welders are also difficult to find, particularly in periods of major maintenance. During times of high economic growth, supply shortages in all types of refinery roles tends to arise, and refineries struggle to find sufficient workers of suitable quality. However, the situation has eased slightly with the current economic downturn, as overall demand for workers in the economy has reduced. [24]

[24] This information was gathered during interviews with refinery representatives.

4 Trends in imports and exports

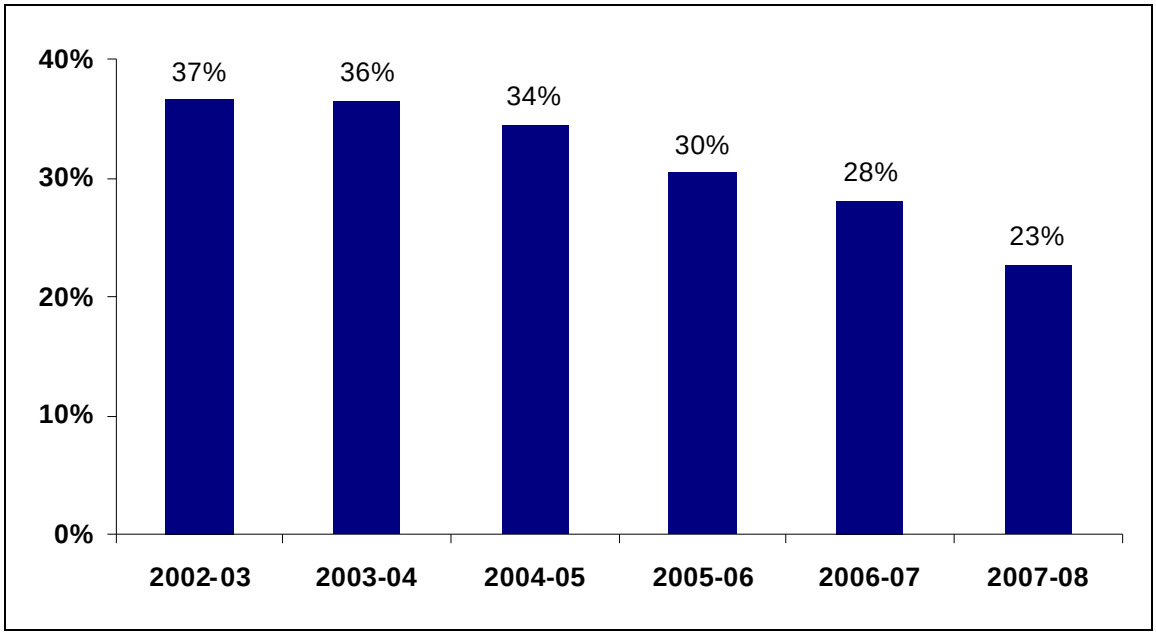
Australia's refining industry is an import-competing industry, with its production geared towards Australian consumption, and exports making up only a small proportion of domestic production. In total, Australian production supplies only around 73 per cent of total Australian demand for petroleum products (DRET 2008 b). This section describes the import and export trends in the sector.

Australia is a small international player, importing both inputs to the refining sector, as well as refined products that compete with Australian refinery outputs. Section 8, later in the report, examines the impacts that the Asia Pacific regional market has on the Australian industry.

Refinery input imports

Crude oil is the major input into petroleum refining. The proportion of Australian crude oil used in Australian refineries has been falling over time, as shown in chart 4.1. below.

Chart 4.1: Use of indigenous crude in Australian refineries (per cent)



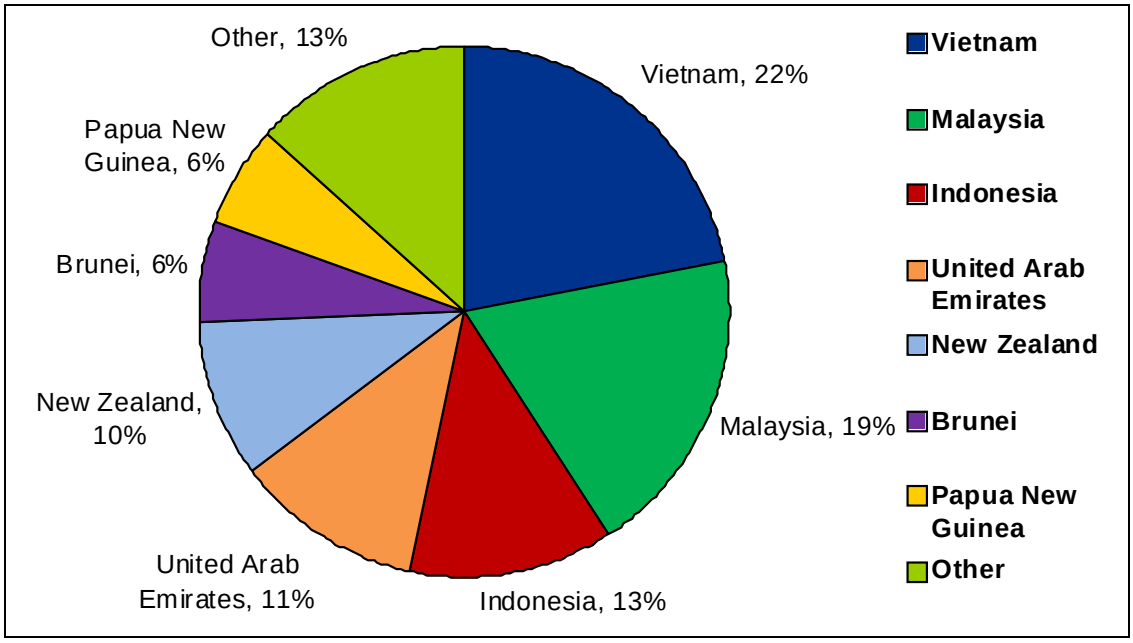
Source: DRET, Australian Petroleum Statistics, ABARE

There are a number of reasons for Australian refineries to prefer imported crude oils to Australian ones. Firstly, in areas where crude oil is extracted close to domestic refineries, production from those wells tends to be insufficient to support production levels at the refinery, and has been in decline in some areas. Secondly, the quality and composition of Australian crude oils often does not suit the product mix that is demanded on the domestic market. Moreover, Australian crude tends to be more expensive, since it tends to be lighter and sweeter (ACCC, 2007). Crude input costs are important for determining refinery costs, and refineries choose the optimal mix of domestic and imported crude. The optimal mix of domestic and

imported crude depends on their relative costs and the value of the products that can be produced from them.

Chart 4.2 reveals that Australian refineries import crude oil from a diverse range of countries. The chart shows that the bulk of crude oil imports come from countries in the Asia-Pacific region, with Vietnam and Malaysia being the largest suppliers in 2008.

Chart 4.2: Crude oil imports by country of origin, 2008 (per cent)



Source: DRET, Australian Petroleum Statistics, ABARE

Note: *Other* includes Saudi Arabia, Iraq, Philippines, Thailand, Singapore (although Singapore does not produce crude itself), Algeria, Russia, international waters and other confidential sources.

Refined product imports

As argued in chapter 8, the Australian refining sector is in direct competition with imported products. Imports make up a large proportion of domestic consumption and exports are very small.

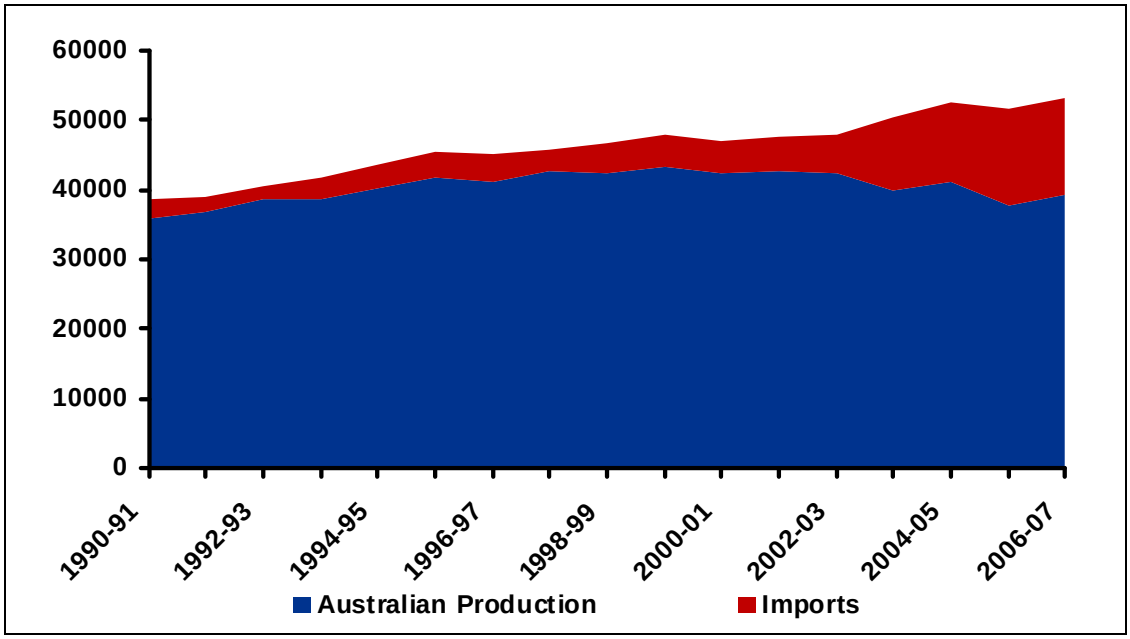
Australian fuel suppliers import refinery products for two main reasons. The first is to supply the gap between domestic demand and domestic production. The second is to fill any short-term supply gaps to ensure a stable and reliable supply of refinery products to the Australian economy, as will be discussed in section 7.1.

Since 2003, imports of petroleum products have increased as a proportion of Australian consumption. For the ten years 1993/94 to 2002/03, imports made up an average of only 9 per cent of consumption. However since 2003/04, imports have constantly exceeded 20 per cent, and were as high as 33 per cent in 2007/08 (DRET, 2009). However, there are

differences between imports of each fuel type. As shown in Chart 4.4, diesel and petrol are the largest fuel imports.

As can be seen in Chart 4.3 below, the increase in imports has been brought about by the combination of both an increase in domestic consumption of petroleum products, and a decrease in domestic production. The increase in consumption is due to increasing consumer and industry use, as outlined in Section 2. The fall in Australian production coincides with the reduction in production capacity and the introduction of cleaner fuels specifications, as mentioned in Section 3.

Chart 4.3: Australian consumption of refinery products 1990/91 to 2006/07 (ML)

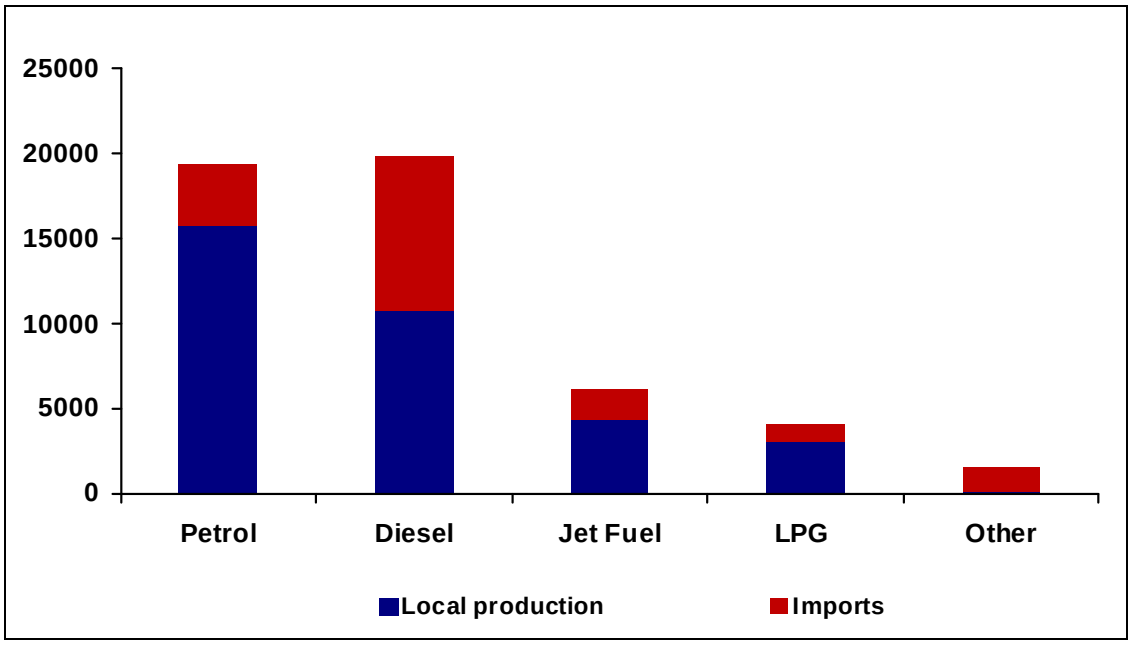


Source: DRET, Australian Energy Statistics, Table M and Table K

Australian import dependency varies across the different product groups. Import dependency is highest for diesel, where Australian imports made up around 46 per cent of domestic consumption in 2007/08. For petrol, the proportion of domestic production in consumption is higher, with imports supplying around 18 per cent of domestic consumption in 2007/08.

Chart 4.4 overleaf illustrates the proportion of Australian consumption of the refinery product categories sourced from imports and from domestic production.

Chart 4.4: Australian consumption by fuel category and source 2007/08 (ML)

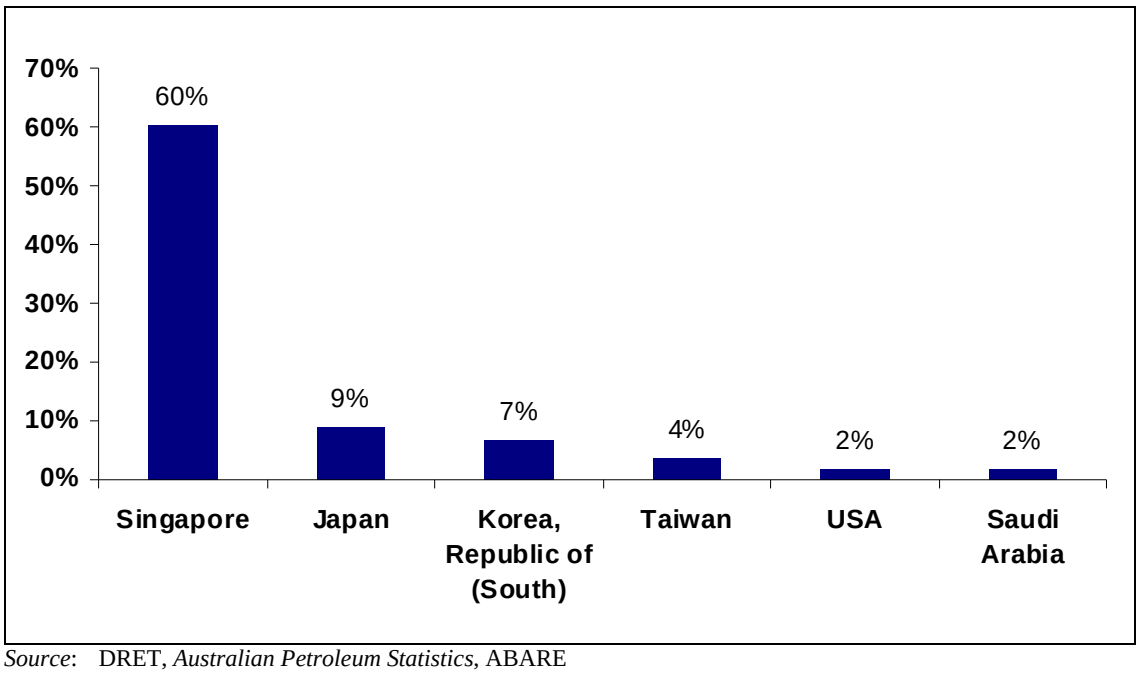


Source: DRET, *Australian Petroleum Statistics*, ABARE, 2009 b

Imports of refined petroleum products have impacts on the domestic refining industry. The most important of these is that import prices determine the prices that domestic refiners are able to charge for their products. The Australian market, given enough time for product shipments to arrive, can switch from consuming domestically produced products to consuming imported products. This means that the Australian price of refinery products cannot be higher than the competing import prices. Therefore, since the prices Australian refineries pay for their inputs (crude) and receive for their outputs are linked to regional prices, the profitability of Australian refineries is closely tied to product prices in Asia. This issue will be discussed in more detail in Section 8.

For Australian refineries, the main competition lies close to home. Singapore, the regional liquid fuels hub, supplies the bulk of Australia's imported petroleum products, supplying 60 per cent of Australian imports of refined petroleum products in 2008. Chart 4.5 shows Australian imports of petroleum products by country of origin.

Chart 4.5: Australian imports of refined fuels by country of origin, 2008, (per cent of total imports volume)



Source: DRET, *Australian Petroleum Statistics*, ABARE

Note The remaining 17 per cent of imports are sourced from other countries. These include United Arab Emirates, Kuwait, Iran, Qatar, Bahrain, Iraq, Vietnam, Indonesia, Brunei, Papua New Guinea, Malaysia, New Zealand, Philippines, Thailand, China, Canada, Germany, France, Algeria, South Africa, the United Kingdom, the Netherlands, Belgium, India and others (which are not reported for confidentiality reasons).

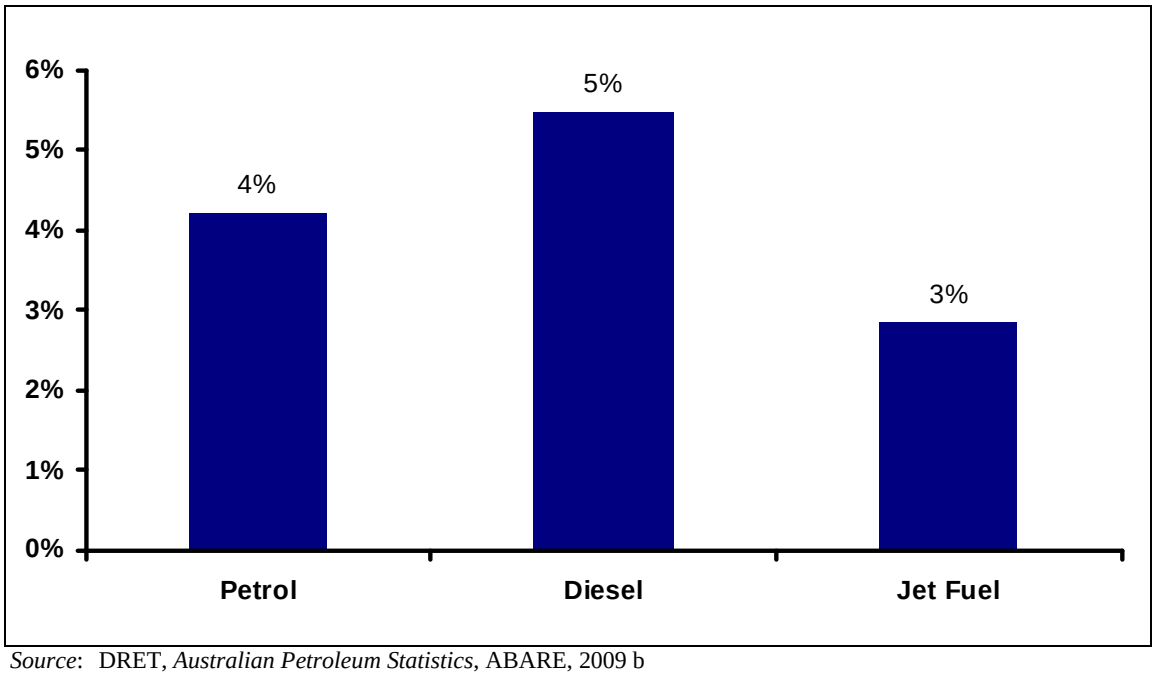
In addition to Singapore being the major international supplier of petroleum products, imports from Singapore have been growing over past years, as shown in Chart 4.6.

Exports

As noted above, rather than being an exporter, the Australian petroleum refining industry is import-competing. As a result, exports of refined products are small. In 2007/08, they were less than 5 per cent of production. This partly reflects the large distance between Australia and the rest of the region. Destinations for exports include New Zealand and Antarctica, which are small markets. These destinations are chosen because Australia is close to these countries compared to Singapore, and so exports from Australia become more competitive. Other exports include products that cannot be sold on the Australian market because they are either surplus to requirements or do not meet Australian fuel specifications.

Chart 4.7 shows the proportion of production that is exported for the products with comparable export data. As expected, these are very small.

Chart 4.7: Australian refined petroleum exports, 2007/08 (per cent of production volume)



Source: DRET, *Australian Petroleum Statistics*, ABARE, 2009 b

5 Approach to modelling industry contribution

The next two sections of this report explain KPMG Econtech's modelling of the domestic refining industry's contribution to the Australian national and state economies. Section 5 outlines the methodology used, including the details of the model and an explanation of the scenarios. The following Section 6 reports the modelling results for each of the scenarios.

5.1 The MM600+ model

While it is relatively straight forward to determine the direct effects of the refining industry on the Australian economy, quantifying the indirect effects requires economic modelling. KPMG Econtech has used our highly detailed economic model, MM600+ to estimate the economic contribution of the refining industry to the Australian national and state economies. In particular, MM600+ was used to estimate the economy wide impacts of a number of specific economic scenarios, including refinery closures and the curtailment of imports.

MM600+ is a computable general equilibrium (CGE) model of the Australian economy that models a long-run equilibrium. MM600+ is highly detailed, distinguishing 672 products produced by 108 Australian industries. MM600+ has the following important features that make it well suited for this analysis.

- It estimates the effects of industry changes on key macroeconomic aggregates such as GDP, trade balance and Australian consumer living standards (as measured by the average consumption per head of population).
- It estimates the effects of industry changes on key State and Territory aggregates such as gross state product (GSP).
- It distinguishes 6 different petroleum products. This is shown in Table 5.1, with 'other' encompassing two of the refinery products in MM600+.

Table 5.1: Petroleum Manufacturing Industries and Products in MM600+

MM600+ Industry	Product in MM600+	Product Definition
Petroleum and coal products	Petrol	Automotive petrol; gasoline refining or blending; motor spirit (incl. aviation spirit)
	Diesel	Gas oil or fuel oil (excl. motor spirit and kerosene)
	Jet Fuel	Kerosene (incl. kerosene type jet fuel)
	LPG	Liquefied petroleum gas produced at refineries
	Other	Refinery products nec. *and* Misc. other petroleum & coal products

The high level of product disaggregation available in MM600+ is important when simulating the refinery closures using the model. Each of the seven refineries produces a different range of petroleum products depending on the refinery's configuration and the type of crude oil processed. This detailed representation of the industry in MM600+ means that we are able to better simulate the closure of a particular refinery in a more sophisticated manner. Descriptions of the MM600+ product categories can be found in the Appendix.

- It allows for the substitution effects triggered by changes in the prices of goods and services. Specifically, MM600+ allows substitution between:
  - labour and capital;
  - different types of capital inputs such as motor vehicles, computers, buildings etc;
  - different forms of primary energy, including black coal, brown coal, LPG and natural gas; and
  - road and rail freight transport.

Using MM600+, KPMG Econtech has estimated the impact of a contraction in Australia's petroleum refining industry, including its impacts on upstream and downstream industries, economy-wide effects on GDP, prices, employment and consumer welfare. Additionally KPMG Econtech has estimated the impact of this contraction for relevant states.

Key assumptions

MM600+ models a long-run equilibrium. It is assumed that in the long run, economic agents optimise, all markets are in equilibrium, and assets and liabilities follow sustainable paths. Some of the key assumptions involved are as follows.

Labour market equilibrium: local employment in MM600+ is fixed, which means that in the long run the labour market is assumed to attain equilibrium, so that an economic shock has no lasting effect on total employment. This assumption is implemented by fixing the level of total employment. This means that job losses in a particular industry or region from a refinery closure will be exactly balanced by job gains in other industries or regions.

External balance: in MM600+, the balance of trade is at a sustainable level. Specifically, a trade surplus is run equal to the amount required to service foreign-owned capital. The real exchange rate needed to achieve this trade surplus is determined by MM600+. Thus shocks to international trade affect the real exchange rate, not the trade surplus.

Budget balance: the government budget is also assumed to be at a sustainable level. Specifically, it is assumed to be in balance. A lump sum tax/transfer is used as the fiscal policy instrument to balance out the effects on the government budget of increase taxation revenue. Thus any change in revenue is associated with a balancing cut/increase in labour income tax.

Private saving: the level of private sector saving and associated asset accumulation is sustainable in the long run. Private saving is held constant in MM600+ by fixing the quantity of capital that is owned locally, and changes in capital are only in the foreign-owned portion.

5.2 Model simulations

KPMG Econtech has simulated three scenarios, using its MM600+ model, a base case, the closure of a small refinery in state with a domestic-oriented and labour intensive economy and the closure of a large refinery in a state with an export oriented and capital intensive economy. The externalities identified in this report have not been considered in this economic modelling.

First, using data supplied by the industry, a baseline scenario has been simulated in MM600+ to ensure that the model reflects the industry changes that have taken place since the ABS input output data was released. Second, two alternative scenarios have been run to demonstrate the contribution of the refining industry to the Australian national and state economies. The results from the two scenarios are compared to the baseline results to isolate the effects that the scenarios would have on the national and state economies. The following is a description of each scenario.

Scenario 1 – small refinery closure

This scenario simulates the closure of a typical 'small Australian refinery' in a 'domestic-oriented' state. It asks the question, "What happens to the national and state economies if a small refinery in a state with domestic-oriented industry permanently shuts down?" This allows the estimation of a small refinery's contribution to GDP.

For this scenario, production of the six refining industry products was reduced by the average volume produced by 'small Australian refineries'. Small Australian refineries were defined as refineries producing on average around 5000 ML per annum or less. This shock was applied in New South Wales to illustrate the impact of such a shock on states with domestic-oriented industries, which are New South Wales and Victoria. That is, this scenario is indicative of the industry impacts in a state with a smaller mining sector and more labour intensive industries than the Australian economy as a whole.

Scenario 2 – large refinery closure

This scenario simulates the closure of a typical 'large Australian refinery' in a state with export-oriented and capital intensive industries. The question asked in this scenario is, "What happens to the national and state economies if a large refinery in a state with export-oriented industry permanently shuts down?" This allows the estimation of a large refinery's contribution to GDP.

For this scenario, production of the six refining industry products was reduced by the average volume produced by 'large Australian refineries'. Large Australian refineries have been defined as refineries producing on average above 6000 ML per year. This shock has been applied in Queensland to illustrate the impact of such a shock on the states with industries which are more export-oriented and capital-intensive than the Australian economy as a whole. These are Western Australia and Queensland.

5.3 Data

The AIP has supplied KPMG Econtech with historical data on the production of each of the six refinery products at each of the seven refineries currently operating in Australia.

This data, in conjunction with the ABARE publication, Australian Petroleum Statistics, has been used in the baseline simulation to ensure that the model adequately reflects the current industry structure in terms of production, imports, exports and consumption. Australian Petroleum Statistics has also been used to determine the import propensity for crude oil inputs to the industry.

As mentioned above, for each scenario, the shock inputted into the model was a reduction in the production of refinery products. To find the appropriate amount by which to reduce production, KPMG Econtech has used data supplied to it by the AIP. This AIP data gives the amount produced at each refinery over a number of years. For the scenario of the small refinery closure, the average amount produced by the small Australian refineries was found. For the scenario of the large refinery closure, the amount produced by large Australian refineries was found.

6 Estimated contribution of the refining industry

This section presents the results of the scenarios outlined in Section 8. First the purpose of the baseline scenario is explained. Next, an indicative estimate of the overall economic contribution of the refining industry is given. The estimated economic impact of two refinery closures are then compared, giving national and state results.

6.1 Baseline

The refining industry's value added accounted for around 0.2 per cent of GDP or $2.4 billion in economic activity in 2007/08. Annual industry turnover is a much larger number, at around $42 billion and annual investment is around $1 billion (AIP 2007 b). The main users of the refining industry's output are households and the transport, mining, manufacturing and agriculture industries. The most important fuels produced by the industry, in terms of consumption and production volumes, are petrol and diesel. Jet fuel has also been increasing in importance in recent years. All of these aspects of the industry have been described in the previous sections.

However, as noted in the preceding sections, changes in production, consumption, and international trade have occurred in recent years. Consumption of diesel and jet fuel have increased associated with the mining boom and changing consumer preferences. Overall production levels have historically been stable. However, in recent years production has been more volatile, associated with the introduction of cleaner fuel standards, and with the changing viability of individual refineries. Accordingly, imports, particularly of petrol and diesel, have increased over time, especially since 2003.

In our baseline simulations, KPMG Econtech has used data collected from the industry to adjust the model so that it properly reflects the current industry structure. That is, simulations have been run so that the model reflects the most up to date picture of the industry's actual product mix (in output, exports, imports and consumption). It is important that the industry structure is appropriately reflected in the model baseline because the two scenarios described above are compared to the baseline to find the flow-on economic impact of the simulated refinery closures.

6.2 Overall contribution of the industry

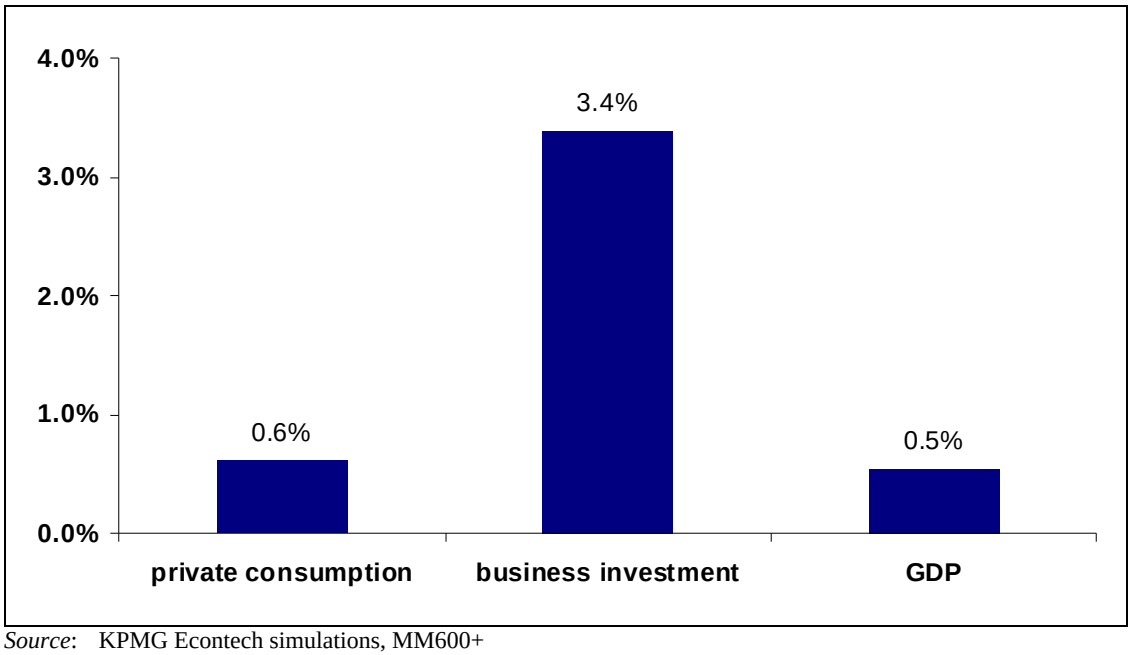
As an indicative figure, Australia's refining industry in total contributes 0.5 per cent[25] of GDP, or $2.4 bn in 2007/08 terms, to the Australian economy. This is the sum of the industry's direct contribution to GDP, which is 0.2 per cent of GDP[26], plus its indicative indirect contribution, which includes the additional activity that the industry supports in other areas of the economy.

[25] This 0.5 per cent estimate is indicative only. A more rigorous modelling of the refining industry's contribution would need to model the circumstances that may lead to the closure of the industry, rather than being based on an assumed outcome.

[26] This direct contribution is calculated using ABS data, and is not part of the economic modelling.

The overall contribution has been estimated by modelling the contribution of 20[27] per cent of the industry, and then multiplying it by a factor of five, meaning that the 0.5 per cent figure is an indicative estimate only. A more rigorous modelling of the refining industry's contribution would need to model the circumstances that may lead to the closure of the industry, rather than being based on an assumed outcome.

Chart 6.1: Total economic contributions of the refining industry



Source: KPMG Econtech simulations, MM600+

Chart 6.1 shows that the presence of the refining industry allows private consumption to be 0.6 per cent higher than would be the case if there were no domestic refining industry. Business investment is 3.4 per cent higher because of the investment that the refining and other sectors are making to maintain their stock of physical assets.

Although we have provided an indicative estimate of the impact on the economy if the refining industry were to close, it is unlikely that this would occur. A more useful and interesting question is to analyse the impact on the economy of closing specific refineries. Therefore, the economic impact of closing a typical small refinery and typical large refinery have been simulated. The results of these simulations are presented below.

[27] The contribution of 20 per cent of the industry was modelled rather than the contribution of 100 per cent of the industry for technical reasons. The contribution is modelled by reducing the size of the refining industry and comparing the results of this simulation with the baseline simulation. If the proportion of the industry removed is too large, then the results will be more dependant on the functional form of the equations in the model. As with all economic models, the larger the shock being simulated, the less accurate are the results. This is the reason that a 20 per cent change was modelled rather than any larger change.

6.3 Economic contribution of refineries – national results

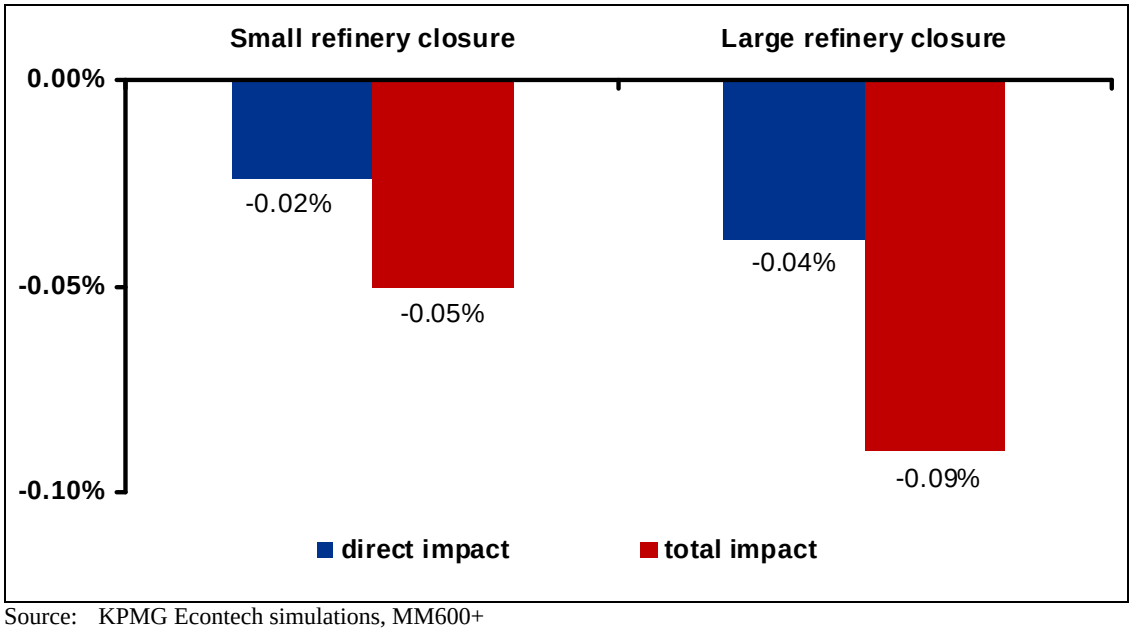
As described in section 5.2, the economic effects of the closure of a small refinery in a state with domestically-oriented industries, such as services, has been estimated. The closure of a typical large refinery in a state with industries that are export-oriented, such as mining, has also been estimated. These scenarios allow the estimation of the contribution of refineries to the national and state economies. The most prominent result is that GDP is expected to be smaller than otherwise if refineries close. This comes not only from the direct impact of refinery production, but also from the flow-on effects to other Australian industries.

The typical small refinery produces around 11 per cent of refining industry output. Given that output from the refining sector accounts directly for 0.2 per cent of Australia's GDP, a typical small Australian refinery therefore directly accounts for 0.02 per cent of GDP. However, by capturing the indirect, or 'flow-on' effects of the refinery, the model results show that a small refinery actually contributes 0.05 per cent to national GDP, or $0.6 billion in 2007/08 values.

The same is true for the closure of a large refinery. A large refinery produces around 18 per cent of total refining industry production, which directly contributes 0.04 per cent of national GDP. However, by taking into account the indirect effects, the modelling results show that a large refinery contributes around 0.09 per cent of GDP, or around $1.0 billion in 2007/08 values.

Chart 6.2 shows the direct and the total (direct plus indirect) impacts of refinery closures on GDP. GDP would be 0.05 per cent smaller if a typical small refinery were closed, and 0.09 per cent smaller if a typical large refinery were closed. The estimates assume that if a refinery closes total employment levels are unchanged in the long-run, so that all jobs lost from the refinery and related industries are replaced by new jobs elsewhere in the economy.

Chart 6.2: Direct and indirect economic impact of refinery closures – (percent change in GDP)

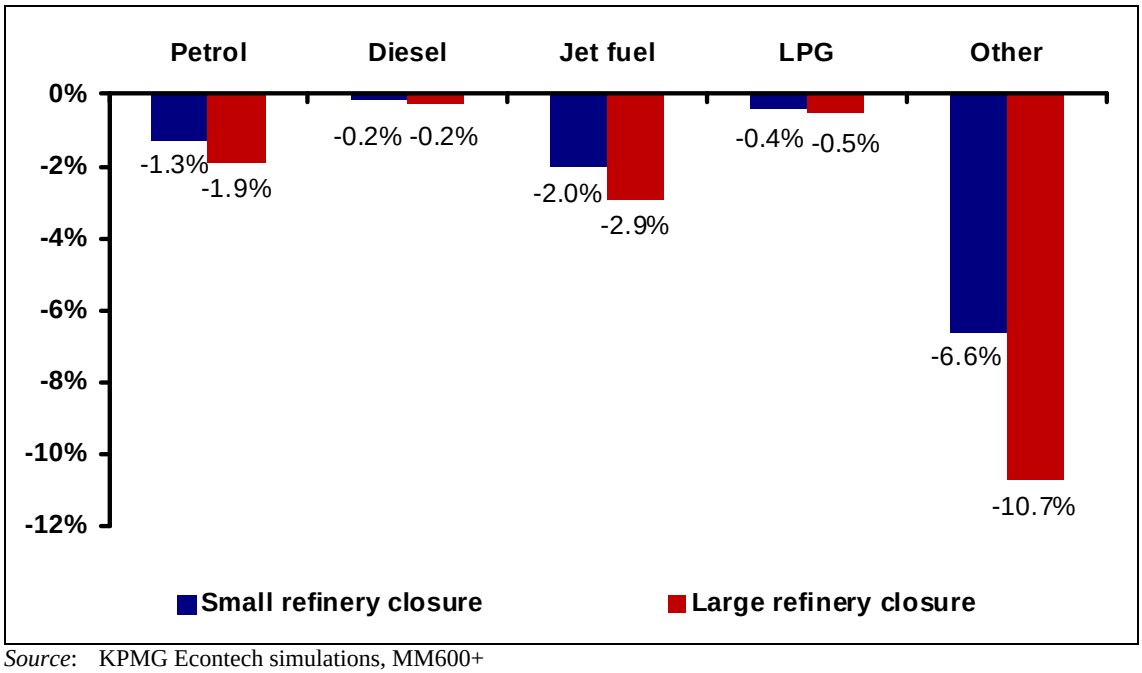


Source: KPMG Econtech simulations, MM600+

These modelling results can be described in more detail. First the macroeconomic effects of closing a refinery are presented, as these form the foundations on which to interpret changes in individual industries. As might be expected, the national macroeconomic impacts of closing a small refinery and a large refinery differ only in scale.

Consumption of petroleum products does not change very much, since the elasticity of demand for petroleum products is low. Chart 6.3 shows that consumption of most refinery products is expected to be similar whether or not the refinery closures occur, except for the *Other* product category, which includes waxes, lubricants and other products with relatively higher elasticities of demand. The *Other* category, also contains products which are used in the production of other petroleum products, and so reduced domestic refinery production implies reduced domestic demand for products in the *Other* category.

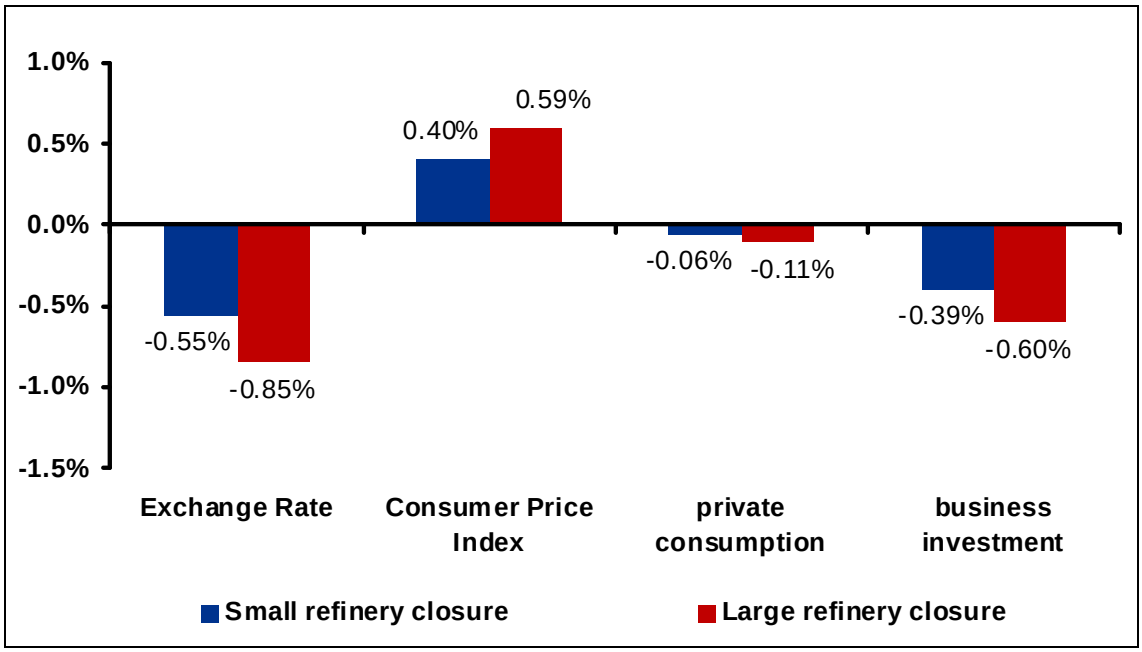
Chart 6.3: Changes in petroleum product consumption from refinery closures



Source: KPMG Econtech simulations, MM600+

In order to maintain these consumption levels, increased imports of petroleum products are required to replace the lost domestic petroleum production. The higher level of imports increases the supply of Australian dollars on the international market, meaning that the value of the Australian dollar (AUD) is lower than it would otherwise be. This is somewhat offset by lower imports of crude oil because of the decreased demand from the refineries. Overall, however, the AUD depreciates, meaning that Australian exports become relatively cheaper to the international market, boosting exports. Chart 6.4 overleaf shows that the exchange rate is expected to be 0.6 per cent lower in the absence of a small refinery, and 0.9 per cent lower in the absence of a large refinery.

Chart 6.4: Macroeconomic effects of refinery closures



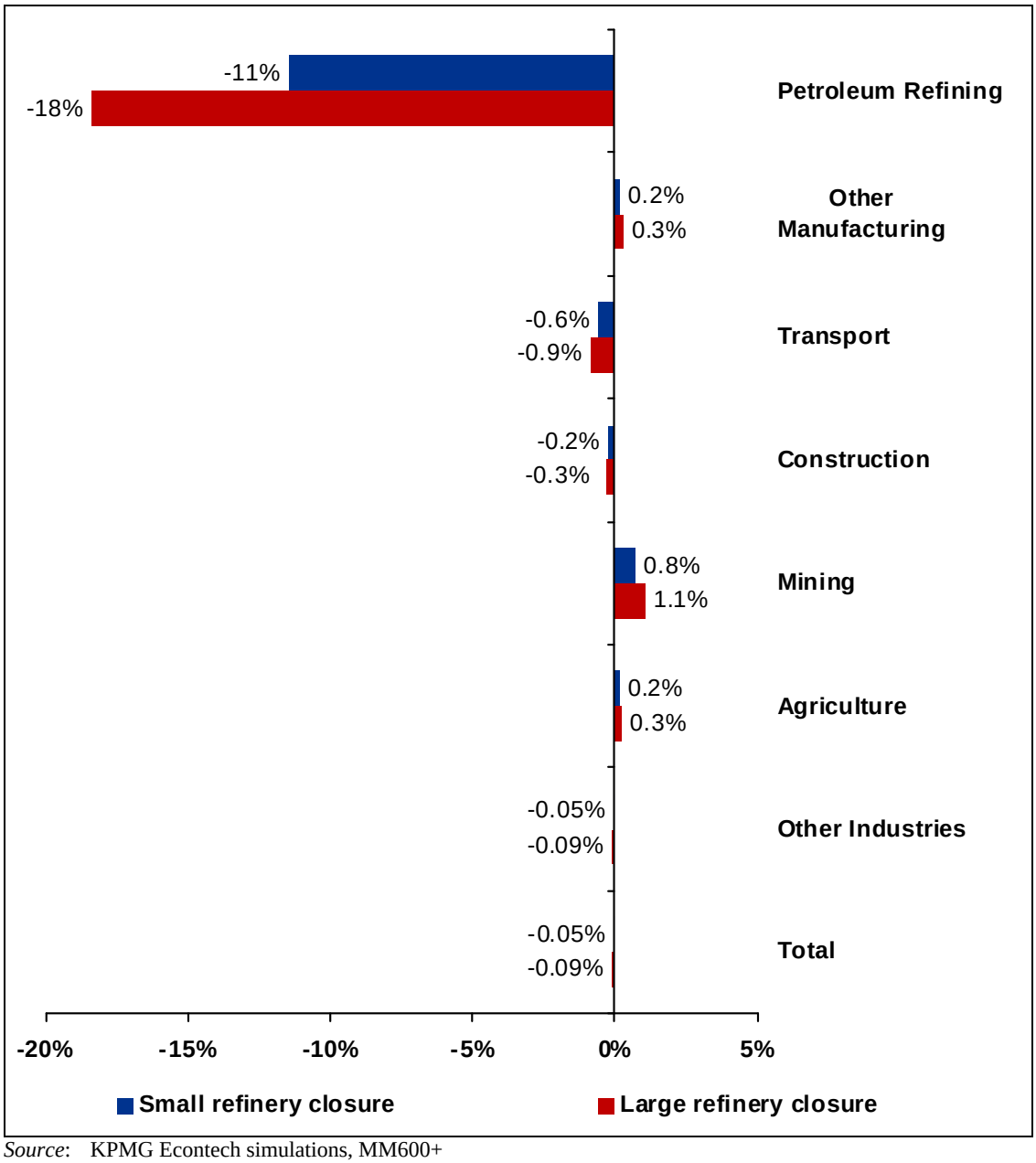
Source: KPMG Econtech simulations, MM600+

Refinery closures also put upward pressure on the cost of living, proxied by the Consumer Price Index, as shown in chart 6.4. The domestic price of all imported goods (including petroleum products) is greater with the weakening of the Australian dollar. Thus, the purchasing power of consumers is lower, which reduces their overall demand for goods and services. Private consumption is expected to be 0.06 per cent lower if a small refinery closes and 0.11 per cent lower if a large refinery closes.[28] Business investment also falls, associated with the lower GDP and capital stock levels.

As highlighted in the previous sections, the petroleum refining industry has intrinsic links with the rest of the Australian economy. As discussed in section 2.2, the refining industry provides an important input to many other Australian industries. It is also a purchaser of products from other Australian industries. The expected impacts of refinery closures on production in other Australian industries are shown in Chart 6.5 overleaf. The differences observed in economic impacts for each industry can generally be explained by differences in their relationship with the refining industry, differences in international trade orientation, and differences in price elasticities of demand and supply.

[28] In general, we would expect the change in total consumption (which is an indicator of household welfare) to be smaller than the change in GDP. However, the modelling of refinery closures shows that the change in consumption is *larger* than the change in GDP. This is because the refining industry is taxed through the application of fuel excises. Fuel excises result in artificially high prices that inhibit demand and lead to sub-optimally low production levels. Therefore, in the presence of taxes, consumers' value of production exceeds production costs, making consumers worse off. Reducing production further has a large welfare cost, as indicated by the large change in total consumption.

Chart 6.5: Changes in national industry production from refinery closures, per cent



Source: KPMG Econtech simulations, MM600+
Notes: *Other Manufacturing* is defined as all manufacturing sectors except petroleum refining.
Other Industries is defines as all industries except for the ones shown separately. That is, it includes the Electricity, Gas and Water industry along with the service industries.

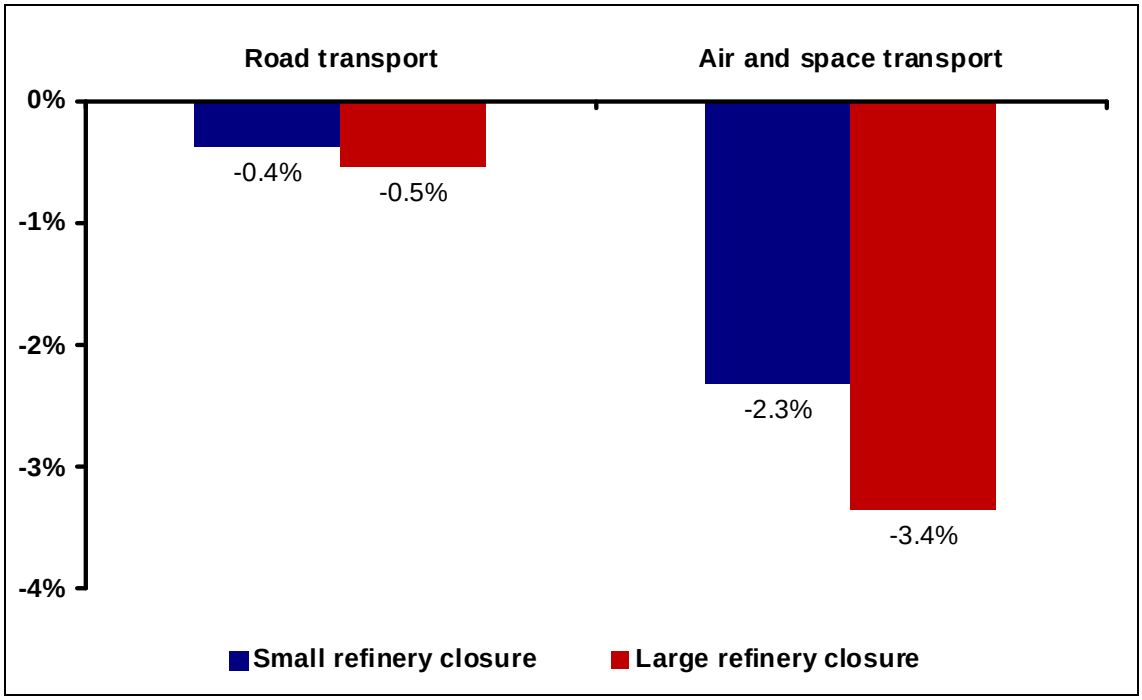
As described in section 1, the outputs of the refining industry are important inputs for the manufacturing and transport industries. The construction industry is also closely linked to the refining industry. The effects of refinery closures on each of these industries are described in turn.

Other Manufacturing is defined here as all of the manufacturing industry except for petroleum refining. Overall, this part of the manufacturing sector benefits from the closure of the refinery, despite some sections of the industry having relatively large usage of petroleum products. This is because they are able to absorb some of the workforce that have been released from the refining and other industries. The lower exchange rate also adds to the export competitiveness of the industry, increasing global demand for relatively cheaper outputs of the Australian manufacturing industry.

Transport activity is likely to suffer if a refinery closes, with GDP from the overall industry 0.6 per cent lower with the closure of a small refinery and 0.9 per cent lower with the closure of a large refinery. This result comes from two main forces. Firstly, the Transport Industry is highly dependent on refinery products as important inputs, which account for over a quarter of its costs. The lower exchange rate means that the cost of petroleum products is higher, having an adverse effect on the profitability of Transport Industry. Secondly, overall consumer purchasing power is diminished, meaning that the sources of demand for transport services are also diminished.

There are differences within the Transport Industry, which depend on the elasticities of demand for different types of transport services and the changes in industries to which transport services are an input. These differences can be seen in Chart 6.6.

Chart 6.6: National changes in Transport industry production associated with refinery closures



Source: KPMG Econtech simulations, MM600+

The price elasticity of demand for the Road Transport sector is relatively low, somewhat mitigating the impact on Road Transport activity. Moreover, the sector includes freight services. The larger size of the Mining and Agriculture Industries under each scenario, as

discussed below, adds to the demand for freight services, somewhat offsetting the negative impact on the Road Transport sector.

Air Transport has a high elasticity of demand compared to Road Transport, and this sector therefore suffers from the reduction of overall consumer purchasing power. Chart 6.6 shows that Air and Space Transport is 2.3 per cent smaller than would otherwise be the case with the closure of a small refinery, and 3.4 per cent smaller with the closure of a larger refinery. This reduction in the size of the Air Transport sector helps to explain the relatively large change in consumption of jet fuel products identified previously in Chart 6.3.

Activity in the Construction Industry is also expected to be lower. This is associated with its sensitivity to business investment and economic activity, both of which are lower after a refinery closes. With the closure of a small refinery, the Construction industry is likely to be 0.2 per cent smaller, and 0.3 per cent smaller with the closure of a large refinery.

The Mining and Agriculture Industries are both export-oriented industries, meaning that demand for their outputs is affected by the value of the AUD. The depreciation of the AUD with the closure of a refinery makes Australian produced Mining and Agriculture products relatively cheaper compared to their international competitors. This encourages activity in these industries, with Mining 0.8 per cent larger if a small refinery is closed and 1.1 per cent larger if a large refinery is closed. Likewise, Agriculture activity is 0.2 and 0.3 per cent higher with the closure of a small and large refinery respectively.

Other Industries includes the Electricity, Gas and Water Industry along with the service industries[29]. These industries are domestically-oriented since they mostly rely on the domestic consumer market. Therefore, since the price of petroleum products and other imports is higher when a refinery is closed, the purchasing power of consumers is lower. This adversely affects overall demand for domestic-oriented industries.

6.4 Economic contribution of refineries – state results

To demonstrate the contribution of refineries to the economy of a state with a high proportion of industries oriented towards the domestic economy, the small refinery closure shock was applied in New South Wales. Likewise, the large refinery closure was applied in Queensland in order to demonstrate the contribution of a refinery to the economy in a state with industries oriented to the export market. While refineries contribute to the levels of economic activity of the state in which they operate, they also have broad impacts across the national economy, including price and exchange rate impacts. A small change in petrol prices will impact production in a wide range of industries and consumption will also be affected though pressures on household budgets.

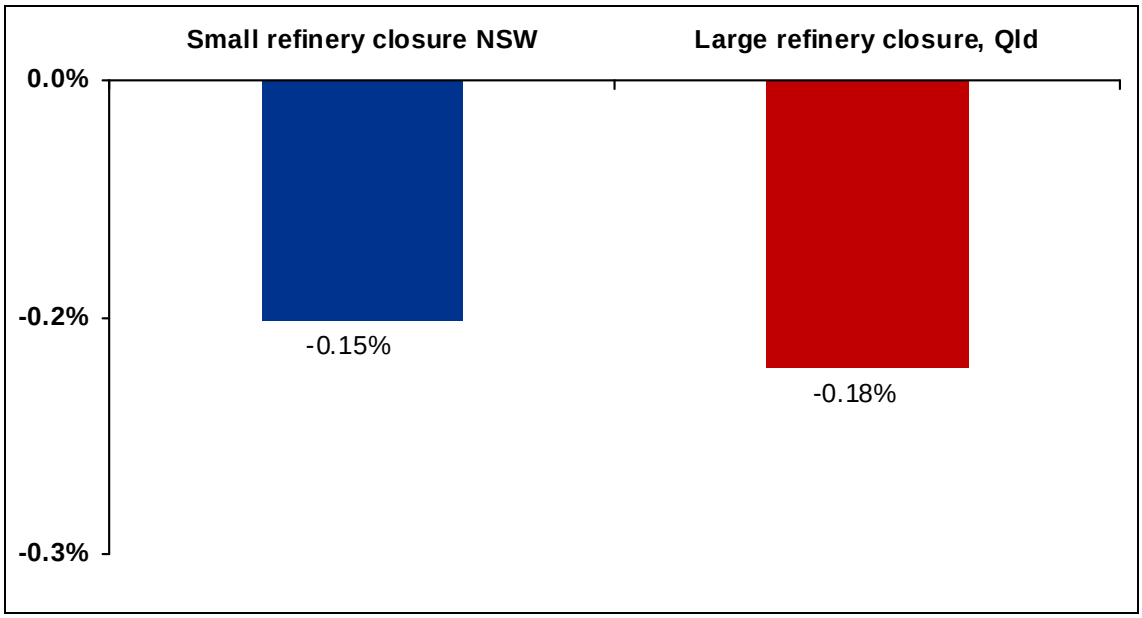
[29] The service industries include the Wholesale Trade; Retail Trade; Accommodation, Cafés and Restaurants; Communication Services; Finance and Insurance; Property and Business Services; Government Administration and Defence; Education; Health and Community Services; Cultural and Recreational Services; Personal and Other Services; and, Ownership of Dwellings.

Output effects

It was estimated that if a typical small refinery in New South Wales closes, output in New South Wales is expected to be around 0.15 per cent lower, which was equivalent to $0.5 billion in economic activity in 2007/08. If a large refinery in Queensland closes, output in Queensland is lower by 0.18 per cent, which was equivalent to $0.4 billion in 2007/08.

Chart 6.7 shows the overall falls in output in each state when the refinery closes within its borders.

Chart 6.7: Change in output from refinery closures, per cent

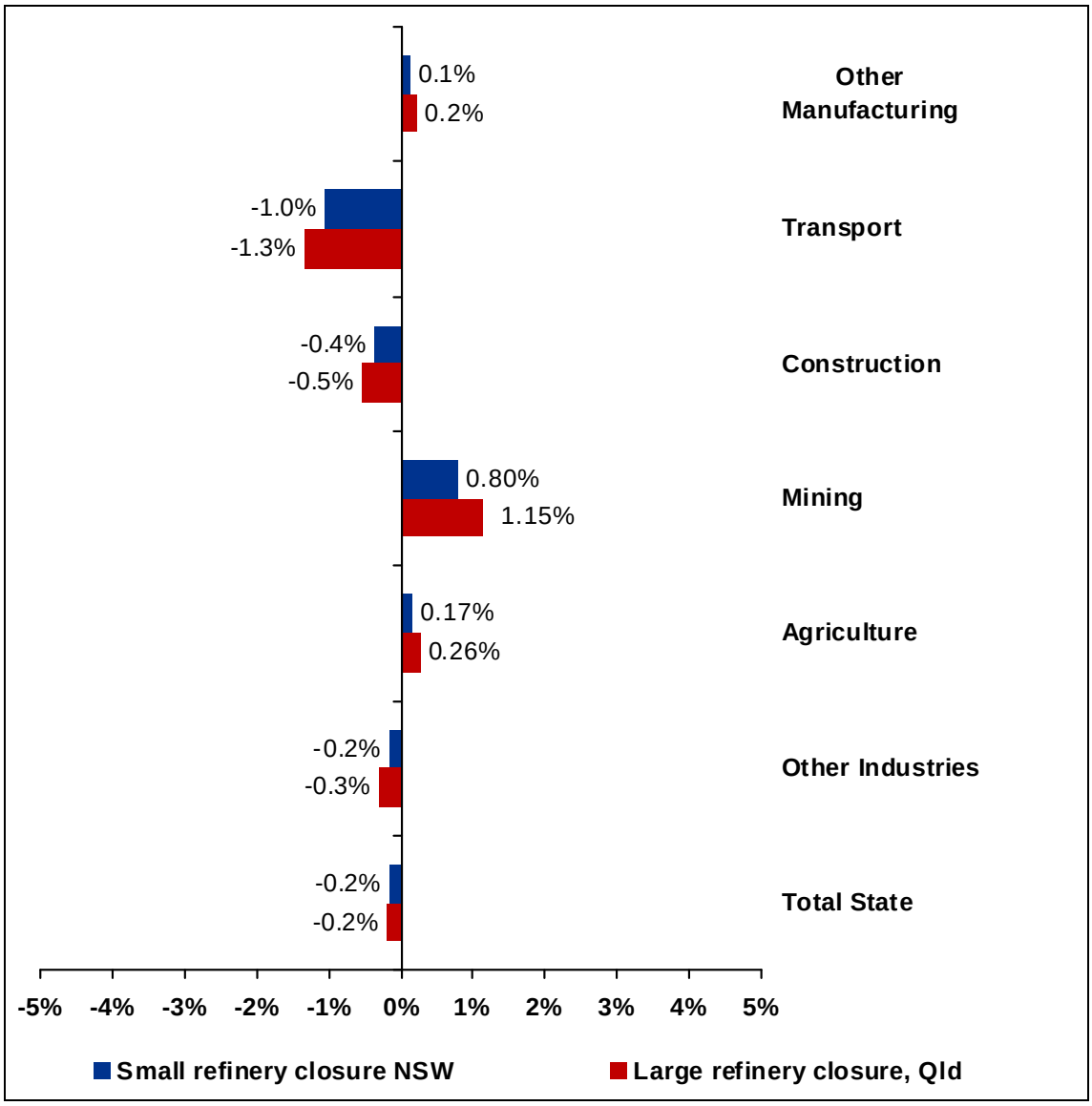


Source: KPMG Econtech simulations, MM600+

Interestingly, although the closure of a large refinery was simulated in Queensland, the fall in output in Queensland (in dollar terms) is smaller than the fall in output caused by a small refinery closing in New South Wales. This is due to the different types of industries in each state. In general, Queensland's higher proportion of export-oriented industries provides an offset to the negative impact of higher prices for petroleum products. This is explained in more detail below.

The industry effects in each state are shown in Chart 6.8. overleaf. These are associated with a reduction in the New South Wales refining industry of around 41 per cent and a reduction in the Queensland refining industry of around 67 per cent.

Chart 6.8: State changes in industry output from refinery closures, per cent

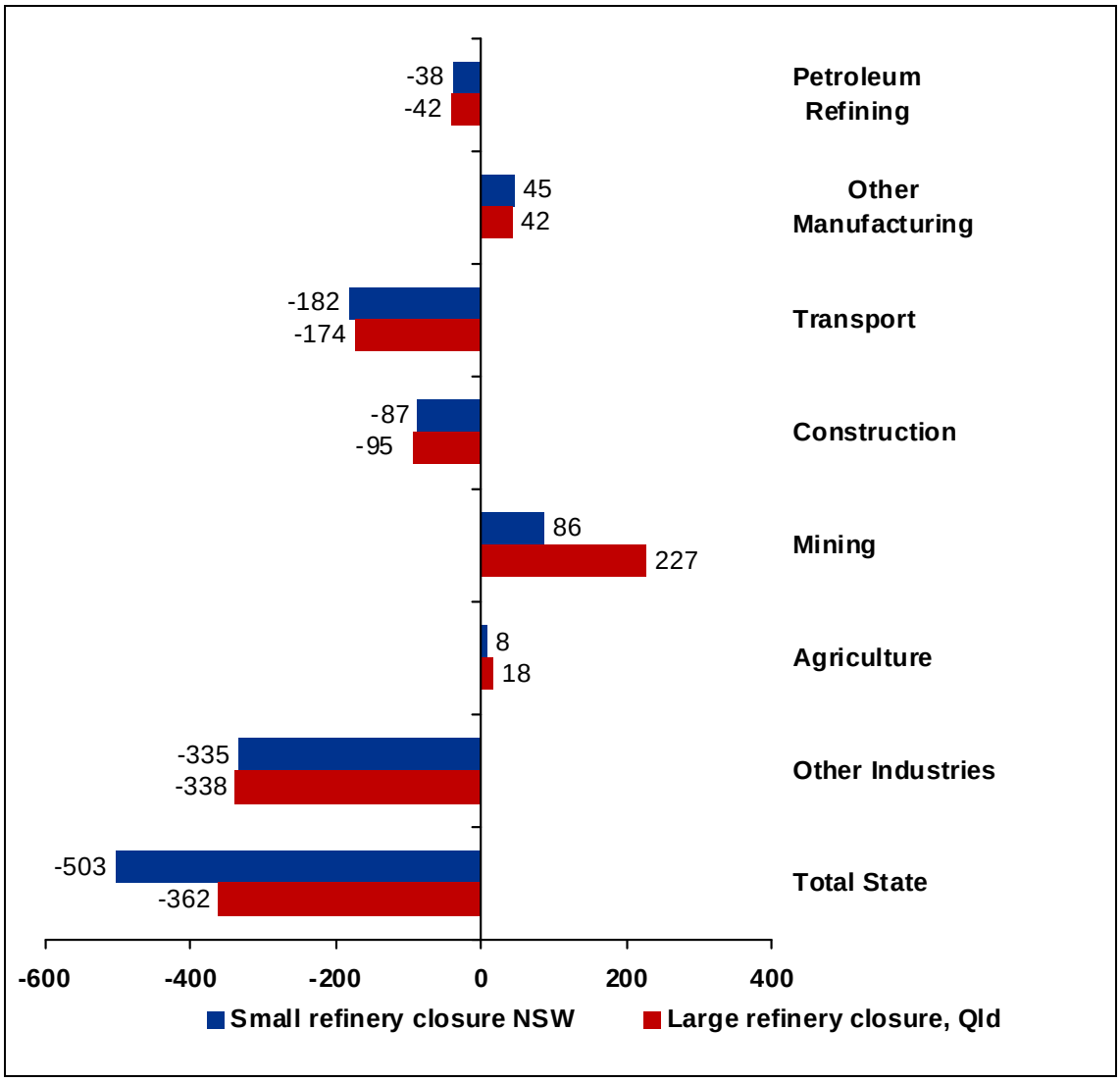


Source: KPMG Econtech simulations, MM600+
Notes: *Other Manufacturing* is defined as all manufacturing sectors except petroleum refining.
Other Industries is defined as all industries which are not shown separately, except for Petroleum Refining. They include the Electricity, Water and Gas industry and all service industries.

These results reflect the effects of a refinery closure on industries up-stream and down-stream from the refining industry and the changes in the exchange rate, as explained in section 6.3 above. Interestingly, many of the percentage changes in industry output at the state level are larger than those at the national level, which are shown in Chart 6.5. This means that the impacts of refinery closures are felt most keenly in the state where the refinery is located. This is due to the flow-on impacts to industries which are directly related to petroleum production, such as the Transport and Construction Industries. The losses in these industries then flow through to the level of consumer demand within the state, affecting the service industries. This is discussed in more detail below.

The differences between the state results, however, is seen most clearly when the relative sizes of each of the industries in New South Wales and Queensland are considered. This is reflected in the dollar changes in output, as shown in Chart 6.9.

Chart 6.9: State changes in industry output from refinery closures, AUD millions, 2007/08 values



Source: KPMG Econtech simulations, MM600+
Notes: *Other Manufacturing* is defined as all manufacturing sectors except petroleum refining.
Other Industries is defined as all industries which are not shown separately, except for Petroleum Refining. They include the Electricity, Water and Gas industry and all service industries.

These results give some insight into the different impacts that refinery closures have on states with different types of industries. The most interesting differences between the state impacts occur in the Mining and Transport and Other industries.

The relatively large impact on the mining industry in Queensland stems from the relatively large initial size of the industry in that state. This means that overall, Queensland benefits from the exchange rate depreciation more than New South Wales does.

Despite the larger size of the refinery closure in Queensland, the size of the impacts on the Transport and Other industries are similar in both states. For the Transport industry, air travel represents a greater portion of the New South Wales industry than the Queensland industry, because of the high demand for road freight transport from the Queensland mining industry. That is, the New South Wales Transport industry is more domestic-oriented than the Queensland Transport industry. Thus, the New South Wales transport industry is more adversely affected by the reduction in domestic consumer demand than the Queensland industry.

Likewise, the Other Industries category, is mostly services industries[30], which are affected by the lower overall consumer demand brought about by the reduction in purchasing power. These industries had a value added of $232 bn in 2007/08 in New South Wales. This is twice as large as their value added in Queensland, which was $118 bn in 2007/08. Despite this, Chart 6.9 shows that the dollar changes in Other Industries for New South Wales and Queensland are almost the same. This is for two reasons. Firstly, these industries make up a larger proportion of output in New South Wales than in Queensland, being 70 and 60 per cent respectively. Therefore, the lower consumer spending makes a larger impact in New South Wales. Secondly, Queensland has more export-oriented industries than New South Wales, meaning that the exchange rate depreciation offsets some of the tightness in consumer budgets in Queensland.

Employment effects

The economic impacts described above will naturally have flow-on effects for employment in the affected industries. The employment results described here should be understood in the context of the industry changes detailed above as well as the relative labour intensity of each industry.

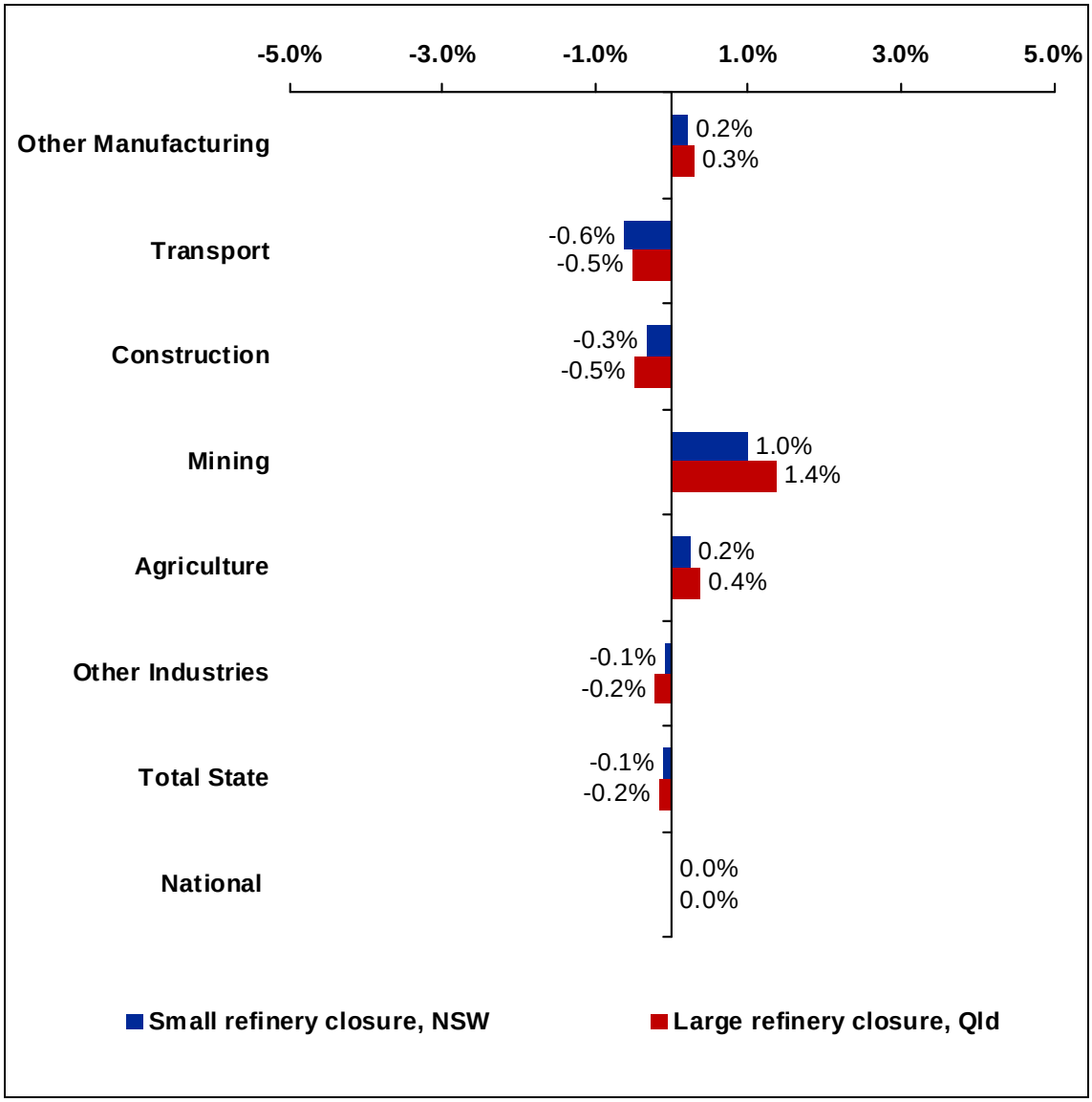
Another important consideration that in the long run, the economy is constrained by the size of its labour force. MM600+ takes this into account by holding national employment fixed, but allowing for the movement of labour between states and industries. Thus, when a refinery closes, employees move from the relatively capital-intensive refining industry and move to less capital intensive industries. This means that, since the same amount of labour resources are combined with fewer physical capital assets, overall labour becomes less productive. Therefore, wages fall in all industries in the long-run.

The movement of jobs between states is estimated for each scenario. With the closure of a small refinery in NSW, around 3580 jobs move from NSW to other states. With the closure of a large refinery in Queensland, around 3890 jobs transfer from Queensland to other states.

[30] The service industries include the Wholesale Trade; Retail Trade; Accommodation, Cafés and Restaurants; Communication Services; Finance and Insurance; Property and Business Services; Government Administration and Defence; Education; Health and Community Services; Cultural and Recreational Services; Personal and Other Services; and, Ownership of Dwellings.

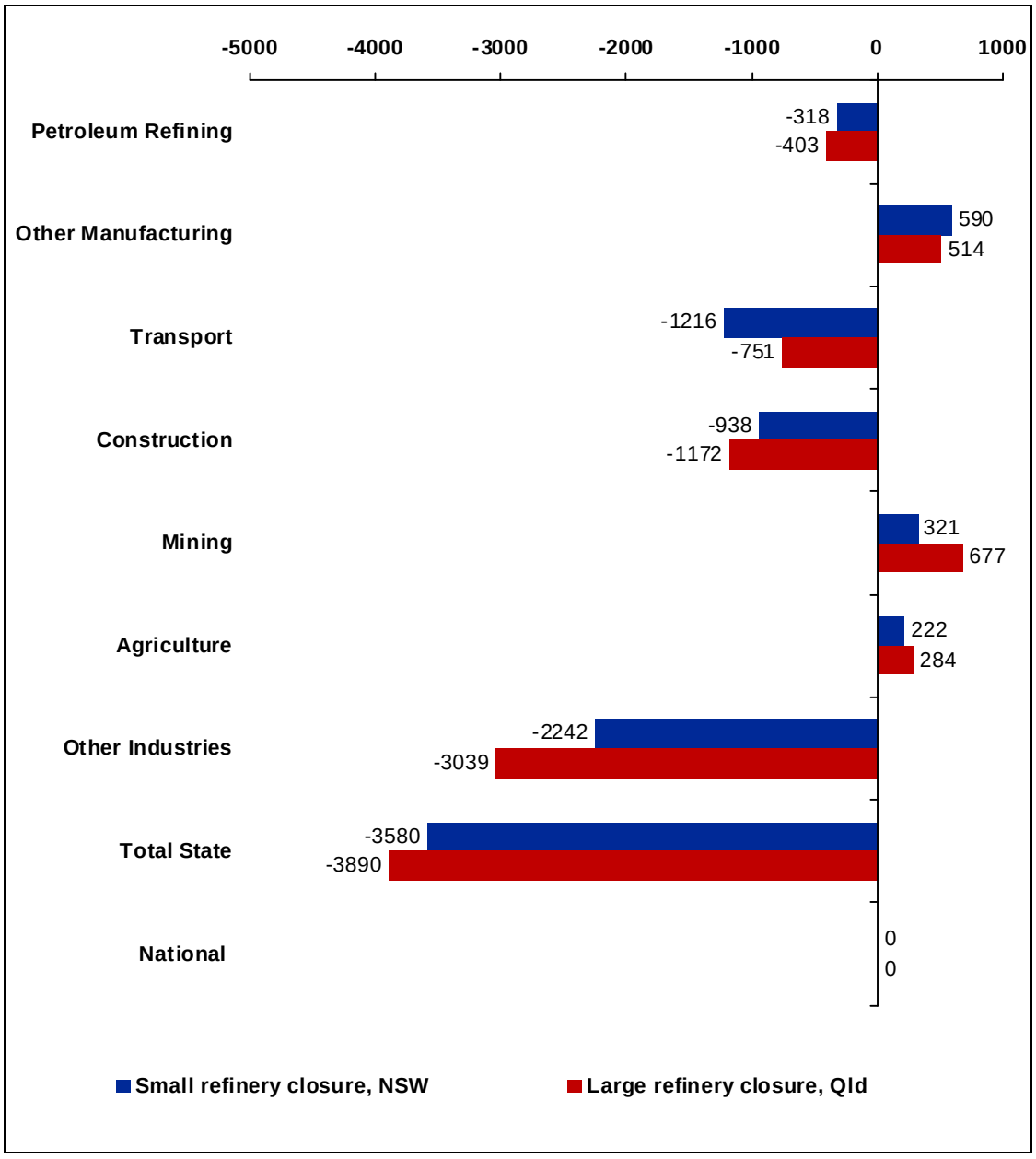
The percentage changes in employment for the two scenarios by industry in each state are shown in Chart 6.10 below. These changes are comparable to the changes in output by industry for each state, as shown previously in chart 6.8.

Chart 6.10: State changes in industry employment from refinery closures, per cent



Source: KPMG Econtech simulations, MM600+
Notes: *Other Manufacturing* is defined as all manufacturing sectors except petroleum refining.
Other Industries is defined as all industries which are not shown separately, except for Petroleum Refining. They include the Electricity, Water and Gas industry and all service industries.

Chart 6.11: State changes in employment for refinery closures, people



Source: KPMG Econtech simulations, MM600+

The expected changes in state employment resulting from refinery closures are reported in Chart 6.11 above. The changes in employment levels in each industry largely reflect the changes in the levels of output. Interestingly, despite the larger size of the refinery closure in Queensland, the overall state employment impact is similar to the impact of closing a small refinery in New South Wales. This is because the boost to the Mining and Transport industries in Queensland offsets the negative employment impacts to a greater extent.

7 Benefits to the Australian economy of the refining sector

In addition to the economic benefits quantified above, this section highlights a number of benefits that the Australian refining industry adds to the Australian economy which cannot be quantified. These benefits are often not taken into account when considering the economic contribution of the industry. They include contributing to the security of fuel supply, sharing inputs with other industries, technology and knowledge spillovers as well as various community development activities. Although they have not been captured in the economic modelling, these contributions are economically important.

7.1 Supply security

The International Energy Agency defines energy security broadly as the provision of adequate, affordable and reliable supplies of energy (IEA 2007). A secure supply of petroleum products benefits households and firms. It enables firms and consumers to easily access goods and services and also aids efficient production and mobility of labour and other inputs. Moreover, there is upward pressure on prices during periods of supply disruption, increasing the costs to households and firms. In particular, since fuels are important inputs for sectors of transport, mining, manufacturing and agriculture[31], security of supply is important to these industries.

The National Energy Security Assessment (Department of Energy Resources and Tourism, 2009c) rates the current level of overall liquid fuel supply security in Australia as high. However, there are a number risks within the supply chain that could cause short-term disruptions to that security. In particular, these include:

- refinery production disruptions;
- breakdowns in the domestic supply chain caused by infrastructure problems;
- short term demand shocks, where actual demand exceeds expected demand; and,
- global supply disruptions.

Given the diverse nature of potential disruptions, all points in the supply chain, including importers, refiners, distributors and retailers have the ability to contribute to supply security. Indeed, economic theory would suggest that each agent in the market for liquid fuels would have incentives to increase the overall reliability of supplies. Firstly, they would benefit from taking some action to hedge against the risks of increased costs caused by any interruption to supply. Secondly, they would have incentives to fill any supply gaps in order to take advantage of the upward price pressure, which would in turn soften any pressure on the market.

[31] See section 2.2 for a discussion on this.

According to a report for the Department of Resources Energy and Tourism by ACIL Tasman (2008), the increasing diversity of imported petroleum products has assisted in mitigating some of the risks to a secure product supply. However, the Australian refining industry contributes to petroleum product supply security in ways that other points in the supply chain are unable to.

The ACIL Tasman report suggests that any likely disruption to the supply of petroleum products "should only be short term in nature". Therefore, flexibility to respond quickly to disruptions is an important aspect of managing risks to supply security. It also notes that, "the existence of domestic refineries provides a much greater degree of flexibility in the product supply chain in the event of an unexpected mishap" (ACIL Tasman, 2008, p89).

Specifically, domestic refineries are well placed to deal with short-term supply disruptions. This is because domestic refineries are able to respond in a shorter time frame compared to imported supplies. In general, the industry has three options to fill a short-term supply shortfall. The fastest option is using any available inventory, including stocks which are currently on ships. Second, refineries can approach other domestic producers to purchase any of their excess supply. Third, refineries can source from imports, although this option generally has the longest time frame. It takes around three weeks for an urgent shipment from the closest import source, Singapore, to arrive on the Australian market. The more general ordering time for imported products is five weeks (AIP, 2009).

The following example in Box 7.1.2 shows the process that refineries go through when supply is disrupted by an unplanned shutdown at a refinery.

Box 7.1.2 Management of refinery supply disruptions – Lytton Refinery, Caltex

In December 2008 the Caltex refinery at Lytton in Queensland experienced a loss of steam, requiring the refinery to be temporarily shut down. The incident caused reduced availability of petrol and diesel supply at some service stations in Queensland and northern New South Wales. The supply disruption lasted for more than 4 weeks.

In response to the situation, Caltex first ran down its own inventories in the Lytton and Kurnell refineries. Caltex then sourced product from other local suppliers, who were able to assist by diverting imported cargoes already in transit. Caltex also sent some product from its Kurnell refinery, which was originally intended for use elsewhere. This variety of alternative supply options available in the domestic market allowed Caltex to overcome the supply disruption as smoothly as possible.

In order to protect their reputations, refiners regard supply reliability and meeting contractual obligations as a key priority. Discussions with refinery representatives indicate that refineries believe that it is beneficial to focus on filling supply gaps as quickly as possible, even if it means that margins will be eroded.

(Caltex, 2008, a & b) (Interview with refinery representatives)

Thus, the established networks of the Australian refining industry, as well as the focus on brand reputation, enhances the ability of the Australian refining industry to respond flexibly to any supply disruptions that occur.

The following Box contains an example of the refining industry's response to a demand spike. The closure of a natural gas processing plant in Western Australia lead to reduced gas availability, which increased demand for diesel as a substitute.

Box 7.1.1 Western Australian gas shortage

Starting in June 2008, Apache Energy's natural gas processing plant in Western Australia was offline for two months following an explosion in one of its pipelines. The facility supplies 30 per cent of Western Australia's gas supplies, and so the shutdown caused major disruptions. The mining, construction, hospitality and food industries were all affected.

Diesel was used as a substitute to help fill the gap caused by the lost gas production, and refineries put plans into place to service this extra demand. For example, BP noted a 20 per cent increase in demand for its diesel products. Caltex, which supplies the mining industry, diverted some diesel shipments to Western Australia. Shell also diverted diesel cargos and drew down its diesel stocks to help increase supply to Western Australia.

(Oilgram News, 2008) (Australia's Mining Monthly, July 2008) (The Age, 18 June 2008)

Refineries also contribute to the reliability of petroleum supplies through their holding of reserves of crude oil, ready for production. The stock levels are chosen to accommodate short-term fluctuations in demand and are based on commercial considerations. Refineries typically hold enough stocks to cover between 5 and 10 days of their consumption. Thus, refineries have some limited capacity to increase their levels of production in response to a short term supply disruption (ACIL Tasman, 2008). This may allow refineries to respond to supply disruptions in a more timely manner than relying on imports.

Therefore, the domestic refinery provides greater flexibility to respond to short-term product shortfalls, compared to imported supplies. While the expansion of imports is contributing to the security of the liquid fuels supply chain, "the closure of domestic refineries will not improve Australia's energy security in liquid fuels" (ACIL Tasman 2008).

7.2 Input sharing

The domestic refining industry may also benefit other sectors through adding to the demand for certain inputs. By increasing the demand for inputs which are shared with other industries, the refining industry assists upstream industries in achieving economies of scale. When economies of scale are achieved, all industries that share these inputs benefit from lower costs in the industry supply chains. Of course, the benefit from input sharing is dependant on the existence of economies of scale in input production (Holmes 1999).

Related industries tend to congregate around refineries to take advantage of the inputs available from the companies established to service the refinery. This tendency for related industries to cluster in one area and support each other is known as *external economies of scale* or

agglomeration economies[32] (Rosenthal 2003). This type of spillover from the refining industry is difficult to measure, but makes an important contribution to many industries in the Australian economy.

Industries that benefits from sharing inputs with the refining industries include petrochemical industries, plastics and other heavy industry such as steel manufacturing. Manufacturing sectors such as food processing that also consume similar products to the refining industry benefit from reduced costs for commonly consumed products. These industries benefit as they share inputs used by the refining industry. Inputs utilised by the refining industry and other sectors include engineering services, chemicals, electronic equipment and mechanical components.

To illustrate input sharing, an example concerning the use of specialised labour in the refining industry will be used. The refining industry demands a large amount of contracted labour, particularly during major maintenance periods when parts of the refinery are closed. The maintenance requires specialised skills provided by contractors, and these skills are demanded not only by the refining industry, but also by other sectors. For example, many sectors, including the refining industry, would contract an engineer to perform a stress test. By contributing to the demand for this input, the refining industry aids in lowering the costs for all sectors located in the same area and using engineering contractors.

The refinery industry utilises a wide range of contract services including, maintenance services, inspection engineering and water treatment. The refining industry may make up a large portion of such a contract firm's demand, and create the base demand that allows that firm to exist. Importantly, that contracting firm will also service industries other than the petroleum refining industry, and in so doing, add to other industries productive capacities. The following box highlights a specific example of input sharing.

Box 7.2 Input sharing

Contract Resources, an industrial and mechanical services firm, was established in order to service the refining and petrochemical industries in New Zealand. The firm now supplies services to refining companies in Australia as well as the oil and gas, chemical, mining, cement, utilities and dairy industries. That is, the firm now contributes to all kinds of industries because it has been able to develop highly specialised services. Examples of services used by the refining and other industries include reactor and catalyst services, protective coatings services, environmental services and tank maintenance services.

(Contract Resources, 2009)

The potential for knowledge spillovers is another force behind the agglomeration of industry. This is discussed in the next section.

[32] Rosenthal 2003 defines external economies of scale or agglomeration economies as forces that lead to concentration, both of industries in clusters and of aggregate activity in cities. These forces include the benefits of sharing inputs whose production involves internal increasing returns to scale, labour market pooling and knowledge spillovers.

7.3 Technology and knowledge spillovers

The Australian refining industry benefits the domestic economy through technology and knowledge spillovers. The spillover effect occurs when knowledge and technologies are transferred from the refining industry to other sectors. The effect has the benefit of stimulating technological improvements in other sectors, without them having to bear the full costs. Innovation and technological change depend on new knowledge more than most other economic activities[33]. Merely developing and using technology and knowledge does not constitute a contribution to the Australian economy. This is because the refining industry is able to capture the full benefit of any know-how that they develop though reduced costs or increased profits. However, if the technology and knowledge originating in the refining industry is transferred to other sectors of the Australian economy, then the receiving industry gains the benefit of the technology or knowledge without having to pay for the costs of its development.

Technology and knowledge spillovers can benefit industries outside the refineries. These spillovers can occur through three main avenues.

- The workforce may move between industries, taking with them knowledge developed in the refining industry.
- Communication between the members of different industries may facilitate the transfer of ideas.
- Other firms or industries may observe the practices of refineries and adapt the technologies for use in their own industry.

Petroleum refining is a highly capital-intensive and technologically advanced industry. It is continuously developing new technologies to improve performance. The knowledge and technology developed in the refining industry gives it the ability to contribute to the skills of the Australian workforce and the productive capacity of other industries. The most important means through which technology or knowledge can be transferred to other industries is the movement of its workforce. When employees leave the refining sector, they take their skills to industries such as mining and chemical (such as petro-chemical) industries.

The highly technological nature of the refining industry provides a challenging environment for engineers, software developers and other technicians to enhance their skills. Training and development activities undertaken by the industry include apprenticeships, traineeships, and training in higher-level technical skills. Some domestic refineries pay for their employees to complete formal qualifications, adding to the skills of the workers in the industry. These labour skills are provided by the refining industry, but the knowledge can be transferred into other sectors when the skilled workers change occupation.

[33] Audretsch & Feldman (1996) *R&D Spillovers and the Geography of Innovation and Production*, The American Economic Review, Vol 86-3, pp 630-640.

As an example, Box 7.3.1 gives a brief description of the education program at the Caltex Kurnell refinery.

Box 7.3.1 Education and training

Caltex sponsors employees to undertake training in areas such as trade apprenticeships and university studies, and many of the skills learned are readily transferable to other sectors of the economy.

Caltex supports its employees to undertake post-graduate studies. At the Kurnell refinery, there are currently 12 employees undertaking post-graduate studies. Caltex generally provides financial support of about 75% of the total cost of such programs.

Refining-specific skills, such as procedures in hazard management, are also taught. Training for work cover certifications, which qualifies workers to operate certain machinery is also provided.

(Interview with refinery representatives)

As discussed in section 3.3, a large proportion of workers in the industry are contract workers. These workers are inherently mobile and therefore facilitate the transfer of innovations between industries. The refinery training programs often extend to contract workers, and the skills they learn in the refining sector can be utilised in other industries.

As might be expected, the turnover of skilled engineers tends to be higher than for other types of workers, due to high demands in recent years and the relatively broad nature of engineering skills. For example, during the mining boom that recently occurred in Australia, many highly skilled workers have left the refining industry to take part in the expansion of the mining sector, where their skills are directly applicable.

An example of technology transfer through the use of contractors can be found in Box 7.3.2.

Box 7.3.2 Technology transfer

A new method for cleaning tanks was developed at the Mobil Altona refinery in conjunction with contract workers from Saunders International, a specialist tankage contractor. The new technology allowed the tanks to be cleaned more effectively and with greater speed, which is important to the efficient running of the refinery. This new technology would also be useful for other industries, including the chemical complex and petrochemical manufacturing plants in Altona.

The involvement of contractors in developing this technology meant that the method was readily transferred to other industries and refineries. Saunders International works with a number of different industries, including water supply, chemical manufacturing and mining industries. As the workers from Saunders International move between industries and businesses, they take the method developed at Mobil Altona with them. Mobil Altona also shared the technology with other ExxonMobil refineries around the world, which would then be able to become points from which technology transfer could again occur.

(Interview with refinery representatives)

Around the world, refineries use similar technologies that are adapted for the domestic demand and supply conditions. The Australian refining industry utilises technologies adapted from parent company applications or those purchased elsewhere as best practice. In doing so, the industry acts as a point at which new technologies can enter Australia.

Applying any new technology to the industry invariably requires innovative techniques to enable the technology to operate under domestic conditions. The refining industry invests directly in technological innovation which can benefit industries with similar production processes. Major technological advancements made by the refining industry include improvements in safety standards, environmental impacts, cleaner fuels production and in the de-bottlenecking of production processes. Although these innovations seem to have applications mainly focused on the refining industry, industries including petrochemicals, plastics, steel manufacturing, and food processing can benefit from these technology spillovers.

7.4 Community development – Shell Geelong refinery case study

Many Australian refineries also make contributions outside the economic sphere, through community development activities. These activities benefit the refinery and the community in which the refinery operates. Refineries make contributions to community development through grants, donations, volunteer work, and sponsorship of events and community programs. These activities include interaction with community groups seeking to enhance the education, environment and health outcomes of the local area.

The projects and production facilities of domestic refineries can affect communities in numerous ways, both positively and negatively. It is in each refinery's self interest to manage their facility in a way that achieves corporate sustainability. *Corporate sustainability* is an evolving management paradigm that incorporates societal goals into the traditional growth and profit maximisation model (Wilson 2003). Under this paradigm, companies incorporate the idea

that community development activities can have benefits to the refineries including better risk management, cost savings and management of intangible assets such as brand and human capital.

By contributing to a community's economic and social development through the idea of corporate sustainability, a refinery not only derives benefits in terms of enhanced reputation and community acceptance, but it also creates positive externalities for the community. In 2007, Finsia commissioned Econtech to investigate the costs and benefits of environmental, social and corporate governance (or sustainability) reporting to businesses and to the overall economy (Finsia, 2007). The report concluded that the "voluntary adoption of sustainability risk reporting by more Australian businesses appears to be a worthwhile investment for them, as well as having wider economic benefits". According to the report, company undertaking sustainability risk reporting could expect to receive benefits including:

- a reduction in the risk premium of around 30 basis points;
- a lasting gain in labour productivity of around 0.8 per cent; and
- a brand-based price premium of around 2 per cent.

The report also found that these benefits flow through to wider economic benefits, such as higher GDP and consumer living standards.

Corporate sustainability is a concept taken on by the refining industry, which is involved in numerous community development activities. Below is a case study of the Shell Geelong refinery which highlights these activities. The socio-economic benefits gained through community development activities are expected to benefit the Australian economy in the long run. All information regarding Shell Geelong's social development activities is sourced from interviews with representatives of the refinery.

Box 7.4 Geelong refinery case study

Shell's social investment activities aim to deliver long-term benefits to the local community. The objective is to help build capacity in the local community in the areas of education, health and the environment. According to the refinery, it seeks to enhance the welfare of the local community by focusing its efforts on the particular needs identified in the local community.

The Victorian Government has identified the suburbs surrounding the refinery to be some of the most disadvantaged in the state. Shell Geelong is involved in the Neighbourhood Renewal program, a long-term commitment by the Victorian State Government to narrow the gap between disadvantaged communities and the rest of Victoria.

Shell has representatives on the Corio Norlane Development Advisory Board, which brings together the residents, governments, businesses and community groups to tackle disadvantage in areas with a high concentration of public housing. The refinery is also involved in the Northern Futures Steering Group, which aims to strengthen the local economy by linking the labour market with education and training opportunities.

Shell's Geelong refinery takes a structured approach to organising its community development activities. Three main vehicles are used to achieve this aim: the Social Investment programme; grants and donations; and sponsorships.

According to Shell, Shell Geelong's Social Investment programs are the major vehicles for the refinery's community development work. The intent of these programs is to contribute to the educational, environmental and health needs of the Geelong community.

The Geelong refinery also supports programs run by Shell Australia. These include the *Shell Questacon Science Circus*, the *Shell EcoVolunteers*, run with Conservation Volunteers Australia, and *Let's Read Corio*, run with the Smith Family.

The refinery encourages Shell employees and some contractors to participate in these activities and increase their awareness of community needs, by offering a number of paid days per year to do volunteer work. Further, Shell Geelong also encourages employee participation through its Community Grants Committee. The refinery also encourages employee donations, matching the contributions of its employees up to $50,000, and funds are donated to not-for-profit organisations.

Another vehicle used by the refinery to extend its support to local community groups is grants and donations. Since the refinery was first established, Shell has contributed to *United Way*, a local community chest, raising funds to donate to other programs.

The refinery contributes to the wider community by sponsoring local activities. In 2009, Shell Geelong sponsored the Northerly Aspects Newsletter, Geelong Gallery – Regional Artists program, Geelong Business Excellence Awards, Geelong Business Networks, BacLinks, Shell Swim Scholarship, Corio/Norlane Community Schools Pilot and various community events.

Shell also aims to equip students and young adults with the necessary information and skills to find employment with Shell and other employers. Each year Shell also provides financial support and mentoring provides a mentor for one student per year who is completing Vocational Education and Training engineering studies. Other activities include hosting refinery tours, providing work experience opportunities, working with local schools and attending career fairs.

Shell's successful involvement in community development is reflected in the improved community perceptions of the Shell refinery. From a 2008 survey of 300 residents living in the area surrounding the refinery, more than a quarter responded that the refinery was performing "better than before" in terms of its responsibility in operations and employment within the last 2-4 years. The survey also gave positive feedback on perceptions about Shell's respect for the environment and contribution to the quality of life in the local community.

7.5 Summary

It is often not broadly recognised that the refining industry contributes a number of positive externalities to the Australian economy. These contributions are made through more avenues than simply value-added and consumption. The main contributions in this section have been identified as: fuel supply security; input sharing; technology and knowledge transfer; and community development activities. These make contributions to the Australian economy at the national, industry and community level.

Nationally, the domestic refining capacity contributes to the overall health of the Australian economy through its contributions to the level of fuel supply reliability. This is important for efficient production and mobility of labour and other products.

At the industry level, the domestic refining industry provides benefits to other industries using similar inputs and technologies. This occurs when the refining industry adds to the economies of scale of input industries and also when technological innovations from the refining industry are transferred to other industries. Examples of industries benefiting in this way include petrochemical industries, plastics, food processing and heavy industry such as steel manufacturing.

At the community level, Australian refineries participate in numerous community development activities in the areas of education, local environment and health. These can be expected to have wider economic benefits, such as higher GDP and consumer living standards.

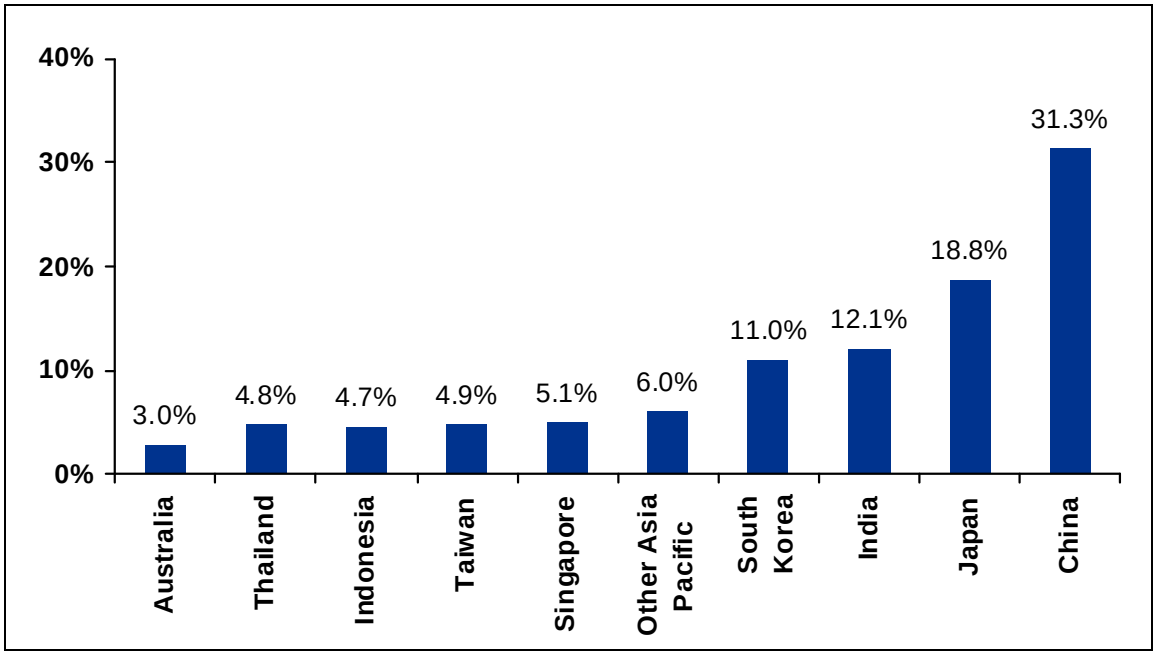
Nevertheless, the production of petroleum products is associated with negative externalities. The industry has obligations under environment and work safety legislations, which limit the extent of these externalities. The environmental impacts of the refining industry are further discussed in section 8.3.

8 Australia in the Asia Pacific liquid fuels market

Australian refinery production is in direct competition with products from refineries in the Asia Pacific region. There are no barriers to trade in the sector and all seaboard capitals have import facilities. As discussed in section 4, imports have been increasing as a proportion of domestic consumption, accounting for over 33 per cent in 2007/08.

Australia is a small player in the Asian regional fuel market. Data in the 2009 BP Statistical Review of World Energy shows that Australian refining capacity accounts for only 3 per cent of total refining capacity in the Asia Pacific region. Although a large proportion of Australian imports come from a small number of countries, as discussed in Section 4, the refining activity in other countries also indirectly impacts on the Australian industry. This indirect impact comes through the influence that regional demand and supply trends have on regional prices. Refining capacity in the region is summarised in Chart 8.1.

Chart 8.1: Asia Pacific regional refining capacity, 2008, per cent of total Asia Pacific capacity



Source: BP Statistical Review of World Energy, June 2009

Developments in the liquid fuel markets in the Asian region have flow through impacts on the Australian market via three main avenues. First, changes in the regional price of inputs and outputs affect the profitability of Australian refineries. Second, changes in the cost of new and upgraded facilities in the region impact on the Australian investment environment. Third, changes in regional and domestic fuel standards and environmental policies influence Australian refineries' competitiveness. These three aspects will be discussed in turn below.

8.1 Prices and import competition

As noted in Section 4, Australia's production of liquid fuels is not sufficient to supply all of Australia's demand. Most of Australia's imported liquid fuel imports are sourced from Singapore. According to the ACCC, prices at all stages of the Australian petrol supply chain are "heavily influenced" by the spot prices at which petrol is traded in Singapore, together with the costs of shipping that petrol to terminals in Australia.

The 2007 ACCC inquiry into the price of unleaded petrol concluded that the "wholesale prices paid by resellers with a credible importing operation are close to the resellers' costs of imported fuel" (ACCC, 2007, p208). The report also noted, however, that "wholesale prices paid by resellers without a credible threat to source imports tend to be above other wholesale prices" (ACCC, 2007, p208). The ACCC report does not specify the areas in which there is limited credible import competition, or the reasons for this limited competition.

However, a 2008 report for the Department of Resources Energy and Tourism by ACIL Tasman suggests that there are import supplies available in every state. In general, Australian refineries are in strong competition with imports and must accept the price of imports for both their inputs and their outputs. Australian refineries cannot offer to pay less than the international price for their inputs of crude oil, because otherwise crude oil suppliers would not be willing to sell to them. Moreover, refineries cannot charge more than the price of imported product (plus the costs of transporting the imported petrol to the end user) for their outputs. If refineries charged more than the price of imported products, domestic buyers would switch to using imported products. Therefore, the profitability of Australian refineries largely follows price trends in the Asia Pacific region.

As mentioned in Section 4, around 60 per cent of Australian imports of petroleum products come from Singapore. This alternative source of supply means that the prices on the Singapore market provide the benchmark for fuel prices in Australia. The benchmark generally used is the Import Parity Price (IPP) which is the Singapore spot price plus the price of transporting and landing the fuel in Australia. The IPP represents the cheapest alternative supply of fuel. The IPP can generally be expressed as shown in the box below.

IPP-based domestic refinery price =	**a benchmark refinery price (usually a benchmark Singapore price) + quality premium + shipping costs + wharfage + insurance and loss**

Source: ACCC, 2007

The benchmark refinery price is the basis for the IPP price. For petrol, the MOPS 95 ('Mean of Platts Singapore') index is used. It is the average daily spot price for petrol of the specification traded in Singapore. The ACCC explains the relative importance of each of the price components of the domestic refinery price as follows. The MOPS 95 price represents around 92 per cent of the domestic refinery price and is closely linked to the international price of crude oil. A quality premium is then added to the price, which accounts for the fact that Australian fuels have tighter quality and environmental specifications than the Singapore benchmark. This

makes them more costly to produce and more difficult to purchase from international sources. The quality premium represents around 3 per cent of the domestic refinery price. Shipping costs are then added to the price, which change from day to day. Shipping costs differ from port to port, but generally make up around 4 per cent of the domestic refinery price. Allowance for wharfage, insurance and loss is also included in the price of refinery products, making up around 0.25 per cent of the total domestic price. (ACCC 2007)

Since crude oil and finished petroleum product prices are set internationally, generally in US dollars, fluctuations in the value of the Australian dollar can also impact significantly on prices in Australia.

Nonetheless, the Singapore benchmark price is the largest determinant of the prices that refineries receive. That is, changes in domestic prices follow changes in the IPP price. Changes in the Singapore benchmark price, and therefore domestic prices, come about because of changes in demand and supply factors on regional markets. The International Energy Agency's (IEA) report, *Medium-Term Oil Market Report* (2009), expects that demand in the region will continue growing despite the recent economic downturn. It also expects recent capacity additions to continue, particularly in China, India and Vietnam.

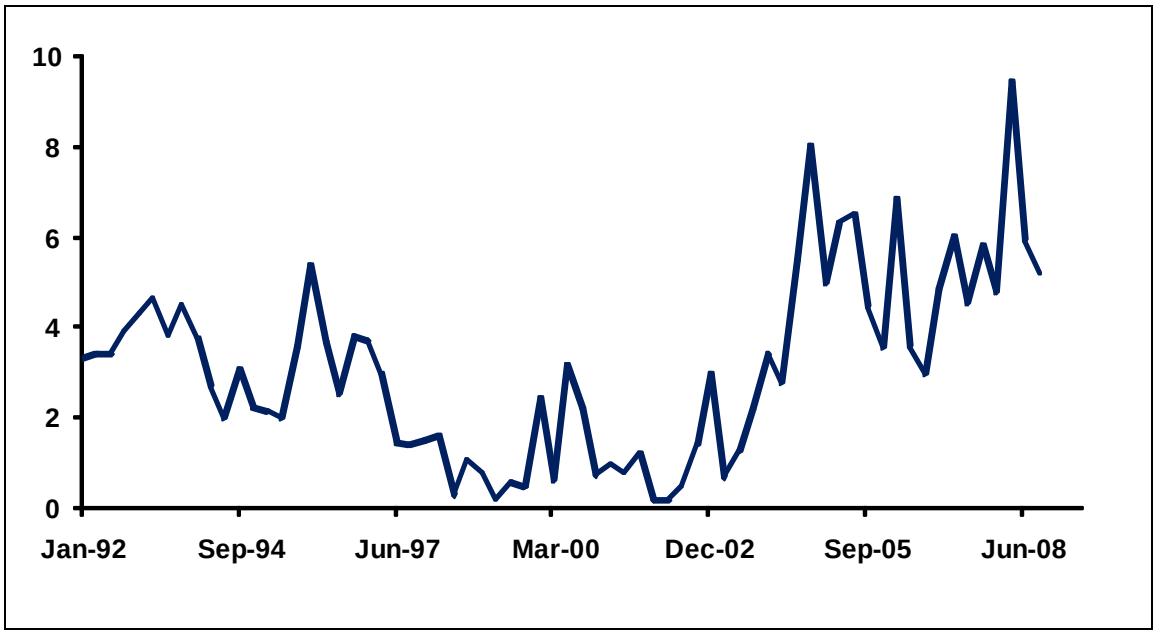
The major factors currently influencing regional demand and supply are outlined below.

Regional demand

Demand for liquid fuels varies seasonally, and is heavily influenced by the economic cycle. The dominant feature of the Asian liquid fuel market in recent years has been the industrial growth in India and China, which has increased fuel demand from these countries. This high level of demand has pushed refining margins above their average in recent years, in turn, this has affected Australian fuel prices and margins.

Refining margins in Singapore are important indicators of refining margins in Australia, because they are representative of margins in the Asia Pacific region. As shown in Chart 8.2, the trend since 2004 has been for higher refinery margins. This can be partly attributed to strength in demand from China and India, due to the rapid economic growth experienced in these countries.

Chart 8.2: Singapore Dubai hydrocracking margin (US dollars per barrel)



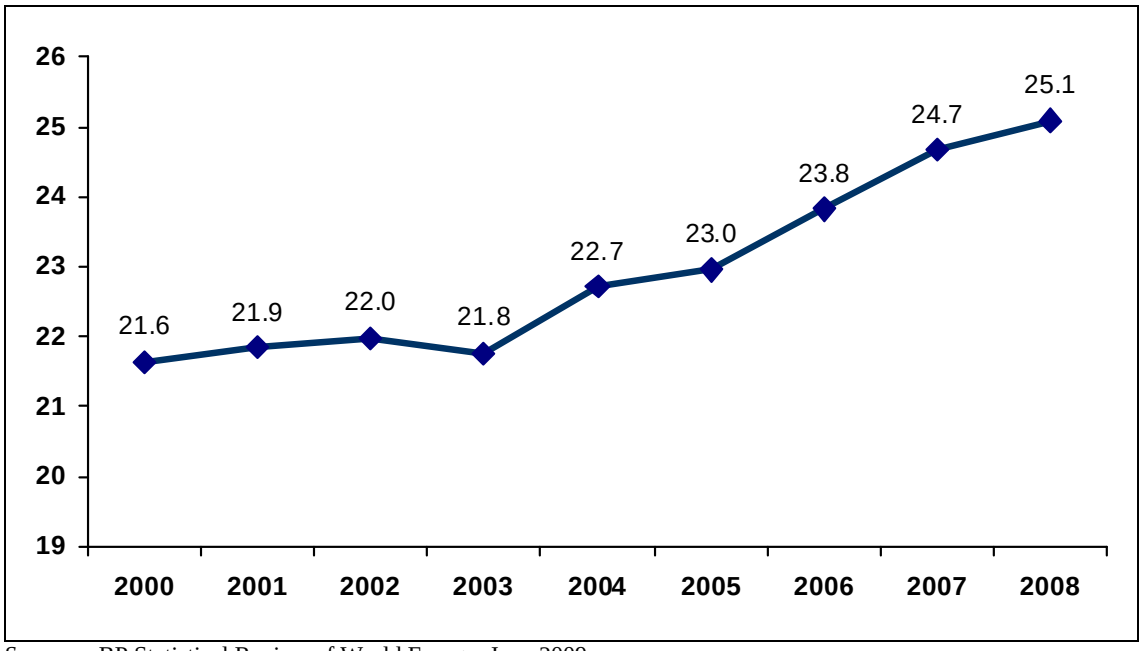
Source: BP Statistical Review of World Energy, June 2009
Note: The margin shown represents the margin achieved on Singapore markets for fuels produced using crude oil sourced from Dubai and the representative refining technology for the region (hydrocracking). It is the margin after all variable costs and fixed energy costs have been accounted for.

The reverse side of this economic boom is the downward slide occurring from 2008, as the global economy slows. The global economic crisis has affected Japan more severely than other countries in the region. Hence, demand from Japan is expected to decline accordingly. This compounds Japan's structural decline in demand for petroleum products, as the effects of demographic, technological and behavioural changes take hold (IEA, 2009). However, the International Energy Agency expects demand for petroleum products in the rest of Asia to expand by an average of 2.3 per cent per year over the medium term. This is fuelled by continued GDP growth in the region, despite the economic crisis. As disposable incomes increase, demand for vehicle use will also rise. The report also notes that "the prevalence of administered end-user price regimes in some countries such as India and Indonesia may also provide demand support if oil prices were to spike again" (IEA, 2003 p32).

Regional supply

Refinery investment in the Asia Pacific region has been encouraged by changes in the profit margins of refineries in the region. The upward trend in demand associated with the strong economic growth between 2003 and 2008 has led to a significant reduction in spare refinery capacity in the region. This has contributed to a regional supply shortfall, resulting in higher prices and stronger refining margins. The acceleration in the rate of increase in refining capacity in the Asia Pacific region since 2003 is shown in Chart 8.3.

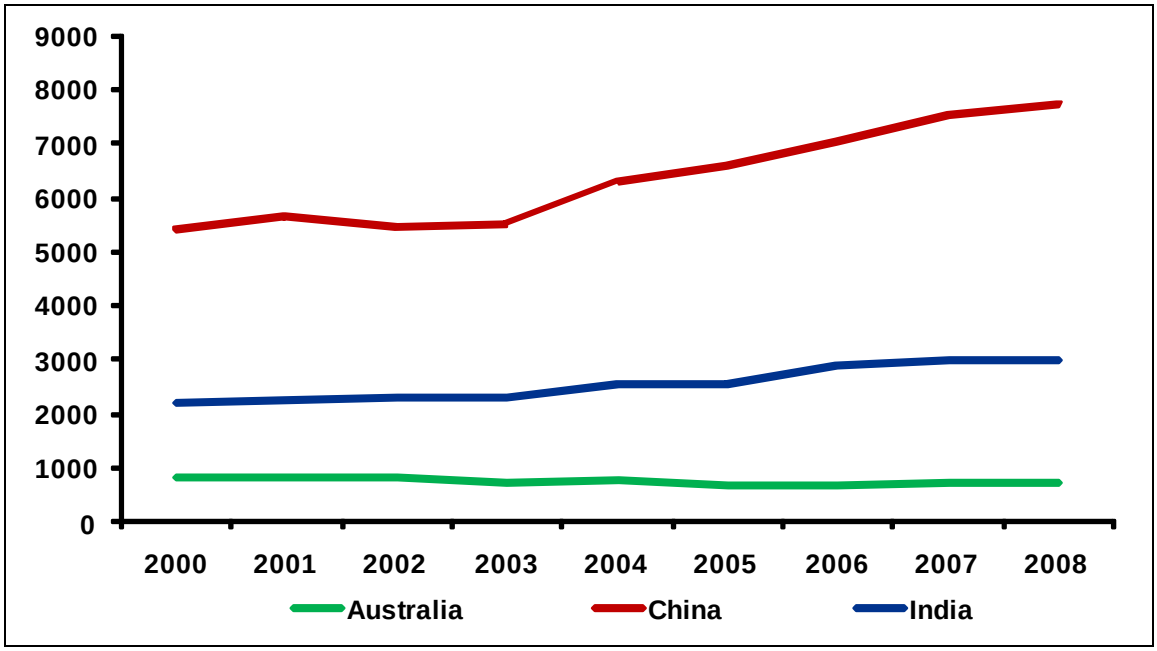
Chart 8.3: Refining capacity in the Asia Pacific region (million barrels a day)



Source: BP Statistical Review of World Energy, June 2009

Refineries across the world face competitive pressure from these new refineries in the Asia Pacific region, which take advantage of new technologies and economies of scale. The rate of increase in refining capacity has been particularly high in China and India. This increase is shown in Chart 8.4.

Chart 8.4: Refining capacity in selected countries, thousand barrels a day



Source: BP Statistical Review of World Energy, June 2009

This expansion in capacity is expected to continue into the medium term. In India, Reliance's newly expanded Jamnagar refinery will further contribute to the surge in capacity. The Jamnagar refinery has a capacity double that of Australia's total refining industry. There are also expansions planned at several other Indian refineries. (IEA, 2009) In China, the IEA expects "a shift in China's role from a product importer to exporter" (IEA, 2009, p87), as new projects come on stream. In the near term, Chinese capacity will be boosted by the recently completed CNOOC Huizhou refinery, and the expansion of the Sinopec/Saudi Aramco/ExxonMobil Fujian refinery (IEA, 2009). Vietnam is also contributing to the increase in capacity in the Asia Pacific region, where the Dung Quat refinery has recently been expanded.

This increase in the regional supply of petroleum products is exerting downward pressure on prices.

Regional supply balance

Overall, the IEA expects the Asia Pacific region to experience an over-supply of diesel and jet fuel products in the medium term[34]. Over the medium term (until 2014) an over-supply of 928,000 barrels per day is expected, led by the decrease in demand from the more developed countries in the region. This was equivalent to around 10 per cent[35] of total consumption of middle distillates in the Asia Pacific region in 2008. However, over the same time horizon, the region is expected to be unable to meet its own needs for petrol. The region's undersupply of these lighter products is forecast to be 427,000 barrels per day, or 6 per cent of 2008 consumption[36] (IEA, 2009).

Given these expectations for regional supply, it is likely that there will be downward pressure on regional prices for middle distillates (diesel and jet fuel), but upward pressure on regional prices for light distillates (petrol).

8.2 Economies of scale and investment

Refining is a capital-intensive process, and as such there are significant fixed costs involved in the production of liquid fuels. This gives rise to considerable economies of scale. With current technologies, larger refineries have lower average costs than smaller refineries. This arises from having larger production runs so that fixed investment costs can be spread over greater output.

[34] The IEA estimates are over the period 2008 to 2014

[35] This 10 per cent figure is derived by finding the ratio of the expected supply surplus of gasoil and kerosene as forecast by the IEA to the total consumption of middle distillates in the Asia Pacific region for 2008 as reported in the BP Statistical Review of World Energy 2009. The BP data defines middle distillates as "jet and heating kerosines, and gas and diesel oils (including marine bunkers)".

[36] This 6 per cent figure is derived by finding the ratio of the expected supply surplus of gasoline and naphtha as forecast by the IEA to the total consumption of light distillates in the Asia Pacific region for 2008 as reported in the BP Statistical Review of World Energy 2009. The BP data defines middle distillates as "aviation and motor gasolines and light distillate feedstock (LDF)".

Therefore, the small size of refineries in Australia makes it difficult for those refineries to reap the benefits of economies of scale.

Refinery production, like production in any other industry, is the result of a complex optimisation exercise, taking into account constraints on the industry. Constraints on the size and configuration of the industry include historical investment patterns, the geographical dispersion of the Australian population, global prices, impediments to investment and government regulations.

To make any investments in changing their production processes, Australian refineries need to attract investment funds. However, refineries in Asia Pacific countries make more attractive investment targets than Australian refineries for a variety of reasons.

- Labour and construction costs are lower in the Asia Pacific countries than in Australia.
- Taxation treatment for new facility construction and upgrades is more favourable in some industrialising economies than in Australia.
- Environmental and other regulations are less stringent in the Asia Pacific countries than in Australia.

Labour costs affect refinery profitability in terms of both construction costs and operating costs. The United States Department of Labor produced an index of labour compensation costs in 2007 for workers in manufacturing industries in different countries. Normalising this to set Australian manufacturing compensation costs to 100, the index value for selected Asian countries is shown in Table 8.1. The large differences between Australian labour costs and labour costs in the region highlight the cost disadvantages of operation within Australia. In Singapore, labour costs were 44 per cent of those in Australia[37]. At two, the index in China was extremely low (although the estimates for China may not be directly comparable to those for other countries). These lower labour costs mean that Asian refineries can potentially produce fuels at a cheaper price.

[37] This is on a per-person basis.

Table 8.1: Hourly compensation costs, all employees 2007

Country	Index
Australia	100
Korea, Republic of	53
Singapore	44
Taiwan	24
Philippines	4
China	2

Source: United States Department of Labor, 2009
Note: The index number for China's labour costs should be interpreted with care because the compensation costs used by the United States Department of Labor for China are not directly comparable with compensation costs for all other countries. Also, the Chinese index number refers to 2006 and are for all employees in manufacturing.

Refineries operating in the Asian region also have a cost advantage over Australian refineries because of comparatively favourable tax treatment, for both new facility construction as well as for upgrades. For example, in October 2008, the Indonesian Government announced income tax incentives for investment at refineries. Currently, the Indonesian Government is considering further tax incentives, such as exempting imports of equipment for refineries from tax. In Vietnam, Dung Quat Economic Zone was created, which offers tax incentives for firms locating there. As mentioned previously, the Dung Quat refinery has recently been expanded. In Thailand, the Government has set out a 'Development Plan for Petrochemical Growth' which is being implemented between 2004 and 2018. Likewise, India is developing an economic zone for refineries and petrochemical production.

In addition, environmental and regulatory constraints in many Asian countries are also less strict than in Australia, and this impacts on Australian refineries in differing ways as discussed in section 8.3.

Despite these constraints, the Australian refining industry has been investing in upgrading production facilities. Refinery investment over the 10 years to 2008 was $8.6 billion, compared to statutory profits of $7.8 billion (AIP, 2009). This investment has been for a number of reasons. According to the industry, the most important of these is to meet cleaner fuel standards and other regulations that have been introduced. There has also been some investment in marginal adjustments to existing refinery configurations to accommodate the changing Australian consumption patterns, which have seen increasing shares of diesel and jet fuel.

8.3 The environment and regulations in the Australian market

Australian refineries are regulated by Federal, State and Local governments so that their refining activities meet certain environmental standards.

The environmental impact of petroleum refineries fall into two categories. The first is the consumption of fuels produced by the refineries. While some level of pollution from the use of these fuels will inevitably occur, it may be argued that the presence of a domestic refining industry means that the government can exert more influence over the fuel specifications and

their environmental impact. The second environmental impact is that of the production process itself. This is regulated by standards for refinery production processes, including regulations associated with licences. These two categories of environmental impacts are discussed in turn.

Environment and fuel use

In Australia, under the Fuel Quality Standards Act 2000, the fuel supplied to the Australian market must meet strict environmental standards. Under this act, a series of fuel standards have been introduced since 2002. The standards aim to improve air quality and human health, and to facilitate the adoption of better vehicle engine and emission control technologies. Standards have been set for petrol, diesel, biodiesel and autogas. Australian standards are based on the European standards, which provide a global benchmark. The current major requirements are for diesel to have a sulfur content of no more than 10ppm and petrol to have a sulfur content of no more than 50ppm for premium grade and a benzene content of no more than 1 per cent. Further constraints include that petrol must contain less than 1 per cent MTBE[38] and less than 18 per cent olefins.

These more stringent requirements for fuel quality were introduced under the Cleaner Fuels Program. Cleaner fuels cost more to produce because they require new investment or modification of existing equipment and technologies. So far, Australian refineries have invested more than $2 billion in implementing the Cleaner Fuels Program (AIP 2007 a). Running this additional equipment is also costly, particularly because it makes the production process more energy intensive. This, of course, has environmental impacts as well. For example, the IEA Medium-Term Oil Market Report for 2009 notes that "to remove sulfur from light and middle distillates requires heat, pressure, and invariably hydrogen, the production of which is inexorably linked to increased CO2 emissions" (IEA 2009, p87).

The industry has been able to recoup some of the cost of producing cleaner fuels through the application of a quality margin, equivalent to around 3 per cent of the total price of fuels (ACCC 2008), as discussed in Section 7.1. This is because the standards made it more difficult to source compliant petrol product from the Asian region. For example, the restrictions on MTBE content in petrol, which were introduced in 2004, meant that many Asian refinery products did not meet the Australian fuel standards (ACIL Tasman 2008). However, the quality margin that can be applied may be eroded because of increases in the availability of petrol imports that meet Australian standards. Moreover, the ACIL Tasman report also notes that diesel and jet fuel imports meeting Australian standards have been available because of standards for jet fuel are global and because standards for diesel in Australia are now more compatible with fuel grades commonly traded in the Asian region (ACIL Tasman 2008).

The quality margin mentioned above has the potential to decline over time, particularly as Asian fuel standards converge with Australian standards. This means that the quality premium that Australian refineries are able to apply in order to recoup costs will eventually be eroded. Japan and Korea are introducing low sulfur diesel, and Japan also introduced low sulfur gasoline in 2005. The Jamnagar refinery will also be able to produce petrol that meets Australian

[38] MTBE stands for methyl tertiary-butyl ether.

specifications. It is also expected that new refineries in Vietnam will be able to produce products that can be sold in Australia. Singapore, Australia's biggest import source of refined petroleum products, is also lowering its diesel sulfur content to 10ppm in 2010. China will also lower its sulfur content in gasoline to 50ppm by 2010 for urban areas.

The environment and fuel production

Refineries operate under legislations imposed by Local, State and Federal governments which govern the impact that the refinery is permitted to have on its surrounding environment. These include licence requirements and controls over construction activities at refineries. They are aimed primarily at limiting emissions to the air, water and land. Regulations concerning air pollution include limiting the odours from a refinery, as well as emissions of sulfur dioxide and other air toxins. Water pollutants include discharge from refinery facilities as well as pollutants that are released through stormwater and other run-off from the refinery site. Other issues include the monitoring of ground level concentrates at the plant, as well as spills and on-site disposal. Moreover, the sulfur that has been extracted from fuels in accordance with cleaner fuel standards must also be treated and disposed of appropriately. The environmental efforts of refineries are largely directed towards compliance with these regulations.

All of Australia's refineries undertake environmental impact reduction activities in line with government regulations. For example, the Mobil Altona refinery has set out its environmental aims in its Environment Improvement Plan. The plan includes improvements in leak detection, reductions in flaring and improvements in the re-useability of waste water. It also contains commitments to reduce water consumption, improve waste water effluent quality and manage groundwater.

As an example of the refining sector's activities aimed at reducing the environmental impact of fuel production, the AIP (and therefore Australian refineries) are members of CRC CARE, the Cooperative Research Centre for Contamination Assessment and Remediation of the Environment. It is a research and development company that develops and provides technologies for assessing, preventing and remediating contamination of soil, water and air. The company aims to develop and commercialise new technologies for more effective treatment of wastes and contaminants. In 2007, the company, in partnership with others, announced that they will use the Port Stanvac refinery site to test environmentally-friendly, cost-effective bioremediation strategies to clean petroleum residues from the soil (CRC CARE, 2009).

8.4 Implications for Australian refineries

Amidst the increase in refinery capacity in the Asia Pacific, the IEA noted that "uncompetitive plants in the OECD Pacific region have been forced to cut runs in response to more difficult regional trade patterns and weaker margins" (IEA, 2009, p87). In this context, the IEA expects refinery closures in Japan and possibly also in Australia.

The competitiveness of Australian refineries will depend on a number of factors. These include factors that affect the prices that they can achieve for their outputs compared to the price that they must pay for their inputs.

As discussed above, the price of outputs depends largely on the cost of imported products. These prices are in turn determined by the regional demand and supply balance. The over-supply in the region in the medium-term, as forecast by the IEA, can be expected to put downward pressure on the prices that Australian refineries can receive for their products.

The costs of crude oil makes up a large portion of refinery input costs, and are also determined on international markets. The Asia Pacific region is a net importer of crude oil. According to the IEA, compared to 2008 (before the impact of the global economic downturn had taken hold) global trade in crude oil is expected to rise by only a small amount, 0.2 million barrels per day by 2014. Other costs, such as labour and construction costs are determined on the domestic Australian market. In these areas, Australian refineries face higher costs than other refineries in the region, as discussed in Section 8.2 above.

The domestic regulatory environment also plays an important role in determining the international competitiveness of Australian refineries. Cleaner fuel specifications and regulations to reduce the environmental impact of refineries increase the cost of production. The proposed Carbon Pollution Reduction Scheme is also expected to increase refining costs, as discussed in the next section.

9 Regional climate change policies

Australia's petroleum refining industry is directly affected by climate change policies that are introduced in Australia. If climate change policies increase the costs of production for the refining industry in Australia, *ceteris paribus*[39], it has the potential to reduce the international competitiveness of the Australian refining sector. For example, if a carbon price is applied to production in the domestic industry and is not applied to imported products, then domestically produced petroleum products will be at a disadvantage compared to imported products. Therefore, policies in Australia should be viewed in light of policies in other countries. This section compares the proposed measures to address climate change in Australia with those in key Asia Pacific countries.

9.1 Australia

Legislation to start a Carbon Pollution Reduction Scheme (CPRS) in Australia was introduced to Parliament in May 2009 (Senator, the Hon. Penny Wong, 2009). The aim of the proposed CPRS is to reduce Australia's greenhouse gas emissions. Currently, the economic cost of carbon pollution is not reflected in costs to businesses or consumers because firms do not bear any cost for their carbon emissions. This market failure can be addressed by introducing an emissions trading system, which places a cap on total emissions for the economy.

If introduced, the CPRS will put a price on carbon. The liability for emissions will typically be attached to the source of emissions. In general, it is expected that liable entities will pass the cost of their emission permits onto their customers. This is expected to lead to changes in business and consumer behaviour in a way that supports a lower carbon economy. For example, if the CPRS increases the price of electricity, consumers are likely to conserve more energy. Therefore, in the long term, it is expected that the CPRS will encourage the development of less carbon-intensive goods and services.

In light of the impacts of the global recession, the introduction of the CPRS has recently been delayed from 2010 to 1 July 2011. The Australian Government has also recently announced that:

- it is committed to reducing carbon pollution by 25 per cent of 2000 levels by 2020 (provided the world agrees to a global deal to stabilise levels of CO2 equivalents in the atmosphere at 450 parts per million); and

- it will establish an Australian Carbon Trust, to encourage households to reduce emissions (Senator, the Hon. Penny Wong, 2009).

The government has indicated that specific assistance will be provided to two broad industry groups to shield them from the cost-impact of acquiring emission permits under the CPRS.

[39] 'all other things equal': assuming that the only change is the introduction of the CPRS and that no changes in other variables such as the regional market structure, price of inputs or domestic refining technology occur.

These groups are Emission Intensive Trade Exposed (EITEs) industries and Strongly Affected industries (SAIs). The petroleum refining industry is expected to be an EITE activity.

EITEs are entities that participate in the international economy, via either import or export markets. Assistance will be provided in the form of free permits to eligible entities as a transitional measure and to reduce the likelihood of carbon leakage[40]. Under the proposed legislation, the level of assistance that is provided will be either 60 or 90 per cent of a given entity's permit obligations depending on the overall level of emissions intensity. Since the event of the global economic crisis, the Government has also announced a 'Global Recession Buffer' which provides additional permits to EITEs for the first five years of the scheme.

The introduction of the CPRS will increase production costs for the Australian petroleum refining industry, even with the provision of permits under the EITE assistance measures. Greenhouse gas emissions at refineries can be divided into two main sources (Mobil Altona, 2007).

- **Direct sources:** emissions attributable to fuel sources combusted on-site. These are associated with the use of coke, natural gas and refinery fuel gas in the refining process.

- **Indirect sources:** emissions attributable to fuel sources combusted off-site. These mostly result from refinery use of electricity.

The introduction of the CPRS in Australia will increase the cost of producing refined petroleum products, because refineries will pay a cost for their emissions, albeit a reduced amount if they receive EITE assistance. However, as noted in Section 8.1, since the refining industry is in competition with imports, the price that Australian refineries receive for their products is closely linked to the price of imported fuels. Therefore, it may be difficult for the domestic industry to increase the prices that they receive for their products. Therefore, *ceteris paribus*, while the introduction of the CPRS will tend to increase the cost of production for Australian refineries, refineries may have limited scope to increase their prices. As a result, the competitive advantage of Australia's petroleum refining industry could be somewhat reduced.

Under the proposed CPRS, the carbon price will also apply to emissions from the use of liquid fuels, which will be collected from upstream suppliers. This carbon price will be applied to both domestically produced and imported fuels. However, to mitigate the impact that this has on the prices that consumers pay, the Government will reduce fuel excise taxes by the same amount that the emission price increases the costs of fuels for the first three years of the CPRS. For the agriculture, fishing and transport sectors, which do not pay fuel excise, the Government plans to introduce a credit system which offsets any price increase resulting from the CPRS.

The Australian Government has also introduced the Energy Efficiency Opportunities program, which encourages large energy-using businesses to improve their energy efficiency. All businesses using more than 0.5 petajoules (which is approximately equivalent to the energy used

[40] 'Carbon leakage' is when firms relocate their operations overseas to avoid a carbon liability in Australia, or when firms and households purchase goods produced in a country without an emissions trading scheme in lieu of goods produced in a country with one. Carbon leakage implies that global carbon emissions associated with the production of certain goods may not be reduced.

by 10,000 households) per year must participate in the program. Participating businesses are required to undertake detailed energy assessments which identify opportunities to improve energy use and report publicly on outcomes. (DRET, 2009 b)

Compared to Australia, the governments of many countries in the Asia Pacific region have a different approach to reducing greenhouse gas emissions. The carbon pollution reduction policies in the countries of Australia's major trading partners in the Asia Pacific region are briefly outlined below.

9.2 Regional competitors

Australia imports refined petroleum from several countries in the Asia Pacific region. Many of these countries have climate change policies, but the policies do not affect their countries' industries. If Australia implements the CPRS and our regional competitors do not implement a similar policy, then the cost of Australian-produced petroleum products will increase, relative to that of our competitors. This will make Australian refineries less competitive.

Japan has introduced a voluntary ETS. Over 500 businesses have joined, but they are able to set their own caps, and face no punitive action if reductions are not achieved (Business Green, 2008). Japan is working on implementing a mandatory ETS, but as yet there is little information on a timeframe for its introduction.

China is one of the world's largest emitters of greenhouse gas, due to the country's large population, strong capital investment and urbanisation, and its heavy reliance on coal. In June 2007, China released its National Climate Change Program. The program aims to mitigate greenhouse gas emissions but rejects any mandatory limits on emissions. An outline for an ETS was released by the central bank in June 2008, but the introduction of a national scheme is highly unlikely in the near future (Select Committee on Fuel and Energy, 2009).

China's approach to climate change policy is focused on improving the energy efficiency of its industry. One of the objectives is to reduce energy intensity by 20 per cent by 2010. However, China has fallen short of the milestone targets in both 2006 and 2007, making achievement of this objective doubtful. Other goals include doubling renewable energy use by 2020, expanding nuclear power, tightening efficiency standards for buildings and appliances and increasing forest coverage to 20 per cent (CRS, 2008). The scope of China's climate change policy is much more limited than Australia's policy.

India is the fourth largest economy and fifth largest emitter of greenhouse gases (PewCenter on Global Climate Change, 2008). India's National Action Plan on Climate Change (released June 2008) introduced policies to reduce greenhouse gas emissions, but no mandatory emission limits. The Action Plan focuses on eight areas, including renewable energy (such as development of solar and wind power), transportation (converting public transport and taxis to natural gas), biofuels and forestry. While India has not set any emission limits, it is a participant in the Clean Development Mechanism (CDM), which grants emission credits for reductions in developing countries. Like China, the introduction of a mandatory ETS is highly unlikely in the near future (PewCenter on Global Climate Change, 2008).

Singapore is Australia's largest source of imports of petroleum products. Hence, the Singapore Government's approach to climate change policy is very important for the competitiveness of Australia's refining industry. In contrast to the Australian policy, the Singapore Government's climate change policy does not involve specific emission targets, focusing instead on improving energy efficiency through the Energy Efficient Singapore plan. The measures outlined in the plan not only aim to tackle climate change, but also improve the profitability of businesses operating in Singapore. The Singapore Government emphasises the need for "collective efforts of the international community, in a manner that does not unduly penalise the economic needs of individual countries" (Singapore Government, 2009).

The Singapore Government is focusing its efforts on three priority areas: resource management, pollution control and the quality of the physical environment. Commitments in these areas are very broad based and policy announcement has been limited.

Compared to Australia, very little information is available for other countries in the Asia Pacific region. An overview of the position in South Korea, Thailand and Taiwan is provided in the following paragraphs.

South Korea has recently launched a "green growth" strategy. It is focusing on nuclear power to "reduce greenhouse gas emissions and achieve low-carbon sustainable growth (Lee Jong-Heyon, 2009). Like many other countries in the Asia Pacific region, South Korea has signed the Kyoto Protocol, but is not likely to introduce an ETS in the near future.

Thailand's Ministry of Natural Resources and Environment has formed a partnership with the World Bank and agreed to the Country Development Partnership for Environment, Phase II (The World Bank, 2008) in September 2008. This agreement is aimed at helping Thailand address the impacts of climate change and sustainable environmental management. One aim of the agreement is to reduce greenhouse gas emissions in the energy, waste, industry, and forestry sectors. Thailand does not have an ETS.

Taiwan's CO2 emissions increased by 100.8% from 1990 to 2004, and the energy sector accounts for most of the emissions (Climate Change Taiwan, 2008). However, Taiwan has so far only introduced a voluntary scheme that targets large energy producers. In late 2005, a Voluntary Agreement on Energy Conservation and Carbon Dioxide Emission Reductions was signed between the Ministry of Economic Affairs and the Chinese National Federation of Industries. Under this agreement, the top 200 energy consuming manufacturers in Taiwan implemented emission reduction measures (Lila Buckley, 2009). Taiwan has a voluntary system, but it is not national in scope.

Table 9.1 below shows the largest emitters of greenhouse gases in 2000. It shows that six of the top 16 emitting countries are located in the Asia Pacific region (as identified in bold italics in the table).

Table 9.1 Largest Greenhouse Gas Emitters

Country	MtCO2 equivalent	% of world
US	6,928	20.6
China	***4,938***	***14.7***
EU-25	4,725	14.0
Russia	1,915	5.7
India	***1,884***	***5.6***
Japan	***1,317***	***3.9***
Germany	1,009	3.0
Brazil	851	2.5
Canada	680	2.0
UK	654	1.9
Italy	531	1.6
South Korea	***521***	***1.5***
France	513	1.5
Mexico	512	1.5
Indonesia	***503***	***1.5***
Australia	***491***	***1.5***

Source: Baumert, K., Herzog, T., Pershing, J., Navigating the Numbers, Greenhouse Gas Data and International Climate Change Policy, World Resources Institute, 2005, Table 21http://pdf.wri.org/navigating_numbers.pdf

Notes: - data refers to 2000. Countries labeled in bold and italics refer to countries in Asia Pacific region.
- MtCO2 equivalent is millions of tonnes of carbon dioxide equivalent.

9.3 Conclusion

While Australia plans to tackle climate change with the introduction of a CPRS, other countries in the Asia Pacific region appear to be implementing carbon reduction policies that are likely to have minimal cost impacts on industry. Given the differences between the Australian Government's approach and the approach of other Asia Pacific countries, the CPRS has the potential to reduce the competitiveness of the Australian refining industry. The Government has attempted to ameliorate this impact by including assistance for industries defined as EITE industries, which includes the refining industry. If the CPRS materially reduces the competitiveness of Australian refineries, then there is the potential for carbon leakage to occur.

10 Final remarks

This report has argued that the domestic refining industry makes quantifiable and un-quantifiable contributions to the Australian economy. However, the industry's viability is influenced by its regional competitiveness.

The Australian refining industry makes quantifiable contributions to the Australian economy though its own value added, and also through supporting the value added of other industries. In particular, our indicative estimate suggests that the total domestic refining industry may contribute as much as 0.5 per cent to Australian GDP. This report has demonstrated the industry's economic contribution by simulating the impacts of a permanent closure of a small refinery and of a large refinery. The refining sector's links with the rest of Australian industry means that the effects of refinery closures flow throughout the economy. For example, although production at a typical small refinery directly makes up 0.02 per cent of Australian GDP, if it closed, KPMG Econtech simulations show that GDP is expected to be 0.05 per cent lower than otherwise. That is, a small refinery actually contributes around 0.05 per cent of GDP. Similarly, production at a typical large refinery makes up 0.04 per cent of GDP, but its closure is expected to result in GDP being 0.09 per cent lower than otherwise.

The Australian refining industry also contributes to the economy though the positive externalities it creates. These include enhancing the supply security of petroleum products, which is important for the Australian economy. The refining industry also contributes to the development of other industries through the externality caused by 'input sharing'. By adding to the demand for certain inputs used by other industries, shared inputs may have reduced costs through the achievement of economies of scale. The highly technological and knowledge intensive nature of refinery production has also provided opportunities for positive technology and knowledge spillovers into other industries. This report has also presented a case study into the community development activities undertaken in the local areas surrounding Australian refineries, based on the Shell Geelong refinery.

The industry is heavily influenced by regional trends in the liquid fuels market, and its viability is affected by regional prices for its inputs and outputs, as well as the costs of producing within Australia. The recent increase in refining capacity in the Asia Pacific is likely to put downward pressure on the prices the Australian industry can charge for its output. This will tend to reduce the Australian industry's profit margins. Moreover, the costs of production in Australia are high compared to production in other countries in the region because of factors such as higher labour costs and the small size of Australian refineries. Finally, if the introduction of the CPRS materially lifts the cost base for Australian-produced petroleum products relative to imports, it could have the potential to reduce the domestic refining industry's ability to compete with imported product.

Appendix – petroleum product categories

This report uses six main product categories. They represent a detailed breakdown of products produced in the Petroleum Refining sector as defined by the ANZSIC industry code, although the names have been changed for ease of interpretaion.[41] The following is a list of the product groups produced by this industry, as modelled in KPMG Econtech's MM600+ model.

Petrol: automotive petrol; gasoline; petrol (including aviation spirit)

The major product in this category is automotive gasoline, which is mostly used by final consumers.

Diesel: diesel or fuel oil (excluding petrol and jet fuel)

This is used primarily by final consumers and industry.

Jet Fuel: kerosene (incl kerosene type jet fuel)

The major product in this category is aviation turbine fuel (or jet fuel).

LPG: liquefied petroleum gas produced at refineries (excludes naturally occurring LNG)

Other: While *'Other'* is one category in the main body of the report, for modelling purposes, it is split into the two categories listed below.

Misc. other petroleum & coal products: Mineral turpentine, oil and grease base stock, lubricants, paraffin wax, petroleum jelly, petroleum solvent, synthetic petrol

Refinery products nec: This class consists of petroleum or coal products not elsewhere classified. Primary products are: adhesive, bituminous; char (except bone char); coal product n.e.c.; emulsion, bituminous; mastic, bituminous; paper or paperboard, bituminized; paving material (except hot-mix); petroleum oil blending; petroleum product n.e.c.; pitch mfg; recovery of lubricating oil or grease from used petroleum waste products; roofing, bitumen or asphalt; and tar, refined. This is equivalent to the ANZSIC class 2520.

[41] ANZSIC is the Australia New Zealand Standard Industry Classifications, which is the industry definitions used by the Australian Bureau of Statistics (ABS). The Petroleum Refining Industry is the three-digit industry 2510, and it produces the products listed in this appendix. The ABS uses these industry definitions to compile the national accounts data and the input-output tables. This data is used as inputs to KPMG Econtech's MM600+ model.

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