Economic impact of Australian industry participation in the Joint Strike Fighter program
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Executive summary

The Joint Strike Fighter (JSF) F-35 Lightning II (F-35) is a fifth-generation, stealthy, multi-role fighter. The global JSF Program is currently the largest defence program in the world and involves F-35 being developed for the United States and eight international partner nations, including Australia.

As a global partner, Australia has established its own JSF program. The Australian JSF program is about much more than just the delivery of a new fighter capability, it is a catalyst for change for both Australian defence capability and outcomes for Australian defence industry. This allows Australian industry the opportunity to be involved in the global supply chain to produce and maintain the F-35 fleet.

A fundamental goal of the program is a strong industry base that supports the global JSF capability and provides Australia with long-term economic benefit. Over 30 Australian companies have already participated in production supply chains to provide high-end solutions to the JSF capability. The current cumulative total of Australian JSF production contracts is US$681 million and is forecast to reach almost US$4 billion in 2038. It is expected that as the global program moves towards a sustainment phase, Australian industry will also contribute to that global supply chain and with some sustainment contracts already assigned to Australian industry.

The production contracts awarded to date have helped shift Australian companies away from the declining domestic automotive industry toward advanced manufacturing sectors. The JSF program has also provided a platform for Australian industry to engage with major international defence and aerospace companies.

Better understanding and measurement of the economic benefit is at the heart of achieving a fundamental goal of the JSF program. PwC has been engaged to conduct analysis of the economic impact of Australian industry participation. The economic modelling in this report focuses on industry involvement in production, rather than sustainment, as production is already underway and has a better basis for forecasting. Sustainment requires a different consideration to assessing the costs and benefits of purchasing an Australian F-35 fleet, which is outside the scope of this report.

The assessment of economic impact has been conducted using a computable general equilibrium (CGE) model which captures complex economic interactions. This is supplemented with a qualitative discussion of the broader benefits of industry production participation in the JSF program, including spillover benefits.
Executive summary

Australian industry has been involved in the supply chain for the production of the global F-35 fleet for over a decade, with the first Australian contracts for F-35 components awarded in 2006. This participation has led to over US$680 million export contracts for Australian industry, as well as government support, all of which has advanced Australian industry capability.

Over a decade of Australian companies being involved in the global supply chain has resulted in increased exports for affected industries. This has driven increased economic activity in Australia, with today’s (2016) economy being $470 million (real GDP) larger that would not have been otherwise in the absence of the JSF program and 2,400 jobs supported across the Australian economy.

Industry participation in the JSF has led to sustained higher employment creating higher personal income and continued increasing household consumption rates. This means that Australians, on average, are better off as a result of F-35 production participation (as consumption is a reasonable proxy for wellbeing).

Overall, significant benefits accrue over the 30 year period above the expected forecast for economic activity in Australia, with a $1.2 billion GDP contribution forecast in 2038 due to F-35 production participation.

A summary of the impact to the Australian economy from industry participation F-35 production over the life of the program is shown in Figure 1.

Figure 1: Impact of Australian industry F-35 production participation

Economic Impact

Real GDP contributions

$470m AUD 2016

$1b AUD 2023

$1.2b AUD 2038

Exports

$681m USD Production export contracts won by Australian Industry 2006-2016.

$4b USD Production export contracts forecast to grow to between 2006-2038.

Jobs

2,400 jobs Contribution of Australian industry F-35 production participation to date to supporting additional jobs in the 2016 Australian economy.

Source: PwC analysis.
Economic impact of the JSF program in Australia
PwC

February 2017
Chapter 1
Introduction
The global JSF Program was established in 2001 and is currently the largest defence program in the world and involves the development of an F-35 Lightning II (F-35) fleet for the United States and eight international partner nations, including Australia. Around 3000 F-35 aircraft are expected to be produced over the timeline of the global program.

The Joint Strike Fighter (JSF) F-35 is a fifth-generation, stealthy, multi-role fighter. The F-35 combines advanced stealth capabilities with fighter aircraft speed and agility, fully-fused sensor information, network-enabled operations and advanced logistics and sustainment.

There are three variants of the F-35; the F-35A conventional takeoff and landing, the F-35B short takeoff/vertical landing and the F-35C carrier variant. Australia’s fleet will only be made up of F-35As.

The prime contractors for development and production of the F-35 to the United States Government are Lockheed Martin and Pratt & Whitney. The aircraft and associated support systems are being procured through a government-to-government co-operative agreement with the United States and JSF partner nations; Australia, United Kingdom, Canada, Italy, Denmark, Norway, Netherlands and Turkey (shown in Figure 2). Japan, Israel and the Republic of Korea are also procuring the F-35A JSF through foreign military sales (FMS) agreements.

As of February 2016 more than 150 F-35 aircraft had been delivered and were being operated from eight US bases with more than 50,000 flight hours recorded. It is expected that the operational fleet will exceed 200 by the end of 2016.¹

‘It’s the combination of the survivability, lethality and stealth, as well as the ability to continue to upgrade the airplane that makes it special.’

Squadron Leader Andrew Jackson, First Australian F-35A Pilot

Figure 2: JSF global partners, by level of participation

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¹ Economic impact of the JSF program in Australia

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February 2017
1.2 Australian JSF program – overview

Becoming a partner nation

Australia began investigating the options for new air combat capability to replace the F/A-18 fleet in 1999. Project AIR 6000 was established within the Department of Defence to manage the acquisition. This included requesting information on prospective purchases, including the F-35.

Following from this, Australia was invited by the US Government, along with other close allies, to invest in the System Development and Demonstration (SDD) Phase of the F-35 Program. The SDD Phase involves the F-35 capability being developed, tested and evaluated incrementally over time. In June 2002, the Australian Government decided to participate in the SDD Phase, signing the first SDD Memorandum of Understanding (MOU) on 31 October 2002 with a first associated partnership signatory payment of US$150 million.¹

In conjunction with this MOU participation decision, the Australian Government also concluded that the F-35A was the preferred aircraft to provide Australia’s new air combat capability. Defence undertook to monitor other prospective candidates should the F-35 Program not develop as expected. In making this decision Australia recognised the benefits of standardisation, rationalisation and interoperability associated with a cooperative program to satisfy similar operational requirements more affordably, as well as to provide industrial participation opportunities in global supply chains.

In 2006, after a Government approved First Pass, the Australian Government agreed to commit to the F-35 Production Sustainment and Follow-On Development MOU. This MOU, signed on 7 February 2007, set out the framework for ongoing partnership in the program after the SDD phase.

As at December 2015 for the Senate Enquiry Submission, Australia’s F-35 Program total approved budget is A$17.8 billion.² This includes the purchase of the 72 F-35A aircraft as well as support systems, including information systems support, training, weapons, and contingency funding. According to the Department’s submission to the enquiry, the purchase costs component of this budget is an expected US$90 million per Australian F-35 (based on current projections). This is a comparable unit cost to the latest version of the Super Hornet, which is a previous generation fighter aircraft.²

Goals of the Australian JSF program

There are two fundamental goals of the Australian JSF program:

1. A new air combat capability that will meet Australia’s air combat needs out to 2030 and beyond.
2. A strong industry base that supports the JSF capability and provides Australia with long-term economic benefit.

Air combat capacity milestones

In regards to the first goal of air combat capacity, Australia has already passed several milestones and progress so far includes:

- Funding for the first 14 Australian F-35As was approved in November 2009 which included funding enabling elements such as pilot and maintainer training in the United States and operational testing.
- The first two Australian F-35As were delivered to the International Pilot Training Centre at Luke Air Force Base in December 2014.
- The remaining 12 Stage 1 F-35As are currently planned to be accepted in July 2019 to achieve initial operating capability by the end of 2020.
- Funding for the next stage of up to 58 more Australian F-35As was approved in April 2014. This includes enablers to form the first three operational squadrons and a training unit.
- It is expected that a fourth operational squadron will be formed to bring the Australian F-35 fleet to approximately one hundred.
- As of the Senate Enquiry Submission in February 2016, there were two Australian pilots instructing at Luke Air Force Base, with two more undergoing training.¹
1.2 Australian JSF program – industry participation

**Industry participation**

The Australian JSF program is about much more than just the delivery of a new fighter capability. It is a catalyst for change for both Australian defence capability and outcomes for Australian defence industry. The program is an example of how a capability requirement can be used to build new global supply chain opportunities for a competitive Australian defence industry.

This potential benefit of the program is reflected in the second goal to create a strong industry base that supports the JSF capability and provides Australia with long-term economic benefits. A major part of this is establishing Australian industry in the global supply chain for both the initial JSF production and ongoing sustainment of the global fleet. As a global partner, Australian industry is able to compete for and be awarded contracts in the F-35 global supply chain on a ‘best value basis’. On this basis, suppliers in all nine (including the US) of the program’s partner countries are producing F-35 components for all aircraft, not just those in their country.

Most of the progress so far in this area has been Australian businesses winning contracts to be involved in the production phase of the program. As at December 2016, over US$680 million of contracts have been awarded to Australian industry. As these contracts have been award to Australian industry on a ‘best value basis’, this shows the international competitiveness of the over 30 Australian businesses that have been involved so far.

Better understanding and measurement of the economic benefit is at the heart of being able to deliver on the second goal of the JSF program. Therefore, PwC has been engaged to conduct an analysis of the economic impact that will flow out of this industry participation. In particular, this report focuses on the economic impact of Australian industry involvement in production because production already has decade history and a reasonable basis for understanding and forecasting future contracts.

**Industry support**

Australian industry is competing for contracts in the F-35 global supply chain on a ‘best value basis’. To help industry develop capability and build capacity to successfully compete for best value contracts, the Australian Government has put in place the New Air Combat Capability – Industry Support Program (NACC-ISP). The NACC-ISP is a program of grants awarded for the specific purpose of enabling Australian companies and research organisations to support the development of new or improved capability to win work in the production, sustainment and follow-on development phases of the global JSF program. The NACC–ISP is delivered with the assistance of Department of Industry, Innovation and Science through the Defence Industry Innovation Centre and AusIndustry. As of August 2016, AUD$11.6 million (GST inclusive) of grants have been awarded under the NACC-ISP, which is expected to grow to AUD$24.1 million ($21.9 million GST exclusive) by 2023.³

Businesses with JSF contracts may also access other industry support programs at state and federal levels that are not directly linked to the goal of gaining JSF contracts. Such programs include:

- Skilling Australia’s Defence Industry Program
- Next Generation Manufacturing Industry Program
- state based Innovation and Investment Funds.

As the NACC-ISP is a direct cost to government of establishing Australian industry in the global F-35 supply chain, it is an important factor to account for in any assessment of the economic impact of Australian JSF industry participation. Although it is important to understand the existence and support of the other programs, as they are not directly linked to the attainment of F-35 production contracts, it can be assumed that they would exist regardless of Australia being a global JSF partner or Australian JSF production contracts being awarded so they will not be included in this economic impact assessment.
1.3 **Scope of this report**

Figure 3 shows all the considerations that contribute to the net benefit of the JSF Program. The figure illustrates the economic modelling that this report is based on and gives context to the theoretical approach to measuring net benefits of the whole program (including costs of disposal of the previous fleet, and the cost and benefit offsets lost from maintaining that fleet).

The economic modelling in this report measures the economic impact of Australian F-35 production participation (i.e. global supply chain participation). The net benefit of production (highlighted in the black dotted boxes), is measured as production participation industry benefits (B) against production industry support NACC-ISP costs (C). The remainder of the industry costs and benefits relate to sustainment, which is discussed in Chapter 3.

This measurement of industry production participation net benefits is a different consideration to assessing the costs and benefits of purchasing an F-35 fleet. Therefore, it would be inappropriate to compare the costs associated with the F-35 capability against the net industry benefits from production participation (this report) without any consideration of the capability benefits.

**Figure 3: Illustrative costs and benefits of the JSF Program**

- **In scope**
  - The economic impact of Australian F-35 production participation.

- **Out of scope**
  - Cost benefit analysis of purchasing an F-35 fleet.
Chapter 2
Australian JSF production participation
2.1 Understanding production participation – global supply chain

To date over 30 Australian companies have participated in production supply chains to provide high-end solutions to the JSF capability. The current cumulative total of Australian production contracts into the global supply chain is US$681 million and is forecast to reach almost US$4 billion by 2038 (see Figure 4).

Forecasts based on the production of the global fleet show that Australian industry is yet to reach the peak of its involvement in the global F-35 production supply chain. The Australian Government continues to work with Australian industry and their international customers to help position Australian industry to take advantage of the significant increase in production volumes as the program moves from low rate initial production to full rate production.

Australian industry is not only supporting the production of the Australian fleet, rather, every F-35 built globally will contain Australian parts and components. Australian industry production is contributing to Australia air combat capability but is truly about entering a global supply chain.

The following section outlines Australia’s involvement in the global production supply chain to date. Specifically, they detail what parts, components and services Australian industry is contributing and the Australian businesses currently involved in the program.

Figure 4: Australian JSF cumulative production contracts, total values to date (2006-2038)

Source: Defence JSF Industry team
2.1 Understanding production participation – parts and components

To understand the impact that entering this global supply chain will have on the Australian economy, the profile of the contracts awarded must be examined. Australian industry is involved in the production of a wide variety of JSF components from the provision of treated raw materials to high-end manufacturing of components as well as the development of software and sensitive technologies. The variety of firms and the parts they are providing to F-35 production is displayed in Figure 6.

These components are produced by several manufacturing sub-industries (see Figure 5) but Australian participation is not limited to just physical components. There are also services being provided for F-35 production including training courseware development, engineering support and various studies. For some of these components, Australian firms are a main provider, meaning that every F-35 in the global fleet will include at least one of these Australian made components.

Figure 5: Production contracts by top 5 industries (cumulative totals to date)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft Manufacturing</td>
<td>34%</td>
</tr>
<tr>
<td>Specialised and Other Machinery and Equipment Manufacturing</td>
<td>31%</td>
</tr>
<tr>
<td>Professional, Scientific and Technical Services</td>
<td>18%</td>
</tr>
<tr>
<td>Other industries</td>
<td>9%</td>
</tr>
<tr>
<td>Polymer Product Manufacturing</td>
<td>8%</td>
</tr>
</tbody>
</table>


Source: Defence JSF Industry team, using detailed knowledge of contracts and involved companies and is based on ANZSIC definitions (Australia and New Zealand Standard Industry Classifications).

Figure 6: Australian industry production participation by JSF components contributed

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2.1 Understanding production participation – businesses involved

Figures 7 and 8 show the Australian businesses participating in F-35 production and their locations. The location of businesses involved in production will impact the distribution of economic benefits. More importantly, understanding the specific companies involved can show the broad range of impacts that global supply chain participation can have at the firm level. Three examples of participating business are explored to the right.

**Figure 7: Production contracts by state (cumulative value of contracts to date)**

<table>
<thead>
<tr>
<th>State / Territory</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Capital Territory</td>
<td>1%</td>
</tr>
<tr>
<td>New South Wales</td>
<td>13%</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>0%</td>
</tr>
<tr>
<td>Queensland</td>
<td>9%</td>
</tr>
<tr>
<td>South Australia</td>
<td>9%</td>
</tr>
<tr>
<td>Tasmania</td>
<td>0%</td>
</tr>
<tr>
<td>Victoria</td>
<td>64%</td>
</tr>
<tr>
<td>Western Australia</td>
<td>3%</td>
</tr>
</tbody>
</table>

Source: Defence JSF Industry team.

**Figure 8: Production participation locations**

Source: Defence JSF Industry team.

**AW Bell**

AW Bell is a Melbourne based manufacturer of complex metal parts. The JSF program has supported AW Bell’s transition from supplying parts to Australia’s declining automotive industry to producing high value products for export. As a certified US JSF program supplier, AW Bell now has established itself as a globally competitive defence sector manufacturer.

“*Our recent success in becoming part of the F-35 supply chain has opened up opportunities to grow exports to the United States for our world leading and complex castings.*”

Sam Bell, General Manager, A.W. Bell

**Marand**

Marand Precision Engineering is a Victorian based company that has performed well in the JSF program to date, with contracts for vertical tail, engine trailer and production tooling. As a preferred supplier of F-35 engine trailers globally, Marand, is the only producer of this essential solution for the global program.

“We look forward to continuing to build our future as a global supplier to the F-35 Program as well as to other advanced manufacturing opportunities in Australia.”

Rohan Stocker, Chief Executive Officer, Marand

**Heat Treatment Australia**

Heat Treatment Australia is a Brisbane based company that has successfully qualified to provide a vacuum brazing process for the F-35. This process makes the aircraft stronger and lighter through bonding metal together and reducing the need for traditional fastening such as nuts and bolts.

“*Participation in the F-35 Program has had a very positive effect on local employment, training and skills development.*”

Karen Stanton, Director – Corporate and Strategy, Heat Treatment Australia
2.2 Measuring the impact of production - approach

Measurement approach

A strong industry base that supports the JSF capability and provides Australia with long-term economic benefit is one of two fundamental goals of the Australian JSF program. This report aims to establish a method of measuring and communicating that economic benefit.

The impacts presented on the following pages have been estimated using a dynamic computable general equilibrium (CGE) model (details in Appendix A). This was the approach to measuring benefits recommended in the 2016 Policy Partners report Joint Strike Fighter: Improving the use of economics for strategy and reporting.4

CGE is a methodology commonly applied by Australian governments to estimate the economic impacts of policies and projects on the whole economy. CGE captures direct benefits (increased exports) and indirect benefits (links back through the supply chain). It does this by examining the difference between a base case forecast and the economy if a ‘policy change’ is implemented. In this case, the policy change is Australia’s ability to enter the global JSF supply chain. The next page sets out the structure of these benefits, to assist with understanding CGE results.

Scope of the measurement in this report

As discussed above, this report only measures the economic impact of Australian F-35 production (i.e. global supply chain participation), rather than the entire Australian JSF program. The policy change is therefore whether the production of the global F-35 fleet includes the purchase of Australian parts or if they are entirely foreign made.

Inputs in to the modelling

The focus of the estimate of economic impact is on production, as it is currently underway and contracts are measurable and forecastable. How the production will impact the economy will depend on the size and timing of the contracts, as well as the industry and the location of the production (see previous pages).
2.2 Measuring the impact of production – interpreting CGE results

A simplistic diagram of total value add resulting from a contract is shown in Figure 9. Value add is a measure of GDP and is the calculation of the value of final outputs (contracts) minus the value of intermediate inputs (raw materials).

Broadly, total value add consists of direct value add (represented in red in Figure 9) and indirect value add (represented in orange for supply chain indirect effects and pink for consumer indirect effects).

However, this diagram is simplistic as all these transactions will interact with each other and industries will compete for the same inputs of labour, capital and land. The CGE model solves for all these impacts simultaneously allowing the most realistic and properly constrained total value add (GDP) impact which is not decomposable. However, it does assist with understanding the relationship between contract values (input to the CGE model) and total value add (a measure of GDP, an output of the CGE model).

Figure 9: Simplistic representation of interactions captured by CGE

![Diagram showing interactions between contracts and value add]

All numbers in this diagram are indicative only, and will depend on the structure of the industries involved and other economic factors such as availability of inputs and relative prices.
2.3 Economic impact results – current production (2016)

Australian industry has been involved in the global supply chain for F-35 production for over a decade, with the first Australian contracts for components in 2006.

Over a decade of involvement in the program has led to an economy that is currently $470 million (real GDP) larger than it would have been, in the absence of Australia being able to participate in the global F-35 production supply chain. This involvement represents an additional 2,400 jobs currently supported in the Australian economy against baseline employment forecasts as a result of the JSF program.

The global supply chain involvement has meant that Australian companies with JSF contracts have had increased exports compared to the base case. This has driven affected industries and states to produce more, which is reflected in a rise in economic activity (increased gross domestic product (GDP) and employment).

Picture: The first vertical tails, manufactured by Australian company Marand, are installed on F-35 Lightning II AF-73 at Lockheed Martin’s Fort Worth, Texas manufacturing plant.

Source: Department of Defence

Compared to baseline forecasts, the 2016 economy is larger by:

- **$470 million** Real GDP
- **$126 million** Tax revenue
- **2,400** Jobs

These results represent a ‘snapshot’ of comparing 2016 under the base case and the policy change.

Source: PwC analysis. GDP and tax revenue results in real terms (2016 AUD). Employment rounded to nearest hundred.
By 2023, current forecasts show that Australian industry will have reached peak production of F-35 production contracts. This year represents the end of the period (2018-2023) where year on year F-35 related exports are expected to be at their highest. It also represents a milestone year in which cumulative Australian contracts are forecast to exceed US$2 billion (in nominal terms).

The benefits illustrated on the right show how much larger the 2023 economy is forecast to be compared to a base case of no F-35 production involvement.

As well as when Australian industry reaches peak production, 2023 is also the year when Australia expects to reach Full Operational Capability. This means it will be the year where Australia’s full F-35 fleet will be delivered and based domestically.

While 2023 may represent the peak of benefits in the production supply chain, as production benefits start to reduce, they are likely to be supplemented with sustainment benefits.

Compared to baseline forecasts, the 2023 economy is larger by:

- $1,026 million Real GDP
- $328 million Tax revenue
- 5,000 Jobs

These results represent a ‘snapshot’ of comparing 2023 under the base case and the policy change.

Source: PwC analysis. GDP and tax revenue results in real terms (2016 AUD). Employment rounded to nearest hundred.
2.3 Economic impact results – impact over time (2006 to 2038)

Understanding the economic impact of production participation over time

The results on the previous two pages have shown ‘snapshot’ results – that is a comparison of a select year in the base case to that same year in the forecast including F-35 production participation. Although these are insightful results that help demonstrate impacts in a digestible way, these are only two points along a 33 year forecast.

A key factor of this economic impact assessment is that entering the F-35 production global supply chain is not a one-off benefit that gradually dissipates through the economy. Rather, it is a sustained program, with additional exports each year over three decades. These expected year by year exports in real, current (2016 USD) terms are presented in Figure 10. The continuous nature of these exports means that exports in year one will increase the overall size of the economy, creating a larger base on for the next year.

Although the benefits of one year of exports may not last infinitely, it is likely that they are at least in part still noticeable in the next year (through linkages in the supply chain and increased consumer spending from increased employment). Therefore, understanding the impact over time is important in understanding the totality of benefits. Detailed results over time are explored in the following pages.

Key drivers of total economic impact

The increased exports as a result of F-35 production contracts initially results in higher production in the industries that are exporting. However, in a system of constrained inputs, this growth does come at a detriment (at least in some part) of other industries. Therefore, we may see a decline in exports and overall production in industries although the national net impact is positive.

Overall, national exports decline compared to the base case. However, there is a corresponding growth in household spending, essentially a substitution between foreign and domestic consumption. This household spending is driven by the employment result is explored further in the following pages.

Figure 10: Australian JSF production year on year contract values (2006-2038)

Source: Defence JSF Industry team. Results in real terms (2016 USD)
2.3 Production economic impact results – GDP (2006 to 2038)

The net impact to GDP above the base case from Australian industry participation of F-35 production is shown in Figure 11. These results can be understood in three sections as defined by different rates of growth:

- ‘Initiation’ (2006-2016)
- ‘Ramp up’ (2016-2023)
- ‘Consolidation’ (2023-2038).

Initiation

The first decade of results reflect the initiation of the program. Contracts were smaller and the flow of exports was irregular. This irregularity translated to uneven results and the size of the exports meant that most benefits are felt only in the year of that export (not in future years). Therefore, GDP impacts were mostly reliant on the particular exports of that year and slowly accumulated.

Ramp up

As can be seen earlier in Figure 10, the year on year forecast exports are highest in the period from 2018 to 2023 (in real terms). This period of ramp up to peak production shows the greatest rate of change in the GDP result. Not only are the year on year injections larger, the previous accumulation means that benefits are flowing on to subsequent years. The rate of growth above the base case is rapid in this phase.

Consolidation

In the consolidation phase there are still F-35 production exports occurring, but the amounts are much smaller. The benefits in this phase are therefore driven more by the gains established in the previous phase. After 2032, the small year on year exports are not enough to sustain the high GDP impact and it starts to revert towards the base case. However, it should be noted that these results are on top of a growing base case, so this is not a decline in GDP, but rather a smaller contribution of growth on top of the standard forecast growth. Although GDP may return to the base case, real gains were realised in the several decades that it was above the expected forecast. It may be during the consolidation phase that benefits from sustainment begin to be established, supplementing impacts from production.

**Figure 11: Net impact on GDP due to F-35 production participation (2006-2038)**

![Graph showing GDP impact over time with phases labeled 'Initiation', 'Ramp up', and 'Consolidation'.](image-url)
2.3 Production economic impact results – employment (2006 to 2038)

The net impact to employment above the base case from Australian industry participation in F-35 production is shown Figure 12. As with GDP (discussed on the previous page), clear initiation and ramp up phases can be seen between 2006 to 2016 and 2016 to 2023, respectively.

However, after 2023, employment results show a somewhat different pattern. Although not all GDP gains are retained after ramp up concludes, employment does not show a decline towards the base case, but rather looks to establish a new steady state. This is because although the economy does not stay at a larger size (as reflected in GDP impacts), the industry mix in the economy is altered slightly, skewed towards labour intensive industries. With more of the economy made up of industries with higher employment to output ratios, employment gains are sustained.

This sustained employment is reflected in continued increasing household consumption rates. As consumption is an standard economic proxy for wellbeing, on average, Australians are better off as a result of F-35 production participation.

Figure 12: Net impact on employment due to F-35 production participation (2006-2038)

Source: PwC analysis. Employment presented as rounded to the nearest hundred.

Economic impact of the JSF program in Australia

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2.3 Production economic impact results – sensitivity scenarios

The major input to this assessment of economic impact is the forecast values of the Australian F-35 production contracts. Although there are current estimates of program contracts, they are not yet certain due to the fact that most F-35 production contracts are competed for annually. Therefore, the Department of Defence, in their Senate Enquiry Submission, provided high and low sensitivity scenarios for these contract values, to show the indicative range of likelihood for future contracts. These sensitivity scenarios have been put through a similar CGE modelling exercise to show the overall impact should future contracts be higher or lower than currently expected.

The result of this sensitivity analysis is shown in Figure 13 and Figure 14. These demonstrate that the sensitivity scenarios follow a similar path of impact, just to different magnitudes. The largest impact to GDP still occurs in the same year for all scenarios, with a possible impact range between $930 and $1,575 million. The employment impact at the end point of the program in 2038 ranges between 4,800 and 7,800 people.

Figure 13: Net impact on GDP under sensitivity scenarios (2006-2038)

Figure 14: Net impact on employment under sensitivity scenarios (2006-2038)

Source: PwC analysis. GDP results in real terms (2016 AUD) and employment rounded to the nearest hundred.
2.4 Broader production benefits – benefits not currently captured

**Benefits captured in CGE modelling**

CGE results (as presented in the previous section) capture a wide range of benefits. As well as direct benefits (increased exports for F-35 production contracts) indirect benefits are also captured. Indirect benefits are those driven by linkages back in the Australian supply chain of inputs required by F-35 production exporting industries. For example, to export more advanced manufacturing, Australian industry will purchase more local inputs of metal from other Australian industries. Indirect benefits through the supply chain can also come from increased household spending, which flows from increased employment in the industries impacted by direct benefits and require more labour. In turn, this increase in employment means that household income is higher and increased purchases can be made in all industries.

**Benefits not captured in CGE modelling**

Although CGE modelling captures a wide range of benefits, it cannot capture every impact that Australian production entering the global F-35 supply chain could foreseeably have.

One benefit that is not currently captured is the potential for non-F-35 exports to increase in F-35 effected industries. This may occur, for example, if due to being awarded an F-35 production a company becomes more export ready and has the capacity to deliver on other international contracts such as those through other military Global Supply Chain programs. The potential for this to occur was acknowledged in the Department of Defence Senate Enquiry Submission:

‘… the credibility and visibility arising from F-35A performance is assisting Australian firms to capture and grow market share in other military and commercial applications …’

Department of Defence, Senate Enquiry Submission

The other particular benefit not currently captured is gains flowing from increased knowledge or capability. Additional benefits can flow from increased knowledge if it is able to be used in other, non-F-35 production areas without being fully paid for. However, if this productivity enhancement is not purchased, it will not be captured in classic economic interactions such as those at the base of the CGE modelling. These benefits can be referred to as ‘spillovers’. Based on data availability, this is currently examined qualitatively however, it could be modelled in the future.

**Potential spillover benefits**

Spillover benefits occur if execution of the F-35 production contracts results in productivity gains which can then be applied in areas other than F-35 production. This can occur in two ways:

- **Intrafirm spillover** – where a company develops a new process or technology to deliver F-35 production contracts, but then this process or technology is able to increase the productivity of other parts of the same company.
- **Interfirm spillover** – where other companies are able to use that process or technology without paying for the full value such as through reverse engineering or movement of skilled staff between companies.

The potential existence of such spillovers from F-35 production have been acknowledged in the Department of Defence Senate Enquiry Submission:

‘A range of indirect benefits are flowing for Australian industry … including the opportunity to deepen capability within the high end technology sector, specifically through improved skills, and knowledge and technology transfer which builds on those established in other sectors (e.g. automotive manufacturing) … There has also been a growth in capacity and business process improvements which are being applied beyond F-35 product lines.’

Department of Defence, Senate Enquiry Submission
2.4 Broader production benefits – measuring broader benefits

Challenges with measurement

Although it is acknowledged that spillover benefits can theoretically exist, and are anecdotally occurring as a result of Australian industry being involved in the F-35 production global supply chain, they can be difficult to establish and measure.

Because, by definition, spillovers are either not purchased or only partially paid for, measurement often relies on self-reported data and self-estimated benefits. In absence of this kind of data, looking for analogies can help with understanding these broader benefits.

The 2015 Department of Defence report Building Submarines in Australia – Aspects of Economic Impact examined the possibility of spillover benefits from domestic submarine manufacture. This found that whilst spillovers are possible, the defence environment can limit them due to manufacturing being very specialised and tailored to one specific customer and often not transferrable to civilian systems. Although that report concluded that it is likely that some spillover benefits are likely to occur, no evidence could be found that they would be substantial.⁵ Although this analogy is in the Australian context, the different natures of submarine production and defence aerospace production do limit its usefulness in this instance.

Dutch F-35 program

A study into the impacts of the Dutch F-35 program The F-35 Joint Strike Fighter as a Source of Innovation and Employment: Some Interim Results is an example of potential spillover benefits. That report puts forward that for the US$9.2 billion Dutch contracts for development and production, the Dutch economy would benefit from US$1.1 billion of ‘spin off benefits’ (defined in the study as new non-F-35 contracts in the same industries) and US$120 million of ‘spillover benefits’ (contracts using related technologies but in different industries).⁶

However, in using this analogy is should be noted that the Dutch production contracts are more than twice the size of the forecast Australian contracts. Additionally, in the differently structured economies with different innovation enablers, they can be no guarantee of replication of such results.

To make any conclusion on the magnitude of these broader benefits in the Australian F-35 context would require further data than is currently available, but is worth further monitoring.
Chapter 3
Australian JSF sustainment participation
3.1 Understanding sustainment participation

Sustainment requirements
As well as the ability to enter the global production supply chain, being a global JSF partner also means that Australia has the potential to be involved in the sustainment of the global fleet.

Sustainment covers all the activities of maintenance, repair, overhaul and upgrade (MRO&U) as well as the storage and support (including training) that the global fleet requires. As the global F-35 fleet grows, these sustainment activities will be required across all Partner nations and locations.

Global Support Solution (GSS)
The GSS is a centrally managed, best value support system for all F-35 aircraft worldwide. Because the global fleet is centrally manufactured to set specifications to have inter-operability, sustainment needs will also be similar across the global fleet. A central sustainment system will allow Partners such as Australia to benefit from the economies of scale in specialising in certain sustainment areas or just by accessing a larger pool.

As the only Partner nation located in the Asia-Pacific Region, Australia expects that its strong defence industry base will be used to contribute to an affordable, effective and efficient regional and global JSF sustainment system. However, as the Joint Program Office has indicated, as more aircraft arrive in the Asia-Pacific region, Australia’s sustainment capacity may be supplemented by Japan.

Australian Support Solution
While the sustainment of the Australian fleet will draw on the GSS, some sustainment activities may be regarded as sovereign. For example, Australia has identified some sovereign sustainment needs that will be maintained in Australia to satisfy capability, national security, self-reliance or other factors that are strategically important.

A key issue in the sustainment of the Australian fleet will be the affordability of global and Australian support.

Airframe and engine maintenance
Airframe and engine maintenance is the most mature part of sustainment in terms of planning and assignments. Due to the immaturity of standing up these maintenance depots, contract award dollar values have not yet been determined.

As part of the F-35 GSS, the United States Government has made regional assignments for F-35 depot level MRO&U for airframe and engines. Australia has been assigned this work for the Asia-Pacific region. This assignment includes BAE Systems Australia (based in Williamtown in New South Wales) being assigned regional F-35 airframe MRO&U for the South Asia Pacific region and TAE (based at Amberley in Queensland) being assigned regional MRO&U for F135 engines for the Asia Pacific region. These assignments increase the potential volume of work available to Australian industry.

Collaborative planning between the Australian Government, Australian industry and prime contractors (Lockheed Martin and Pratt & Whitney) and the Joint Program Office is well underway. This will ensure that Australia is ready to meet regional demand for deep airframe and engine maintenance by the end of 2018.

Component MRO&U
In November 2016, the US Government assigned Australian industry F-35 depot level MRO&U of componentry for the Asia-Pacific region. Australia is one of four countries outside the US to be assigned the initial tranche of global F-35 component MRO&U.

Other sustainment contracts
Australian industry has further opportunities available in the F-35 Program with two additional RFIs (requests for information) for regional warehousing and non-vehicle support issued by the US Government as of September 2016. The Australian Government are working together with Australian industry to prepare a single response to the US Government.
3.2 Measuring the impact of sustainment

Measurement approach
The recommended approach to measuring the economic impact of sustainment is similar to the approach taken in the rest of this report in regards to production. Using a CGE modelling approach allows the impacts to be understood within a realistically constrained system, which is why this approach is preferred for economic analysis of policies and projects around the world, including by Australian government bodies.

The key difference with modelling the benefits of sustainment will be that, unlike production which was purchased from overseas, sustainment activity will be at least in part, be paid for by the Australian Government as the owner of the Australian fleet. This will result in different interactions within the CGE structure as compared to pure exports.

However, as with all economic modelling, the rigor of any CGE results does depend on the reliability of the inputs. This is why the impact of sustainment has not been estimated in this report. Currently, there are too many unknowns regarding sustainment and the associated contracts remains too unpredictable in both value and timing to form reliable modelling inputs.

Potential benefits
Although the impact of sustainment participation cannot yet be estimated, the potential quantum can be illustrated through public estimates.

- In its submission to the Senate Enquiry, the Department of Defence estimated that Australian industry has the potential to gain between AUD$6 to 9 billion of sustainment work to support the Australian F-35 fleet across their 30 year life. This estimate did not include any additional sustainment work on foreign aircraft that Australian companies may gain through the global supply chain.

- In the 2014 Second Pass, the Government approved AUD$4.6 billion of operating support costs for the Australian F-35 fleet to 2023. Due to the timing of these arrangements, it is likely that sustainment benefits will start accruing as production benefits start to consolidate and reduce.
Appendix A – Computable general equilibrium model methodology

The economic impact assessment of production participation has been undertaken using a computable general equilibrium (CGE) model, specifically the Victoria University Regional Model (VURM) developed by the Centre of Policy Studies (CoPS) at Victoria University.

A CGE model is a mathematical model of an economy that is capable of capturing economy-wide impacts and inter-sectoral reallocation of resources that may result from a ‘shock’ (i.e. change in the status quo) to the economy. CGE models are widely used in economic analysis of policies and projects around the world including in Australia by both government and the private sector.

A CGE model places a change or ‘shock’ on this base input-output table by solving a set of equations that capture neoclassical microeconomic theory to determine behaviour of economic agents (such as households, governments, industries) when they are faced with changes in key economic variables, especially relative prices. The equations are solved simultaneously, where some variables are determined by the model (endogenous variables) and some are determined outside the model (exogenous variables). The classification of endogenous and exogenous variables is determined by the user based on the set of assumptions derived for the specific modelling exercise. In this way, CGE models recognise that complex macroeconomic mechanisms and inter-industry interactions exist in the economy and, in light of this, replicate how the economy will adjust to ‘shocks’ from significant projects and policies.

PwC uses the CGE models developed by the CoPS. These are preferred because they have been peer reviewed, meaning the inputs and assumptions are fully and publicly documented, providing greater modelling credibility. The Victoria University models have wide use in Australia by both government and the private sector. The VURM is a multi-regional, dynamic CGE model. It distinguishes up to eight Australian regions (six States and two Territories) and up to 144 commodities / industries. The model contains explicit representations of intra-regional, inter-regional and international trade flows based on regional input-output data developed at CoPS, and includes detailed data on state and Federal governments’ budgets. As each region is modelled as a mini-economy, VURM is ideally suited to determining the impact of region-specific economic shocks. Second round effects are captured via the model’s input-output linkages and account for economy-wide and international constraints.
Appendix B – Assumptions and limitations

Baseline assumptions

The baseline model of the economy used in the modelling for this analysis is based on long-run projections of productivity, population and participation rates developed by PwC in our Intergenerational Fiscal and Economic Model (IFEM). This analysis is based on the most recent data on the Australian economy and is forecast using Australian Bureau of Statistics (ABS) population projections. The core projection is based on the ABS population projections – specifically, Series B of the ABS series 3222.0 ‘Population projections, Australia, 2012 to 2101’. These have been updated by PwC to reflect actual population figures released since and so better reflect recent demographic trends.

What was modelled

An export shock was modelled using contract values data (provided by Department of Defence including forecasts) as inputs. The proportion of these contracts by state and industry was provided for current cumulative contracts was provided and assumed (in the absence of better data) to be the same across the forecast period. This is a modelling assumption and does not necessarily reflect the Defence view of where future contracts will be awarded.

These contract amounts were converted to real terms using baseline assumptions and to Australian dollars using an average exchange rate. These contracts represent an increase in foreign demand for certain Australian products and services.

For manufacturing and raw materials industries, the model apportioned inputs of capital, land and labour to meet the new exports according to the underlying input-output table. However, for service industries, due to the nature of services being provided, it was assumed that marginally no more capital was required, and labour was the main input to produce marginally more service exports.

For NACC-ISP government spending, a shift in government consumption was modelled in to the areas where grants are being awarded, allowing the model to shift other government spending and income accordingly. The inputs used for this were grants currently awarded (for 2012 to 2016) and forecasts based on the current profile out to the total amount currently committed by 2023 (2017 to 2023). This totalled $24.1 million GST inclusive ($21.9 million GST exclusive).

Limitations

The approach taken has the following limitations:

- This modelling has been conducted using a forecast of contract values so would be subject to any changes in those forecasts. However, sensitivity tests have been conducted around this forecast to provide an understanding of the potential range of impacts.
- As only the impact of production participation was being investigated, it was assumed that no specific government expenditure was required to secure the exports apart from the small amount of NACC-ISP grants. For this reason, general partnership costs and the other costs in Figure 3 that cannot be specifically linked to production have been excluded from this analysis.
- Due to no data available to the contrary, contract are assumed to be executed in the year they are signed. Whilst there may be some delay in reality this will likely delay but not change the benefits illustrated.
- Historical splits of contract amounts by state and industry were applied across the forecast period. Export contracts being executed in different locations and industries is likely to change the distribution of impact.
Appendix C - Sources

Endnotes


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