ECONOMIC DEVELOPMENT BOARD
SOUTH AUSTRALIA

Economic analysis of Australia's future submarine program

Introduction

Following media reports that the Federal Government was considering purchasing Japanese Sōryū class submarines to replace Australia's existing Collins class vessels, the South Australian Economic Development Board (EDB) commissioned an analysis from the National Institute of Economic and Industry Research (NIEIR) to assess the economic impacts of this proposal on the Australian economy. The instructions were to make the analysis very conservative.

Having discussed the suitability of existing vessels with submarine experts domestically and internationally, it is clear that no submarine currently exists anywhere in the world with the ability to operate in Australia's unique environment and has the capabilities required for the defence task of the Australian Navy. This means that whatever Australia ends up operating will in effect be a new submarine class.

As a consequence it is clear that our unique requirements mean significant efficiencies in the R&D program will be gained from the ability to test new developments 'on-site'. This benefit has not been included in the model used.

Detailed cost data on building (1) overseas or (2) locally, has been gathered and checked with numerous Australian and overseas experts. The clear conclusion is that it will cost no more to build locally. This is partly because Australia requires a tailor made vessel, and partly because there are only four potential international partners to build the submarines with (Germany, France, Japan and Sweden) and they are all high-cost countries.

The analysis modelled two scenarios:

- Scenario 1: Build all 12 submarines overseas, with Australia retaining only the light maintenance
- Scenario 2: Build all 12 submarines in Australia with both heavy and light maintenance being undertaken locally over the 40 year life of the project.

In the discussion below, and in the model, the following assumptions were made:

- All $ figures are 2014 AUD unless otherwise stated.
- AUD exchange rates of $0.92USD have been used in the calculations. Assuming that the AUD is currently overvalued, the benefits of local production will be increased if this exchange rate normalises to purchasing power parity. Conversely, at a more competitive exchange rate of $0.74 cents per $US, the impact of an overseas build could be in the regional of 30 per cent worse.
- The total cost of construction in Australia is assumed to be the same as that of overseas construction, namely, $20bn.
- The figures in the report are based on the assumption of fixed public sector deficit targets requiring cuts in government expenditure domestically to fund the purchase of the submarines.
- The average rate of corporate income tax paid in Australia will remain at 28%. The effects on the economy are modelled with and without tax revenue recoupment.

SOUTH AUSTRALIA

- Construction is undertaken at Techport in Adelaide, South Australia and all the heavy maintenance at Henderson in Perth, Western Australia, but goods and services are drawn from many Australian and overseas regions.
- The loss of automotive construction in Australia generates enough surplus capacity in the Australian labour market to ensure that the Australian economy does not hit any capacity constraints from undertaking local construction of submarines. This is verified since there is a clearly identified transformation path from the automotive sector into the defence ship building sector. The model includes an estimate that Scenario 2 (build in Australia) would utilise only 11.4% of the surplus capacity created by auto sector closures.
- A slowdown in mining-related construction in WA would also generate enough surplus capacity for the Henderson program.
- Because virtually no capacity constraints are anticipated in the labour market, the program is not expected to stimulate additional wage increases. For this reason, the Australian 567-local government region input-output model has been used, rather than a computable general equilibrium model.
- In these types of complex projects there is normally a "knowledge spillover" effect from the increased range of competencies of local firms that result from domestic construction. For example, Professor Gunnar Eliasson[1] has estimated that the JAS 39 Gripen multi-role combat aircraft project in Sweden generated a spillover multiplier of 2.6 on the development component alone. For the purposes of this report, a conservative multiplier of 0.7 has been applied to the **local R&D and materials spend**. This means that $7 billion spent on Australian R&D and materials will increase GDP by $5bn.
  Using **total local expenditure** on the submarines as the base, this result is consistent with a spillover multiplier of 0.4 for Scenario 2 over the 40 year life of the project. There are numerous cases from the Collins program, of Australian companies developing new technologies and new capabilities that indicate that this $5bn number underestimates the spillover effects.

Key results

Under any scenario, the cost of a new fleet of submarines will be borne by Australians and there are two separate components to this cost. The first is the impact on the Commonwealth Government (see Table 1) and the second is the impact on the economy (see Tables 2 and 3).

Table 1 indicates two significant benefits to the Government from building in Australia:

- First, an estimated $5.5 billion of tax is recouped by the Government. Under the "no change to budget" assumption in this model, this reduces by $5.5 billion, the need to cut other Government programs to cover the cost of the submarines.
- Second, there is a $7.3 billion reduction in counter party risk and exchange risk carried (or hedged at large cost) by the Government if the AUD mean-reverts to a purchasing-power parity of $0.74 US cents (compared with the $0.92 US cent rate used elsewhere in the model).

[1] Eliasson, G. (2010) *Advanced Public Procurement: The Aircraft Industry as Technical University*, Springer

Table 1	Australia ($m)	
Total Cost to Commonwealth Government	**@0.92 USD**	**@0.74 USD**
Cash cost: build overseas	21,114	28,344
Tax recoupment from building overseas	624	624
Net cost to Commonwealth Government	20,490	27,720
Cash cost: build in Australia	20,957	21,960
Tax recoupment from building in Australia	6,011	6,011
Net cost to Commonwealth Government	14,946	15,949
Saving in net cost to Commonwealth Government if built in Australia	5,545	11,771

Table 2 summarises the more favourable economic impact on the Gross Domestic Product (GDP) of Australia and on the Gross Regional Product (GRP) of the States and Territories from building in Australia. The table indicates that Australia is "better off" by around $21 billion and that every State and Territory benefits.

Table 2: Total Impact on GDP/GRP	Australia $m	South Australia $m	Western Australia $m	Other States $m
Scenario 1 – build overseas	- 29,344	- 2,193	- 786	- 26,366
Scenario 2 – build in Australia	- 8,207	11,081	2,046	- 21,333
Amount by which Scenario 2 is better than Scenario 1 for the economy	**21,137**	**13,274**	**2,832**	**5,032**

Table 3 summarises the difference in impacts between the two scenarios as relates to average jobs over the life of the program. The table indicates that Australia is "better off" by more than 3,000 jobs per year for 40 years and that every State and Territory benefits.

Table 3: Total Impact on Jobs	Australia average number of jobs each year for 40 years	South Australia average number of jobs each year for 40 years	Western Australia average number of jobs each year for 40 years	Other States average number of jobs each year for 40 years
Additional direct employment: Scenario 2	797	378	345	74
Total economy-wide change: Scenario 1	-6,691	-559	-350	-5,782
Total economy-wide change: Scenario 2	-2,886	1,856	218	-4,961
Net economy-wide impact: How many annual jobs Scenario 2 is better than Scenario 1 by	**3,805**	**2,416**	**568**	**821**

The estimated regional impacts can be seen in Table 4 below:

Table 4: Estimated regional impacts by council region and Federal electorate			
Main Commonwealth Electorate	**Build in Australia less build overseas**		
	South Australia	**Addition to GRP $ million**	**Additional total man-years over the 40 year period**
Adelaide	Adelaide (C)	2,837	1,583
Port Adelaide	Port Adelaide Enfield (C)	5,183	14,753
Mayo	Onkaparinga (C)	265	8,588
Makin	Tea Tree Gully (C)	244	8,503
Hindmarsh	West Torrens (C)	388	4,256
Pt Adelaide, Makin	Salisbury (C)	432	10,935
Hindmarsh	Charles Sturt (C)	541	10,303
	Total of these regions	**9,890**	**58,920**
Total SA		**13,274**	**96,621**
	Western Australia	**Addition to GRP $million**	**Additional total man-years over the 40 year period**
Fremantle	Cockburn (C)	75	4,160
Brand	Kwinana (T)	1,975	2,190
Brand, Canning	Mandurah (C)	33	2,385
Brand	Melville (C)	72	2,683
Brand	Rockingham (C)	101	7,063
	Total of these regions	**2,256**	**18,480**
Total WA		**2,832**	**22,734**

In summary, the key results of the analysis indicate the following:

- Under Scenario 1 (build overseas):
  There would be a negative impact of $29 billion on Australian GDP over the 40 year life of the project. This is the equivalent of $725 million every year for 40 years.

  Australian workers could expect to lose 6,600 jobs every year for 40 years.

- Under Scenario 2 (build in Australia):
  The negative impact on Australian GDP if the submarines are built here is estimated to be $8.2 billion over the 40 year life of the project – approximately $21 billion dollars less than the Scenario 1. In other words Australia would be around $525 million a year better off in Scenario 2 than in Scenario 1.

  In addition, at least 3,000 more Australian jobs would be saved every year over the 40-year life of the project if built in Australia.

Modelling method

The modelling has been based on extensive investigation of current technologies and their costs (built on publicly available contract data)[2]in five submarine-building nations including France (including French submarines built in India and Brazil), Sweden, Germany (and the German submarines built in Greece, Turkey and Korea), Japan and Australia.

Under Scenario 2 (build locally), an assumption has been made that construction would be undertaken at Techport in Adelaide, South Australia and all the heavy maintenance at Henderson in Perth, Western Australia, with goods and services being drawn from many Australian and overseas regions.

The Australian 567-local government region input-output model has been used rather than a computable general equilibrium model. This approach is based on knowledge that the loss of the automotive sector in Australia will, in the relevant parts of the Australian economy, generate 8 or 9 times the surplus capacity required for local construction of submarines.

The Submarine program would span 40 years and has been split into four sub-programs: [3](

- R&D (Years 1 – 4): This includes development costs for a submarine that fulfils Australian requirements inclusive of manuals, development of training & maintenance documentation and production support. This is estimated to be 6 million man-hours, equalling $0.9bn (NPV discount rate 0%)
- Construction (Years 3 – 29): This includes building 12 submarines (5 years build time + 1 - 2 years sea trials) with a new submarine started every 2.5 years. For each submarine, domestic material cost is estimated at $0.5bn, imported material cost estimated at $0.25bn and man-hour costs estimated at $0.375bn dropping to $0.27bn for the twelfth submarine due to experience curve effects.

[2] Pacey, Brice (2012) Sub Judice: Australia's Future Submarine, Kokoda Paper No 17. The Kokoda Foundation.
[3] Any cumulative numbers in this text only are discounted at 0.0 per cent to achieve the NPV whereas in the model an appropriate discount rate is used.

- Sustainment [light maintenance (Years 10 – 40) and heavy maintenance (Years 20 – 40)] includes:
    - Light maintenance including capability upgrade (level 1 annually, level 2 after 2 years of operations, level 3 after 5 years of operations)
    - Heavy maintenance including capability upgrade after 10 years of operation.

  In Scenario 1 there is no heavy maintenance and only low level light maintenance.
  In Scenario 2 all building takes place in Adelaide (including first in class) and all sustainment in Perth.
  In summary, light maintenance (worth $2.4 billion) is undertaken in Australia under both scenarios whereas heavy maintenance (worth $4.2 billion), including upgrading as new technology becomes available, is undertaken in Australia only if the submarines are built here, thereby creating the required technical capability to undertake the heavy maintenance.

Macro-economic impact[4]

Advanced system integrators operating in the defence sphere with their associated supplier eco-systems is one of the back-bones of all advanced manufacturing economies i.e. those economies with high economic complexity that generate high productivity growth, highly paid jobs and large export earnings. The economic benefits from advanced and complex defence systems routinely exceed the development costs of these systems because:

- The realisation of a major industrial project such as a complex defence system requires a large number of technical problems to be solved. These projects therefore become broad-based technology drivers that generate a flow of technology spillovers. The result is a situation of dual production since there are two outcomes: (1) the defence system and (2) the spillovers that surround the development project. These spillovers predominantly originate during the product development phase which means that if the procurement is military off-the-shelf there will be minimal or no economic benefits.
- There will be no new products better and more sophisticated than those demanded by sophisticated and competent customers. That means that without a competent customer who understands what is possible, knows how to put what is possible to use and are willing to pay to get what they want, these types of products will not be developed. When it comes to complex and sophisticated products such as military systems, the customer often contributes user knowledge. Advanced and demanding customers therefore raise the quality of the technological spillover flow and represent a competitive advantage for a national economy. In other words, the economic benefit realised from advanced and complex defence systems, is directly proportional to how competent and demanding the customer is.

Long-term competitive sustainability of any industry requires local presence of one or more technology-leading firms at its helm for the rest of the industry to learn from. The defence industry develops and manufactures extremely complex products, developing and using leading edge industrial technology. The defence industry today already uses many of the technologies that will be used in the broader engineering industry tomorrow. It operates as, and compares well in terms of performance with, a really good technical university, both in generating and proving new technologies and in supplying well-educated and experienced workers and engineers to industry at

[4] This section draws heavily on: Eliasson, G. (2010). Advanced public procurement as industrial policy: The Aircraft Industry as a Technical University (Vol. 34). Springer.

large. In fact, while some advanced knowledge may be taught in principle in a university environment, many critical industrial competencies, such as systems integration in which defence industries excel, can only be acquired through direct experience from production. In other words, the presence of a sophisticated defence industry accelerates the dissemination of productivity enhancing knowledge and practice to the broader industrial base. Since the engineering industry, as a subset of the more general manufacturing industry, will continue to serve as the industrial backbone and wealth generator of advanced economies, the continued role of the defence industry as a technical university for engineering industry and hence for manufacturing in general should not be underestimated. As the servitization of manufacturing continues, this role extends also to the sophisticated part of the service industry.

The benefits that can be realised from these projects through entrepreneurial activities require an economy with high complexity (i.e. a broad and deep industrial commons) to create, identify, and commercialize successful projects. This complexity, together with well-established and well-functioning institutions, enable the developed IP (and other intangible assets) to be tradeable and hence end up with agents that have the highest opportunity to create economic benefit. The level of economic benefits that can be realised from spillovers is proportional to the complexity of the eco-system that is required for that industry to function, or in other words, proportional to the economic complexity of the industry.

Spillovers become available to industry at large in proportion to the local entrepreneurial capacity to identify and realise opportunities for commercialisation. They can then be converted to economic benefits to the nation in proportion to the relative economic complexity of the economy. Property rights to intangible assets play a role both in stimulating the development of spillover-rich products and services and in commercializing spillovers. Hence social value creation is supported by policies directed at enhancing both the entrepreneurial capacity and the economic complexity of the national economy as well as the tradability of intangible assets.

For "public goods and services" such as national defence (the services of which cannot be purchased individually in the market), Government is the representative customer of its citizens. Government is also the main beneficiary of the social value created by the spillovers, so we have a case of double customer benefit. Therefore, advanced public procurement can be seen as a component of effective industrial policy. Today, and in the wake of a massive privatization of previously public production of private goods that has taken place over the last 20 years or so, defence is one of the few remaining industries where such public double benefit of considerable magnitude can be effectively achieved. Advanced public procurement is one of the most effective forms of industrial policy and can be used as a vehicle to overcome the considerable underinvestment in private R&D among industrial economies. The efficiency benefits (disregarding the spillovers) of competitive bidding rest squarely on the assumptions of the neoclassical economic model, which is based on a sharp dichotomy between supply (the producer) and demand (the customer). When the producer and the customer cooperate over a long period to improve upon the product, and arrange to share both risks and gains through an incentive contract, the standard conclusions on competitive bidding no longer hold. Mechanical competitive bidding, furthermore, tends to favour low-cost outcomes at the expense of non-contractable quality[5], and there is no readymade alternative set of rules to guide the purchasing process other than to stay away from stereotyped competitive bidding. A practical proof of this on a smaller scale can be seen in the enduring success of the US SBIR program.

[5] Hart, Olivier, Andrei Shleifer and Robert W Vishny, 2001, "The Proper Scope of Government: Theory and application to prisons" The Quarterly Journal of Economics (Nov), 1127–1161.

The social value created around advanced production is potentially very large. The spillover multiplier is defined by Gunnar Eliasson as the ratio between the estimated social value created (net of opportunity costs) and the development investment that has created them. As an example, the JAS 39 Gripen development program has generated (in the Swedish economy) over and above the opportunity costs, an additional social return to society (a spillover multiplier) in the order of magnitude of at least 2.6 times the original development investment during the period from 1982 through 2007[6]. This means that an average investment per year of 0.17% of the Swedish GNP, in the Gripen case, has generated a return to society of 0.43% of GNP annually. To judge from studies on the difference between social and private rates of return (an alternative indirect method to calculate the spillover multiplier), notably on North American data, this Swedish number appears to be on the low side. These studies would support a spillover multiplier of at least 2–4 (and sometimes even larger) for the US economy, being more entrepreneurial than the Swedish economy but with similar levels of economic complexity. While the Gripen is a unique and highly sophisticated development project, the econometric estimates are based on much broader aggregate categories with significantly smaller spillover intensity. The cautious low-end estimate is sufficient to make development programs of the JAS 39 Gripen combat aircraft type worthwhile and socially very profitable. Swedish society, in effect, paid nothing for the development of the aircraft and still received significant benefits in return. Given that the submarine development is a project of even higher complexity than military aircraft development, the return on such a project would be even higher. In the Swedish economy it is estimated it would result in a multiplier of above 3.

Meso-economic impact

Advanced complex defence systems projects have a very large industrial, economic and employment impact and none is more advanced than building a submarine (the only system more complex than a submarine is a space re-entry vehicle). This can be illustrated by some examples:

- The Collins Class through Life Support (TLS) project, signed in 2012, contributes around $150 million and 1400 jobs to Australia's economy every year. Converted it would be equal to 112,000 FTE man years over a 40 year period for 12 submarines.
- The UK Astute class nuclear submarine class construction draws on around 1200 firms, of which 400 are project specific and 150 are tier one suppliers. This equals an estimated FTE range of between 15,000 and 25,000 depending on how many of the low-end service providers you include. Converted to a non-nuclear submarine build of 12 submarines over a 40 year period this would equal approximately 2/3*12*15,000-25,000 = 120,000-200,000 FTE man years.

Assuming that the same work force does the build and the sustainment and staying with the lower numbers, the number of FTE man years is estimated to be around 115,000 which aligns with the results from the model.

[6] Allen Consulting, using a different methodology and not taking into account the technological spillover effects, estimates a multiple of between 1.53 and 2.4 for naval shipbuilding in Australia

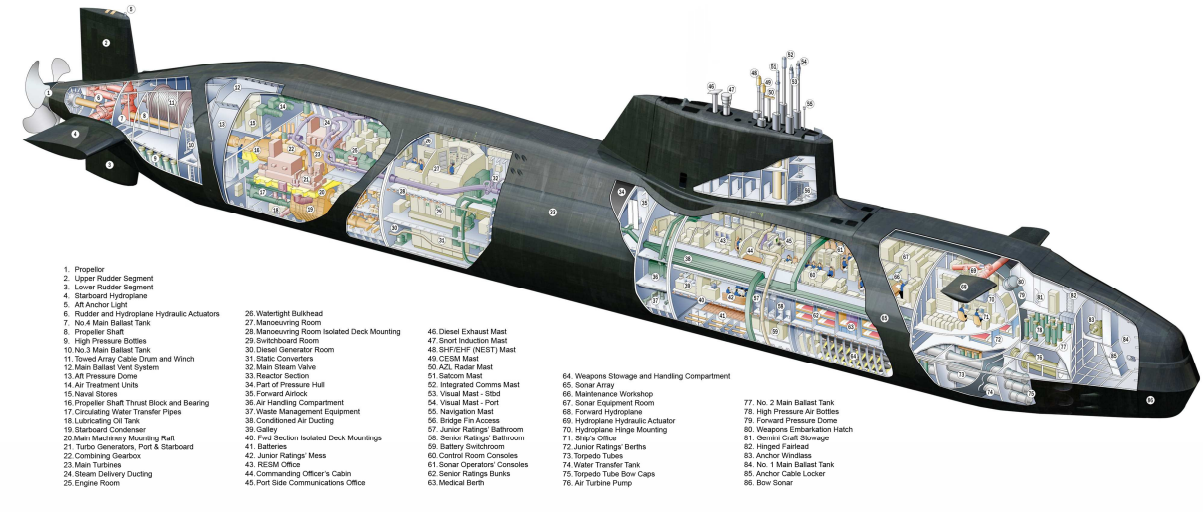

Figure 1: The UK Astute submarine class cutaway drawing (http://www.infohow.org/wp-content/uploads/2012/11/Astute-Class-Submarine.jpg)

Case Studies

The economic benefits generated by building the replacement submarines in Australia can be illustrated by two examples:

- Around nine in every ten of the Australian suppliers sub-contracted for the Navy's Minehunter and ANZAC projects were SMEs. The skills acquired during those projects have had positive, long-term impacts on their ability to enter new industrial domains and offer technologically advanced, innovative goods and services to other industries.
- Secondly, the Australian company Bisalloy Steel supplied the Collins program and Australia's Bushmaster armoured vehicle program with a steel product that was superior to anything available at the time. This world-leading product was developed through collaboration between the firm, the customer and the Defence Science and Technology Organisation. Bisalloy's steel is now used in the US, India, the Middle East and Asia and export sales have grown significantly.