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Should Australia build warships? An economic and strategic analysis

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Executive summary

Australia plans to acquire a wide range of naval vessels in the decades ahead at a total cost in the tens of billions of dollars. Taxpayers can rightly demand that those acquisitions are undertaken in a way that ensures value for money. Meeting that demand requires careful attention to the balance between domestic production and the import of naval vessels.

Since the late 1980s, the trend has been to rely on domestic production for a historically high share of the naval program. This has entailed substantial cost penalties that are reflected in the very high rates of assistance provided to Australian naval shipbuilding. Additionally, there have been substantial schedule slippages, imposing costs both in the form of the delayed introduction of capabilities and of increased sustainment outlays on existing platforms. The overall result has been to distort the allocation of resources, not only in the economy as a whole but also in defence itself, as the high cost of the program reduces the ability to fund the capabilities needed for the defence of Australia. Moreover, analysis suggests the cost penalties associated with Australian production are unlikely to diminish in future.

The goal of defence self-reliance does not provide a sensible justification for bearing these excess costs. Complete self-reliance

is not possible in any case. Policy setting is therefore a matter of degree in which the appropriate extent of self-reliance needs to be determined by balancing costs and benefits. As a result, the penalties associated with domestic shipbuilding should only be accepted if they are offset by commensurate benefits.

While such benefits have often been claimed, closer examination reveals them to be slight or non-existent. In particular, domestic production of naval vessels: does not ensure, or reduce the cost of ensuring, the supply of vessels that meet Australia's strategic requirements; is not necessary to ensure, or to reduce the cost of ensuring, the sustainment of the fleet in peace or in war; and does not materially enhance Australia's sovereignty. Nor is it the case that domestic production should be considered an inherently advantageous way of providing jobs, boosting incomes and hence tax revenues; in fact, the effect is the opposite. Nor is it an efficient way to secure technological and workforce training benefits more broadly.

It is therefore crucial that future decisions about sourcing Australia's naval assets are based on rigorous and transparent cost-benefit appraisal, with special scrutiny applied to decisions that involve customised or Australian-unique platforms. Moreover, that appraisal must be based on realistic

evaluations of life-cycle costs, rather than the underestimates of future costs that have been a recurring feature of Australian defence planning.

Given that the excess costs, calculated over the entirety of the future fleet program, could amount to many billions of dollars, the loss to Australian society from protecting domestic military shipbuilding could be extremely high. There is also the loss, more difficult to quantify but no less real, should the high cost of building ships in this country force us to settle for a smaller fleet or impose unwarranted opportunity costs on other parts of the defence portfolio, thus reducing Australia's net defence capability. Unless credible offsetting benefits can be identified, and they have not been to date, the case for continuing the current preference for domestic production is very weak indeed.

Introduction

On current plans, the RAN will acquire twelve conventional submarines, eight frigates and twenty multi-role offshore patrol vessels over the next twenty years.¹ In each case, the vessels will be substantially larger and more sophisticated than those they replace, and in the case of the submarines more numerous by a factor of two. Apart from the submarines—which the government has promised to assemble in South Australia—it is yet to be decided where these new vessels will be built.

There is a lot at stake: not only is every class of combatant in the RAN being replaced, but we estimate that the total program will cost at least \$40 billion.² One would hope that great care will be taken when comparing the costs, risks and capabilities of competing options—including those between local and overseas construction. Regrettably, despite a succession of reports recommending rigorous cost-benefit appraisal of major

defence acquisitions, this cannot be taken for granted. The decisions for local construction of both the new submarines³ and the under-construction Air Warfare Destroyers (AWD)⁴ occurred very early in their development as projects—arguably long before sufficient information was available for an informed decision. In contrast, the government retained domestic and foreign options for the Landing Helicopter Dock (LHD) acquisition up to the point of contract award.

Preemptive decisions about domestic versus foreign sourcing are hard to reconcile with the government's stated policy of properly comparing the options for major defence acquisitions under the two-pass process. We can only conclude that in the case of the submarines and AWD, the government of the day had great confidence in the relative merits of domestic construction. No doubt, that confidence was encouraged by the lobbying efforts of those with a vested interest, including local defence industry, state governments and unions. The purpose of this paper is to test that confidence by comparing the costs and benefits to Australia of domestic naval construction *vis-à-vis* imports. Our focus will be on the acquisition of major platforms, as that is where the greatest costs are incurred and where domestic supply options are most limited. Oceanographic survey vessels are also not covered because of their essentially civil function.

Sourcing Australia's defence assets: historical perspectives

In considering the role and future of Australian naval shipbuilding, it is useful to start by examining the broad trends in the sourcing of Australia's principal defence systems.

For much of the 20th century, Australia manufactured, or at least assembled, a significant share of its defence equipment

needs—on occasion even going so far as to develop and design its own weapons systems. Over time, however, the trend has been to rely more on foreign sources for major platforms and their component sensors and weapons. The last tank to be built in Australia was the locally designed Sentinel in WWII. The last artillery pieces built here were the British-designed 105mm Hamel guns in the late 1980s, and the last mortar tube was the British-designed 81mm F2 in the 1960s. The tanks and artillery have since been replaced by imported equipment, and it is likely the same will occur for the mortars. The situation is similar for fixed wing aircraft. The last Australian designed and built combat aircraft was the Avon Sabre which ended production in 1961, and the last Australian designed military transport aircraft built was the Nomad in 1985. And while the F/A-18 fleet was assembled in Australia from imported components in the late 1980s, its replacements (the F/A-18E Superhornet and F-35 Joint Strike Fighter) have been or are being built overseas. Only helicopters continue to be assembled in Australia today, albeit almost entirely from imported components.⁵

Australia's shift to foreign sources for its defence materiel is consistent with international trends. As the unit cost of weapons systems has grown over time—significantly outpacing inflation—countries have purchased fewer assets and have then retained them longer. The number of weapons produced has therefore fallen steadily, eroding economies of scale and boosting the share of costs due to first costs, that is the costs of design, development and initial production. One consequence is to increase cost risk: first costs are notoriously difficult to predict for highly complex systems; as these costs come to dominate total costs, total costs themselves become more uncertain; and even small changes

in the size of production runs (as numbers commissioned are adjusted in the light of budget constraints, macroeconomic circumstances and program out-turns) can lead to large shifts in unit costs per commissioned item.

Combined, the decline in the number of assets purchased, the rising share of fixed costs in total costs and growing cost uncertainty have led to widespread industry consolidation and an increasing number of multinational programs. In light of these trends, it simply has not made sense for Australia to go it alone and manufacture, let alone develop, its own systems. Where it has tried, as with the Collins submarines, ALR-2001 radar warning receiver, Seasprite helicopter, HF modernisation project and AEW&C aircraft, the efforts have been plagued by delays, substantial cost overruns and even cancellations.

However, naval shipbuilding has not followed the general trend of increasing overseas sourcing. As Figure 1 shows, following a surge in domestic construction during and immediately after WWII, domestic construction abated to the point where key combatants—destroyers, frigates and submarines—were imported from overseas between the mid-1960s and 1985. Then, following the sale of the government's long-troubled shipyards to the private sector, a series of major naval combatant projects commenced in-country. As a result, Australia now relies less on overseas shipyards than at any time since Federation. However, the shift to domestic construction has delivered very mixed results, as shown in Table 1. With the exception of the LHD, which is still at its early stages, every project apart from the Anzac frigates has suffered adverse variances from initial commitments, notably in the form of material schedule slippages and in some instances, of serious increases in costs. Whatever the shortcomings of the old government-owned yards might have been,

Figure 3: Construction of other RAN vessels 1905 to 2020

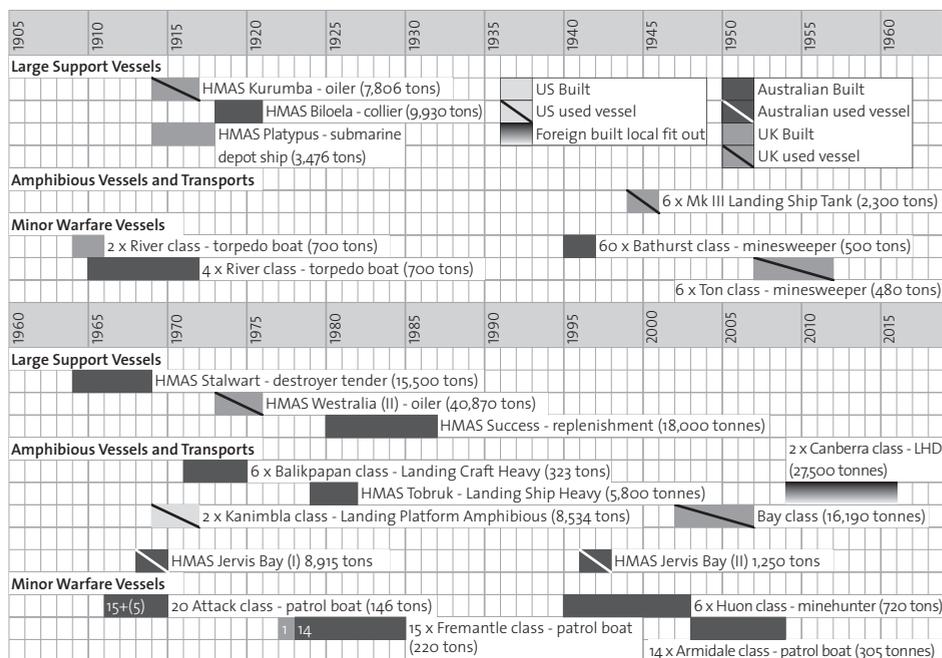


Table 1: Key major post-privatisation Australian naval shipbuilding projects

Project	Prime contractor	Scope	Outcome
Anzac class frigates	Tenix [now BAe Systems]	8 (+2 NZ) frigates based on the MEKO 200 PN design.	All vessels delivered to specification, within budget and largely on schedule. Ships now in service.
Collins class submarines	ASC Limited	6 submarines designed by Swedish firm Kockums.	Project delayed by 62 months. Vessels required around \$1b of remedial work. Fleet remains plagued by mechanical problems and poor availability and costs are likely to rise further.
Huon class minehunters	ADI [now Thales Australia]	6 minehunters based on the Italian Lerici class.	Delivered within budget but with a 40 month delay. Ships now in service.
FFG upgrade	ADI [now Thales Australia]	Comprehensive replacement of sensors, weapons and combat system.	The project suffered a 60 month delay and scope was reduced from 6 to 4 ships (= 50 per cent unit cost increase). Ships now in service.
Anzac class upgrades	Anzac Ship Alliance [SAAB, BAe Systems and Defence] and CEA technologies	Surface and subsurface warfare enhancements including anti-missile defence.	Initial plans were much delayed and suffered cost increases, but the latest revision is largely proceeding on track.
Air Warfare Destroyer	AWD Alliance [ASC, Raytheon and Defence]	3 Aegis equipped AWD based on the Spanish F-100 design.	Costs doubled during planning. 12 month delay so far due to problems with module fabrication.
Amphibious Assault Ships	BAe Systems	2 vessels being built in Spain by Navantia, fit-out will occur in Australia.	On schedule and within budget.

the shift to private ownership has therefore not been a complete remedy.

It is against this background that the question must be considered of where the further, very substantial, planned acquisitions should be sourced.

Some economics of local sourcing

To properly discuss that question, it is first necessary to understand what local naval construction does, and does not, entail in practice. At a minimum, local construction involves the fabrication of the hull and superstructure of vessels.⁶ At the same time, however, almost every significant weapon, sensor and combat system put into vessels is imported from either Europe or the United States. The same is true for most of the major mechanical components such as diesel engines, transformers and generators. A few notable exceptions, such as the Australian-manufactured CEAFA radar presently being integrated onto the Anzac frigates and the locally manufactured batteries on the Collins submarines, do nothing to alter the fact that every major platform in the RAN is very highly reliant on overseas suppliers—especially for the high-tech components that define modern combat capability. Locally built vessels from the 1990s nevertheless contain a significant number of Australian-manufactured secondary components. However, following the government's adoption of a less protectionist defence industry policy in 2007, it is likely that secondary local content will decline from the levels achieved in the 1980s and 1990s when Australian-content targets were imposed.

Of course, a naval vessel is more than the sum of its component parts; there are also the critical aspects of design and integration. Here the picture is mixed. The last major Australian-designed vessel built for the RAN was HMAS

Stalwart in 1965.⁷ Since then, only minor assets such as patrol boats, oceanographic vessels and landing craft have been designed locally, with all new major vessels built to either foreign designs or adaptations of foreign designs. With only the possible exception of the Collins replacement, this is likely to remain the case. But while Australia now eschews the challenge of *ab initio* design, a great deal of effort has been put into the integration of mechanical and electronic subsystems—both during construction and in subsequent platform upgrades. Yet, even here, there is still a significant reliance on overseas expertise. All of the large Australian-based 'systems integrators' are subsidiaries of either US (Raytheon, Lockheed Martin, Boeing) or European (BAe, Thales, Saab) firms that can and do utilise their parent company's IP and expertise. In fact, the only large Australia-owned defence equipment company in operation today is the government-owned ASC Limited. Table 2 summarises the reliance of Australia-built vessels on overseas suppliers.

In short, what is really at issue is mainly local fabrication of vessels, the production of a range of Australian-manufactured secondary components, and some systems integration that while it can occur within Australia, has a substantial reliance on the IP and expertise of non-Australian corporations. It is not controversial that under Australia's current approach to naval shipbuilding, taxpayers pay a significant premium for local construction relative to the alternative of buying from existing foreign production runs. As a recent report⁸ from the South Australian government's defence lobbying agency, *DefenceSA*, put it 'Australia's demand for warships is low in number and this quite fairly attracts a premium in cost to build them in Australia'. The same conclusion was reached by the 2002 joint industry-Defence Naval Shipbuilding and Repair Sector Plan.⁹

Box 1 provides a case study of the cost penalty associated with local construction based on the Air Warfare Destroyer project.

Why is there a cost penalty?

That Australian naval shipbuilding would incur a cost penalty is unsurprising, for reasons that are well known from the economic theory of international trade. According to that theory, patterns of international trade are, to a large extent, dependant on the opportunity costs of production. All else being equal, an economy that has a lower opportunity cost of production (compared to other countries) for a particular tradeable commodity will export that commodity, or at least should do so to make efficient use of resources. Similarly, countries will (or at least should) import commodities for which they have relatively high domestic opportunity costs. A country is said to have a comparative advantage in the production of a particular commodity, relative to some other country, if it has a lower opportunity cost of production, i.e. if supplying it entails a relatively smaller sacrifice of other production.

Now, those opportunity costs are, in the first instance, shaped by factor endowments, that is, by international differences in the availability of labour, capital and natural resources. Compared to other high-income economies, Australia has a very significant endowment of natural resources, including

minerals and abundant agricultural land, relative to its endowments of other factors of production. As a result, our opportunity cost of supply of primary commodities is low: compared to other countries, we can expand their supply with relatively little sacrifice of factor inputs. Conversely, the opportunity cost of using scarce capital and labour to produce goods such as naval vessels is the reduction this causes in the availability of those inputs for the production of primary commodities and of non-tradeable goods such as housing. With that opportunity cost being high, the exchange rate and domestic input and output prices will, if left to their own devices, adjust so as to make it unattractive to produce goods such as vessels locally, while making it attractive to produce goods more closely related to our natural resource endowments¹⁰ and use the resulting export proceeds to import vessels and other manufactured goods.

It is important to understand that this outcome would emerge even if naval construction, considered in isolation, had higher levels of productivity in Australia than overseas, so long as we were relatively even more efficient in producing goods based on natural resources. To that extent, and given just how pronounced our comparative advantage in resource-based activities is, for Australian naval shipbuilding to be competitive it would need to have

Table 2: Australian reliance on foreign naval systems

Component	Source in Australia-build major vessels
Vessel Design	Foreign and adapted from foreign
Precision Munitions and Launchers	Foreign
Naval Guns	Foreign
Combat Systems	Foreign and adapted from foreign
Communications	Foreign and local
Radar and IR Sensors	Foreign*
Sonar	Foreign and local
Hull and Superstructure	Local

*Apart from CEAFAAR targeting radar

Box 1: A case study of the local build cost penalty—Australia’s Air Warfare Destroyers

Australia’s current Air Warfare Destroyer project provides an illustrative example of the cost penalty associated with local sourcing. While there are no precise public figures of the progressive cost per hull across the three ship build, there is enough information in the public domain to make a rough estimate. From various public sources we know the total cost of the project (\$8.1 billion), the marginal cost of a fourth ship (\$1.5 billion) and the cost of the Aegis combat system (\$400 million each), which is the most costly of the imported components. The only other piece of information needed is the ‘learning rate’—for the purpose of this discussion, we assume 85 per cent, a median value of the estimates cited above. Taking a higher or lower figure would change the precise figures but not the general conclusion.

The Table below shows the resulting costs by vessel. The fixed component represents non-production/non-recurring engineering costs, or what might loosely be called fixed overheads. Given that a fourth ship produced on the same learning curve would cost an estimated \$1.47 billion, the estimated project overheads are commensurate with the cost of another ship. This does not include substantial additional spending by the Commonwealth and South Australian governments on infrastructure and training in support of naval shipbuilding in South Australia. State government spending on maritime infrastructure has exceeded \$300 million.

The cost of the SEA 4000 program

Of course, these figures are at best only indicative. We cannot be sure of how much of the production costs are subject to learning curve effects and how much are due to imported components which are not. An independent analysis by DefenceSA estimated that the fixed component of costs was even higher at \$2.5 billion. Of course, not all of this could be avoided by purchasing from overseas; significant fixed costs are unavoidable even in a foreign purchase—though not on the same scale as arises for domestic construction.

Whatever the precise figures might be, it is clear that a substantial premium has been paid for building the vessels in Australia. If we had purchased three vessels from an established foreign production line at the marginal cost of the fourth vessel in our local program (\$1.5 billion), the premium would amount to \$3.6 billion. While this might appear implausible, the current unit production cost of the 50 per cent larger US DDG 51 Destroyer (equipped with the same combat system and similar weapons suite as our vessels) is only US\$2.2 billion. On this basis, we have paid a premium of \$1.5 billion for three substantially smaller vessels. Moreover, it is worth stressing that these are estimated costs for the AWD, with a substantial risk that out-turn costs will prove to be significantly higher.

The cost of the SEA 4000 program

	Fixed	Ship 1	Ship 2	Ship 3	Aegis	Total
Cost	\$1.43b	\$2.04b	\$1.74b	\$1.57b	\$1.2b	\$8.1b

productivity levels that were very high by international standards.

In practice, however, our productivity levels in naval shipbuilding are unlikely to meet that test. After all, Australian shipbuilding has been a stop-start affair, with production

of small numbers of disparate types being the rule rather than the exception. But naval shipbuilding is an activity in which there are substantial economies of scale, so small production runs incur significant cost penalties.

The sources of those scale economies are readily explained. Economists distinguish between ‘internal’ and ‘external’ scale economies: internal economies are those that arise within the firm, say at the individual shipyard, as its output expands; external economies are those that arise within the industry, which can be broadly defined to include the various producers and their suppliers and distributors.

As far as the internal economies are concerned, it is conceptually useful to divide the cost of manufacturing items—be they ships, submarines or saucerpans—into two parts: the fixed cost of developing the wherewithal to manufacture the items, and the marginal cost of producing each successive item. In the case of warships, the former includes the cost of production infrastructure, research and development, design, workforce training and project planning; while the latter includes the cost of materials, labour and capital necessary to produce each vessel.

As noted above, the fixed cost of developing modern weapons systems is often substantial compared to the marginal unit cost of production. Some recent examples from the United States are illustrative. Table 3 lists expenditure to date on research and development (a subset of fixed costs) and the average unit production cost for a range of US naval projects. For small production runs, fixed costs can add substantially to or even dominate total cost.

Additionally and separately, in the manufacture of complex items such as warships, the marginal cost of production of each unit tends to decline as experience is gained and the production methodology matures. In other words, even quite independently of the ability to spread fixed costs, average costs will fall as cumulative

production rises, a phenomenon commonly described as an experience or learning curve.

The learning rate is a function of many variables, and will depend on how well efficiencies are harvested as the project proceeds. In that respect, it is an empirical measure that can only be reliably calculated in retrospect. However, global experience across a large number of vessel classes allows the range of plausible values to be identified. This is often described by a percentage figure and for shipbuilding programs estimates of the learning parameter range between 80 per cent and 90 per cent.

Figure 4 shows some illustrative learning curves for that range of values. Note that the steepest learning curve actually gives the best outcome—contrary to popular use of the term.

The overall learning curve is the sum of curves for each component of the total cost—for example, for materials, labour and management overheads. Over the long run, the total learning effect will be limited by whichever of those components decreases most slowly. Eventually there are no additional productivity gains to be had and a plateau results. However, for many complex weapons systems, production runs are too short to entirely exhaust learning effects, so cost reductions persist over the entire range of output.

In summary, there are two main forms of internal scale economies: the static economies that arise from the ability to spread fixed costs over an increased number of units; and the dynamic economies that occur as experience reduces marginal costs. Both of these are significant in naval shipbuilding.

But there are also external scale economies in shipbuilding. These occur as an increase in the scale of the activity allows reductions

Table 3: Cost of recent and planned US naval construction projects (US\$)

Program	R&D expenditure	Average unit production cost
DDG 1000 Destroyer	7.0 billion	3.3 billion
CVN 21 Aircraft Carrier	4.6 billion	10 billion
Virginia Submarine	7.0 billion	2.5 billion
Littoral Combat Ship	2.1 billion	648 million

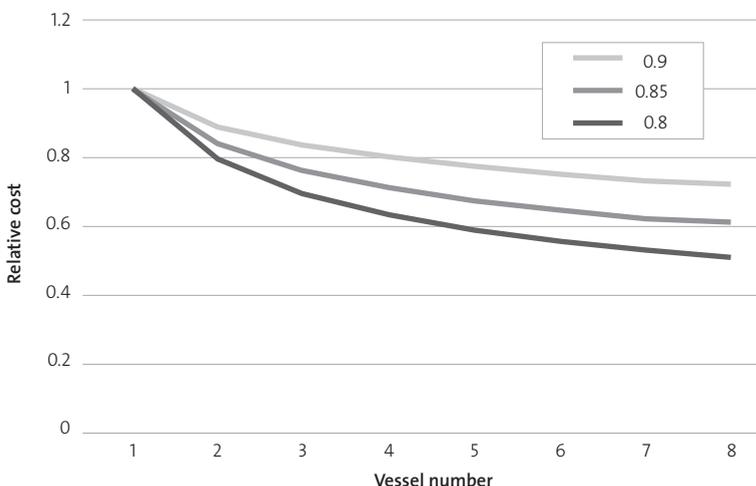
Source: Various US GAO, CRS and CBO reports

in production costs by encouraging the development of a trained labour force, by increasing the scale and cumulative experience of component producers and other specialised input suppliers, and by facilitating the growth of expert sources of technical, commercial and financial oversight and support. These economies can be thought of as shifting down the activity's entire cost curve, and are a spillover (or in the jargon of economics, an externality) the industry as a whole reaps from each individual firm's expansion.¹¹

Combined, these internal and external economies create an additional source of international specialisation, above and beyond that arising from differential factor endowments. Specifically, if the production of a good is subject to material scale economies, international trade can economise

on both fixed and variable costs, so long as transport costs are not too great.¹² Moreover, production will tend to gravitate to those places where demand is greatest, as that can minimise transport costs (again, assuming those are not so high as to make trade unattractive) while allowing the internal and external scale economies to be reaped. There will, in other words, be what economists refer to as a "home market effect", in which the size of domestic demand shapes international relative prices and the pattern of international trade.¹³ Of course, the transport costs will be immaterial in the case of naval vessels, leaving the home market effect to manifest in full. This home market effect is likely to be even more pronounced if close interaction with (and hence proximity to) large and technically sophisticated customers is an important source of learning and competitiveness—as

Figure 4: Indicative learning curves for shipbuilding programs; cost relative to first hull for learning percentages 80, 85 and 90%



exists between the large US and European suppliers and their parent navy customers.

The extent and impact of assistance

Given these factor endowment, scale and home market effects, Australian production of naval vessels will generally only be commercially viable if it is protected. The extent of the protection that has been afforded to production is difficult to estimate, as cost and price data is rarely public. However, an indication of just how great that protection is can be gained from information that was released with the publication of the Pappas review of defence efficiency¹⁴. That information relates to the AWD and LHD projects.

The first relevant indicator, and the one on which attention usually focuses, is the price premium, which can be defined as the percentage difference between the present values of the expected costs of domestic acquisition on the one hand and the similarly defined expected cost of a comparable Military Off The Shelf (MOTS) option on the other. Broadly, the price premium corresponds to the Nominal Rate of Assistance (NRA) to a good, which is the percentage difference between its domestic and international price arising from the policies in question.¹⁵ That price premium exceeds 10 per cent for both projects.

However, the price premium is a significant underestimate of the level of protection local shipbuilding has received in these projects. Rather, that protection needs to be measured by comparing the assistance provided to the activity to its unassisted value added in Australia. This measure is termed the Effective Rate of Assistance (ERA) and is the standard indicator used by the Productivity Commission to quantify and compare assistance across Australian industries – see Box 1.

The effective rate of assistance afforded any activity is simply the percentage increase in value added, or manufacturing cost margins, for domestic producers resulting from the structure of nominal protection on its outputs and inputs. This takes account of assistance to an industry as well as imposes the industry faces due, for example, to tariffs on the inputs it uses. Unlike the price premium, the ERA identifies the impact of the assistance in distorting the allocation of resources, as it measures the maximum increase in the activity's domestic resource cost per dollar of net import substitution. For the AWD, the estimated ERA is 33 per cent; for the LHD, it is over 70 per cent.

It is worth emphasising just how high these rates of assistance are. The Productivity Commission estimates ERAs for each Australian industry. The estimates reflect the combined level of tariff and budgetary assistance to an industry, less the additional costs imposed on that industry as a result of tariff assistance to the industries supplying it with inputs. For 2009–2010, the average ERA for manufacturing industry was estimated at 4.4 per cent, for mining 0.2 per cent and for primary production 4.7 per cent.¹⁶ That said, there is considerable dispersion in ERAs within these broadly defined sectors; but a closer disaggregation shows that the rates of assistance provided to the AWD and LHD projects are nearly three to six times greater than those for the most heavily protected manufacturing industry (textiles, clothing and footwear), whose ERA is just below 13 per cent. In other words, no other activity is as heavily assisted as these projects have been.

These comparisons are significant not merely in highlighting the magnitude of the assistance provided to these projects but also because the distorting effect of protection increases with its dispersion—that is, with the difference between industries in rates of assistance. The industries that have received

high rates of effective assistance are induced to supply goods domestically even when their domestic costs are higher than their opportunity costs through trade. At the same time, the producers of goods with relatively low levels of effective assistance are induced to refrain from producing goods domestically

even when this could be done at a lower cost than in international markets. The result is economic waste.

Unfortunately, these estimates understate the actual degree of assistance. This is because they are based on expected costs

Box 2: Productivity Commission approach to assistance measurement

The main assistance measures that the Commission has focussed on are:

- Commonwealth budgetary assistance;
- tariff assistance;
- agricultural pricing and regulatory assistance.

Many other forms of assistance, including government purchasing preferences, are not included in the current assessments.

Two key assistance measures which the Commission reports are the nominal rate of assistance on outputs and the effective rate of assistance:

The **nominal rate of assistance (NRA)** on output measures the extent to which an industry's value of output is increased by assistance. It is calculated as the value of output assistance to that industry divided by the industry's unassisted value of output, expressed as a percentage;

The **effective rate of assistance (ERA)** is a measure of net assistance. It measures the extent to which the value added of an industry is changed by the net assistance it receives. Value added is the return to the factors of production in that industry—the returns to labour, land and capital. The net assistance concept recognises that an industry may benefit from assistance on the outputs it produces and direct assistance to businesses (such as taxation concessions for R&D) but it may also be disadvantaged by having to pay higher prices because of assistance afforded other industries, for example tariffs applying to imported items. The ERA is calculated as the net

value of assistance divided by the industry's unassisted value added, expressed as a percentage. The formula for measuring the ERA is as follows

$$ERA = \frac{UV_{output}NRA_{output} - UV_{input}NRA_{input}}{UV_{output} - UV_{input}}$$

where

UV_{output} = unassisted value of output (\$)

UV_{input} = unassisted value of material inputs (\$)

NRA_{output} = nominal rate of assistance on output (per cent)

NRA_{input} = nominal rate of assistance on material inputs (per cent)

From the formula, some important properties of the ERA can be identified:

1. the effective rate of protection will be greater the larger the nominal rate of protection on an activity's output, the smaller the nominal protection on its inputs and the smaller the activity's value-added, measured at world prices;
2. if the nominal rate of protection is the same on all of an activity's inputs and its output, the effective rate of protection will be identical to this common rate of nominal protection; and
3. if the nominal protection on an activity's output is larger (smaller) than on its inputs, the effective rate of protection will be greater (less) than the nominal protection on the activity's output (inputs).

for the AWD and LHD at the time of contract close, compared to estimated MOTS costs. Domestic production, however, is associated not merely with higher expected costs (where 'expected' is used in the sense of mathematical expectation), but also with costs that are more uncertain than those of MOTS comparators. This greater uncertainty arises from the inherent difficulty of estimating the cost of Australianised variants of foreign designs. The result is forecast error that imposes a degree of risk on taxpayers, for which they should be compensated. Domestic acquisition is, in other words, a relatively high risk option; however, the estimates above take no account of that greater risk (as they merely reflect dollar outlays as expected at the time of decision), and so understate the effective cost to taxpayers of domestic sourcing.

Now, it is true that in recent years, most of the variance between program expectations and outcomes has not involved increases in 'headline' project costs to the Commonwealth (though those have occurred, for instance, for Collins) but delays in delivery schedules. In itself, this raises a number of interesting questions that cannot be explored in this paper,¹⁷ but what is germane here is that even if the nominal bill paid by taxpayers remains constant, these delays are costly, though those costs are not quantified by the ANAO when it reviews major defence projects.

The costs take two forms. First, a system delayed is a system whose benefits, in present value terms, are reduced compared to initial expectations, with the quantum of the fall in benefits reflecting the extent of the delay, the resulting detriments to capability and the discount rate. Second, when new platforms are delayed, existing platforms need to be operated for longer. As the Rizzo review emphasises, sustainment costs increase, often rapidly, with the age of platforms. As a result, the costs of schedule slippage should be, but

are not, calculated on a basis that includes the added outlays on existing platforms.

As local production materially increases the risk of these added costs being incurred, estimates of assistance that take no account of that risk understate the price premium being paid and the effective protection being provided. It follows that although the estimated levels of assistance are very high, they will also understate the assistance's economic costs.

Those economic costs take several major forms. The first and most obvious is that as the price at which we acquire vessels rises, consumers—in this case, the community as a whole, as it finances and consumes defence services—face increased outlays and reduce their consumption to a degree that depends on the elasticity of demand (the proportionate change in quantity consumed consequent on a proportionate change in price). To illustrate this process, Figure 5 plots a ship affordability index (based on real unit cost escalation) for US Navy acquisitions of DDGs against the number of surface combatants in the US Navy for the period 1960-2010; broadly, these trends imply a price elasticity of demand of approximately -1, in which each 1 per cent increase in unit acquisition costs gives rise to a long-term fall of 1 per cent in the number of vessels purchased.

This implies that as domestic sourcing increases price above opportunity cost (which is the price at which a comparable vessel could be procured from overseas), consumers—again, the community generally—will forgo some consumption that they would have valued at more than that opportunity cost.¹⁸ The supply of defence services will, in other words, fall below the levels the community would have chosen had acquisition prices reflected world costs, with the result that the total benefit the community derives from defence will be below efficient levels. For

example, four air warfare destroyers instead of three.

Second, if the price increase is not fully offset by a reduction in demand, spending on defence will rise, and as that spending is financed by taxes, taxes must be higher than they would otherwise need to be. Since taxes distort economic behaviour, and the extent of the distortion increases more than proportionately with the tax rate, the result is to reduce Australia's wellbeing.

Third and last, as resources are diverted to naval shipbuilding from activities that are less protected, the efficiency with which we use our factor endowments is reduced, and national income with it.

Could the cost handicap be overcome?

It is sometimes argued that adopting a long-term program of continuous naval construction in Australia could overcome any productivity and cost gap between Australian and foreign shipbuilding. Were that so, future domestic construction could be secured with less need for assistance, so that the costs and

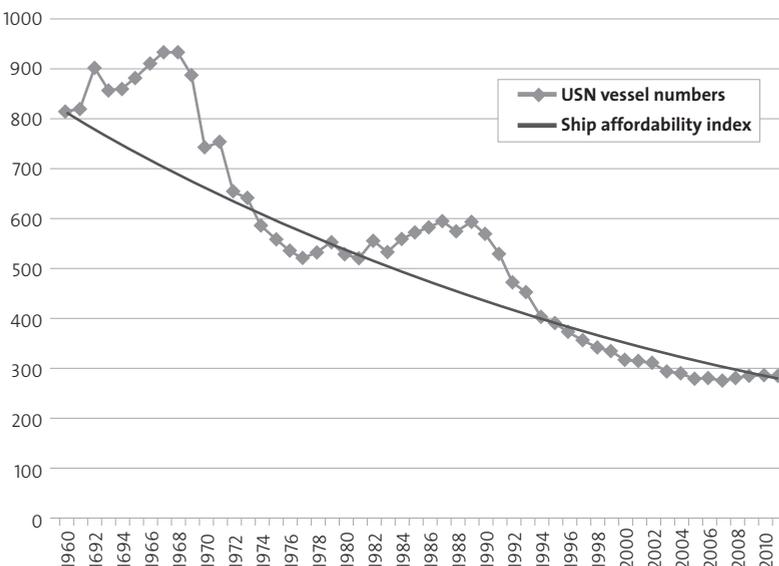
distortions that assistance brings could be materially reduced or even avoided.

Given how large the cost gap is, and its roots in factor endowment, scale and home market effects, the proposition must be doubtful. But at least in principle, the benefits from such a long-term program of naval construction could include:

- reduced overheads and elimination of the periodic fixed start-up costs inherent in the current boom and bust approach;
- learning curves commencing from a lower point (and perhaps being steeper than otherwise) by having an established workforce transition smoothly from program to program;
- better handling of technical and production risk through the long-term accumulation of experience in a single corporate entity; and
- increased opportunities for commonality in spares and support leading to reduced operating costs.

Given these potential benefits, a continuous build program obviously warrants consideration. The first question is whether

Figure 5: Affordability and fleet size



Australia's demand for vessels is adequate to support a continuous program.

Looking back at Figure 1, and forward to the future program, there is more than enough work to keep a single shipyard busy—but through a program of rather disparate vessel types. At this point, it is useful to separate the option of continuous local production into two components: first, aggregating the production of disparate vessel classes together under a single shipbuilder; and second, adopting a rolling production program either for a single class of vessel or between similar classes of vessel. In practice, either or both of these options could be pursued. The 2002 Naval Shipbuilding and Repair (NSR) Sector Plan considered both options focusing on the former. The 2010 DefenceSA report focused on the latter.

Aggregating disparate vessel classes under a single shipbuilder

All other things being equal, overheads can be reduced and equipment commonality can be improved by having a single shipyard undertake continuous or overlapping programs involving disparate vessel types. Further benefits from learning curve transfer between programs and workforce continuity can also be expected—although these will diminish as the difference between the classes of vessel widens. Moreover, the incorporation of common equipment types across disparate vessel classes presupposes a level of redesign that will bring additional cost and risk (or worse still if it presupposes even more costly and risky *ab initio* design). It is sometimes also argued that a larger and more certain workload will increase the willingness of the shipyard to invest in technology, training and infrastructure. Of course, since these costs are going to ultimately be borne by the Commonwealth, the benefit is limited to the productivity gain which they deliver.

Whatever the net advantage of these factors might be, there is a critical problem intrinsic to aggregating work under a single shipbuilder: it amounts to awarding a monopoly to a single public or private entity.

Monopoly shipbuilders have historically been less than hotbeds of productivity and timely output. Indeed, past experience with the old government-owned shipyards, and current experience with submarine maintenance under ASC⁹, demonstrates the corrosive consequences of guaranteed workflow. And while the inherent risks of monopoly supply can be mitigated somewhat through the competitive subcontracting of module construction, this comes at the cost of reducing economies of scale and duplicating fixed production overheads—the very things the approach is intended to reduce.

Could innovative contracting and incentives be used to mitigate such risks? We would want to be very sure of this before committing to a monopoly build program. After all, once the monopoly was established, it would be difficult to subject the single supplier to continuing contestability from foreign yards. Having committed to a single supplier, the option of simply transferring production overseas, should the single yard prove costlier than foreign options, would not be there: or if it was there, the risk of that happening would undermine the predictability of load (and associated confidence to invest) that is assumed to generate the savings the single sourcing promises. In other words, there is an inherent and unavoidable tension between on the one hand, wanting the gains that might come from delivering to a yard an assured load, and on the other, threatening to remove that load should foreign bids prove more competitive: both these commitments cannot be credible at the same time.

To make matters worse, once such a commitment to single sourcing had been made, it would create a political economy that tended to lock it in, not least as specialised investments, with low scrap value outside of that engagement, were made both by suppliers and the work force. Management, unions and local politicians would have every incentive to invest in making it politically costly for the single sourcing decision to be reversed or for exceptions to be made. As any reversal of the policy would impose large, concentrated, losses for the sake of small gains dispersed across the entire taxpayer base, inefficient supply could persist for many years before the political system was willing to bear the costs of removing it. Indeed, that pattern of persistence of inefficiency characterises many areas of Australian defence production, including uniforms and munitions.

It is therefore hardly surprising that the government rejected the recommendation of the 2002 NSR Sector Plan to establish a monopoly shipbuilding entity.

Rolling production

Some of the benefits available through foreign construction might be captured through the rolling production of a single class of vessel or similar classes of vessel in Australia, as this would reduce duplication of fixed costs and allow the accumulation of learning effects. The archetype for this approach is the ongoing Japanese submarine rolling program which involves the continuous construction and evolutionary development of submarines.

Looking to the government's current plans, two obvious candidates come to mind: the 20 vessel offshore patrol vessels and the 12 vessel new submarine programs. The DefenceSA report observes that ongoing build programs would be possible with a patrol

vessel life-of-type of 20 years and a submarine life-of-type of 25 years, corresponding to a 1 year and 2 year production interval respectively. But there is little point in adopting a rolling production program if it requires slowing construction below an efficient rate of labour utilisation, nor (given the high cost of individual vessels) could it make much sense to retire vessels early to create work for the shipyard.

In the case of the offshore patrol combatants, such an approach is difficult to reconcile with recent experience. Although the Anzac class frigates were produced at an average rate of one per year, they are much larger and more sophisticated than the proposed patrol combatants—so an efficient production run for the patrol combatants would surely involve shorter time intervals. As a comparison, the Armidale class patrol vessels, which are admittedly much smaller than the proposed patrol combatants, were produced at a rate of around five per year. The proposed scheme for the submarines is even less plausible. The original delivery schedule for the Collins envisaged vessels being delivered at a rate of about one per year—though delays saw the schedule grow substantially. The Japanese program (which involves 19 operational submarines including training vessels) also produces submarines at twice the rate proposed for an Australian rolling program.

Any proposal for a rolling build program for submarines or offshore combatants would need to take account of this much slower than usual utilisation of labour. Because of fixed management and engineering overheads, it is simply not possible to contain costs by halving the workforce and doubling the production interval. And because of the small numbers involved, a rolling production of large surface combatants (frigates and destroyers) is even more problematic for the same reason. Moreover, given the life-of-type left in the

Anzac class, a move into a rolling program as a continuation of the Air Warfare Destroyer construction is hard to envisage unless vessels are retired well before their useful economic life. This would entail bearing the very high costs of premature scrapping merely so as to bring the cost of new vessels down to levels that—through overseas sourcing—could be secured in any event. The industry tail would be wagging the acquisition dog, at high cost to taxpayers.

Additionally and importantly, establishing a rolling production program to capture the benefits of continuous production presumes that future demand is assured for decades hence. However, the obvious risk is that economic, strategic or technological developments will lead to changes to the type, number and timing of acquisitions in a manner that invalidates the initial business case. Given that it is already questionable whether present demand is high enough to justify a rolling program, it would not take much to tip the balance. An easy way to appreciate the uncertainty in today's projections is to observe that the current demand for vessels by the RAN was not anticipated in 2000 or 1990, let alone 1980. Or to put it another way, would we really have persisted with a rolling production program of surface combatants based around variants of the Anzac frigate, and would we have wanted to continue building Collins class submarines once we appreciated their myriad problems?

Put in more economic terms, a truly firm commitment to rolling production involves abandoning the option value of flexibility: of being able to alter the acquisition program as new information comes to hand. Yet there are few areas where the value of flexibility is greater than in defence procurement: because strategic circumstances change, and because the costs and capabilities of platforms are constantly evolving. A program of acquiring capabilities that is genuinely locked in is

one that gives adversaries an important advantage, as it constrains the scope one has to respond to their actions through the procurement variable.

Arguably, it is unlikely that an Australian government would ever commit to a rolling production program for the simple reason that it would not need to and that the costs of doing so would be high. At best, governments will retain the option of extending a production run but defer any decision, pending clarification of future demand and dependent upon the performance of the initial program. This is the approach consistently taken by the United States despite much higher levels of demand.

Finally, a rolling production program would also invite the emergence of a political economy much like that already discussed for a monopoly shipbuilder, the only difference being that the monopoly only extends over one class of vessel. There would be a narrow base of interests ready to lobby in favour of continued work irrespective of the cost to the taxpayer or the benefit to the community. This is far from a distant threat: for example, the new head of ASC Limited recently expressed a 'strong belief that we in Australia should choose an indigenous design to replace Collins', despite admitting that a cost-benefit analysis of the options remains to be done²⁰.

Conclusions on continuous construction

As a result, we do not believe continuous construction is a desirable or even plausible option for eliminating the cost and productivity gaps between domestic and overseas sourcing. While some elements of a long-term construction program may be adopted, the need to retain procurement flexibility, and the risks inherent in creating monopoly positions, will tell against any policy of this kind. Moreover, even were such a policy

adopted, it is less likely to eliminate cost gaps than to create new ones, as the monopoly power it creates is exploited and as the loss of flexibility reduces the benefit the community obtains from the naval construction program. The high relative costs of local sourcing are therefore likely to persist.

Strategic benefits of local sourcing

Given those high costs, the issue is whether they are offset by commensurate benefits.

The first step in examining potential benefits is to understand Australia's avowed policy of 'defence self-reliance'. This uniquely Australian term-of-art refers to the ability to defend ourselves against attack without the assistance of the combat forces of other countries (though with their economic and logistic support if necessary).²¹ This has traditionally been taken to imply that Australia needs the in-country ability to replenish, repair, maintain and upgrade its major weapons systems.²²

The government's 2010 Defence Industry Policy Statement went further by identifying explicit Priority Industry Capabilities (PICs) and Strategic Industry Capabilities (SICs). The former are industry capabilities which 'confer an essential strategic advantage by being resident within Australia, and which, if not available would significantly undermine self-reliance and ADF operational capability', while the latter 'provide Australia with enhanced defence self-reliance, ADF operational capability, or longer term procurement certainty'.

When the concept of Priority Industry Capabilities was first floated, the intention was to bring a degree of discipline to the process of determining the assistance provided to defence industry. To achieve that objective, identifying PICs and SICs should have involved some form of cost-benefit

appraisal: in particular, an assessment of the consequences of being denied the capability in whole or in part, the resulting willingness to pay for maintaining Australia's access to that capability and on that basis, structured consideration of the options for doing so. In other words, the scheme should have provided a means for translating 'self-reliance', which is inevitably a matter of degree, into a workable guide that properly weighs costs and consequences in the light of budgetary and resource constraints.

However, what has emerged from the application of the concept does not bear close examination. Although many of the listed capabilities are of some relevance to self-reliance, there is a sense that defence industry segments have been accommodated simply because they currently exist. Indeed, the inclusion of combat clothing, infantry weapons and ballistic munitions as 'priority capabilities' is most plausibly explained as reflecting incumbent interests. So, although the government has designated naval shipbuilding as a 'strategic capability', its strategic importance needs to be examined from first principles.

A strategic rationale for domestic naval shipbuilding could be built upon one or more propositions, including that it is:

- the only way to acquire the particular naval capabilities we need;
- necessary for sustaining and upgrading vessels in peacetime;
- necessary for sustaining and adapting vessels in wartime;
- a basis for an emergency naval construction program in case of war;
- necessary to preserve sovereign independence of action.

Each of these propositions is examined below.

Unique requirements demand local construction

From an engineering perspective, if it is feasible to build a vessel in Australia it will be feasible to do so overseas. Australia has no unique production infrastructure or expertise which puts it ahead of foreign alternatives. If anything, the opposite is the case. Moreover, foreign suppliers are willing and able to build vessels to the specifications of their customers—such is the nature of naval construction. The fact that future vessel designs will almost certainly be based on foreign designs further bolsters the argument that foreign yards are capable of meeting our demands. Finally, with defence spending falling across most of the developed world, there is unlikely to be a problem with finding capacity at foreign shipyards.

Where problems can arise is in the handing of intellectual property from different suppliers. There are, in particular, clear sensitivities between US and European arms manufacturers in some areas. It has at times been argued that only an Australian shipbuilder can provide sufficient confidence to suppliers that their intellectual property will be protected, for example, in the process of integrating US weapons and sensors onto a European platform. In the case of surface vessels, this concern is clearly misplaced. European countries routinely integrate US weapons and sensors onto their surface combatants. We need look no further than our own Air Warfare Destroyer (AWD) project for confirmation. Based on the Spanish F100 design, the new AWD will carry essentially the same US manufactured combat system, sensors and weapons as its Spanish predecessors.

This leaves submarines, traditionally one of the more sensitive areas of military technology. In terms of the actual weapons there is no obvious difficulty.

US Mk 48 torpedoes and Harpoon anti-shiping missiles have both been integrated onto European platforms in the past, and the Tomahawk cruise missile has been cleared for export to the United Kingdom, Spain and the Netherlands. However, the United States is especially sensitive about its submarine combat systems (even though a Lockheed Martin combat system is being incorporated onto Spanish submarines). Were Australia to have its submarines built in Europe, we might have to accept a European combat system or retrofit a US system post-construction in Australia. The former should be tested on cost-benefit grounds, as it may not be undesirable²³ and the latter is entirely possible, as demonstrated by the replacement of the Collins combat system.

If you don't build it, you can't sustain it in peacetime

The tyranny of distance makes it impractical for Australia to rely on foreign yards to repair and maintain its vessels in peacetime. Fortunately, it is not necessary to build a vessel in order to be able to sustain and operate it. Over its history, the RAN has successfully operated 70 major²⁴ foreign-built vessels with a cumulative displacement in excess of 360,000 tons. In comparison, only 50 major naval vessels have been built in Australia amounting to only 183,000 tons. Relatively recent examples of Australia operating platforms built in foreign yards are the Oberon class submarines and Charles F. Adams Destroyers (DDG). Many other countries successfully operate naval vessels built far from their shores. Taiwan operates Dutch submarines and US air warfare destroyers. Singapore operates Swedish submarines and French frigates. Malaysia operates French submarines and is acquiring British frigates. Brazil operates a French aircraft carrier and two classes of

British frigate. Chile operates British and Dutch frigates along with French and German submarines. Argentina operates German destroyers and submarines. Israel operates German submarines.

It is sometimes asserted that Australia needs to be able to not just repair and maintain its vessels but also to upgrade them in-country. Although the strategic imperative for doing so is debatable, in practice upgrades can be performed in-country using existing maintenance capabilities, provided that the necessary IP and systems integration expertise are available. Past examples include the successful upgrades of the Oberon class submarines and DDG destroyers. In the aerospace sector, the upgrades to the foreign-manufactured F111 and P-3C aircraft further corroborate this conclusion. Often, a critical factor in naval upgrades is access to the source code for combat systems, weapons and sensors. Since these components are almost completely of foreign origin irrespective of where vessels are built, domestic shipbuilding confers no advantage in this regard.

More generally, Australia (along with most other countries) routinely operates imported commercial and military aircraft. Aircraft engineering is *at least* as complex and surely less forgiving as anything to be found in the marine sector with the possible exception of submarines: if we can safely and effectively sustain advanced foreign aircraft, the same should be true of naval vessels.

However, even though it is not necessary to build vessels to be able to sustain them in-country, the ability to do so cannot be taken for granted. Indeed, as the Collins class submarines have shown, even with the experience accrued during construction it can be difficult to sustain advanced naval vessels. Doing so requires a conscious decision to develop and maintain the infrastructure

and human capital needed. In terms of infrastructure, Australia already has a series of well-positioned dry docks and ship lifts. And, as matters stand, Australia has a wide range of corporate and individual capabilities that can be drawn upon to sustain and upgrade naval platforms, including systems integration. Planned work on the AWD and LHD projects will further enhance these capabilities (though as the Collins experience highlights it may not be sufficient). Were future platforms to be acquired offshore, Australia would have to mirror other countries reliant on foreign suppliers and require the builder to assist in the development of a domestic support capability—just as was done with earlier foreign naval acquisitions and as we do today with combat aircraft.

That said, it is sometimes argued that even if local construction is not necessary for sustainment to occur, it helps reduce the costs of sustainment. There would, in other words, be economies of scope²⁵ between construction and sustainment, reducing the life-cycle costs of acquiring and operating major systems.

Thus, ten to fifteen years ago, it was commonly held that building vessels in Australia with high local content would result in substantial reductions in sustainment costs through the life of the vessels. For example, a report produced in 2000 on the Anzac ship projects²⁶ held that once all eight ships were in service the annual cost of repairs, maintenance and spares 'could be higher by a factor of two if the original source of supply had been overseas': i.e. local production was claimed to halve annual sustainment costs.

Such optimism was endemic. The three big programs of the 1990s—Collins, Anzac and Minehunter—where all predicated on either reduced or static operating costs. But as the vessels entered service, the true cost of ownership slowly became apparent. The

explanation at the time was that the original estimates of operating costs had failed to take account of what were termed 'parent navy costs': that is, the non-recurrent fixed cost of ongoing ownership that had previously been covered by either the USN or RN. There is no doubt that these costs were substantial. But there was probably more to it than that. By demanding high local content, the cost of spares had to cover both the fixed cost of duplicating foreign production lines and the higher marginal cost due to small cumulative production runs.

This should have been obvious at the time; be that as it may, the extent of the error involved in those optimistic assessments, which were often funded by the firms that were proposing to undertake the projects, is certainly clear in retrospect.

For example, the aforementioned report into the Anzac class estimated that annual cost of repairs, maintenance and spares would be \$45 million for the eight vessel fleet. The most recent figure from the Defence Materiel Organisation for the Anzac class reported annual sustainment costs of \$211 million. Even adjusting for inflation, the original estimate was too low by more than a factor of three. The continuing rapid growth in the sustainment cost of the Collins class further confirms that past expectations of reduced through-life costs as a result of Australian construction were poorly founded.

With targets for local content no longer applied in defence projects, it is likely that current projects use more imported components than was previously the case. This will probably result in a reduction in sustainment costs relative to what would have occurred under the high local content policies of the 1990s. In any case, there is no reason or evidence to support the assertion that local construction—and certainly not local parts—permit a reduction in

sustainment costs. To the contrary: the more Australia-unique our naval platforms are, the higher the parent navy burden we will have to carry through the life of the vessels.

If you don't build it, you can't sustain it in wartime

Sustaining naval vessels during a conflict potentially introduces two additional tasks: rapid modifications to counter enemy capabilities, and battle damage repairs. In the first case, the ability to rapidly modify a vessel will arguably be independent of where the vessel was built. Rather, the critical factor will be the depth and sophistication of the peacetime sustainment regime that has been put in place, including the extent of access to the underlying (almost invariably) foreign IP and software.

In the case of battle damage repairs, the question is clouded by the scarcity of data on the damage likely to arise in a modern conflict. Nonetheless, an adequate peacetime support capability will no doubt result in a robust capacity for repairing minor battle damage. And if moderate to major battle damage occurs, the time taken for repairs at even a manufacturers' yard is likely to exceed the duration of modern conflict. For example, it took 11 months to repair the USS Cole after a suicide attack, and 15 months for the USS Stark after it was struck by two Exocet missiles. But even this might be overly optimistic given the lethality of modern weapons against invariably unarmored modern warships; of the four Royal Navy vessels damaged during the Falklands conflict, only one was able to return to service.

In short, the critical element determining our capacity for minor repairs is likely to be the adequacy of arrangements for peacetime sustainment; where the vessels were initially built will only be a secondary factor. That said, the nature of modern conflict, and

the likely damage vessels would sustain, means the capacity for major repairs will play only a limited role in determining warfighting capability.

Naval shipbuilding as a basis for industrial mobilisation

Twice in the 20th century, the developed nations of the world converted their peacetime economies for total war. And although Australia built few vessels in WWI (1 collier and 3 torpedo boats), an emergency construction program during WWII delivered 60 minesweepers, 3 destroyers and 12 frigates, of which 6 were complete by war's end. With this precedent in mind, it must be conceded that an extant shipbuilding program would greatly accelerate any future emergency construction program. The question, however, is how likely the need for such a response is in the 21st century. We believe that likelihood is low enough to be responsibly ignored in our planning.

The wartime industrial mobilisations of the last century involved great powers striking at the heart of each other's vital interests in a clash of military-economic attrition. No such conflict has occurred (much less persisted) since the advent of nuclear weapons. If there were to be a great power conflict in the 21st century—a possibility that cannot be dismissed—it would likely be short, sharp and potentially catastrophic, leaving no time for crash naval construction programs. Of course not all wars involve great powers, but it would be even more fanciful to envisage the world looking on as Australia and one of its South East Asian neighbours fought a conventional war of attrition extending over the two to three years it takes to initiate a program and build a warship. To put things in perspective, in WWII, the first Australian-built Tribal class destroyer took until March 1942 to be commissioned, and the first River class frigate did not see service until November 1943.

Logistic dependence and sovereign independence

Dependence on foreign technology and support leaves open the possibility that our sovereign independence might be compromised if our strategic interests diverge from those of our supplier. Such a situation emerged during the Vietnam conflict when Sweden ceased the export of anti-tank missiles to Australia and the United States. While this possibility cannot be denied, in most circumstances there is no realistic option but to accept and manage that risk. Australia simply does not have the capability to develop and manufacture weapons systems from scratch without a very substantial level of investment—well beyond what the current Defence budget would support and what the community would tolerate. More importantly, the notion is largely a red herring in the context of naval shipbuilding. Our dependence on foreign suppliers is manifest in the advanced subsystems aboard our vessels, not on the location in which the hull is fabricated and the inevitably foreign-sourced subsystems are installed. Irrespective of whether our air warfare destroyers are built in Adelaide, Maine or Cadiz-San Fernando, the United States can withdraw its software support for the critical Aegis combat system if and when it chooses. The same is true for the US combat system being integrated aboard the Collins class submarines and the mission computer aboard the F-35 Joint Strike Fighter.

Other economic benefits

Overall, the claimed strategic benefits of local construction are at best unproven, at worst highly implausible. Taken as they stand, they are unlikely to offset cost penalties of the magnitude set out above. Are there nonetheless wider economic benefits that could do so?

Creating jobs

The most common wider benefit claimed for defence projects is the stimulation of economic activity. For example, in a recent article defending local construction of the future submarine, the CEO of the ASC writes that “for every direct employee involved in the Collins Class Submarine construction program, it was estimated that there was a multiplier effect of two or three in Australian industry”.²⁷

The obvious difficulty with claims of this kind is that they confuse costs and benefits. In effect, they amount to saying that the greater the local inputs consumed by a project, the more worthwhile the project must be. The underlying error is to assume that in the absence of the project, the inputs it uses would lie idle: that the workers it requires, to take but one example, would otherwise live in trees eating nuts until the project comes along, so that employing those workers constitutes a benefit from the project. This assumption is obviously entirely fanciful, especially for the very skilled workforce required for major defence programs. Rather, those employees have a high opportunity cost, best measured by the wages required to attract them, so that the labour income generated by the project is a cost, not a benefit.

The need to take account of these opportunity costs—and the failure of multiplier studies to do so—has been repeatedly stressed by relevant Australian government authorities. As the Industry (now Productivity) Commission has put it:

Multipliers, as simply measures of linkages, can measure a net gain to the economy only to the extent that their demand on resources for associated activities can be met from resources which otherwise would not be used. They do not consider possible

alternative uses of such resources. If an expansion of one industry can occur only by bidding resources away from another industry, then there is no net multiplier effect. Indeed, the initial expenditure itself will increase activity only if it involves a more efficient use of resources. In particular, the alternative uses of government funds used to assist the investment are usually ignored. These funds may have greater value (or even higher multipliers) used in other ways or if left in the hands of taxpayers.²⁸

Equally, the Commonwealth Department of Finance, in providing guidance on public sector project appraisal, has stated that:

Inclusion of a multiplier effect from income and spending generated by a project is only justified when (a) the affected resources would have otherwise been unemployed and (b) the activities displaced by the project would not have also made use of the idle resources. As a general rule, it is recommended that analysts assume that labour, as with other resources, is fully employed.²⁹

Conversely, it is worth noting that it is sometimes argued that using skilled labour in defence production will ‘crowd out’ more valuable uses of those resources, for instance in mining. This argument is incorrect, at least if the implication is that there is a cost to using those resources—in the form of contraction of other uses—above and beyond the amount paid for them. Rather, in a well-functioning labour market, the amount that must be paid to attract skilled labour will measure its cost, in terms of forgone output, in other activities. To the extent those wage costs have been taken into account in the analysis, any such ‘crowding out’ will already have been reflected in input prices. Indeed, it is for this reason that a domestic cost penalty (in the form of the 30 per cent ERA) signals that the resources at issue are being withdrawn from more productive uses.

Overall, as well as being analytically flawed, a focus on the indirect benefits of projects, such as alleged job creation effects, is an invitation to inefficiency as it distracts attention from maximising the difference between the direct costs and benefits of the project. If the objective is to generate economic activity and create jobs, the usefulness of the project, the desires of consumers, cost control and value for money are of lesser concern.

Paying taxes

An error similar to that made in respect of multipliers is often made about tax revenues. Thus, it is frequently argued that local defence production is preferable to overseas sourcing because of the tax revenues local production generates. However, this is only correct if the resources being used (say, the skilled labour) would otherwise be unemployed (thus generating no tax revenues), or employed in uses which generated lower tax revenues. This is highly unlikely. Rather, the more likely case is that the same tax revenue would be secured from alternative uses of the resources. In that event, any taxes paid in the domestic shipbuilding activity are part of the opportunity cost of that activity (in the sense that if domestic shipbuilding were not undertaken, the alternative use of those resources would pay the taxes).

As a result, domestic shipbuilding should only be undertaken if it is capable of paying those taxes, from which it follows that the taxes should be included in the comparison of domestic and overseas costs. Matters are somewhat more complicated for indirect taxes (such as duties on imported components). However, most of the materials used in naval shipbuilding are probably exempt from tariffs under the Tariff Concession System, either because they are not produced locally or because they are being imported under a government contract.

As a result, there will, in the usual case, be no (or only minimal) tax revenue advantage from local production, and certainly not one sufficient to offset cost penalties of the magnitude set out above.

What is correct and important, however, is that defence procurement is tax funded. Simply put, each dollar spent on defence equipment is a dollar that must be raised in tax. Raising a dollar in tax transfers a dollar from the taxpayer to the government but also distorts the taxpayer's decisions, for instance by inducing a reduction in hours worked or in the incentives to save. That distortion imposes an economic cost (the so-called deadweight loss or excess burden of taxation), estimated at anywhere from 3 to 71 cents for an extra dollar of revenue, with the most widely accepted estimate being in the order of 30 cents. What this means is that when two dollars are spent producing in Australia defence equipment that could be purchased for a dollar overseas, the loss is not merely the waste of \$1 worth of resources (that could be put to some other use) but also of 30 cents of distortion created by raising that wasted dollar in tax. In other words, each \$1 of excess cost may cost \$1.30 in economic loss.

Spillovers

Finally, it is sometimes claimed that there are 'spillovers' to local construction, in the sense that undertaking production locally reduces costs (or increases quality) in other activities, without the activities that benefit making any explicit payment to government for this gain. (The spill-over is, in other words, an externality, i.e. a benefit given or cost imposed without a market transaction.)

While this is not impossible, there is little evidence of such spillovers and even less that they are policy-relevant, in the sense that they would not be secured without policy intervention. Account must also be

taken of the possibility that serving military markets may inculcate a corporate culture and workforce attitudes poorly suited to competing in the commercial world—a negative spillover. Additionally, even if there were positive, policy-relevant, spillovers, the question would be whether they were most cost-effectively obtained through local production, as compared to (say) relying on targeted subsidies for skill development. Given the substantial cost penalties local production seems to involve, targeted subsidies, even if less effective, may be more efficient. Lastly, even if overseas sourcing were to lead to any positive spillovers being entirely lost (rather than secured by other means), the gain to Australia from the resulting cost saving may still be far greater than the value of any forgone spillover benefits.

Conclusions

Australia plans to acquire a wide range of naval vessels in the decades ahead at a total cost in the tens of billions of dollars. Taxpayers can rightly demand that those acquisitions are undertaken in a way that ensures value for money. Meeting that demand requires careful attention to the balance between domestic production and the import of naval vessels.

Since the late 1980s, the trend has been to rely on domestic production for a historically high share of the naval program. This has entailed substantial cost penalties that are reflected in the very high rates of assistance provided to Australian naval shipbuilding. Additionally, there have been substantial schedule slippages, imposing costs both in the form of the delayed introduction of capabilities and of increased sustainment outlays on existing platforms. The overall result has been to distort the allocation of resources, not only in the economy as a whole but also in defence itself, as the high cost of the program reduces the ability to fund the capabilities needed for the defence of Australia. Moreover, analysis

suggests the cost penalties associated with Australian production are unlikely to diminish in future.

The goal of defence self-reliance does not provide a sensible justification for bearing these excess costs. Complete self-reliance is not possible in any case. Policy setting is therefore a matter of degree in which the appropriate extent of self-reliance needs to be determined by balancing costs and benefits. As a result, the penalties associated with domestic shipbuilding should only be accepted if they are offset by commensurate benefits.

While such benefits have often been claimed, closer examination reveals them to be slight or non-existent. Specifically, domestic production of naval vessels: does not ensure, or reduce the cost of ensuring, the supply of vessels that meet Australia's strategic requirements; is not necessary to ensure, or to reduce the cost of ensuring, the sustainment of the fleet in peace or in war; and does not materially enhance Australia's sovereignty. Nor is it the case that domestic production should be considered an inherently advantageous way of providing jobs, boosting incomes and hence tax revenues; in fact, the effect is the opposite. Nor is it an efficient way to secure technological and workforce training benefits more broadly.

It is therefore crucial that future decisions about sourcing Australia's naval assets are based on rigorous and transparent cost-benefit appraisal, with special scrutiny applied to decisions that involve customised or Australian-unique platforms. Moreover, that appraisal must be based on realistic evaluations of life-cycle costs, rather than the underestimates of future costs that have been a recurring feature of Australian defence planning.

Given that the excess costs, calculated over the entirety of the future fleet program,

could amount to many billions of dollars, the loss to Australian society from protecting domestic military shipbuilding could be extremely high. There is also the loss, more difficult to quantify but no less real, should the high cost of building ships in this country force us to settle for a smaller fleet or impose unwarranted opportunity costs on other parts of the defence portfolio, thus reducing Australia's net defence capability. Unless credible offsetting benefits can be identified, and they have not been to date, the case for continuing the current preference for domestic production is very weak indeed.

Notes

- 1 Department of Defence, Force 2030; *Defending Australia in the Asia-Pacific Century*, Australian Government, Canberra, 2009; see also; Department of Defence, *2011 Defence Capability Plan*, Australian Government, Canberra, 2011.
- 2 Specifically, based on the characteristics given in the 2009 White Paper, we estimate that the submarines will cost at least \$25 billion, the frigates (~4,000 tonne) at least \$10 billion and the (~2,000 tonne) multi-role patrol vessels at least \$6 billion. Note that the Government refuses to disclose the estimates it is using for planning purposes.
- 3 The decision to build the new submarines in Australia was announced in the 2009 Defence White Paper.
- 4 The government expressed a 'strong preference' to build the air warfare destroyers in Australia in the 2000 Defence White Paper, which by 2004 had hardened into a commitment.
- 5 The last two AEW&C aircraft are being modified from commercial Boeing 737 airframes in Australia.
- 6 Exceptions arise; a small number of hull modules for the new AWD are being built in Spain, and parts of the first Collins class submarine were fabricated in Sweden.
- 7 Note, however, the West Australian based firm *Austal* designs and builds innovative naval vessels in the United States.
- 8 DefenceSA, *Naval Shipbuilding: Australia's \$250 billion Nation Building Opportunity*, 2010.
- 9 Department of Defence, *The Naval Shipbuilding and repair Sector Strategic Plan*, 2002.
- 10 This includes the mining technology services and equipment (MTSE) sector, in which Australia now leads the world: see Tedesco, L. and Haseltine, C. (2010), 'An economic survey of companies in the Australian mining technology services and equipment sector, 2006-07 to 2008-09', ABARE-BRS research report 10.07, Canberra, July.
- 11 The externalities may be wider than naval shipbuilding. Thus naval shipbuilding may involve externalities to and from commercial shipbuilding and to and from the production of other weapons systems. Note that, technically, these externalities may involve some combination of complementarities (which are situations in which an increase in the supply of one good reduces the marginal cost of producing another) and spillovers (where the increase in supply of one good reduces the average, but not necessarily the marginal, cost of another). For simplicity, both of these are referred to here as spillovers.
- 12 If transport costs are high, the savings (such as avoiding the duplication of fixed costs) achieved through trade can be more than offset by the additional costs of transport.

- 13 Specifically, all else equal, prices will be lower in the home market, while being raised elsewhere by transport costs. The lower (higher) prices will be reflected in higher (lower) real wages for non-mobile labour.
- 14 George Papas, *2008 Audit of the Defence Budget*, McKinsey & Company, 2009. The results on the ERA for Australian naval shipbuilding come from a study undertaken by CRA International for the Department of Defence. The CRA study team included one of the authors of this paper, Henry Ergas.
- 15 In other words, the NRA is a measure of the total price-raising (or reducing) effects on a tradable good of the policies being examined.
- 16 Productivity Commission 2011, *Trade And Assistance Review 2009-10*, Canberra, p. 19, Table 2.6.
- 17 Weapons systems have three major dimensions. First, the military value of a system depends on its quality which may be described in terms of features such as its speed, destructive force or accuracy. Second, the value of a system also depends on the time at which and for which the system is available. Third, the cost of a system, both at initial deployment and in terms of recurrent resource requirements, needs to be balanced against quality and timeliness.
- Now, when project difficulties occur, headline cost and quality seem to be kept reasonably constant, while the schedule is delayed. From an economic perspective, this is in and of itself suggestive of ex ante inefficiency. In effect, if the initial choice was optimal, and assuming the scope for continuous variation in each dimension, at the optimal point the marginal value of the last development time increment saved should be equal to the marginal value of the last quality increasing activity, which should each be equalised to its marginal cost. A change in the constraints relative to that initial optimum should then lead to adjustments in all the dimensions of performance, rather than only or mainly to one. What the observed pattern (in which it is schedule that bears the brunt of the adjustment to the change in constraint) implies is that when difficulties arise, either the marginal valuation of quality rises (so that the willingness to wait for quality increases) or the marginal cost of quality falls, neither of which seem sensible.
- 18 In some cases, the cost of acquisition from overseas would be very close to the marginal cost of production, thereby avoiding the burden of contributing to fixed costs altogether. Under the US Foreign Military sales program, for example, customers pay the marginal cost of supply plus approximately 3.8% (though this is sometimes waived).
- 19 See, for example, John Cole, *Collins Class Sustainment Review—Phase 1 Review*, Department of Defence, November 2011.
- 20 Steve Ludlam, 'We should build on our 30-year submarine expertise', *The Australian*, 26 January 2012.
- 21 Adopted in the 1970s, the policy of self-reliance is almost a word-for-word restatement of the Guam doctrine announced by Nixon in 1969 to rhetorically facilitate the US withdrawal from Vietnam.
- 22 See for example; Department of Defence, *Defence and Industry Policy Statement*, 2007.
- 23 The original tender evaluation for the replacement Collins combat system chose a European solution but this was

overturned on 'strategic grounds' by the then government.

- 24 Here, major vessels are defined here as displacing 1,000 tons (1,100 tonnes) or more.
- 25 While economies of scale are the cost reductions that come from producing more of a product, economies of scope are the efficiencies that can be secured by producing two or more products jointly.
- 26 Tasman Asia Pacific, *Impact of Major Defence Projects: A Case Study of the ANZAC Ship Project*, 2000.
- 27 Ludlam, *ibid.*
- 28 Industry Commission. 1996. *State, Territory and Local Government Assistance to Industry*. Report No: 55, 29 October. Australian Government Publishing Service, Canberra. Available at: <http://www.pc.gov.au/ic/inquiry/55stateassistance/finalreport/>
- 29 Department of Finance. 1991. *Handbook of Cost-benefit Analysis*. AGPS. Canberra, pages 103 and 34-35.

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This paper was presented at the RAN Seapower Conference, Sydney, Australia, 1 February 2012. Consistent with ASPI's charter to provide alternative sources of input to government decision-making processes on major strategic and defence policy issues, we are circulating this discussion paper to a range of government agencies and have produced this public version in order to help nourish public debate and understanding of this important issue.

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