Department for
Business, Energy
& Industrial Strategy

HOW TO MEASURE THE PROSPERITY IMPACTS OF UK SHIPBUILDING

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Contents

Executive Summary

Ipsos MORI (in association with George Barrett and Professor Keith Hartley) were commissioned by BEIS in February 2017 to undertake a review of the prosperity impacts of military shipbuilding.

Study Aims and Objectives

The overall aims of the study (as set out in the Invitation to Tender) were to assist Government (BEIS, MOD and HMT):

- Gain a better understanding of the prosperity impacts of building warships in the UK both at a national and regional level, and
- Support the development of a practical set of metrics for measuring these impacts.

These questions should be seen in the context of an overarching Government objective to develop an approach for assessing the prosperity benefits of defence procurement that can be used as part of the Ministry of Defence's value for money assessments, aligning with HM Treasury Green Book principles for the preparation of business cases in the public sector.

Approach

The results of this study are based on a series of in-depth consultations with policy officials and representatives of the shipbuilding sector, a review of the available secondary data, academic literature and Government studies, and a series of econometric models using small area data to assess the local impacts of shipbuilding. Case studies were conducted focusing on a selection of UK-based yards to understand the impact of a hypothetical light warship contract on the shipyards and their local economies. These case studies are commercially sensitive and are for internal government use only.

Framework for Measuring Prosperity

Although there is a growing policy interest in prosperity, there is - as yet - no precise definition of the concept. There has been much research interest in enhancing traditional measures of living standards (such as GDP per head), and numerous indices have been developed that capture aspects such as safety, health, or well-being. A review of the common factors included within these indices, alongside an assessment of those aspects expansions in shipbuilding activity may reasonably be expected to influence, led to the definition of prosperity set out in the following table. These indicators include 'intermediate' measures that capture factors that drive prosperity and are not always additive (i.e. some measures may double count prosperity gains measured by other indicators).

Table E1 Prosperity Impacts of Shipbuilding: Dimensions and Metrics

Dimension of prosperity	Intermediate Metrics	Prosperity Metrics
Income	R&D spending Capital investment	Net effects on: Economic output (GVA) Total factor productivity (TFP) Average labour productivity GVA created by productivity gains Wage income Measurable productivity and other relevant effects arising from the exports of ships, systems and designs
Employment		Net number of jobs
Unemployment		Net effects on: JSA claimants Long term JSA claimants Out of work benefit claimants
Economic security		Net effects on: Full-time jobs Part-time and temporary jobs Jobs with contractors Claimant on-flows
Income inequality		Net effects on income distribution
Education and training	No. of apprenticeship opportunities	Net increase in wages resulting from training
Subjective well-being		Improvement in life satisfaction Monetary value of improvements in life satisfaction
Strength of community	Outmigration	

Alignment with the HMT Green Book

The Green Book provides the key framework for assessing the costs and benefits of Government spending decisions and only a subset of the metrics defined above could be considered within an analysis that aligns with its general principles:

- **National effects**: Procurement decisions should be assumed to be welfare neutral at the national level except where the choice is between domestic and overseas suppliers. Where the choice is between producing warships at different UK shipyards, there will likely be no overall gains in social welfare owing to displacement and crowding out effects. The emphasis of national level analysis would focus on the supply side effects involved. This would imply an assessment of the GVA resulting from the productivity gains that may arise from capital, R&D, or training spending (though the costs of these investments would also need to be considered). Other supply side effects, such as avoiding or reversing hysteresis effects, may also be relevant.
- **Local effects**: The emerging Green Book (which is currently being refreshed) will give greater scope for local analyses where procurement decisions involve a choice between selecting which shipyard or shipyards will be the lead contractor and manufacturers of the blocks. Much of the spending associated with the procurement of a military warship will be with Original Equipment Manufacturers and the impacts of this spending are unlikely to be affected in a material way by the choice of local shipyard. As such, the focus of local analysis will largely be on hull construction. The metrics considered as part of a local analysis could extend beyond measures of productivity and deprivation to include effects on local incomes, employment and education opportunities, economic security, productivity, income inequality, outmigration, subjective well-being and strength of community (though not all would be admissible within the guidelines of the Green Book).

Evidence on Metrics: National Level

Spill-overs from Research and Development spending

R&D spending associated with a new warship construction programme will have the potential to produce productivity gains either directly or indirectly (and may be lost if this investment is taken forward overseas). There is little direct evidence from the shipbuilding sector that would support a quantification of these gains. Recent cross-country research suggests military R&D spending in general terms both crowds-in private R&D expenditure and raises the rate of total factor productivity growth (a permanent increase in the ratio of military R&D expenditure to output of one percent has been found to raise the rate of TFP growth by 5 percent). This could serve as a starting point for assessing the productivity gains associated with R&D spending. However, there are questions regarding how far the results are applicable to the shipbuilding sector and whether the expenditure involved could be considered to qualify as a permanent increase in military R&D spending.

Human and Physical Capital Investment

Human and physical capital investments that would not go ahead if the vessels were procured overseas would potentially raise the productivity of shipyards and the wider supply chain. There is general literature describing the returns associated with these types of investments, though there is no specific evidence relating to the rates of return that may be obtained in the shipbuilding sector. Additionally, while planned training and capital spending plans could be collected during a procurement exercise, consideration also needs to be given to how the

resources involved might have otherwise been deployed in the absence of an expansion of shipbuilding activity. Without further evidence, it would not be credible to assume that such investments would produce supply side impacts (particularly as productivity in the shipbuilding and wider manufacturing sectors are largely equivalent). As such, there is no firm basis for making an ex-ante assessment of the impacts associated with the human or physical investments induced.

Long-term unemployment (Hysteresis)

Shipyards are typically significant local employers offering well paid employment opportunities. If expansions in activity have the potential to avoid or reverse losses of productive capacity caused by long term scarring or hysteresis problems, then there may be supply side effects that could be considered in a national analysis. There are numerous case studies of shipyard and plant closures in the literature, though the results of these studies are variable and rarely show that closures have lasting effects in terms of increasing long-term unemployment. However, detailed studies of the closure of coal mines and MG Rover suggest that a focus on unemployment masks other underlying issues. Evidence from the econometric analysis is consistent with the findings of these studies but also suggests that increases in shipbuilding activity does help to reduce long-term unemployment (with the creation of 100 jobs at a shipyard estimated to reduce the number of long-term JSA claimants within 60km by 9 after three years). The strength of these effects will vary across shipyards and, while the research has uncovered factors likely to increase the exposure of an area to long-term hysteresis problems (primarily an absence of alternative employment opportunities), there are no quantitative metrics that can be applied to predict the likelihood and strength of these effects at a local level.

Redistributive effects

While changes in shipbuilding activity may raise incomes, it considered likely that these benefits will largely accrue to higher skilled (and therefore higher earning) residents. As such, analysis of the redistribution of income is not advised as part of a national assessment and there is little basis for such an analysis. The findings also suggest that expansions in shipbuilding activity increase the numbers of non-JSA claimants within 60km of the shipyard, and any effects may be complex in nature.

Evidence on Metrics: Local Level

Employment

Expansions in shipbuilding activity have the potential to lead to locally significant impacts in the form of well-paid employment opportunities provided this does not crowd out other activities. This study has found that increases in shipbuilding employment has positive effects on employment in the areas surrounding shipyards. The creation of 100 jobs at the shipyard is estimated to result in a net increase in employment of 19 jobs within 60km of the shipyard after three years. This includes the creation of 32 additional jobs in the manufacturing sector, an estimate that is broadly consistent with other studies exploring the regional impacts of defence industries based on input-output models (which do not allow for offsetting general equilibrium effects). However, these manufacturing jobs are offset by crowding out of 113 jobs in the service sector[1], implying a net positive impact of 19 jobs). This implies a cost per net additional job of £700,000 (based on an assumption of £133,000 of local warship spending per shipbuilding job created). Effects are likely to vary across shipyards, given the variable extent to which they make use of locally or nationally configured supply chains.

Productivity and Incomes

This study offers some ready reckoners that could be employed to assess the local productivity and income gains associated with procurement options. The creation of 100 shipbuilding jobs is estimated to increase output (GVA) within 60km of the yard by around £4.3m and local incomes by £1.8m after three years. These gains arise primarily from growth in manufacturing jobs at the expense of lower paid and less productive service sector employment. These estimates are inferred from changes in the employment shares of the shipbuilding, manufacturing and service sectors implied by the econometric findings, and could be improved with direct observations of productivity and earnings that could not be accessed within the timescales for the study.

Unemployment and Out of Work Benefits

The econometric evidence suggested that increases in shipbuilding activity reduce unemployment. The creation of 100 shipbuilding jobs created is estimated to reduce the claimant count by 16 claimants within 60km of the shipyard after three years. This suggests that 83 percent of the 19 net additional jobs created are taken by residents. Again, this appears to vary across shipyards with some using workers at other sites or migrant labour to meet peak demand. Over 50 percent of the effect on claimant numbers came from reductions in the numbers claiming JSA for one year or more. However, the estimated reduction in numbers of out-of-work benefit claimants (11 for every 100 jobs created at the shipyard) was smaller than the effect on JSA claimant numbers, implying an expansion in the number of non-JSA claimants. This suggests that while expansions in shipbuilding have positive local effects in reducing unemployment, it may have offsetting effects through increasing economic inactivity rates (possibly shedding some light on the nature of the crowding out mechanism).

Economic Security

Given the findings above, it is possible that expansions in shipbuilding may lead to local improvements in economic security (though case studies suggested that use of temporary on-site contractors is sometimes used as a risk management strategy). Owing to issues of data

[1] This effect may be overstated as the available data did not include self-employment.

availability, it has only been possible to examine the effects of shipbuilding activity on economic security in terms of claimant on-flows. This evidence does not suggest that increases in shipbuilding activity reduces claimant on-flows over and above what might be expected given reductions in claimant numbers. However, frequency of unemployment episodes is only one dimension of economic security and it has not been possible to assess effects on aspects such as part-time working or temporary contracts.

Subjective Well-being and Strength of Community

The literature review did not identify any research exploring the impact of shipbuilding on subjective well-being. Additionally, while outmigration was defined as a metric of the strength of local community ties, no small area data was available to help metricate effects of this nature.

Use in Procurement

The table below summarises the metrics derived from this study that could be applied to develop a tool to aid future procurement decisions. These measures provide insight into the local labour market effects of shipbuilding, but it has proven challenging to derive measures of supply side effects that could be applied in national or local welfare analyses. The measures quantify the relationship between changes in shipbuilding employment and local measures of prosperity, and could be used in the following way:

- Future procurement exercises could collect information related to the expected jobs created and safeguarded associated with the procurement options under consideration. Assuming that the procurement does not crowd out other activity at the shipyard, the metrics below could then be applied to estimate a number of prosperity effects within 60km of the shipyard.
- These metrics represent averages across different shipyards. As the study illustrates, local effects may vary across different shipyards depending on the configuration of local and national supply chains and the profile of the workforce. Information on the spatial distribution of supply chain spending and workforces should be gathered as part of future procurement exercises to allow adjustments to be made regarding the likely scale of local effects.
- The metrics average productivity levels across shipyards (and their application could potentially disadvantage more productive shipyards that require fewer workers to deliver warship programmes). The metrics also do not capture any improvements in productivity that may result from human or physical capital investments. While further research is needed to address the latter issue, information on the productivity of individual contractors (and wages offered) should also be gathered to adjust estimates of local effects on GVA and earnings.
- Local economic impacts are likely to vary according to local economic conditions. Impacts are likely to weaker in stronger local economies where there is strong competition for skilled workers in manufacturing industries. It has not been possible to quantify the relevant relationships as part of this study, though these issues merit consideration when comparing different procurement options.

Alongside collecting information on these aspects during the procurement process, one of the key constraints faced in the study was the absence of data on the spatial distribution of past spending on military warship programmes. Some information is available on spending placed

with prime contractors, but this offers little insight into how spending breaks down across the supply chain and the spatial distribution of said spending. For the purposes of understanding the prosperity impacts of military procurement spending and how these impacts evolve over time, there would be substantial benefits in systematically collecting information from prime contractors describing patterns of supply chain spending (ideally at the level of individual subcontractors) and the outputs it generates. This applies equally to shipbuilding and other sectors in which the Government procures defence equipment.

Table E2 Metrics – Local Prosperity Impacts of Shipbuilding (within 60km)

Aspect of prosperity	Effect for 100 shipbuilding jobs created	Measure
Employment	Warship spend per gross job (at shipyard) Net increase in employment	£10m - £13m 19 jobs
Education	Gross apprenticeships created	25 – 33 apprentices
Income	Net increase in GVA per annum Net increase in wages per annum	£4.3m £1.8m
Unemployment	Reduction in JSA claimants Reduction in LT JSA claimants Reduction in OOW benefit claimants	16 claimants 9 claimants 11 claimants

Source: Ipsos MORI analysis

Further Research

The findings in this report are based on a rapid review of the available evidence which placed constraints on the extent to which it has been feasible to access and assemble the detailed information at an individual, firm or area level needed to provide high resolution quantitative estimates of all prosperity effects of interest. The main gaps in the evidence base relate to measures of the possible supply side impacts of shipbuilding activity. Further research is recommended in the following areas:

- **Spill-overs from R&D spending**: Although there are metrics available to assess the impact of the military R&D spending on productivity growth, there are considerable questions regarding how far they would be applicable in this context. These issues can potentially be overcome with further bespoke research, as time series data on R&D spending in the shipbuilding sector is available (and it may be possible to use cross country time series data at a sector level to identify the effects of interest). This may have wider benefits in supporting similar assessments of procurement decisions in other sectors (such as aerospace). An attempt would need to be made to assess the effects of temporary rather than permanent increases in R&D spending, introducing complexities, as the lags involved can be expected to be long term in nature.

- **Human and physical capital investment**: Measures of the value of human and physical capital investments could not be generated through this study because there is also no publicly available data at a small area level. However, they can be obtained with access to data in the Individualised Learner Record and the ONS Virtual Microdata Laboratory data. A similar econometric framework to that suggested above could potentially be applied to assess the impacts of shipbuilding in increasing the availability of educational opportunities and stimulating capital investment. BEIS and DWP have also collaborated to link the DWP Work and Pensions Longitudinal Study and the Individualised Learner Record, making it potentially feasible to assess the long-term wage impacts of apprenticeship opportunities in the shipbuilding sector.

- **Local productivity and wage gains**: Estimates of the local productivity and wage gains associated with expansions in shipbuilding activity were inferred from effects on the employment shares of the shipbuilding, manufacturing and service sector. Superior estimates could be developed using direct observations of firm level productivity and wages available through the ONS Virtual Micro-data Laboratory and the DWP Work and Pensions Longitudinal Study.

- **MOD spending**: The findings could be further improved if it were possible to construct time series data of MOD warship spending by contractor (including the supply chain). This will facilitate a superior assessment of additionality by establishing the extent to which military spending crowds out civil activities at the shipyard, as well as help to determine the local significance of the prosperity impacts of spending with OEMs.

1.0 Introduction

Ipsos MORI (in association with George Barrett and Professor Keith Hartley) was commissioned by BEIS in February 2017 to undertake a review of the prosperity impacts of military shipbuilding. This report sets out the findings from the review, providing a framework for understanding the prosperity impacts of the procurement of military vessels, and the results of a literature review, supplementary quantitative analyses and in-depth research with stakeholders in the industry.

1.1. Study Objectives

The overall aims of the study (as set out in the Invitation to Tender) were to assist Government (BEIS, MOD and HMT) gain a better understanding of the prosperity impacts of building warships in the UK both at a national and regional level, and support the development of a practical set of metrics for measuring these impacts. The study focuses particularly on understanding:

- Productivity effects and associated drivers, such as higher wages, skills, innovation and spill-overs; and,
- Sub-national effects to understand the role that procurement decisions might play in local areas and their economies, such as effects on local employment and wages, clustering of technologies and skills, local supply chains and deprivation.

The Invitation to Tender also defined a set of detailed research questions to be addressed (outlined in Table 1.1). These questions should be seen in the context of an overarching Government objective to develop an approach for assessing the prosperity benefits of defence procurement that can be used as part of the Ministry of Defence's value for money assessments, that aligns with HM Treasury Green Book principles for the preparation of business cases in the public sector.

Table 1.1 Research Questions

	Research Question
1	What economic factors or outcomes best indicate the prosperity impacts of shipbuilding?
2	Should prosperity be defined as improving productivity and reducing deprivation? Are there other indicators that should be included?
3	Which indicators are the most robust in terms of measuring prosperity at national and sub-national levels?
4	What data, information or literature is currently available that relates to both the regional and national economic impact of the shipbuilding in the UK?
5	What are the gaps in the available data and other information, and what would the Government need to do to address them?

1.2 Approach

The results of this study are based on the following research activities:

- **Stakeholder consultations**: In-depth consultations with both policy officials and representatives of the shipbuilding sector were completed to refine an understanding of how the concept of 'prosperity' should best be defined for the purposes of the exercise and gather views on the range of national and sub-national prosperity impacts of the shipbuilding sector and the contextual factors that may influence their scale and significance.
- **Analysis of secondary data**: A review of the available secondary data was undertaken to understand and quantify the broader national and subnational prosperity impacts of shipbuilding and recent trends that have influenced the performance of the industry.
- **Literature review**: A review of the available academic literature and Government studies was completed to provide further evidence on the local and national prosperity impacts of the shipbuilding sector.
- **Econometric analysis**: The study involved the development of a series of econometric models using small area data on employment and claimant numbers to assess the spatial distribution of impacts associated with changes in shipbuilding activity. This was supplemented by an analysis of the effects of locally significant changes in shipbuilding activity: the construction of the Type 45 Destroyer at the two BAES shipyards yards in Glasgow, the lead shipyard role of Rosyth from 2009 in the construction of the QE class Aircraft Carrier, and the closure of the BAES shipyard in Portsmouth from 2013.
- **Case studies**: Case studies were conducted focusing on a selection of UK-based yards to understand the impact of a hypothetical light warship contract on the shipyards and their local economies. These case studies are commercially sensitive and are for internal government use only.

1.3 Study Constraints

The findings in this report are based on a rapid review of the available evidence which placed constraints on the extent to which it has been feasible to access and assemble the detailed information at a firm or area level needed to provide quantitative estimates of all prosperity impacts of interest. There are also several questions (for example, regarding the nature and value of spill-overs arising from research and development and the character and volume of vocational education opportunities in the shipbuilding sector) that have not been explored in the secondary literature.

As such, the findings presented in this report should be regarded as an initial exploration of the local and national prosperity impacts associated with shipbuilding activity. There are opportunities to improve understanding of the socio-economic impacts of shipbuilding procurement decisions and possible strategies for doing so are considered in the conclusions to this report.

1.4 Report Structure

The remainder of this report is structured as follows:

- **Section 2** provides an overview of the context for the study, covering recent policy developments and trends in the shipbuilding industry drawing on publicly available data and consultations with both policy officials and the industry.
- **Section 3** sets out an analytical framework for understanding the local and national prosperity impacts of shipbuilding activity, and assesses how these concepts can be reconciled with the principles for the preparation of business cases in the public sector set out in the emerging HM Treasury Green Book.
- **Section 4** provides a review of the available academic and Government studies exploring the extent and strength of the prosperity impacts of shipbuilding activity.
- **Section 5** presents the results of a set of econometric analyses exploring the local economic impacts of shipbuilding activity.
- **Section 6** sets out conclusions and recommendations from this review.

2.0 Study Context

This section provides context for the study. Consideration is given to the policy context, including the increasing prominence of a wider agenda around prosperity and the current Government strategy for the shipbuilding industry. This section also provides an analysis of the key characteristics of, and trends in, the shipbuilding industry. The section draws on a review of the available literature, stakeholder interviews and a review of documents supplied by interviewees.

2.1 Policy Context

2.1.1 Prosperity Agenda

In 2015, the Strategic Defence and Security Review (SDSR) set out strategic intentions to supplement the capabilities of the Royal Navy by designing and procuring a new class of flexible and light warships to enter service in the 2030s[2]. These vessels were to be introduced in support of 8 new Anti-Submarine Warfare Frigates (the Type 26 Global Combat Ship), two further Offshore Patrol Vessels, and committed the Government to maintain a fleet of 19 frigates and destroyers. The review also outlined objectives to promote the prosperity of the UK, including maintaining a more open, competitive and innovative sector, enhancing support to exports and creating the best conditions for the industry and its investment in skills and people.

A Green Paper was also published for consultation in January 2017[3] in support of the development of the Government's forthcoming Industrial Strategy which further emphasised the importance of the twin priorities of growing the prosperity of the UK and ensuring more people share in that prosperity. The Green Paper acknowledges regional disparities in productivity growth (which have continued to grow under successive governments despite considerable policy efforts to counter these[4]), and the role that industrial policy and public procurement can potentially play in rebalancing growth.

2.1.2 Parker Review

The 2015 SDSR also announced the development of a National Shipbuilding Strategy and, following its publication, Sir John Parker was commissioned to undertake an independent review of the shipbuilding industry in the UK to support the process. The review focused on the drivers of efficiency within the shipbuilding industry and its supply chain, with a view to outlining strategic principles that could be applied to raise both the productivity of the industry and increase its contribution of the prosperity of the UK.

Many recommendations were made to raise the efficiency of the shipbuilding industry. The majority related to the governance of procurement contracts (such as freezing designs, more rigidly defined contracts, and creating multi-annual capital budgets over a 30-year time

[2] National Security Strategy and Strategic Defence Review 2015, A Secure and Prosperous United Kingdom, www.gov.uk/government/publications/national-security-strategy-and-strategic-defence-and-security-review-2015
[3] Building Our Industrial Strategy: Green Paper, HM Government, January 2017, www.gov.uk/government/consultations/building-our-industrial-strategy (accessed March 2017).
[4] For example, many similar challenges were identified in the 2011 White Paper on Local Growth.

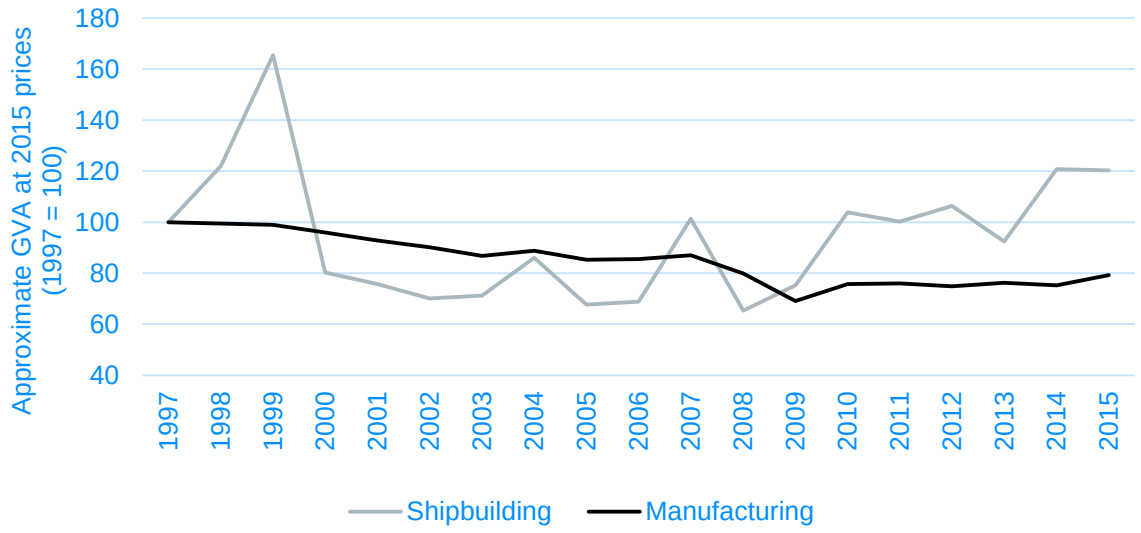
horizon). The review also made recommendations for an industrial strategy for the sector including the adoption of a virtual shipbuilding industry model (with blocks allocated to competing yards and built in series), encouraging suppliers to develop global competitiveness plans and invest in digital engineering technologies, and allocating a share of the contract price to invest in a Technology and Innovation Centre to help meet the industry's challenges in raising competitiveness.

2.2 Industry Context[5]

Output in the shipbuilding sector in the Great Britain was £1.6bn in 2015, 20 percent higher than in 1997 (in contrast to manufacturing overall which shrank by around 21 percent). Year-to-year fluctuations in output levels are typical and are likely linked to gaps between major shipbuilding programmes (Figure 2.1). The requirement for steel working skills in the industry enables it to serve other sectors that involve the manufacture of large steel pieces and diversification opportunities have been found in recent years, for example in supplying inputs for offshore wind turbines.

Employment in shipbuilding has been relatively stable since the early 2000s while growth in average labour productivity in the industry has broadly matched that of the manufacturing sector overall (Figure 2.2). However, productivity levels have been volatile which may be partly attributable to shipyards retaining capacity during gaps in production activity. Capital investment in the sector was also volatile relative to the manufacturing sector between 1997 and 2015. Over the entire period, capital investment as a percentage of total output was lower than for the manufacturing sector overall (at an average of 6.8 percent per annum, compared to 9.4 percent).

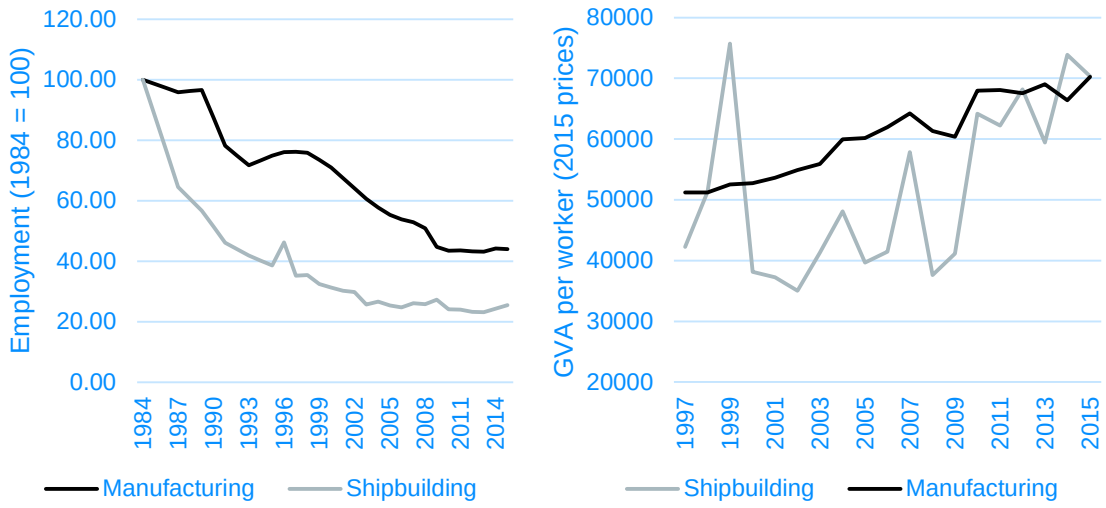
Figure 2.1 Approximate GVA, Shipbuilding and Manufacturing, GB 1997 to 2015



Source: Annual Business Inquiry (97 to 08) and Annual Business Inquiry (09 to 15).

[5] The figures in this section relate to the shipbuilding sector overall and includes both civil and military activity, as well submarine manufacturing.

Figure 2.2 Employment 1984 to 2017, and GVA per worker 1997 to 2017 (Shipbuilding and Manufacturing), Great Britain



Source: Annual Business Inquiry, Annual Business Survey, and Census of Employment, Office for National Statistics.

2.2.1 Wage Patterns and Skill Characteristics

Gross weekly pay in the shipbuilding sector rose in real terms from around £470 to £630[6] between 1997 to 2016 (growth of 35 percent[7]). Earnings for those working in the sector have been consistently higher than the manufacturing sector overall, and are around 20 to 40 percent higher than local averages for those areas containing a major shipyard.

The origin of the apparent wage premium is partly driven by the skill requirements associated with modern military shipbuilding. These include: complex design work: systems engineering and integration: high technology complex weapons systems; and combat systems integration skills[8]. BEIS commissioned research into the drivers of wage premia in defence industries[9] suggested that workers in military shipbuilding earned a wage premium of approximately 18 percent over those working in a civil capacity between 2012 and 2014 (rising from 10 percent between 2004 and 2011). More than half of the premium could be explained by differences in the characteristics of defence jobs from all other jobs, which are mainly driven by skill requirements. However, when comparing defence jobs with other jobs with similar characteristics, it appears that defence producers are willing to pay more to overcome a skills shortage than others in the economy (driving 3.5 percent of the 8 percent defence premium), while Primes in the sector are also willing to pay a premium.

2.2.2 Commuting Patterns

The extent to which shipbuilding activity will produce local prosperity impacts will depend on the extent to which shipyards draw labour from the communities in which they are based. There is little detailed information on the commuting patterns associated with shipbuilding

[6] Annual Survey of Hours and Earnings, Office for National Statistics.
[7] Though it is possible that some of these differences could be attributed to changes in the underlying methodology of the survey and the SIC classification used.
[8] Shipbuilding: Evaluation of Intervention with Clusters and Industries, Scottish Enterprise, 2005
[9] Exploring the Value of Jobs in the UK Defence Sector, BEIS, 2017

workers beyond the small area data that was captured in the 2011 Census[10]. The proportion of workers commuting less than 30km varied from 50 percent to over 80 percent in areas containing shipyards, while the percentage reporting that they work from home or from no fixed place was as high as 50 percent in some areas (who potentially represent on-site contractors). Stakeholders engaged in the study suggested that a variety of strategies were employed to manage workloads and risks. These included use of external contractors alongside a core labour force to manage peak loads, transferring workers between sites, and using migrant labour.

2.2.3 Supply Chain

The shipbuilding sector spent £2.8bn on goods and services[11] in 2015 (around 65 percent of turnover). The supply chain of shipyard contractors can be broadly decomposed into two broad groups of suppliers. The shipyard will procure a range of goods and services to build and outfit the hull, including spending with on-site contractors. Delivery of warships will also involve expenditure with Original Equipment Manufacturers (OEMs) to provide key systems and components. The ratio of combat systems to platform costs in modern warships is typically 2:1[12] , though this is linked to the sophistication of the systems involved ('off-the-shelf' systems are considerably cheaper than one-off bespoke systems developed specifically to enhance the capabilities of the warship). There is little evidence available on the nature of spending with OEMs, though information published on the Type 26 Global Combat Ship supply chain suggests suppliers are nationally dispersed. Stakeholders indicated that some of the sub-systems fitted to warships in the UK are the best in the world in their category (including in high value components such as radar technologies and missiles).

2.2.4 Research and Development

Real business R&D spending on shipbuilding has approximately doubled since 2004 (rising from £154m to £300m over the period)[13]. This growth in spending was more rapid than observed across the whole economy (33 percent). R&D intensity (i.e. R&D spending as a percentage of GVA) was also relatively high in 2015 at 18.5 percent of total output (compared with less than 2 percent for the whole economy). This was largely attributed by stakeholders to the design costs associated with the development of the Type 26 Global Combat Ship. Stakeholders suggested that there is little R&D undertaken by shipyards with an explicit focus on improving the efficiency of production processes. Although R&D spending has risen rapidly, the UK appears to be far from the technology frontier as far as can be assessed from the distribution of patents registered between 2005 and 2014[14]. Great Britain accounted for a small share of shipbuilding patents filed over the period (with those nations with strong commercial shipbuilding sectors - South Korea, China and Japan accounting for the majority).

2.2.5 Exports

The UK is estimated to have been the second largest exporter of defence equipment between 2006-15 behind only the US (with the UK accounting for $122bn or 23 percent of global defence exports over the period, based on orders and contracts signed). However, this appears to be driven to a large degree by high competitiveness in the aerospace sector rather than a comparative advantage in military warships. Eighty five percent of UK defence exports

[10] Origin Destination Statistics, 2011 Census, Office for National Statistics
[11] Annual Business Survey 2015, Office for National Statistics
[12] This compares with approximately 20:80 for commercial vessels.
[13] Business Expenditure on Research and Development, Office for National Statistics.
[14] PATSTAT, European Patent Office

were in the aerospace sector over the period (relative to 63 percent globally), while 7 percent were in the maritime sector (relative to 13 percent globally)[15].

The view from stakeholders is that while UK shipbuilders are currently unable to compete in relation to the production of simple, repeat vessels with shipyards in Japan, South Korea and China, they are potentially competitive in niche markets for complex, 'one-off' vessels with low production runs. However, the market for warships is constrained by national purchasing policies. The Department for International Trade has undertaken an extensive Government to Government consultation exercise identifying a potential market for 60 light warships over the next 15 years. However, the market will be highly competitive and it is believed that Government subsidies mean that some European competitors will sell at below cost. It may be potentially more feasible to export or license the designs of warships than the whole ships for many markets (as many developing and developed nations have shipbuilding industries capable of producing the ship to the required standards).

Exporting the ship design rather than whole ships can produce a benefit in that this type of design can include UK made systems as a standard option, thus promoting the use of UK components in ships built elsewhere in the world. Consultations with key purchasers have focused on identifying likely requirements to ensure that the necessary potentials are built in. This needs to respond to the different roles which the ships will need to play in different navies and the implications of this for requirements in relation to combat systems, sonars, etc – the suggestion is that 'cut here templates' should be incorporated so that different requirements can be readily accommodated.

[15] UK Defence and Security Export Figures 2015, Department for International Trade.

3.0 Analytical Framework

This section sets out an analytical framework for understanding the prosperity impacts of the procurement of naval vessels in the UK and how these might be potentially quantified. This section also considers how far key concepts align with the principles set out in the emerging HM Treasury Green Book in relation to the preparation of business cases and the associated implications for the necessary supporting analysis.

3.1 Defining Prosperity

Although the priority of increasing prosperity has taken on increasing significance in the policy agenda, stakeholders consulted in this study have noted that, as yet, there is no precise definition of the concept. There was consensus that the idea of prosperity is intended to extend beyond the measures of social welfare typically captured in Government economic appraisals (which largely focus on the aggregate supply impacts of public interventions). Numerous possible effects are potentially admissible under the umbrella of 'prosperity impacts,' such as raising the productivity of local economies, redistribution of income to those at the lower end of the income distribution, protecting areas from issues of long-term decline, and broader measures of subjective well-being or happiness.

There was some discussion with the Steering Group on how far the local environmental impacts of shipbuilding activities should be included under the concept of the prosperity. It was agreed that environmental impacts of all types (including those driven by CO2 emissions) would be excluded for the purposes of the study due to time and resource constraints. There are also issues regarding the defence, security and protection benefits of warship building which are of strategic importance but are highly challenging to measure and are treated as out of the scope of this study.

3.1.1 Wider Efforts to Measure Prosperity

There has been much interest in improving measures of living standards to include aspects that are not captured in traditional metrics (such as levels and trends in GDP per capita). These measures are often thought to have weaknesses because they do not capture how income is distributed across groups, improvements in the quality or availability of goods or services that are not reflected in prices, or the value of externalities that are not traded in markets (such as air quality or access to the natural environment). Measures of GDP also do not capture subjective well-being or happiness. This has led to numerous proposals as to how living standards or prosperity might be better measured, and several indices have been constructed to capture these additional aspects. There are several areas of commonality across these indices that could form the basis of a framework for measuring the prosperity impacts of shipbuilding activity over time:

- **Economic prosperity**: Most indices involve some form of measure of economic prosperity (income, employment, or consumption) as a core indicator. Income inequality is also included as a metric in some indices.
- **Economic safety**: Some measures supplement economic prosperity with a measure of economic safety (for example, certainty or security of employment).

- **Education**: Education and training is included in most indices as a measure representing the quality of opportunities available to the population.
- **Health**: Health is included in almost all indices, typically measured by life expectancy and extended in some cases with measures of the prevalence of behaviours likely to cause negative health outcomes.
- **Crime or physical safety**: Physical safety is also included in many indices. This typically refers to prevalence of crime, extended in some cases to exposure to threats to physical safety (such as natural disaster or road safety).
- **Democratic rights and freedoms**: Many indices also include the role of institutions in guaranteeing basic rights and freedoms as a key measure of prosperity.
- **Social interaction and leisure**: Levels of social interaction, civic participation, strength of community, and work-life balance are also widely considered as key measures of quality of life or prosperity.

However, not all of the dimensions above are necessarily useful because they will not be influenced either directly or indirectly by shipbuilding activity (and not all can be monetised):

- Procurement of military warships from UK shipyards may influence the extent to which democratic rights and freedoms are protected through safeguarding capacity to produce military hardware. However, as noted above, while these issues are of strategic importance, the challenges involved in quantifying these effects are likely intractable and this item is excluded from the suggested index.
- Additionally, the links between shipbuilding activity and health, crime, and community outcomes will be at best indirectly felt (raising questions as to how far they would be helpful or credible measures to include within a framework for assessing the relative impacts of different procurement options).

3.2 Prosperity Impacts of Shipbuilding

This section outlines a framework for understanding the prosperity impacts of decisions to procure naval warships from shipyards in the UK.

3.2.1 Effects driven by the Shipyard

The receipt of a new order for naval vessels will require the shipyards involved to increase overall output to produce the required blocks or finished ships. The size of the effect will depend on how far the commitment to the construction of naval vessels results in crowding out of other activities at the shipyard (such as maintenance and repair or civil activities). Any net increase in output (or safeguarding of output where procurement serves to maintain activity) might be expected to lead to the following chain of events:

- **Increase in employment**: Increasing output may require the shipyard to increase employment to meet the increase in demand. The shipyard will face options to increase capacity, including recruiting workers from the local economy or elsewhere in the UK, importing labour from overseas territories, and increasing use of contractors to supply the required labour inputs. Choices could be influenced by levels of certainty regarding future workloads.

- **Change in economic security**: The prosperity gains involved will partly depend on the level of permanence associated with these positions and will be driven by the choice of the shipyard on how far to employ permanent staff or to use temporary or contract labour (potentially visible in claimant flows).
- **Decreases in unemployment**: Unemployment will fall to the degree to which the shipyard meets any increase in labour demand through recruitment from the pool of resident unemployed workers.
- **Education and training opportunities**: The new order may create incentives for the shipyard to train new workers (particularly if it faces challenges in obtaining the skills required in the labour market). It should be noted that apprenticeship programmes are typically 3 or 4 years long, which will create limits as to how far the overall increase in labour demand can be met by training new entrants.
- **Increased capital investment**: The shipyard may also seek to reduce the overall labour requirement by investing in new capital equipment or making other investments that raise labour productivity.
- **Increased earnings**: As the shipbuilding industry offers higher wages than other manufacturing sectors, jobs and earnings tend to be higher than local averages. The above effects could be expected to lead on to higher incomes for any new workers or trainees recruited by the shipyard, and may help reduce regional disparities in income if increased activity draws lower income residents into the workforce.
- **Redistributive effects**: To the extent that any increase in demand for labour leads to the employment of individuals who would have otherwise remained unemployed (or long-term unemployed), then there may also be redistributive effects.
- **Well-being**: The combined effect of the above processes would be expected to result in further prosperity gains in the form of increased subjective well-being.

The above effects may also play out across varying time horizons, and some shipyards make take time to respond to the increase in demand.

3.2.2 Indirect and Induced Effects

An increase in output would also be expected to lead to an increase in supply chain spending. This will include:

- **Shipyard spending**: Direct spending by the shipyard on the intermediate goods and services needed to deliver the block or vessel.
- **Original Equipment Manufacturers**: Spending with original equipment manufacturers on on-board systems.

These type of effects (commonly known as supply chain multiplier effects) would be expected to produce a similar pattern of effects to those described in the section above. Additionally, impact assessment methods have traditionally identified the likelihood of wider induced effects as those who have derived higher incomes from the direct and supply chain effects increase their consumption expenditure, although the extent of such effects is generally acknowledged to be more speculative. However, increases in demand both at the shipyard and across the supply chain will place pressure on wages and other input prices, triggering offsetting general

equilibrium effects whereby other producers reduce their demand for those inputs in response. The overall prosperity gain will be driven by the net effects involved.

3.2.3 Research and Development

Further prosperity gains might be expected if the shipbuilding programme involves R&D spending to design the ship, improve the efficiency of production processes at the shipyard or to develop new sub-systems. This spending may lead to production of new knowledge that can be exploited by shipyards or OEMs to raise productivity or generate spill-overs as other firms 'free-ride' on the original investments made. Improvements in productivity resulting from R&D activities may result in other prosperity gains to the extent that they feed through into greater earnings for workers (or demand for additional workers). Workers may also benefit from the acquisition of new skills or experience through the R&D process, improving their employability (assuming those skills are transferable to other contexts).

3.2.4 Exports

Increases in export activity are also best characterised as a demand side effect and subject to the same types of issue associated with crowding out described above. Increases in exports have the potential to lead to improvements in overall social welfare (and prosperity) through increasing demand for sterling (thereby increasing its value relative to other currencies at the margins). In turn, this will reduce the price of imports, leading to improvements in real incomes. This will also reduce the competitiveness of other exporters, increasing demand for imports, and having the opposite effect on the currency. The net effect is almost certainty unquantifiable and cannot therefore reasonably be included within an appraisal of a military procurement decisions.

The shipbuilding programme could lead to greater export demand via a variety of mechanisms. The ship or its systems may attract international interest and, if this leads to additional procurement from UK shipyards or OEMs, this would reinforce the scale and longevity of the types of effects described in the preceding sections. Increased export demand could arise in other ways – for example, if the procurement improves the competitiveness of UK shipyards in international markets, they may secure further export work in producing warships or other low production run contracts. Licensing of the design would be less likely to create the types of prosperity gains captured within the framework (as the potential benefits would likely accrue as income to holders of the relevant intellectual property rights without the wider effects of creating jobs, improving productivity, and so forth).

3.2.5 Other Prosperity Outcomes

The procurement decision may protect individuals and areas from social problems associated with long term unemployment. Where shipyards are highly significant local employers, the procurement decision could insulate an area from the risks of longer term 'scarring' (or hysteresis effects) that result in long term unemployment or under-employment of individuals. These types of effect can also occur where the loss of a locally significant employer causes selective out-migration of skilled labour or otherwise reduces incentives for firms to locate in the area (permanently reducing levels of economic activity and disproportionately affects those residents less able to adjust by moving to more buoyant local economies).

3.2.6 Prosperity Metrics

Based on the analysis above, a range of potential metrics of the prosperity impacts of shipbuilding are set out in Table 3.1. These have been divided into 'prosperity metrics' that capture the key dimensions of prosperity, and 'intermediate' metrics that measure aspects that

may produce gains or losses in prosperity. There are some issues to be alert to in the selection of these metrics:

- There is scope for double counting across the metrics (e.g. the wage premia associated with education and training opportunities will also be captured in measures of wage income and could be considered redundant). The monetary value of improvements in life satisfaction will also capture the value of many of the other prosperity measures set out in the table.
- The prosperity gains of shipbuilding may not be positive under all scenarios. For example, a shipyard may choose to expand its output by externalising risks to on-site contractors, potentially creating issues of economic security for those employed. Equally, allocating block construction across multiple shipyards may increase the spatial distribution of employment impacts but come with costs in terms of reduced efficiency.

Table 3.1 Working Definition of Prosperity: Key Metrics

Dimension of prosperity	Intermediate Metrics	Prosperity Metrics
Income	R&D spending Capital investment	Net effects on: Economic output (GVA) Total factor productivity (TFP) Average labour productivity GVA created by productivity gains Wage income Measurable productivity and other relevant effects arising from the exports of ships, systems and designs
Employment		Net number of jobs
Unemployment		Net effects on: JSA claimants Long term JSA claimants Out of work benefit claimants
Economic security		Net effects on: Full-time jobs Part-time and temporary jobs Jobs with contractors Claimant on-flows
Income inequality		Net effects on income distribution
Education and training	No. of apprenticeship opportunities	Net increase in wages resulting from training
Subjective well-being		Improvement in life satisfaction Monetary value of improvements in life satisfaction
Strength of community	Outmigration	

3.2 Local Analysis of Prosperity Gains

The spatial distribution of the prosperity gains associated with increases in shipbuilding activity (i.e. how far those gains accrue to the local area in which the shipyard is located) will differ across areas depending on the characteristics of the shipyard, its recruitment behaviour, and its supply chain. These include:

- **Spatial distribution of the workforce**: The extent to which prosperity gains accrue to the local area will partly depend on how far the shipyard draws its workforce from the surrounding area. The strength of local prosperity gains will be dampened, for example, if the shipyard seeks to satisfy labour demand by using workers from other sites, or recruits from national or international labour markets.
- **Depth of the local supply chain**: The strength of local effects will also be driven by the extent to which suppliers are located in proximity to the shipyards (and the spatial distribution of their workforces).
- **Strength of local R&D spill-over effects**: To the extent that any R&D associated with the development of the warship and its systems results in spill-overs, then there may be further prosperity gains where these occur locally.
- **Long-term scarring or hysteresis effects**: The risk of hysteresis will be largely a local issue, and will be determined by how far the area would adapt to the changing economic circumstances associated with a loss of shipbuilding activity. Areas that are more dependent on the shipyard are likely to be more exposed to these risks.

3.3 Alignment with the Green Book

The HM Treasury Green Book is the key Government framework for considering the relative costs and benefits of different options for public sector interventions. The framework is grounded in the principles of cost-benefit analysis, seeking to provide a common analytical approach for assessing the overall social welfare impacts of Government decisions. Economic appraisals should (broadly speaking) consider all welfare gains and losses associated with public interventions regardless of to whom they may accrue. There are some exceptions, including that only the welfare of UK residents should typically be considered within an economic appraisal. As such, the emphasis of the Green Book is on understanding costs and benefits at a national level. The prosperity metrics described in the preceding sections do not always align neatly with these principles, and this section provides an overview of the possible tensions between the two analytical frameworks and describes how they could potentially be reconciled[16].

3.3.1 Counterfactual or Reference Case

Implementation of an economic appraisal aligning with Green Book principles will require an assessment of the costs and benefits associated with the procurement options under consideration.

[16] It should be noted that the analysis below is based primarily on the principles set out in the 2003 edition of the Green Book. A refreshed version of the Green Book is nearing completion and approval and HM Treasury was consulted as part of the study to understand the possible implications of the refresh.

This introduces complexities that would need to be considered:

- **Macro-level spending constraints**: Procurement decisions should be viewed within the context that overall public spending budgets are set by the HM Treasury, and in any counterfactual scenario or reference case it can be assumed that the relevant resources will be otherwise expended on unknown alternative uses. As the relative cost-effectiveness of these counterfactual scenarios is unknown, it is reasonable to assume the impacts of the decision to procure military vessels (as opposed to not procuring[17]) are neutral in social welfare terms at the national level.
- **Choice of local shipyard(s)**: Where the procurement decision is a choice between selecting which shipyard or shipyards will be the lead contractor and manufacturers of the blocks, the overall prosperity gains of these types of decision will be negligible at a national level (as an increase in production at one shipyard will be largely offset by a reduction at others). Spending associated with OEMs are also unlikely to be affected by the choice of local shipyard (implying that local analysis should focus on hull construction).
- **Domestic versus overseas procurement**: For auxiliary ships, there is a possibility that the procurement choice is between domestic and overseas suppliers. These decisions will have national implications. Where vessels are purchased from overseas suppliers, the benefits associated with production will accrue to residents of those territories while there will be a benefit to the UK of potentially being able to procure the vessel at a lower cost. Other relevant costs and benefits would need to be estimated to provide an overall assessment of the change in social welfare.

3.3.2 Demand side impacts

Treatment of the prosperity impacts of shipbuilding procurement decisions will require consideration of general equilibrium issues. The procurement of a military vessel involves a demand side stimulus and under conditions of full employment, an increase in demand would be expected to increase pressure on prices. This would trigger offsetting effects by encouraging other producers to reduce their usage of those inputs (a crowding out effect that restores employment to long term general equilibrium levels). Such effects may be considered likely regardless of local levels of unemployment given the relatively high skill nature of shipbuilding activity. In light of this, an increase in shipbuilding activity may not be considered likely to produce significant increases in employment or reductions in unemployment at a national level.

3.3.3 Supply Side Impacts

Economic impacts should only be included to the extent that they involve an expansion of the overall productive capacity of the economy, typically through increasing productivity or enhancing the supply of inputs. In the context of a decision to procure a military vessel from a domestic or overseas supplier, there may be national level impacts driven by the creation of training opportunities, capital investment, or R&D spending. Treatment of these types of effect are also problematic, as they involve the consumption of inputs that are made unavailable to other industries or firms and other opportunity costs that should be accounted for (such as leisure time forgone).

[17] This would qualify as the ‘do nothing or do minimum’ option that is typically considered as the reference case in Green Book appraisals.

3.3.4 Hysteresis Effects

The areas within which the shipyards are based may differ in their exposure to the risks of long term scarring effects associated with a decline in shipbuilding activity. Decisions to procure in areas which face the greatest risks have the potential to result in social welfare improvements in the form of the value of output that would have otherwise been lost (which would be reflected in local incomes as well as the profits of the shipyard).

3.3.5 Redistributive Effects

The Green Book permits analysis of the redistributive effects of Government spending decisions. The application of this approach creates some challenges as it requires knowledge of the groups affected and, as described above, the counterfactual scenario. If the choice being made is between different UK sites that might produce the vessel, then it is highly unlikely that there will be any redistributive effects associated with a military procurement decisions at the national level (as one area will gain at the expense of another) though this would change under a scenario where the choice being made relates to producing a vessel within the UK or overseas.

3.3.6 Exports

Increases in export activity are also best characterised as a demand side effect and subject to the same types of issue associated with crowding out described above. However, where increases in exports produce long term effects on productivity, then a valuation of those outcomes would potentially be permissible under the guidelines of the Green Book. For example, greater exports may increase certainty regarding future workloads, encouraging shipyards to undertake human and physical capital investments. Additionally, while exportability is unlikely to be influenced by the choice of local shipyard, additional export demand may – in general terms - have the potential to produce redistributive effects through further creating or sustaining highly paid jobs in low income local economies.

3.3.7 Well-Being and other Non-Market Effects

The HM Treasury Green Book does not rule out consideration of non-market effects such as improvements in well-being. However, there are numerous challenges in monetising these types of effects arising from conceptual and empirical issues in valuing improvements in subjective well-being. While there has been recent interest in valuing changes in life satisfaction, these methods remain experimental and their findings are not recommended by HMT for inclusion within a core business case for public intervention.

3.3.8 Local Analysis

The refreshed Green Book will make provision to provide local analyses alongside an assessment of national level impacts. This would involve the following considerations:

- **Local employment and unemployment impacts**: While local analyses will need to address issues of crowding out at a local level, increases in shipbuilding activity may lead to net increases in employment at local levels.
- **Multiplier effects**: It is understood that the refreshed Green Book guidance may not permit the inclusion of any supply chain multiplier effects and will certainly exclude potential second and subsequent round effects. Exclusion of even first round effects could be problematic in the context of shipbuilding given the variability in use of subcontractors to meet peak demand across shipyards.

3.4 Metrics for Potential Inclusion

The above analysis suggests that there may be merit in undertaking an analysis of the effects of decisions to procure military warships at three levels depending on the nature of the procurement decision under consideration:

- A national welfare analysis of the effects of military procurement decisions completed in accordance with the HM Treasury Green Book is appropriate where the decision being made is between procuring a vessel from a domestic or overseas supplier. Such an analysis will also be appropriate where the decision being made has the potential to avoid or produce significant hysteresis effects by enabling a shipyard to remain open (or force its closure). This form of analysis would need to treat additional R&D, capital and training spending as a cost of the procurement decision, with the primary benefit monetised in the form of the additional output arising from gains in the productive capacity of the economy.
- An assessment of the relative scale of local impacts associated with those decisions (hypothetically involving a comparative analysis across the different shipyards being considered, though this may raise politically sensitive issues).

Table 3.2 describes which prosperity metrics identified in Table 3.1 could potentially be included within the scope of each of these analyses. These indicators serve as a framework for the following sections, which explore the available evidence that could be used determine the quantitative magnitude of the effects associated with the procurement of naval vessels.

Table 3.3: Potential Metrics for Inclusion as Part of National and Local Analyses

Dimension of prosperity	Intermediate Metrics	National Analysis	Local Analysis	Prosperity Metrics	National Analysis	Local Analysis
Income	R&D spending			Net effects on:		
	Capital investment			Economic output (GVA)		
				Total factor productivity (TFP)		
				Average labour productivity		
				GVA created by productivity gains		
				Wage income		
				Measurable productivity and other relevant effects arising from the exports of ships, systems and designs		
Employment				Net number of jobs		
Unemployment				Net effects on:		
				JSA claimants		
				Long term JSA claimants		
				Out of work benefit claimants		
Economic security				Net effects on:		
				Full-time jobs		
				Part-time and temporary jobs		
				Jobs with contractors		
				Claimant on-flows		
Income inequality				Net effects on income distribution		
Education and training	No. of apprenticeship opportunities			Net increase in wages resulting from training		
Subjective well-being				Improvement in life satisfaction		
				Monetary value of improvements in life satisfaction		
Strength of community	Outmigration					

4.0 Literature Review

This section sets out key findings of a review of the academic literature available that explores the prosperity impacts of shipbuilding activity. The section focuses on the evidence relating to the key metrics identified in the previous section.

4.1 National Welfare and Prosperity Impacts

This section examines the findings on the available literature with respect to the key metrics of interest at a national level (i.e. measures of the supply side impacts of shipbuilding activity that could feed into a welfare analysis).

4.1.1 General productivity impacts of shipbuilding procurement

Several studies reviewed explored the relationship between different warship procurement options and associated productivity impacts:

- **Competition**: A single study examined the effect of competition in raising the productivity of shipyards[18] in the context of the Type 45 destroyer. At the time, only two UK yards had the physical facilities, management, labour experience and financial resources to construct Type 45 warships. Questions explored included: the potential benefits expected from monopolistic versus a competitive industry; whether the destroyer should be assembled in blocks produced at several yards, and, whether the work should be allocated on a directed or competitive basis. Overall, the study concluded that the sole-source option was the least-cost option. One alternative involving block building in different shipyards was estimated to increase costs by about 4 percent over the sole-source option of BAES building all 12 ships. However, the results of the study were qualified and the conclusion was that none of the options was dominantly superior to the others.
- **Gaps in production**: Maintaining the capacity to produce military warships creates a substantial challenge in managing gaps between production programmes. This has proven an issue of concern for the UK submarine industry, which in 1999 faced unprecedented gap in design and production work of 8 years between completion of design work on Astute and the start of detailed design work on the Future Attack Submarine (FASM)[19]. Gaps in design and production work were expected to have an impact on those skills and facilities which are unique to submarine design, construction and integration. A Rand study looking at Australia's Future Frigate programme[20] identified some key issues relating to workforce learning and productivity and the challenge of managing gaps in work. Rapid build-up of the workforce for a new shipbuilding program might affect quality assurance, especially if labour lacks the necessary skills and experience. There are also challenges in sustaining shipbuilding capability once a naval

[18] The Royal Navy's New-Generation Type 45 Destroyer, Acquisition Options and Implications, Rand Corporation, 2002. Available at: www.rand.org/pubs/monograph_reports/MR1486.html.
[19] FASM Industrial Base Study, Keith Hartley for Ministry of Defence, 1999.
[20] Keeping Major Naval Shipbuilding Acquisitions on Course: Key Considerations for Managing Australia's SEA 5000 Future Frigate Program, Rand Corporation, 2014. Available at www.rand.org/content/dam/rand/pubs/research_reports/RR700/RR767/RAND_RR767.pdf

program has ended. Suggested solutions to the gap problem in a later study included starting work earlier on the new frigates or building more existing naval vessels. It was expected to be costly to sustain more than two shipyards and the long-term solution to the work gap was a continuous build strategy of 1.5 to 2 surface ships.

- **Outsourcing and advanced outfitting**: One 2005 study[21] focused on the UKs Future Aircraft Carrier programme and the economic implications of using alternative manufacturing options in the form of advanced outfitting and outsourcing. Both options were considered as possible means of providing the industrial capacity needed for the carrier programme and other UK naval requirements. The study found that: outsourcing was limited because the UK subcontractor base was very limited; policy-makers should not expect total outsourcing to lead to significant cost savings; and that, for the Future Carrier programme, there were opportunities for outsourcing accommodation and personnel support functions (e.g. hotel functions). Rand suggested that UK shipbuilders could expand their levels of outfitting (EU and US shipbuilders undertake higher levels of outfitting).

4.1.2 Training and Impact on Productivity

No studies were found that explored training and productivity effects in a shipbuilding context. However, there is a considerable body of literature on the wage and productivity impacts of training in general. For example, a review for UKCES suggested an annual wage premium from an intermediate level apprenticeship of 8.9 percent, and 19.0 percent for an advanced apprenticeship[22]. For comparison, the net cost to employers per apprentice per annum has been estimated at £4,816, taking into account apprentice pay, recruitment costs, course fees, administrative costs and supervision costs. Other researchers have identified substantial variations in the estimated returns to vocational qualifications for different qualification, levels, subjects and points of the wage distribution[23].

It is important to note that the findings from these studies do not suggest that additional apprenticeships in shipbuilding would have a net effect on wages of this scale. These studies consider a counterfactual of no training rather than what individuals might have done had they not received the training. It is reasonable to suggest that some individuals will acquire other skills that would have been valued to either a greater or lesser extent, making the results difficult to transpose to procurement decisions.

4.1.3 Research and Development and Impacts on Productivity

There is evidence of significant technical progress in shipbuilding. Over the 20-year period 1975 to 1995, the design and construction time for frigates was roughly halved with labour productivity improving by a similar magnitude. Part of this productivity improvement resulted from changes in labour practices, including reduced demarcation and training in more than one trade[24]. However, the literature makes few references to technology spill-overs from warship building and there are no examples equivalent to those from aerospace where examples

[21] Outsourcing and Outfitting Practices: Implications for the Ministry of Defence Shipbuilding, 2005, www.rand.org/content/dam/rand/pubs/monographs/2005/RAND_MG198.pdf
[22] Forecasting the Benefits of the UK Commission's Programme of Investments: Evidence Report 80, UKCES, 2013. Available at www.gov.uk/government/publications/forecasting-the-benefits-of-ukces-investments
[23] See for example: Labour Market Returns to Vocational Qualifications in the Labour Force Survey, LSE, 2016. Available at http://cver.lse.ac.uk/textonly/cver/pubs/cverdp002.pdf
[24] British Aerospace Public Limited Company and VSEL plc: A Report on the Proposed Merger, Monopolies and Mergers Commission, CMND 2851

include the jet engine, radar, composite materials and Formula 1 racing cars[25]. The application of stealth technology to warships is an example of a 'spin-in' (from aerospace). If there are examples of technology spill overs from warship building, they may be more likely to arise in the systems sector than in the hull construction industry. Examples include: power generation management systems, sensors and sonars, acoustics, uninhabited maritime systems and submarine technologies.

A more recent study explored the diffusion rates of military-funded R&D aiming to examine how far the knowledge spill-overs occurred more or less rapidly than in the civilian sector. The study noted that some technologies arising from military R&D spending such as internet and semi-conductors spurred large numbers of subsequent innovations whilst others such as light-water nuclear reactors and stealth technology have not had such large-scale spill-over effects. Examples from aircraft, computers, the internet, nuclear power, semi-conductors and satellite technologies show that without defence funding, the appearance of each technology would have been significantly delayed (though there are no mention of shipbuilding examples in this study). An analysis of patent records from patent data from 35 organisations was used to test several hypotheses, and found that military and civilian patents diffuse at similar rates[26].

A final recent study of relevance for this review is an international study examining the relationship between defence R&D, productivity, and spill-overs[27]. The study sought to address a range of questions regarding the economic impacts of defence R&D spending, using international panel data. The results suggested:

- **Domestic R&D spending**: Domestic military R&D (and public R&D in general) had a crowding-in effect, with every $1 of public spending leading to an additional $4 in private R&D spending. This effect is visible in higher levels of R&D employment (not just wages). A permanent increase in the ratio of defence R&D spending to total output of one percentage point results in an increase in TFP growth of 5 percent.

- **Foreign R&D spending**: The study also found that foreign defence R&D spending had two offsetting effects. Firstly, foreign public R&D spending was found to displace domestic R&D spending by domestic firms, causing productivity losses. However, domestic productivity also rose due to international knowledge spill-overs (with these spill-overs being more significant where countries were geographically proximate). The overall net effect was small but positive.

The results from this study could potentially form the basis of metrics to capture the impact of R&D spending associated with military warship procurement. It should be, in principle, possible to estimate the R&D spending associated with warship contracts as a percentage of total military R&D, enabling an approximation of the likely effects on TFP growth[28]. Issues arise as to how far any R&D spending associated with warship procurement can be treated as permanent. Given the lack of evidence of spill-overs from shipbuilding, there are also questions as to how far these estimates would overstate the effects involved.

[25] The Political Economy of Aerospace Industries, Keith Hartley, 2014
[26] The Diffusion of Military Technology, J. Schmid, Defence and Peace Economics, 2017
[27] The Intellectual Spoils of War? Defense R&D, Productivity and Spillovers, Moretti, Steinwender, and Van Reenen, 2016. Available at: http://eml.berkeley.edu/~moretti/military.pdf
[28] Some compromises may need to be made to convert this to a measure of the increase in aggregate supply as TFP is not measured in conventional units. An approximation could be possible by assuming the increase in TFP growth will be also be reflected in changes in average labour productivity, enabling the increase in productive capacity to be estimated in monetary units.

4.1.4 Exports

There was little mention of the role of military shipbuilding in supporting exports in the literature reviewed in the study. A 1995 report on the proposed merger between British Aerospace and VSEL, and between GEC and VSEL[29], suggested the commission viewed the export market for warships as extremely limited because it is politically protected in other Western nations and, where it is open (e.g. Middle and Far East), there is strong competition from excess capacity in other Western shipyards (often heavily subsidized). This largely aligned with the stakeholder views gathered as part of this study.

4.2 Local Welfare and Prosperity Impacts

4.2.1 Local and Regional Employment and Wage Impacts

Regional multipliers measure the economic impact of increased or reduced spending on levels of regional income, output and employment. Within the defence economics literature, they have been used to assess the local economic impact of spending on new equipment projects, project cancellations, and the impacts of large military bases on their local economies. However, over a 26-year period, there were relatively few papers on the regional impacts of defence spending.

The size of regional multipliers will depend on the magnitude of leakages of expenditure from the regional economy, reflecting the different import propensities of different industries and the spending propensities of the labour force. One UK study provided a detailed account of the industrial and regional impacts of the UK's decision to replace its nuclear deterrent[30]. This identified major suppliers and several UK towns and regions that are dependent on a Trident replacement, especially BAE Systems' submarine facility at Barrow-in-Furness, Cumbria. BAES' Barrow facility has three distinctive features. First, submarine construction requires skills and facilities which are specific to submarines. Second, BAES is the largest employer in Barrow - it is a submarine-dependent town. Third, Barrow has a unique location: it is the only major town in a geographically remote region with few alternative employment opportunities. A further case study of supply chains in the South West of England found that defence-dependent firms are more likely to purchase inputs locally than less defence-dependent firms. This finding suggests that the defence industry supply chain (at least in the South-West) is more locally concentrated than civilian supply chains, a result which suggests that defence spending will have higher regional multiplier effects than equivalent civilian spending[31].

Estimates of regional employment multipliers in the defence sector have ranged between one and two indicating that each direct job in defence supports up to one additional job indirectly elsewhere in the regional economy[32]. One of the few UK studies of the regional impacts of a military base explored the economic impacts of the naval base at Portsmouth in 2003-04. It found regional output and employment multipliers of 1.55 and 1.44, respectively (e.g. the employment multiplier suggested that every 100 direct jobs led to a further 44 jobs in the sub-regional economy). Details are presented of direct employment, first-round multiplier effects

[29] British Aerospace Public Limited Company and VSEL plc: A Report on the Proposed Merger, Monopolies and Mergers Commission, CMND 2851
[30] Defence Industrial Issues: Employment, Skills, Technology and Regional Impacts, Keith Hartley, 2012
[31] The Defence Industry Supply Chain: Linkage Patterns in the South West of England, T. Williams, 2000
[32] See The Regional Impact of Defence Expenditure, in Handbook of Defense Economics, D. Braddon, 1995, and Success and Failure in Defense Conversion in the Long Decade of Disarmament, M. Brzoska, 2007

and the types of jobs created by the multiplier process[33]. However, it should be noted that these studies have largely estimated multiplier values based on input-output tables, which do not account for general equilibrium effects and offer little guidance on the true value of local and regional multipliers as a result[34].

4.2.2 Unemployment, Hysteresis and Outmigration

The response of a region to a reduction or increase in defence spending will depend on the operation of local labour markets: how well and how quickly local markets are able to adjust and respond to change. Few studies address these issues and all focus on the impacts of reductions in defence spending.

There have been several studies of the regional impacts of military base closures (though not in the UK). A study of base closure in Sweden during the early 1990s focused on the impact on average income growth and net migration rates, both of which affect the local authority's ability to provide public services. The study concluded that base closures had no significant effect on average income growth and net migration rates[35]. A similar study of base closures in Germany started from the proposition that a military base could be viewed as a form of regional subsidy from the central government to the local community. Closure represents a negative demand shock leading to a deterioration of socio-economic indicators such as household income, regional output and unemployment. Unlike base closures in the USA, the German cases were based on military and not on political and socio-economic criteria. In Germany, base closures "hardly made a dent in the local economy". This reflected the relatively small size of German military bases and their self-sufficient and autonomous nature[36].

Of relevance to the current study was the closure of the Swan Hunter shipyard. Swan Hunter went into receivership in 1993 following its failure to win a key Ministry of Defence order (HMS Ocean). Of those made redundant, 44 percent were employed at the time of the survey and 39 percent were unemployed in 1998 (the rest were retired, sick or in training). Age and skill levels were determinants of unemployment. Most of those who were in employment remained in the North-East (78 percent) but 15 percent obtained jobs elsewhere in the UK and 5 percent were working abroad[37]. The 1995 Monopolies and Mergers Commission reports also estimated the employment and unemployment effects of closing the yards at VSEL and Yarrow, highlighting the importance of local factors in determining exposure to hysteresis issues: while Barrow is geographically remote from other industrial and commercial centres, Glasgow was Scotland's largest city and the main manufacturing centre of the region, providing workers with employment opportunities outside shipbuilding[38].

The economic impacts of closures in other industries have been more widely explored. Examples are presented from the automotive and coal industries.

MG Rover

The MG Rover plant at Longbridge closed in April 2005 with the loss of over 6,000 jobs with additional job losses estimated at some 25,000 in the supply chain. Inevitably, the closure was

[33] Analysing Defence Dependency: The Impact of the Royal Navy on a Sub-regional Economy, 2007
[34] Local Multipliers, Enrico Moretti, American Economic Review, Papers and Proceedings, 2010. Available at http://eml.berkeley.edu/~moretti/multipliers.pdf
[35] Regional Effects of Military Base Closures: The Case of Sweden, L. Andersson, 2007
[36] The Regional Economic Effects of Military Base Realignment and Closures in Germany, A.R. Paloyo, 2010
[37] Defence Closure and Job Loss: The Case of Swan Hunter on Tynesdie, A. Pike, 2000
[38] The General Electric Company plc and VSEL plc: A Report on the Proposed Merger, Monopolies and Mergers Commission, CMND 2851, 1995

associated with claims of 'devastation and catastrophe' for the local economy. The reality was different[39]: the impact was reflected in an immediate increase in local unemployment (rising from 3.9 to 6.2 percent between April and May 2005 but 10 years later, local unemployment had returned to its pre-closure levels (3.7 percent in January 2015). A detailed study[40] of the MG Rover closure found that its economic impacts were more complex than reflected by trends in local unemployment rates. By April 2008, about 90 percent of ex-MGR workers had obtained some form of employment, with almost 75 percent employed full-time, 11 percent self-employed and 5 percent employed part-time (only 5 percent of workers remained unemployed and searching for work). However, there was shift of employment from manufacturing to services, and workers experienced significant pay cuts with average pay falling by £5,640 in real terms by April 2008. The wage falls were concentrated amongst those working in the services sector.

Coalfields

Since 1985, the UK coal industry has lost over 250,000 jobs and over 150 collieries were closed. No other UK industry in modern times has experienced such a scale of job losses. Commentators view coal as a study of major industrial decline and the responsiveness of government policy to adapt to such rapid decline[41]. There is a long tradition of pit closures in the UK. Typically, coal seams became exhausted leading to pit closures, with miners willingly moving to a nearby pit. The last UK deep coal mine closed in December 2015. Often, pits were the dominant or only employer in local communities. Examples included the Yorkshire pit villages of Grimethorpe, Fitzwilliam, South Elmsall and Barnsley. Similar pit villages dominated the North-East (e.g. Easington, Horden, Seaham) and South Wales. Pit closures had an immediate and devastating impact on the local community leading to higher local unemployment (especially where there were no other pits nearby).

Miners often lacked academic qualifications and found it difficult to find new jobs, especially in the service economy. Pit closures meant that the local community faced the challenge of promoting the regeneration of the former coalfield areas. The pits often supported a range of local services (e.g. housing; sports facilities; brass bands), many of which disappeared with pit closures. Studies of alternative estimates of unemployment in coalfields suggested unemployment might be 2-3 times the level recorded by the official claimant count. Other problems include ill health, poverty and crime.

A study of three coalfields in Scotland (Lothian), South Wales (Central Valleys) and South Yorkshire examined their regeneration and their dependence on links with neighbouring cities. There were some interesting findings about local labour markets for English and Welsh coalfields over the period 1981-2004. Over this period there were job losses in coal of 222,000. Within this total, it was found that[42] there was a fall in recorded unemployment of 75,000 men, while replacement non-coal jobs for men in other sectors of the coalfield totalled 132,000 personnel (60 percent of job losses). The reduction in economic activity for men totalled 162,000 individuals. These were additional men aged 16 to 64 who were neither in employment nor recorded as unemployed: they had withdrawn into economic inactivity. Net outward migration by men totalled 58,000. From the recorded and low unemployment figures, it appeared that the coalfields had recovered from job losses caused by pit closures. The large

[39] The Closure of MG Rover, National Audit Office, 2006
[40] Plant Closures and Task Responses: An Analysis of the Impact of and Policy Response to MG Rover in Birmingham, D. Bailey, 2014
[41] Coalfield Regeneration, K. Bennett, 2000
[42] Coalfields and Neighbouring Cities, S. Fothergill, Joseph Rowntree Foundation, 2007

rise in economic inactivity for men showed a diversion of non-employed adults away from recorded unemployment into incapacity benefits.

4.3 Summary

- **Supply side effects of procurement options**: The literature offers some guidance and general lessons on the types of issue that that will raise or lower productivity in the shipbuilding industry, including many that were considered in the Parker Review. These include the importance of freezing designs to maximise the benefits of learning across units and effective management of gaps in shipbuilding programmes to maintain capabilities and skills (though prior studies suggest that block construction in separate yards has the potential to reduce efficiency). However, these studies offer little in the way of metrics that could be applied on a generic basis as part of an ex-ante evaluation of the costs of different procurement arrangements (which are likely to be linked to the complexity of the specific vessel under construction). These will be important considerations in an economic evaluation of the available procurement options, though are possibly tangential to the underlying objective to explore the broader prosperity impacts of shipbuilding.

- **Training**: While there are numerous estimates available regarding the wage and productivity impacts (and costs) associated with apprenticeships in the manufacturing sector, application of these measures in an ex-ante appraisal of procurement options would be problematic for two primary reasons. Firstly, the available literature does not provide any evidence regarding the specific wage and productivity effects associated with apprenticeships in shipbuilding. More problematically, these estimates are based on a counterfactual of the receipt of no training and would require significant adaptation to make them suitable for the procurement scenarios under consideration. It is likely that at least some of those filling shipbuilding apprenticeships would take up alternative training opportunities, which may offer greater or lower wage and productivity gains.

- **R&D spending**: There are estimates in the secondary literature which could possibly be used to prepare an ex-ante assessment of the likely knowledge spill-over effects associated with a new shipbuilding programme. However, they are also problematic because they describe the effects of military defence R&D in general rather than shipbuilding (and the review pointed to few examples of spill-overs from shipbuilding to other areas of the economy), and relate to permanent, rather than temporary, increases in R&D expenditure.

- **Regional employment impacts**: The regional or local multiplier effects of defence spending have been estimated at between 1.0 and 2.0 though these are likely to vary across sub-regional economies. These estimates are largely based on input-output models and are unlikely to offer meaningful guidance on the likely significance of local and regional impacts of increases or decreases in shipbuilding activity as they do not allow for price effects and other adaptive mechanisms.

- **Unemployment and hysteresis**: There are numerous case studies of shipyard and plant closures in the literature. However, the results of these studies are variable and rarely show that such closures have lasting effects in terms of increasing long-term unemployment. However, detailed studies of the closure of both coal mines and MG Rover suggest that a focus on unemployment often masks other underlying issues, where high skilled and well-paid jobs are not always replaced with jobs offering similar benefits.

5.0 Econometric Analysis

This section sets out the results of a set of econometric analyses focusing primarily on assessing the local economic impacts of shipbuilding activity. This includes attempts to develop indicative parameters that could be applied in an ex-ante assessment of the local prosperity impacts of procurement decisions, alongside an examination of how those prosperity gains may vary across local economic conditions and time.

5.1 Impacts of Shipbuilding on Local Economies

As described in the preceding section, there are a range of estimates of the regional and national multiplier effects associated with shipbuilding activity and defence spending more generally. However, these estimates are largely based on input-output models or survey based approaches that measure these effects based on patterns of supply chain spending. These models do not consider the possible price impacts of these expenditures and thus represent gross rather than net effects. As such, studies relying on input-output models to estimate the economic impacts of expansions in local activity (or the closure of locally significant firms) can overstate these effects as these approaches do not allow for possible crowding out effects caused by pressure on local factor markets. These approaches also do not account for other possible adaptive responses such as using workers resident elsewhere, the transfer of work to other facilities, and so forth.

To further explore the local prosperity impacts of shipbuilding activity (and the possible issues associated with crowding out at local levels), a set of spatial econometric models were developed to provide an initial assessment of the scale and persistence of local impacts. This involved the assembly of a panel dataset describing those prosperity metrics identified in Section 3 that could be measured at a small area level between 2003 and 2015 using data available in the public domain:

- **Number of Jobs**: Shipbuilding, manufacturing, and service sector employment[43];
- **Unemployment**: Unemployment, long-term unemployment, JSA claimant on-flows; and,
- **Worklessness**: Out of work benefit claimants.

The bulk of this data was derived by synthesising the results of the ONS Business Register of Employment Survey (2009 to 2014) and the preceding Annual Business Survey (2003 to 2008)[44].

An econometric model was specified to estimate how far increases (or decreases) in shipbuilding employment at increasing distances (up to 60km) resulted in increases or decreases in shipbuilding, manufacturing and service sector employment, and claimant

[43] The highest resolution data available includes the manufacture and repair of floating vessels (though not pleasure craft). As such, this will include some activities that are not in the scope of this study, such as submarine manufacturing as well as some yards which undertake significant amounts of commercial and/or repair work. These activities cannot be excluded from the publicly available data though it may be possible to do so through using the firm level microdata available in the ONS Virtual Microdata Laboratory.
[44] Owing to changes in the methodology used to prepare these surveys (and changes in the Standard Industrial Classification) there will be some inconsistencies in the panel data assembled.

numbers within the area. The model controlled for some area level characteristics at a local authority level (total employment as a measure of economic mass, skills supply – approximated by the percentage of the working age population with NVQ level 3 and above, and the ILO unemployment rate). Three lags of changes in shipbuilding employment in nearby areas were also included to explore how far the effects involved were persistent or decayed with time. As these models explore total employment effects at an area level, they will account for issues of crowding out.

However, there are a variety of inconsistencies in the small area data that may weaken the findings set out below. For example, there were examples of shipbuilding employment being reallocated to adjacent MSOAs in different years, and in some areas, known centres of shipbuilding activity did not appear in the data (possibly because those jobs were allocated to other sectors).

Additionally, the model will provide biased results if the outcome variables of interest are correlated with unobserved characteristics of the areas (e.g. if there are asymmetric shocks that have a disproportionate effect on areas with higher levels of shipbuilding activity). These problems might occur, for example, if local increases in shipbuilding activity were driven by increases in global demand for goods which also caused local manufacturers to increase their output. In this case, the model would overstate the local economic impact of shipbuilding activity.

For the purposes of the following analysis it assumed that these types of issue do not apply. Shipbuilding activity in the UK is understood to be primarily driven by military sources of demand, and it is assumed that procurement decisions are driven primarily by long term geopolitical considerations. If this assumption holds, changes in shipbuilding activity can be assumed to be exogenous and the estimated results will be unbiased. However, if procurement decisions were driven partly or wholly by local economic considerations (e.g. protecting local areas from economic shocks) then the model could understate the impacts of shipbuilding activity. There may be coincidental issues of the nature because work on the QE class Aircraft Carrier began in 2009 following the financial crisis of 2008, which precipitated some apparent changes in labour market patterns (such as a growth in self-employment and a stagnation of labour productivity growth).

Further research could potentially explore approaches to address these potential concerns directly (e.g. by considering potential instruments that are correlated with activity at shipyards but not the outcomes of interest, and further work would be needed to identify possible candidates). There may also be issues of endogeneity or reverse causality that are not fully addressed by the analysis. These inconsistencies could not be addressed in full within the timescale of the study and the results set out below should be treated as indicative. Additionally, there may be opportunities for further research by reframing the analysis in terms of tradable and non-tradable goods and services, and investigating the effects of shipbuilding on the construction sector (which is not covered in the analysis below).

5.1.1 Employment Impacts

Table 5.1 sets out the total estimated effect of a 100 percent increase in shipbuilding in one area on employment in areas up to 60km away (over one and three years).

Table 5.1 Estimated percentage change in employment in response to a 100 percent change in shipbuilding employment in proximate areas over one and three years

	Shipbuilding		Manufacturing		Services	
Distance	1 years	3 years	1 year	3 years	1 year	3 years
0-1km	84.3%	84.2%	9.6%	8.6%	0.0%	0.0%
1-5km	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%
5-10km	0.0%	0.0%	0.5%	-0.5%	0.0%	-0.9%
10-20km	0.0%	-0.2%	0.6%	0.8%	0.0%	-1.5%
20-30km	0.0%	0.3%	1.2%	1.4%	0.0%	-1.0%
30-40km	0.0%	0.2%	1.0%	1.1%	-0.2%	-1.2%
40-50km	0.0%	0.0%	0.0%	-0.6%	0.0%	0.0%
50-60km	0.0%	0.0%	0.7%	0.6%	0.0%	0.5%

Source: Ipsos MORI analysis

The findings suggest:

- **Displacement**: The within industry effects of increases in shipbuilding activity are highly localised. A doubling of shipbuilding employment in one area results in a rise in shipbuilding employment of 86 percent over three years in areas within 1km, with little in the way of effects beyond this distance. These results imply that increases in shipbuilding activity produce little in the way of displacement effects (which would be visible in negative impacts at longer distances). Significant displacement effects may not be expected as shipyards do not tend to have direct competitors within 60km.
- **Effects within 0-1km**: The results did not suggest that increases in shipbuilding employment produced either multiplier or crowding out effects within 1km of the shipyard. The models suggested that an increase in shipbuilding employment had the same effect on shipbuilding and manufacturing employment on areas within 1km[45]. There were no effects on service sector employment within 0-1km. As such, the estimated multiplier effect within 1km of the shipyard is 1.0.
- **Wider effects on manufacturing employment**: At further distances, there was evidence of both crowding-in and crowding-out of manufacturing employment. Areas between 10km and 40km saw an increase in manufacturing employment in response to an increase in shipbuilding activity, while those areas within 5-10km and 40-50km appeared

[45] This result came from a set of models measured impacts in terms of differences in the absolute levels of employment, rather than the natural logarithm of those differences which have formed the focus of reporting in this section (which give the percentage response of areas to a 100 percent change in shipbuilding employment).

to see a decline[46]. The findings were not consistent across distances, though in most cases the three-year effect is slightly smaller than the one-year effect (suggesting some crowding out with time).

- **Wider effects on service sector employment**: The findings suggested that the effects on the services sector in proximate areas were largely negative. Again, there are mixed effects at different distances, though the findings suggest that an increase in shipbuilding employment results in a fall in service sector employment in areas between 5km and 50km from the shipyard. The apparent crowding out effect appears to grow with time. This suggests that labour demand requirements are at least partly met through attracting workers from service sector industries (possibly due to the higher wages offered by the industry). However, these effects may be overstated as figures on self-employment are not available. There is also a possible simultaneity issue in that as the expansion of shipbuilding activity associated with the QE class Aircraft Carrier coincided with recession caused by the 2008 financial crises (again, possibly resulting in an overstatement of these effects). However, the findings are consistent with the case studies of plant closures presented in the literature review, which suggest that while some areas have adapted to losses of manufacturing jobs through expansion of lower paid and less productive services employment.

5.1.2 Implied Multiplier Effects

Table 5.2 provides an assessment of the quantitative significance of these effects, based on applying these estimated effects to the top ten areas by shipbuilding employment. These areas accounted for 80 percent of shipbuilding jobs (17,192) in Great Britain in 2014 and the findings are largely representative of areas with major shipyards. As noted above, the results indicated that within 0-1km of a shipyard, the multiplier effect is 1.0 (i.e. shipbuilding does not crowd in or out other activities), so the focus is on areas further than 1km from the shipyard. The application of these estimates to total employment levels in these zones give the estimated total gain in manufacturing and services employment in response to a doubling of shipbuilding employment over one and three years (i.e. an additional 17,200 jobs across the top 10 shipbuilding areas). The findings suggest that:

- **Manufacturing**: A doubling of shipbuilding employment creates a further 6,500 manufacturing jobs within 1-60km of the shipyard (in addition to the 17,200 jobs created at the shipyards) after one year. This falls to 5,600 after three years.

- **Services**: A doubling of shipbuilding employment crowds out 3,500 service sector jobs within 1-60km of the shipyard after one year. This increases to 19,500 jobs after three years.

- **Net impacts on jobs**: These results suggest a doubling of shipbuilding employment has a positive net effect on employment within 60km. After one year, the creation of 17,200 at shipyards would lead to the creation of 20,700 net additional jobs within 60km (a multiplier value of 1.2[47]). This effect is estimated to decay to 3,300 net additional jobs after three years (a multiplier value of 0.2[48]).

[46] These differences in the direction of the effect cannot be explained based on the evidence available (but suggest some relocation of firms between zones), though the general spatial pattern of effects is consistent with the spatial distribution of the local supply chain captured within the case studies.
[47] I.e. 20,700 / 17,200 = 1.2
[48] I.e. 3,300 / 17,200 = 0.2

Table 5.2 Implied Multiplier Effects

Distance	Employment in 2014	Estimated % response to a 100% increase in shipbuilding activity: One Year	Number of Additional Jobs	Estimated % response to a 100% increase in shipbuilding activity: Three Year	Number of Additional Jobs
Manufacturing					
1-5km	36,613	0.0%	-	1.0%	373
5-10km	47,147	0.5%	246	-0.5%	-241
10-20km	152,899	0.6%	972	0.8%	1,260
20-30km	188,273	1.2%	2,222	1.4%	2,542
30-40km	154,545	1.0%	1,482	1.1%	1,654
40-50km	234,832	0.0%	-	-0.6%	-1,357
50-60km	216,874	0.7%	1,577	0.6%	1,329
Total	**1,031,183**	**0.0%**	**6,499**		**5,559**
Services					
1-5km	470,987	0.0%	-	0.0%	-
5-10km	826,560	0.0%	-	-0.3%	-2,554
10-20km	1,412,532	0.0%	-	-0.2%	-3,305
20-30km	1,656,615	0.0%	-	0.3%	4,986
30-40km	1,619,105	0.0%	-	-0.5%	-8,776
40-50km	1,585,418	-0.2%	-3,028	-0.6%	-9,814
50-60km	2,311,174	0.0%	-	0.0%	-
Total	**9,882,391**		**-3,028**		**-19,462**
Net Change			**3,471**		**-13,903**

These multiplier values are lower than those estimated using input-output tables. The estimates are consistent with the results of studies exploring the impact of recent plant closures, but are not always consistent with studies employing a similar methodology in other sectors[49]. There is a risk that the absence of data on self-employment is leading to an overstatement of impacts on local services, while there are some risks of reverse causality or simultaneity that have not been fully addressed in the analysis. As noted, construction of the QE class Aircraft Carrier began in 2009, at the same time as self-employment expanded in response to the 2008 financial crisis, and it is possible the findings may be partly capturing some structural changes in the economy.

5.1.3 Net local impacts of shipbuilding on incomes and productivity

The estimated effects of increases in shipbuilding employment[50] on the employment shares of the manufacturing and services industry can be used to estimate the net local effects of shipbuilding on wage incomes and productivity. The above results suggest that the permanent addition of 100 jobs to the shipyard causes the creation of an additional 32[51] manufacturing

[49] See Relocation of Public Sector Workers: Evaluating a Place Based Policy, Giulia Faggio, Spatial Economics Research Centre, October 2015.
[50] In principle, these estimates are the causal effects of an increase in shipbuilding in employment of 1 job at the shipyard over a distance of 60km (with a counterfactual or reference case of no increase in jobs at the shipyard).
[51] I.e. 5,600 / 17,200 = 0.32

jobs and the crowding out of 113[52] service sector jobs within 60km over the three years (which is taken to represent the medium-term effect of interest). It is assumed that these marginal jobs carry rates of productivity (GVA per worker) and earnings (average weekly pay) that are equivalent to national averages.

Applying these assumptions leads to estimates of net local economic impact of the creation of one permanent additional shipbuilding job (a workplace based measure). The jobs created at the shipyard increases GVA within 60km by £7.0m per annum and leads to an additional £2.3m produced by the 32 additional workers in the wider manufacturing sector per annum. However, there is an offsetting loss of £5.0m in GVA per annum in the service sector resulting from the 113 jobs crowded out. The net effect is an increase in economic output of £4.3m per annum. Applying similar principles, the jobs created lead to an increase in total incomes of workers working within 60km of the shipyard of £1.8m per annum. These calculations are set out in Table 5.3.

Table 5.3 Net Impact of Shipbuilding on Local Incomes and Productivity

Sector	Employment effect (per 100 additional jobs in Shipbuilding)	GVA per worker (impact on output)	Net effect on GVA	Median annual gross earnings	Net effect on Earnings
Shipbuilding	100.0	£70,343	£7.0	£33,280	£3.3
Manufacturing	32.3	£70,218	£2.3	£27,674	£0.9
Services	-113.2	£44,342	-£5.0	£21,840	-£2.5
Net effects	0.2		£4.3	£17,505	£1.8

Source: Ipsos MORI analysis

To give an indication of how these could be used in local analysis, news reports suggest that the closure of the BAES shipyard in Portsmouth could lead to the loss of 940 jobs[53]. Applying these results, the net effect on Portsmouth and the surrounding area over three years might be a loss of around 180 jobs[54] (reflecting the likelihood that many would otherwise find work in services). The closure might also be estimated to reduce total local economic output by £40.2m per annum after three years[55], and local incomes by £16.5m[56] per annum. This should not be taken as a formal estimate of the local economic impact of the closure of the yard, but as an illustrative example. Improvements would also be found if productivity and wage incomes could be estimated directly (which would be possible using the micro-data available in the ONS Virtual Microdata Laboratory).

5.1.4 Effects on unemployment, long-term unemployment, and claimant flows

A similar approach was taken to assess the impacts of shipbuilding on unemployment, long-term unemployment, out of work benefits, and claimant flows. Table 5.4 shows the estimated percentage change in the number of JSA claimants, long-term JSA claimants, out-of-work

[52] I.e. 19,500 / 17,200 = 1.13
[53] www.theguardian.com/business/2013/nov/06/bae-closure-portsmouth-shipyard-jobs
[54] I.e. 940 x 0.19 = 180
[55] I.e. 940 x £4.3m / 100 = £40.2m
[56] I.e. 940 x £1.8m / 100 = £16.5m

benefit claimants, and JSA on-flows in response to a doubling of shipbuilding employment in proximate areas (up to 60km).

The findings suggest:

- **Effects**: The models suggest that at all distances, an increase in shipbuilding employment reduces the JSA claimant count, numbers of long-term JSA claimants, numbers of out of work benefit claimants, and JSA claimant on-flows.
- **Temporal issues**: The effects appear to be larger in year 3 than in year 1, which is the opposite pattern to that observed in the employment impacts. One explanation for these patterns is that the initial increase in employment demand may be satisfied by residents outside of the 60km radius under consideration before vacancies are filled by local residents. This would align with case study findings that suggested that some shipyards maintain a standing workforce that is moved around the country depending on workloads (and other reports that migrant labour can sometimes be important in managing peaks).
- **Economic security**: The effects on the claimant count and JSA claimant on-flows are broadly equivalent (if not smaller for the latter). This does not suggest that shipbuilding has an effect in improving economic security as measured by frequency of JSA episodes. It has not been possible to assess effects in terms of numbers of part-time or temporary employment owing to an absence of data at a sufficiently detailed spatial scale (which may be superior indicators of economic security issues).

Table 5.4 Estimated percentage change in number of JSA claimants, long-term JSA claimants, out-of-work benefit claimants and JSA on-flows in response to a 100 percent change in shipbuilding employment in proximate areas over one and three years

	JSA Claimants		Long-term JSA Claimants (1 year or more)		Out of Work Benefit Claimants		JSA Claimant On-Flows	
Distance	1 years	3 years	1 years	3 years	1 years	3 years	1 years	3 years
0-1km	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
1-5km	0.0%	0.0%	0.0%	-0.7%	0.0%	0.0%	0.0%	0.0%
5-10km	-0.4%	-0.9%	-0.7%	-0.8%	-0.1%	-0.2%	0.0%	-0.7%
10-20km	-0.5%	-1.5%	0.0%	-2.2%	-0.8%	-0.3%	-0.4%	-0.9%
20-30km	-0.2%	-1.0%	0.4%	-1.3%	0.0%	-0.2%	0.0%	0.5%
30-40km	-0.2%	-1.2%	0.4%	-1.9%	0.1%	-0.2%	0.0%	-0.7%
40-50km	-0.3%	0.0%	-0.6%	-0.5%	0.0%	0.0%	0.0%	0.0%
50-60km	0.0%	0.5%	0.0%	0.0%	0.1%	0.2%	0.0%	-0.3%

The quantitative significance of these results is set out in Table 5.5 (again, by applying the estimated elasticities to claimant numbers in areas proximate to the top 10 major shipbuilding centres in Great Britain). Overall, it is estimated that the creation of 100 jobs at a shipyard will reduce JSA claimant numbers by 16[57]. This is equivalent to around 83 percent of the 19 net additional jobs created by the increase in shipbuilding employment. This is taken to imply that 83 percent of the jobs (and associated income gains) are taken by residents within 60km of the shipyard, with the remainder going to residents outside the area (or in-migrants).

[57] 2999 / 17,192 * 100 = 16

Table 5.5 Impact of Shipbuilding on Unemployment

Distance	Claimants in 2013	Estimated % response to a 100% increase in shipbuilding activity: One Year	Reduction in Number of Claimants	Estimated % response to a 100% increase in shipbuilding activity: Three Year	Reduction in Number of Claimants
JSA Claimants					
0-1km	3,662	0.0%	0	0.0%	0
1-5km	25,368	0.0%	0	0.0%	0
5-10km	42,914	-0.4%	-181	-0.9%	-367
10-20km	86,364	-0.5%	-391	-1.5%	-1,267
20-30km	91,573	-0.2%	-160	-1.0%	-945
30-40km	84,678	-0.2%	-176	-1.2%	-1,008
40-50km	91,767	-0.3%	-294	0.0%	10
50-60km	114,839	0.0%	0	0.5%	578
Total	**541,165**		**-1,202**		**-2,999**
Long-term JSA Claimants					
0-1km	1,050	0.0%	0	0.0%	0
1-5km	7,270	0.0%	0	-0.7%	-49
5-10km	12,555	-0.7%	-82	-0.8%	-99
10-20km	25,575	0.0%	0	-2.2%	-549
20-30km	26,955	0.4%	100	-1.3%	-361
30-40km	24,020	0.4%	105	-1.9%	-445
40-50km	27,330	-0.6%	-155	-0.5%	-127
50-60km	30,750	0.0%	0	0.0%	0
Total	**154,455**		**-33**		**-1,630**
Out of Work Benefits					
0-1km	14,095	0.0%	0	0.0%	0
1-5km	100,190	0.0%	0	0.0%	0
5-10km	160,520	-0.1%	-129	-0.2%	-244
10-20km	336,220	-0.8%	-2,609	-0.3%	-1,147
20-30km	369,520	0.0%	0	-0.2%	-695
30-40km	324,590	0.1%	328	-0.2%	-571
40-50km	374,800	0.0%	0	0.0%	0
50-60km	426,845	0.1%	338	0.2%	832
Total	**2,106,780**		**-2,072**		**-1,826**

Source: Ipsos MORI

Additionally, the findings suggest that in the short-term, there is a limited effect on the number of long-term JSA claimants. However, after three years, around 54 percent of the reduction in claimant numbers is from those claiming JSA for one year or more. The findings indicate that every 100 jobs created (lost) at the shipyard reduces (increases) the number of long term JSA claimants by 9 within 60km. This raises questions as to how far the skills of those working at shipyards and in their supply chains can be straightforwardly redeployed in other industries, with some individuals likely to struggle to find alternative employment in the event there is a

reduction in shipbuilding activity. These findings also suggest that increases in shipbuilding activity have some potential to reverse local hysteresis effects.

Finally, the estimated effect on the numbers claiming out-of-work benefits within 60km is smaller than the estimated effect on the claimant count (i.e. every 100 jobs created at the shipyard reduces the number of out-of-work benefit claimants by 11 within 60km). This implies that for every 10 individuals taken off JSA as a result of an expansion of shipbuilding, there is an offsetting increase in the numbers of claimants of other out of work benefits of 4 (i.e. 10 – 10 x 11/16). This raises some questions regarding the nature of the crowding out mechanism (with the higher household incomes associated with shipbuilding activity possibly encouraging others to withdraw from the labour market).

5.1.5 Local Variations in Impacts

The results above are not sensitive to variations in local economic conditions and an additional set of models were developed to explore how far the strength of the effects estimated were linked to rates of unemployment within the local economy[58] (with the expectation that the strength of crowding out effects would be smaller in those local economies with higher levels of unemployment). These models suggested:

- The strength of employment impacts in the manufacturing and service sectors did not appear to be linked in a clear or systematic way to rates of unemployment in the local economy.
- There were inconclusive results with respect to how far the strength of unemployment impacts varied with local unemployment. Those models exploring effects over five year suggested that increases in shipbuilding employment had stronger effects on unemployment when unemployment rates were high (while those exploring effects over three years suggested the opposite).
- Given the likely variability of the potential impacts of increases in shipbuilding activity at a local level (as demonstrated in the following chapter), further research to unpick the relevant parameters could potentially be beneficial in helping to discriminate between procurement options.

5.2 Synthetic Control Group Analysis

A second set of analysis sought to explore the effects of shipbuilding activity at larger spatial scales (local authority level) to take advantage of the superior availability of information at this level and provide a richer characterisation of the impacts of changes in shipbuilding activity at a local level. This involved the identification of three local authorities subject to significant changes in local shipbuilding activity since 2000, and establishing ‘control’ areas that shared similar characteristics to those authorities prior to the event.

Control areas were defined by applying synthetic control group methods. This involves the application of a statistical algorithm that weights all possible control areas (i.e. all other local authorities in Great Britain that were not exposed to the event) so that they match as closely as possible the characteristics of the areas of interest in the years prior to the events of interest. A wide range of characteristics were included in these models, including employment, the share

[58] As measured by the ILO unemployment rate at the level of the local authority, derived from the ONS Annual Population Survey.

of employment in manufacturing, the unemployment rate, numbers of JSA claimants and those claiming JSA for 1 year or more, the economic activity rate, the proportion of the working age population with NVQ level 3 qualifications or above, population, and gross average weekly earnings.

The three cases chosen for further exploration were:

- **Glasgow**: The BAES Govan and Scotstoun shipyards were chosen to produce the Type 45 Destroyers between 2003 and 2010. The yards produced and assembled all of the blocks and outfitted the warships. The findings of the analysis suggested that the shipbuilding programme had an effect in terms of reducing overall claimant numbers. However, effects on long-term unemployment appeared to be limited (though this may be explained by the historically low levels of long term unemployment at the time, and the high skill nature of work involved in shipbuilding). The findings also suggested that construction of the warships protected Glasgow from the wider decline in manufacturing sector seen in similar areas. However, there was no visible effect on average earnings (potentially because the effects of shipbuilding simply may not be visible in local authority averages, as the sector accounts for a small proportion of overall employment in Glasgow).

- **Rosyth**: Rosyth was the yard chosen to assemble the blocks of the QE class Aircraft Carrier (with construction of those blocks taking place at five other sites). Work on the vessel commenced in 2009, just after the onset of the 2008 financial crisis that caused a recessionary period for many areas of the UK (and it is understood that the local authority within which the shipyard was located housed several call centres for financial services firms that were downsized in the aftermath). The analysis suggested commencement of the shipbuilding programme in Rosyth may have helped insulate the area from the negative effects of the recession. The models suggest that the number of JSA claimants and long-term JSA claimants would have otherwise been substantially higher had the shipbuilding programme not commenced. As such, it is possible that the shipbuilding programme may have helped avoid the types of ‘hysteresis’ problems that have been caused in some areas by the decline of traditional industries. The analysis did not suggest, however, that the QE class Aircraft Carrier had a significant effect on manufacturing employment in Fife, or on gross average weekly pay. The analysis in this case may have struggled to find a set of areas that were wholly comparable to Fife. These findings may also reflect that key suppliers to Rosyth are national firms.

- **Portsmouth**: Closure of the BAES shipyard in Portsmouth was announced in 2013. Shipbuilding activity at the yard finished in 2015 with the completion of a block for the second QE class Aircraft Carrier. The closure resulted in the loss of 940 shipbuilding jobs, raising concerns regarding the potential negative impacts on local communities. By 2013, however, the UK had begun to emerge from the recession precipitated by the financial crisis and unemployment levels had peaked. The analysis suggests a similar picture to that associated with the case of the closure of MG Rover described in the literature review. The closure of the shipyard appeared to have a limited effect on both unemployment and long-term unemployment levels locally (with post 2013 local trends tracking ‘synthetic’ Portsmouth very closely). This suggests that the area to some degree adjusted to the closure relatively rapidly. This may be in part due to other investments that have been made in Portsmouth’s naval base that employs approximately 10,000 workers. It is also acknowledged that the long-term effects of the closure may not be clear (the available data does not extend beyond the full closure of the shipyard). Portsmouth is also based within a relatively prosperous regional economy, which may have enabled workers to adapt more rapidly. Similarly, the analysis found no impact on overall

manufacturing employment, or average gross weekly earnings (though again, there are questions as to how far the analysis would detect such effects given the limited employment share of the shipyard in Portsmouth).

5.3 Summary

- **Local employment and unemployment impacts of shipbuilding activity**: Spatial econometric models suggest that increases in shipbuilding activity have a positive net impact on employment and unemployment at a local level. The findings set out here suggest that while increases in shipbuilding activity do produce multiplier effects within the manufacturing sector, these are offset by the crowding out of service sector employment. The implied net multiplier values (0.19) are lower than those suggested by studies using an input-output framework or survey evidence to estimate regional multiplier effects (within a range of 1.00 to 2.00). The pattern of results aligns with studies examining the impacts of plant closures (e.g. MG Rover in 2005).

- **Data and model limitations**: However, the above results may overstate effects on the service sector, partly because data on self-employment was unavailable, but also potentially due to endogeneity problems whereby expansions in shipbuilding activity from 2009 onwards coincided with the recession caused by the 2008 financial crisis.

- **Local incomes and productivity**: However, the results also suggest that shipbuilding activity has locally significant economic impacts by creating higher productivity and higher paid jobs in the manufacturing sector, and crowding out lower productivity and lower paid jobs. It is estimated that each job created in shipbuilding results in an increase in local economic output of around £42,800 per annum and increases in local incomes of £17,500. These prosperity gains are thought to accrue largely to residents (around 83 percent) based on the relative patterns of local employment and unemployment impacts.

- **Local variability**: The findings suggest there could be substantial variations in the net local impact of shipbuilding at a local level. There was some evidence that the impacts of increases in shipbuilding activity were stronger in areas with higher rates of unemployment (and may help insulate areas from the more acute social problems associated with hysteresis). However, these findings were of insufficiently high resolution to permit their use in an ex-ante assessment of the prosperity impacts of different procurement options.

- **Data gaps**: While the analysis offers a platform for preparing an ex-ante assessment of local economic impacts, they are largely driven by an analysis of employment impacts (with productivity and income effects estimated from employment shares rather than directly). Additionally, it has not been possible to quantify the impact of shipbuilding on other metrics of prosperity of potential interest to the study. There are several opportunities to enhance the supporting evidence, which arise largely from using detailed firm and individual level micro-data available within the ONS Virtual Microdata Laboratory, the Individualised Learner Record and the DWP Work and Pensions Longitudinal study. Additionally, it has not been possible to directly examine the full supply chain impacts associated with shipbuilding programmes (which would require more extensive research to identify all firms in the supply chain, including Original Equipment Manufacturers). Lack of long term data on MOD spending by suppliers also constrains the extent to which it is possible to assess the additional effect of military spending on local shipbuilding activity.

6.0 Synthesis

This section provides a synthesis of the results of the study, describing the recommended approach to undertaking an analysis of the prosperity impacts of decisions to procure a military warship in the UK.

6.1 Indicators of the Prosperity Impacts of Shipbuilding

Table 6.1 provides an overview of the potential metrics that could be included within an analysis of the prosperity impacts of shipbuilding activity at a national and local level. These include both direct measures of prosperity ('prosperity metrics') and factors that are thought to drive prosperity ('intermediate metrics'). It should be noted that there is scope for double counting across the metrics, and the prosperity gains of shipbuilding may not be positive under all scenarios. Additionally, not all metrics can necessarily be monetised.

Only a subset of these impacts could be considered within a national analysis that aligns with the general principles of the HM Treasury Green Book. Additionally, the scope of the analysis required will depend on the nature of the procurement decision.

National analysis

Where the procurement choice is between domestic and overseas suppliers, decisions will potentially have national implications. A procurement choice from an overseas supplier will lead to welfare benefits shared between the citizens of the supplier country and UK citizens; other relevant costs and benefits need to be estimated in order to provide an overall assessment of the change in UK social welfare.

A national level analysis should be completed in line with principles of the HM Treasury Green Book and explore the supply side effects involved. This would focus on the GVA resulting from measurable productivity gains in the economy that may arise from capital, R&D, or training spending induced by the procurement or later exports (and the costs of these investments would also need to be factored into such an analysis). Other supply side effects, such as avoiding or reversing hysteresis effects may also be relevant.

Table 6.1 Prosperity Impacts of Shipbuilding: Dimensions and Metrics

Dimension of prosperity	Intermediate Metrics	Prosperity Metrics
Income	R&D spending Capital investment	Net effects on: Economic output (GVA) Total factor productivity (TFP) Average labour productivity GVA created by productivity gains Wage income Measurable productivity and other relevant effects arising from the exports of ships, systems and designs
Employment		Net number of jobs
Unemployment		Net effects on: JSA claimants Long term JSA claimants Out of work benefit claimants
Economic security		Net effects on: Full-time jobs Part-time and temporary jobs Jobs with contractors Claimant on-flows
Income inequality		Net effects on income distribution
Education and training	No. of apprenticeship opportunities	Net increase in wages resulting from training
Subjective well-being		Improvement in life satisfaction Monetary value of improvements in life satisfaction
Strength of community	Outmigration	

Local analysis

All procurement decisions could involve an assessment of local prosperity impacts involved. These decisions will involve a choice between selecting which shipyard or shipyards will be the lead contractor and manufacturers of the blocks. These types of decision will have a negligible impact at a national level (i.e. an increase in production at one shipyard will be largely offset by a reduction in production at other shipyards). Much of the spending associated with the procurement of a military warship will typically be with Original Equipment Manufacturers and the impacts of this spending are unlikely to be affected in a material way by the choice of local shipyard. However, the shipyard itself could produce locally significant impacts. As such, the focus of local analysis will largely be on hull construction rather than the development of systems.

The metrics considered as part of a local prosperity analysis could extend beyond measures of productivity and deprivation to include measures of local incomes, employment and education opportunities, greater economic security, productivity, wage gains, income inequality, outmigration, subjective well-being and strength of community. Some of these metrics would not be considered admissible within the rules of the Green Book (and not all can be monetised).

6.2 Measures of Prosperity: National

This section provides an assessment of the metrics that could be applied in a national analysis. Where relevant, recommendations for further research are made.

Productivity Gains

Spill-overs from Research and Development spending

R&D spending associated with a warship will have the potential to produce productivity gains either directly or indirectly (which may be lost if this investment is taken forward overseas). However, there is little direct evidence from the shipbuilding sector that supports a quantification of these gains, though recent cross-country research suggests that military R&D spending in general terms both crowds-in private R&D expenditure and raises the rate of total factor productivity growth (a permanent increase in the ratio of military R&D expenditure to output of one percent has been found to raise the rate of TFP growth by 5 percent). This could serve as a starting point for assessing the productivity gains associated with R&D spending though there are questions regarding how far the results are applicable to the shipbuilding sector and whether this spending could be considered to qualify as a permanent increase in military R&D spending.

These issues can potentially be overcome with further bespoke research, as time series data on R&D spending in the shipbuilding sector is available from ONS. Such a study could build on the general approach adopted by the authors of the study from which the above estimates were derived, using cross country time series data at a sector level to identify the effects of interest. This may have wider benefits in supporting similar assessments of procurement decisions in other sectors (such as aerospace), though some attempt would need to be made to assess the impacts of temporary rather than permanent increases in R&D spending (which may introduce complexities, as the lags between R&D spending and associated gains in productivity can be expected be substantial).

Human and Physical Capital Investment

Human and physical capital investments that would not go ahead if the vessel was procured overseas would likely raise the productivity of shipyards and the wider supply chain. However, although there is general literature describing the wage returns associated with these types of investment, there is no specific evidence relating to the specific rates of return that may be obtained in the shipbuilding sector. While training and capital spending volumes and plans could be collected during the procurement exercise, consideration would also need to be given to how those factors might have otherwise been deployed in the absence of an expansion of shipbuilding activity. Without further evidence, it would not be credible to assume that such investments would produce supply side impacts (particularly given that productivity in the shipbuilding and wider manufacturing sectors are largely equivalent). As such, there is no firm evidential basis for making an ex-ante assessment of the supply side impacts associated with any human or physical investments induced by the procurement of a military warship.

Metrics could not be generated through this study because there is also no publicly available data on training and capital investment at a small area levels. However, this could be obtained with access to the Individualised Learner Record and the data held within the ONS Virtual Microdata Laboratory, and similar models could be deployed to assess the impacts of shipbuilding in terms of increasing the availability of educational opportunities and stimulating capital investment. BEIS and DWP have also collaborated to link the DWP Work and Pensions Longitudinal Study and the Individualised Learner Record, making it potentially feasible to assess the long-term wage impacts of apprenticeship opportunities in the shipbuilding sector (as individual employers can be identified in the ILR).

Long-term unemployment (Hysteresis)

The evidence from the econometric analysis suggests that increases in shipbuilding activity helps to reduce long-term unemployment (with the creation of 100 jobs at the shipyard reducing the number of long-term JSA claimants by 9 within 60km, 54 percent of the overall effect on JSA claimant numbers). As such, expansions in shipbuilding activity have the potential to reverse hysteresis effects. The strength of these effects will vary across different shipyards and, while the research has uncovered several factors likely to increase the exposure of an area to long-term hysteresis problems (primarily an absence of alternative employment opportunities), there are no quantitative metrics that can be applied to gauge the likelihood and strength of these effects at a local level. The data available during the constraints set by the timescale for the study did not permit examination of the period prior to 2000 during which there were significant declines in shipbuilding employment and the closure of shipyards. Again, more detailed investigation of the long-term effects using microdata held within the VML could be beneficial in understanding such effects in more detail.

Redistributive effects

While changes in shipbuilding activity may raise incomes, these benefits will largely accrue to higher skilled (and therefore higher earning) residents. It should be noted that the findings also suggest that expansions in shipbuilding activity also increase the numbers of non-JSA claimants within 60km of the shipyard, suggesting that the redistributive effects involved may be complex. As such, analysis of the redistribution of income is not advised as part of a national analysis and there is little basis for such an analysis.

Exports

Although exports are potentially an important indicator of prosperity gain, scope for exports will be unique to the design and it will not be possible to develop a ‘ready reckoner’ that quantifies the relative impacts of procuring military vessels domestically or overseas. It is suggested that a qualitative assessment of the export potential is completed as part of a prosperity assessment (focusing on how far export potential may be affected by the decision to procure domestically or overseas). This assessment would potentially need to exploit or integrate intelligence gathered by DIT on the global market for relevant warships over a reasonable time period and the extent to which the proposed designs would be able to claim a share of that market.

6.3 Measures of Prosperity: Local

This section provides an assessment of the metrics that could be applied in a local analysis.

Employment

Expansions in shipbuilding activity have the potential to lead to locally significant impacts in the form of well-paid employment opportunities provided this does not crowd out other activities. This study has found that increases in shipbuilding employment have positive effects on employment in the areas surrounding shipyards. The creation of 100 jobs at the shipyard is estimated to result in a net increase in employment of 19 jobs within 60km of the shipyard after three years. This includes the creation of 32 additional jobs in the manufacturing sector, an estimate that is broadly consistent with other studies exploring the regional impacts of defence industries based on input-output models (which do not allow for offsetting general equilibrium effects). However, these manufacturing jobs are offset by the crowding out of 113 jobs in the service sector[59]). This implies a cost per net additional job of £700,000 (based on an assumption of £133,000 of local warship spending per shipbuilding job created). Effects are likely to vary across shipyards, given the variable extent to which they make use of locally or nationally configured supply chains.

The application of these results would also need to be sensitive to the following considerations:

- **Additionality**: Although the estimated multiplier values are net of crowding out, it cannot be assured that the jobs set out in proposals will be additional. Military production could potentially crowd out commercial work (although the case study evidence suggests this may be unlikely). An adjustment would need to be made for deadweight, and while this could be assessed on a qualitative basis, an econometric analysis exploring the employment impacts associated with the winners and losers from past procurement exercises could help parameterise these considerations. More detailed information on MoD spending on warship building (e.g. by supplier) could also be beneficial in improvement the estimates.
- **Local conditions**: The study has shown that the scale of the economic impacts involved may be linked to local economic conditions, which those areas with higher rates of unemployment likely to benefit from an expansion in shipbuilding activity to a higher degree. There are also variances in shipyard employment practices and supply chain management that will alter the scale of the local economic impacts involved. As such, it may be helpful to adapt estimates of local impacts considering information on the spatial profile of employees and subcontractors which could potentially be collected through a procurement exercise.
- **Self-employment**: The estimates do not account for self-employment, and information on self-employment numbers is not available at a small area level. It may be possible to investigate these issues by pursuing an alternative approach focusing on local authority level data which are captured through the Annual Population Survey (though owing to the small numbers involved, these numbers are often not reported for reasons of statistical reliability).

[59] This effect may be overstated as the available data did not include self-employment.

Productivity and Incomes

This study offers some ready reckoners that could be employed to assess the local productivity and income gains associated with procurement options. The creation of 100 shipbuilding jobs is estimated to increase output (GVA) within 60km of the yard by around £4.3m and local incomes by £1.8m after three years. These gains arise primarily from growth in manufacturing jobs at the expense of lower paid and less productive service sector employment. These estimates are inferred from changes in the employment shares of the shipbuilding, manufacturing and service sectors implied by the econometric findings, and could be improved with direct observations of productivity and earnings that could not be accessed within the timescales for the study.

Unemployment and Out of Work Benefits

The econometric evidence suggested that increases in shipbuilding activity reduce unemployment. The creation of 100 shipbuilding jobs created is estimated to reduce the claimant count by 16 claimants within 60km of the shipyard after three years. This suggests that 83 percent of the 19 jobs created are taken by residents. Again, the evidence suggested this may vary across shipyards with some using workers at other sites or migrant labour to meet peak demand. Over 50 percent of the effect on claimant numbers came from reductions in the numbers claiming JSA for one year or more. However, the estimated reduction in numbers of out-of-work benefit claimants (11 for every 100 jobs created at the shipyard) was smaller than the effect on JSA claimant numbers, implying an expansion in the number of non-JSA claimants. This suggests that while expansions in shipbuilding have positive local effects in reducing unemployment, it may have offsetting effects through increasing economic inactivity rates (possibly shedding some light on the nature of the crowding out mechanism).

Economic Security

Owing to issues of data availability, it has only been possible to examine the effects of shipbuilding activity on claimant flows. This evidence does not suggest that increases in shipbuilding activity reduce claimant flows over and above what might be expected given reductions in claimant numbers. However, frequency of unemployment episodes is only one dimension of economic security and it has not been possible to assess effects on aspects such part-time working

Subjective Well-being

The focus of the study has been on literature and data pertaining to the shipbuilding sector, though no study was identified exploring the impact of shipbuilding on subjective well-being. The topic area is relatively experimental, and recent research has exploited the availability of life satisfaction measures in the British Household Panel Survey to assess and monetise the well-being effects of some non-market interventions[60]. A further survey of the literature could be undertaken to understand some of the well-being effects of key events captured in above (e.g. entry or exit from long-term unemployment) – provided these issues have been explored, but it is not considered likely that it would be possible to establish a direct link between shipbuilding activity and well-being measures given the available secondary evidence.

[60] See Museums and Happiness: The Value of Participating in Museums and the Arts, Daniel Fujiwara for the Happy Museum, available at http://happymuseumproject.org/happy-museums-are-good-for-you-report-publication/museums-and-happiness/

Strength of Community

Finally, outmigration was identified as a metric of the strength of community. Again, no small area data was identified as part of the study, and no metrics regarding the impact of shipbuilding on outmigration could be identified (though the literature review provided ambiguous findings on this point). It may be possible to explore outmigration effects using econometric models configured at a local authority level (using the local population estimates published on NOMIS).

6.4 Use in Procurement

Table 6.2 summarises the metrics derived from this study that could be applied to develop a tool to aid future procurement decisions. These measures provide insight into the local labour market effects of shipbuilding, but it has proven challenging to derive measures of supply side effects that could be applied in national or local welfare analyses.

Table 6.2 Metrics – Local Prosperity Impacts of Shipbuilding (within 60km)

Aspect of prosperity	Effect for 100 shipbuilding jobs created	Measure
Employment	Warship spend per gross job (at shipyard) Net increase in employment	£10m - £13m 19 jobs
Education	Gross apprenticeships created	25 – 33 apprentices
Income	Net increase in GVA per annum Net increase in wages per annum	£4.3m £1.8m
Unemployment	Reduction in JSA claimants Reduction in LT JSA claimants Reduction in OOW benefit claimants	16 claimants 9 claimants 11 claimants

Source: Ipsos MORI analysis

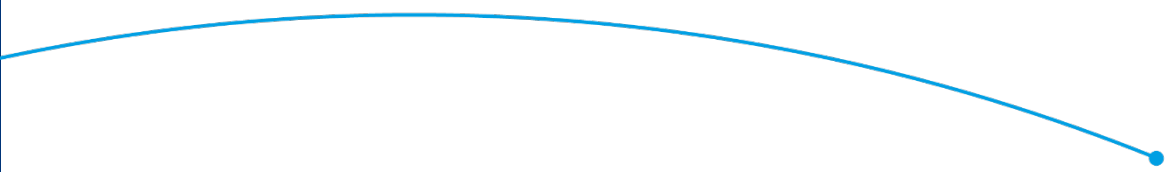
The measures derived quantify the relationship between changes in shipbuilding employment and local measures of prosperity, and could be used in the following way:

- Future procurement exercises could collect information related to the expected jobs created and safeguarded associated with the procurement options under consideration. Assuming that the procurement does not crowd out other activity at the shipyard, the metrics below could then be applied to estimate a number of prosperity effects within 60km of the shipyard.
- These metrics represent averages across different shipyards. As the study has illustrated, local effects may vary across different shipyards depending on the configuration of local and national supply chains and the profile of the workforce. Information on the spatial distribution of supply chain spending and workforces should be gathered as part of the procurement exercise to allow adjustments to be made regarding the likely scale of local effects.
- These metrics average productivity levels across shipyards (and their application could potentially disadvantage more productive shipyards that require fewer workers to deliver warship programmes). The metrics also do not capture any improvements in productivity

that may result from human or physical capital investments. While further research is needed to address the latter issue, information on the productivity of individual contractors (and wages offered) should also be gathered to adjust estimates of local effects on GVA and earnings.

- Local economic impacts are likely to vary according to local economic conditions. Impacts are likely to weaker in stronger local economies where there is strong competition for skilled workers in manufacturing industries. It has not been possible to quantify the relevant relationships as part of this study, though these issues merit consideration when comparing different procurement options.

Alongside collecting information on these aspects during the procurement process, one of the key constraints faced in the study was the absence of data on the spatial distribution of past spending on military warship programmes. Some information is available on spending placed with prime contractors, but this offers little insight into how spending breaks down across supply chain and the spatial distribution of said spending. For the purposes of understanding the prosperity impacts of military procurement spending and how these impacts evolve over time, there would be substantial benefits in systematically collecting information from prime contractors describing patterns of supply chain spending (ideally at the level of individual subcontractors) and the outputs it generates. This applies equally to shipbuilding and other sectors in which the Government procures defence equipment.



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