Some Economic Aspects of the Weapons Systems Acquisition Process

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"War is a matter not so much of arms as of expenditure, through which arms can be made of service"

(Thucydides, The History of the Peloponnesian War, I)

A. Background

1 A weapons system is defined as a composite of equipment employed as an entity to accomplish a military mission (such as destroying enemy installations, identifying hostile aircraft, protecting advancing infantry or surveilling territory). Each weapons system provides a range of capabilities, which are of military value in and of themselves and in their interaction with other systems and resources.

2 Relatively simple systems such as rifles and mines account for the bulk of fatalities in current conflicts, with one estimate being that they were responsible for 90 per cent of combat casualties in the 1990s [Singer (2003), 55]. Moreover, in describing future conflicts as "a war of listening devices and car bombs, of men killing each other at close quarters and of women using their handbags to carry explosives", a leading scholar has argued that the weapons systems that account for the vast bulk of harm inflicted will get simpler rather than more complicated in the years to come [Van Creveld (1991), 212]. These trends notwithstanding, very complex weapons systems, such as those associated with fighter aircraft and bombers, frigates and submarines, tanks and armoured personnel carriers, account for a high share of defence outlays in the more advanced economies.

3 The process of acquiring complex weapons systems encompasses their conception, development and production. Increasingly, the maintenance and refurbishment of systems, including in terms of their upgrading and eventual decommissioning, is also integrated into the acquisition process.

4 Efficiency in the acquisition of complex weapons systems involves:

(i) choosing the portfolio of systems likely to best serve in accomplishing anticipated military missions (that is, that for given resource constraints, secures the greatest military value), and

(ii) organising the process of acquiring each of those systems in a manner likely to maximise the systems' net value (that is, the discounted stream of benefits from the systems, net of the opportunity costs incurred in their acquisition) [Hitch and McKean (1960), Chapter 7].

It is this latter aspect that is the main focus of this paper. References to weapons systems are therefore to be read as referring to complex systems, except where otherwise noted. Additionally, references to efficiency refer to efficiency in weapons acquisition, rather than to the "efficiency in the large" concept, which encompasses concerns about the allocation of resources as between different weapons systems and as between weapons systems and other uses of society's resources.

5 The structure of the paper is as follows. A first section sets out the main features of the products at issue in the weapons acquisition process, of the participants in the process and of the interaction between those participants. A second section examines the outcomes of the process in terms of their apparent efficiency. A third section looks at options for reform, that is, at remedies that have been offered with a view to increasing the efficiency of the acquisition process. A fourth section concludes.

B. The main features of the weapons acquisition process

6 At least for complex systems (on which this paper concentrates), the weapons acquisition process has a number of distinctive attributes that greatly affect the manner in which this process is and can be structured and shape the outcomes it generally yields. These attributes can be grouped under four broad headings, in terms of those that characterise respectively, the **product**; the **buyer**; the **seller**; and the **relation** between the buyer and seller.

The "product"

7 Considered as a product, weapons systems are distinguished by the substantial technical difficulties that are involved in their conception, development and production. These difficulties reflect partly the sheer technical complexity of the systems and partly the very long periods of time involved in their planning and use cycle. An important result of these difficulties is that the weapons acquisition process is both highly uncertain and highly risky.

Technical complexity

8 The technical difficulties associated with weapons systems arise mainly from three sources [Peck and Scherer (1962), 42 and follows]:

- First, bringing each system into operation involves a large number of distinct technical problems – for example, devising an effective ballistic missile requires addressing a wide range of issues about propulsion systems, guidance mechanisms, hydraulic controls, heat and shock resistance of materials and so on. Simply because of the sheer number of separate technical issues that are involved, the probability of encountering substantial problems in respect of at least some aspects of the system must be high.

- Second, the difficulties involved in solving each such problem are greatly complicated by the inter-dependence between technical issues. It is in the nature of complex weapons systems that they involve large numbers of closely integrated sub-systems. Such close integration of sub-systems means, however, that the failure of any one sub-system to meet its originally planned weight, size or output may require re-design of other sub-systems. As a result, each technical problem that arises must be addressed taking account of its impact on the system as a whole.

- Third, further constraints on system design and redesign arise from the need for reliability. Because most systems involve very large numbers of individual components, attaining reliable operation requires finding ways either of reducing failure probabilities for individual components or of protecting system performance from individual component failure. Understanding how components (including ever more complex software) will and do behave in operation, and determining and providing the appropriate degree of protection against malfunction, can themselves be problems of a high degree of technical difficulty.

9 The complexity of the technical issues involved in conceiving, developing and producing weapons systems introduces substantial uncertainty[1] into the weapons acquisition process. It is rarely possible to fix the main parameters of a system – be it in terms of its outputs or in terms of its inputs – with any degree of precision prior to incurring what may be considerable outlays.

10 It would be tempting, but often misleading, to think that these uncertainties can be resolved at the conception and development stage. In the jargon of information economics, most weapons systems are 'experience' rather than 'search' goods – their attributes only become fully known in use. Even modern simulation techniques, which can allow performance to be tested under highly destructive conditions, can replace only a small part of the 'learning by using' that generally characterises complex systems [Rosenberg (1982)]. As a result, the need for ongoing adaptation persists, so that system parameters generally change, in some cases very substantially, during the acquisition process.

Lead times, life-times and obsolescence

11 The need for adaptation is accentuated by the fact that because of weapons systems' complex nature, long lead times are involved in the acquisition process – with 8 to 12 year lags being typical, and even longer lags being observed in individual cases [Peck and Scherer (1962), 53-4; Baron (1993), 8]. Additionally, weapons systems are typically long lived, with life times that can extend over several decades. The planning cycle for a system, covering the period from serious commitment to its acquisition through to the time of decommissioning, therefore spans many years.

12 As circumstances will inevitably change over that period, including during the time of initial development, weapons systems are exposed to substantial risk of obsolescence, that is, of loss in value (in terms of their ability to accomplish their military mission) due to the appearance of superior alternatives.

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[1] **Uncertainty** refers to the unpredictability of the outcomes of a course of action. In contrast, **risk** refers to the consequences of a wrong prediction of outcomes. That is, uncertainty characterises the distribution of possible outcomes, while risk characterises the distribution of consequences from those outcomes.

13 Buyers of weapons systems are affected by the appearance of superior alternatives somewhat differently (at least in terms of extent) from buyers of products in commercial markets. To begin with, the military value of most systems depends solely on their performance **relative to** the systems of adversaries, rather on the absolute level of their performance as such. Second, experience shows that superior quality can only be countered by increased quantity at high cost – as the Allies discovered in the closing months of World War II with bomber losses in the face of the ME-262. As a result, the appearance of a superior alternative makes the buyer of earlier systems worse off, with the effect being especially marked for buyers whose strategic posture relies on technical superiority and who are poorly placed to respond to obsolescence by increasing the volume of resources they devote to the system's military mission.

14 Almost inevitably, responding to obsolescence involves allowing some degree of system redesign during development. It also involves providing scope for refurbishment or modification during the system's operating life.

15 The response to obsolescence therefore increases the extent to which weapons systems are evolving products that cannot be well specified in advance.

Sunk costs and risks

16 Although the precise outcomes from a weapons acquisition process cannot be readily determined in advance, substantial costs need to be incurred for a system to proceed to the production stage. Usually, a very large share of these costs are specific to the system at issue and need to be sunk prior to volume production – 'first costs', are in other words, very high.[2] Weapons programs are therefore risky for three reasons.

17 First, the combination of high sunk costs and technically uncertain outcomes in and of itself imports a substantial element of risk, which must be borne by the buyer, the seller, or both. The fact that weapons systems costs have tended to rise sharply over time[3] makes the absolute extent of this risk all the more acute.

18 Second, as well as technical risk, there is a high degree of demand risk. In effect, high first costs mean that potentially, substantial quasi-rents are available on later units in a production run, in the sense that the avoidable costs of these units are low relative to average costs. In practice, however, few weapons systems ever attain the scale of production originally envisaged, much less that which would be efficient in the light of their cost structure [Rogerson (1993)].

19 Third, to the extent to which the net benefit from the program depends on the exploitation and distribution of quasi-rents, uncertainty as to how these rents will be distributed (essentially as between the buyer and the seller) creates risk for the program as a whole.

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[2] First costs are the costs that need to be incurred to deliver the first unit of output.

[3] On one estimate for the UK real systems costs have risen by over 11 per cent a year in real terms. US cost growth trends seem to be lower – see [Kirkpatrick (1995) 265] and [McNaugher (1989) 72] respectively.

The buyer

20 Turning from the attributes of the product to those of the parties involved in the acquisition process, there are generally only a few buyers for any complex weapons system. This is for four reasons:

(i) It is the natural result of the State's monopoly over the legitimate use of violence that only governments are purchasers for complex weapons systems;

(ii) As weapons systems generally need to be adapted to the particular circumstances of the military context in which they will be deployed, each system is to some extent bespoke;

(iii) Since the military value of a system depends on its performance relative to the performance of the systems possessed by adversaries, each country has some incentive to limit the international diffusion of its most advanced systems; and

(iv) In practice, governments have pursued local content policies that restrict trade in weapons systems.

Given these factors, it is reasonable, for most practical purposes, to treat the purchaser as holding a high degree of monopsony power.

21 Governments are usually distinguished by their limited ability to commit. In democratic systems such as Australia's, governments face constraints on the degree to which they can bind future governments. Even within the term of any given government, the annual nature of most budgetary processes reduces the scope for spending programs to be 'locked in'.

22 The difficulties the seller faces in predicting the behaviour of the buyer, and hence gauging the risk that behaviour creates, are accentuated by the fact that governments are not unitary actors. Rather, the governmental process involves a range of players, from the armed services through to finance and treasury departments and the legislature, whose views and interests will differ, and whose power may vary substantially over time. The civilian-military relationship, in which the weapons acquisition process is embedded, involves all the complexities of principal-agent interaction, with extensive game playing (for example, between the armed services, their civilian controllers and treasury and finance departments) whose outcomes, as circumstances change, are often difficult to predict [Feaver (2003)].

23 The seller of weapons systems therefore faces a buyer who (a) is a monopsonist and (b) is not fully capable of entering into credible precommitments. Sellers are consequently exposed both to monopsony power and to the risk of the buyer acting opportunistically – that is, taking advantage of changing circumstances to increase its share of the benefits from supply.

24 The risk of opportunism is all the more important as appropriable quasi-rents (see paragraph 19 above) account for a substantial share of the total expected value[4] of a weapons system.

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[4] The total expected value of a system can be defined as the sum of its net military value and the producer surplus generated in its supply.

The seller[5]

25 Although there are many suppliers of weapons systems internationally, even the largest economies have only a few domestic firms capable of acting as prime contractors for major systems. To the extent to which there is a requirement for domestic firms to play an important role in weapons programs, the range of competing sellers will be limited.

26 The extent of competition in supply is also limited by learning effects. More specifically, experience, defined as previous participation in similar programs, appears to have a significant impact on supplier costs and capabilities [see for example Lorell (1995)]. Since few major systems of any given type are ever produced, the number of firms with the experience needed to be competitive in the supply of systems of that type is likely to be small.

27 Additionally and perhaps even more importantly, within-program learning reduces the ability to shift suppliers in the course of a program. To begin with, the original contractor usually has specialised know-how, skills and facilities acquired in the program's early stages which can be duplicated by another firm only at the cost of considerable time and expense. Moreover, reliance on concurrent performance of development and production work so as to reduce lead times generally requires a degree of organisational continuity, at least into the early stages of production contracts. Once selected, the original contractor therefore faces limited competition in terms of subsequent supply [Peck and Scherer (1962) 325; Fox (1988) 43-4 reports that the US Department of Defense has been reluctant to terminate even very poorly performing contractors because of the high costs of shifting to new sources of supply].

28 As well as facing limited competition, suppliers are to some extent shielded from full monitoring by buyers. There is, in other words, scope for moral hazard, that is for suppliers to act in ways which generate a benefit to the supplier which is less than the costs they impose on the buyer.[6] This moral hazard can take several forms, of the which the most important are under-investment in cost reduction, 'scrimping' on quality improvements which will reduce costs in periods in which the contractor does not bear cost responsibility, and an inadequate level of investment in or disclosure of innovations that are of net social value.

29 In the jargon of principal-agent models, the scope for moral hazard in the weapons acquisition process arises from asymmetric information about costs and quality (that is, information known to the seller but not the buyer about opportunities to reduce costs and/or improve quality) and limited cost and quality verifiability (that is, constraints on the degree to which the buyer can ascertain the actual costs of the system or fully assess its quality at the time of delivery) [see generally Bower (1994)]. These features of the seller's position then make a range of investments non-contractable (in the sense that investments that are potentially of net social value cannot be the subject of distinct contracts which would induce that investment to occur because of constraints on the scope to monitor their execution).

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5 It is assumed here that the buyer and the seller are distinct entities, with the seller usually being a private, for profit, corporation. This reflects the fact that privately-owned supply is currently the standard pattern, though it has not always been so – see for example Peck and Scherer (1962) 98. Whether such vertical separation between buyer and seller is efficient is another matter, which needs to be analysed using the tools set out in Baker and Hubbard (2001), Hart (2003) and Whinston (2002).

6 Conduct which generates a supplier benefit that exceeds the cost it imposes on the buyer will occur even with perfect monitoring and hence does not constitute moral hazard.

30 As a result, the seller is usually in a position both to exercise some degree of market power (reflecting the constraints on competition) and having secured a contract, to act in ways inconsistent with joint value maximisation under that contract.

31 As a practical matter, it is important to note that there is rarely, if ever, a single seller in a major weapons acquisition program. Though programs will usually have a prime contractor, almost all major programs involve a myriad of distinct entities, including sub-system firms, overflow producers, parts suppliers and makers of specialised materials. [The Collins submarine program, for example, involves over 1500 design and construction sub-contracts – see ANAO (1997) 35. These subcontractors are responsible for some 80 per cent of the work associated with the program – see Parliament of Australia, Joint Committee of Public Accounts and Audit (1999), ¶ 4.9]. Further important difficulties arise from the fact that outcomes depend on the coordinated conduct of these entities, each of which experiences only part of the costs and benefits of its actions.[7]

The relation between the buyer and seller

32 Because the buyer is essentially a monopsonist, and the seller (at least once the program is underway) has a degree of monopoly power, the governance of the relation between buyer and seller centres on the contract between them, rather than on any scope for each to turn from the other to alternative partners in exchange (as would happen in a competitive market). This primacy of bilateral governance, and hence of 'voice' relative to 'exit' as the main means of controlling performance and outcomes, is made all the important but also more difficult by (1) the need for each party to incur substantial costs that are specific to the program at issue and non-recoverable outside that program and (2) the sheer length of time for which the parties are effectively 'locked in' to each other and hence for which the relationship must last.

33 There are however, substantial limits on how efficient the contract between the buyer and the seller can be as a means of governing their long-term interdependence. In particular, given the uncertainty inherent in the nature of the product, the contract between the buyer and the seller is necessarily highly incomplete, in the sense that it can only explicitly deal with some part of the full range of eventualities the parties are likely to experience. In practice, incompleteness is accentuated (1) by the inability of the buyer to enter into fully credible commitments with respect to its future conduct, and (2) by the difficulties involved in verifying contract performance.

34 As contract incompleteness increases risk, it must, if left unchecked, increase costs and reduce contracting efficiency [see generally Williamson (1975)]. Weapons systems contracts seek to deal with incompleteness through elaborate provisions for "filling in the blanks", including by arrangements for altering product specifications as technical information emerges.[8] Those provisions notwithstanding, analysis and experience shows that in this market as in others, contract incompleteness creates a risk of opportunistic conduct, in which parties, faced with changing circumstances, either threaten to 'work to rule' (thus reducing the aggregate value of the project) or as the price of accepting contractual modifications, seek to increase their share of any surplus from the project.

7 Situations in which a principal's payoff depends on the joint effort of two or more agents are described in the literature of economics as involving "moral hazard in teams", with the hazard arising from the fact that the payoff to each agent does not fully capture the impact of its conduct on the team as a whole [see Predergast (1999)].

8 There are also, of course, extensive provisions aimed at ensuring compliance with performance requirements – that is, at securing verifiability of contract performance even for given circumstances.

35 The Prescott-McIntosh review of the Collins Class submarine program[9] instances this in a striking way. It notes that since the program's specifications were set in 1984

> *.. technologies have changed, the region has changed and Defence's ambitions for the boats have changed accordingly, but there has been no sensible mechanism for incorporating such changes into the contract* [Commonwealth of Australia (1999) 14].

Faced with this situation, the prime contractor, the Australian Submarine Corporation ("ASC"):

> *.. has no motivation to provide more than what it interprets as its contractual obligations, especially when the Commonwealth has established it will not pay more that the original contracted price..[However, the Project Office] acting on behalf of the Navy.. is concerned that anything other than very minor amendments to the contract could let the prime contractor "off the hook" and lead to substantial blow-outs in time and cost* [Commonwealth of Australia (1999) 15].

36 Contract incompleteness, and the risks it creates for each party, also induce the parties to engage in what may be wasteful conduct aimed at reducing that risk. For example, the fear of being disadvantaged in the renegotiation process may itself induce parties to seek extensive and rigid rules, thus providing them with a degree of veto power over any change in the contract's terms. This, of course, merely exacerbates the difficulties involved in adjusting to changing circumstances, but it promises each party an increased ability to protect its interests when contract modifications need to be made.

37 For example, in the Collins class submarine project, even though the buyer recognised that the stringent requirements set down in the contract were simply no longer tenable, the fact that those requirements were set out in a stringent way allowed a senior Defence official to say that:

> *It is fair to say that there is going to be a good quid pro quo. In other words, if we agree to modify the specification in this area [the combat system] so as to make it more achievable, [ASC is] is going to have to do some work in that other area where we now decide it seems much more feasible [to have outcomes]* [Mr Garry Jones, Deputy Secretary, Defence, cited in Parliament of Australia, Joint Committee of Public Accounts and Audit (1999), ¶ 8.18].

38 Another frequently studied example of behaviour aimed at reducing the risk posed by contract incompleteness involves military buyers who engage sunk costs too quickly so as to lock governments into programs they might otherwise be tempted to terminate (or substantially scale back) [Rogerson (1993)]. By thus front-loading costs, the armed services (1) reduce the attractiveness to governments of program cancellation, since cancellation only allows few costs to be avoided and (2) increase the political costs associated with cancellation, since in the event of cancellation, the funds so far expended will appear to have been entirely wasted.

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9 The Review describes the Collins class submarine as "Australia's most important strategic asset for the decades starting 2000 and ..Australia's most ambitious and technically advanced defence industrial project ever" – Commonwealth of Australia (1999) 5.

39 Be it for this reason or for others, in the Collins class submarine project, as of 31 March 1999, Defence had:

> *.. Spent ..$4742 million or some 93% of the expected total project cost (including $4310 million, or some 98% of the expected total contract price), for which there are five boats in the water, but none performing anywhere near adequately* [Commonwealth of Australia (1999) 13; see also ANAO (1997) ¶ 4.19, showing that substantial early payments had already been made by 1992, and the discussion in Parliament of Australia, Joint Committee of Public Accounts and Audit (1999), ¶ 4.28 and follows].

40 In short, the main features of the relations between buyer and seller are that:

- Governance of their interaction hinges on the contract that binds them, rather than on any scope to turn to alternative exchange opportunities (as would happen in a competitive market);
- However, the product required is difficult, if not impossible, to fully specify in advance, which makes that contract necessarily incomplete;
- Ongoing contract adaptation is therefore required, but that adaptation increases the risk each party bears; and
- The parties anticipate that risk and seek to protect themselves from it, including by engaging in conduct which exacerbates the underlying problem.

C. Outcomes

41 Unsurprisingly, given the structural features of the situation, the outcomes of weapons acquisitions programs are often problematic and in some instances seem extremely unsatisfactory.

42 An obvious difficulty any assessment of the outcomes of the weapons acquisition process must address is that of defining performance. Additionally, it is important to distinguish *ex post* assessment, which may be distorted by reliance on “20/20” hindsight, from the evaluation of actions on an *ex ante* basis. *Ex post* assessment (that is, knowing whether there is a systematic failure to achieve intended outcomes) is nonetheless important in framing expectations for the future and notably in allowing reasonable evaluations to be made of the costs and benefits of devoting resources to weapons acquisition programs.

43 In terms of assessing program outcomes, three dimensions seem most important. First, the military value of a system depends on its **quality** which may be described in terms of features such as its speed, destructive force or accuracy. Second, the value of a system also depends on the **time** at which and for which the system is available. Third, the **cost** of a system, both at initial deployment and in terms of recurrent resource requirements, needs to be balanced against quality and timeliness.

44 Successive evaluations of weapons acquisition programs, conducted over a period of many years, have largely confirmed the early findings that programs tend to perform extremely poorly in terms of cost, moderately poorly in terms of timeliness and, ultimately at least, relatively well in terms of quality [see Peck and Scherer (1962), 425 and follows].

45 These outcomes do not seem inconsistent with those observed in non-military projects of high technical sophistication: on balance, careful comparisons find that it is not easy to conclude that weapons programs perform 'more poorly' than their closest civilian and private sector counterparts [see Peck and Scherer (1962), 432-433; and Merrows (1988)]. In both cases, large-scale, technically advanced programs involve substantial cost over-runs and are often delayed.

46 This finding suggests that 'poor' outcomes in these dimensions of performance are to some extent inherent in the nature of the programs and, most notably, in their technical complexity. While this is undoubtedly true in part, a more nuanced assessment is required.

47 In effect, the proper interpretation of the evaluation results is that when technical difficulties are encountered, it is mainly cost that 'gives.' In other words, decision-makers, faced with the problems that inevitably arise, systematically tend to trade-off higher cost and somewhat delayed delivery so as to ensure that quality objectives are met.

48 From an economic perspective, this is in and of itself suggestive of *ex ante* inefficiency. In effect, were *ex ante* choice optimal, the equi-marginal conditions imply that at the optimal point, the marginal value of the last development time increment saved would be equal to the marginal value of the last quality increasing activity, which would each be equalised to its marginal cost. A change in the constraints relative to that initial optimum should then lead to adjustments in **all** the dimensions of performance, rather than only or mainly to one.[10] What the observed pattern (in which it is cost that bears the brunt of the adjustment to the change in constraint) implies, is that when difficulties arise, either the marginal valuation of quality rises (so that the willingness to pay for quality increases) or the marginal cost of quality falls, neither of which seem sensible.

49 Rather, the observed behaviour seems consistent with a pattern in which there are soft budget constraints – that is, in which there is scope to renegotiate costs subsequent to the discovery of factors (most obviously, technical difficulties) that compromise the viability of the initial cost assessment [see Maskin and Xu (2001)]. The expectation that budget constraints are soft then has two consequences.

50 The first is a tendency to systematically under-estimate costs, most notably so as to advance the prospects of the program in its competition with other (military and non-military) uses of resources. Weapons programs are of course, not alone in this respect – systematic under-estimation of costs has been observed in many areas of public administration [see for example Flyberg, Holm and Buhl (2002)] and in those aspects of private sector activity where principal-agent are most acute. Nonetheless, the inherent uncertainty involved in the programs and their technical complexity means that

> *.. the technical specialists concerned with quality maximisation have a distinct advantage over persons defending time and cost limits, since the latter can neither understand nor argue with the former* [Peck and Scherer (1962), 476].

[10] This assumes that the relations between the different dimensions of performance are relatively well-behaved, in a mathematical sense, i.e do not involve fundamental non-convexities.

51 The second consequence of soft budget constraints is that suppliers, faced with costs that are under-estimated to begin with, have less incentive to invest in cost reduction efforts, especially if an increase in allowed costs will increase their net earnings from the project. If cost-overruns are seen as unexceptional, too little effort will then be expended in avoiding them as incurring such overruns will not seriously harm the supplier's reputation. In contrast, especially in mission-critical systems, failures to achieve intended quality likely will seriously harm supplier reputation, and hence considerable resources will be devoted to avoiding such failures from occurring.

52 In short, while some degree of cost uncertainty is inherent in technically complex programs, the extent and pattern of the cost variances observed in weapons programs suggest that it is not only random error in cost estimates that is at fault. Rather, the presence of soft budget constraints has imparted a systematic direction to the error, inducing recurring cost overruns.

D. Remedies

53 At least since the mid-1960s, cost-plus contracts, allocated and/or implemented under conditions of limited competition, have been widely viewed as a central element in allowing the outcomes noted above to prevail [see McNaugher (1989) 60].

54 More specifically, in the absence of the disciplines (including through the scope for benchmarking performance) that come from competition, cost-plus contracts provide limited penalties for cost overruns, while also providing few rewards for aggressive cost containment. Indeed, to the extent to which the allowed rate of return under such a contract exceeds the supplier's weighted average cost of capital, there will be incentives for cost padding, with the use of an input mix that is too capital intensive (the so-called Averch-Johnson effect). If capital intensity and system quality are correlated, there can also be 'gold plating', in the sense that quality will be over-provided.

55 As a result, attempts at improving the efficiency of the weapons acquisition program have involved placing greater reliance on competition and/or moving away from cost reimbursement contracts. Experience shows however, that there are severe limits to both of these remedies. More recent reform efforts have therefore involved a more complex mix of measures.

Competition

56 In technologically dynamic industries, competition has both a *rivalry* effect and a *portfolio* effect.

- The rivalry effect refers to the impact that the threat of oneself being displaced or the prospect of displacing rivals has on suppliers' incentives to perform. Simply put, the presumption is that suppliers are keener in terms of cost and quality when their market position is not assured.

- The portfolio effect refers to the impact the concurrent conduct of a range of independent development efforts has on the probability of identifying, in a timely and cost-effective way, the optimal approach: with many horses in the race, the likelihood that one will be a winner rises.

The extent of these effects, and of the net benefits that flow from them, depend both on the degree and on the type of competition.

57 Economists usually distinguish two broad forms of competition. Competition can occur either "in the market" – in the sense of involving concurrent supply by several independent firms – or "for the market", that is, through the competitive allocation of an exclusive contract to supply (as in franchise bidding for a natural monopoly).

58 The classic forms of competition "in the market" prevail in ordinary commercial contexts. The primary features of these forms are that it is supplying firms that choose to enter (by developing the products they intend to supply), engage the investments required and then strive for sales at the expense of rivals.

59 This conventional kind of competition "in the market" cannot occur, at least on any substantial scale, for complex weapons systems.[11] In particular, it would be highly risky for potential suppliers to engage substantial product development, testing and engineering prior to having obtained some degree of buyer support. In effect, as the buyer is largely a monopsonist, and as a substantial share of the assets needed to supply are specific to serving that monopsonist, the buyer could use its market position to pay the supplying firm an amount that covered its avoidable costs going forward but was not sufficient to recompense it for the sunk costs involved in the prior stages.

60 This risk of 'hold up' means that unlike conventional markets, the firms involved in the supply of weapons systems do not choose to enter and then offer their wares in the market-place; rather, even initial development – the entry stage for product supply – involves some prior contractual arrangement with the buyer. It is the buyer, in other words, who takes the initiative in soliciting and securing entry.

61 As a result, the 'architectural' issue buyers need to address is how many sellers they want to bring into the market for any particular system, and whether to retain the parallel presence of those sellers throughout the acquisition process or only for some phase(s) in that process.

[11] Obviously, were countries willing to simply rely on imported equipment, sellers could compete internationally – as happens in the less complex weapons systems. Australia could, in this scenario, benefit from the presence of competing suppliers "in the market" overseas. In practice, however, there are often strong military value grounds for 'customising' even imported designs to local conditions, with relatively extensive modifications being needed. As a result, the scope for straightforward import competition is generally thought to be very limited. Whether that assumption is correct obviously warrants careful testing in individual cases.

62 Typically, the fixed costs involved in weapons acquisitions programs are high. Full scale competition "in the market" involves duplicating these fixed costs, which is often prohibitive. This is all the more the case given that the gains which appear to come from weapons system competition in terms of greater supplier 'keenness' are not so great as to outweigh the cost penalty duplication entails [see Birkler, Dews and Large (1990) and Pilling (1989) for empirical studies].

63 As a result, full parallelism in supply (that is, the parallel presence of independent sellers throughout the acquisition process) has been very much the exception. That exception has generally occurred in circumstances where an extremely high value has been placed on the portfolio effect that competition can have. In other words, reliance on multiple sources of supply has been chosen primarily as a way of securing a hedge against technical uncertainty, rather than for its disciplining effect.

64 For example, in the Manhattan Program, five completely different, full scale methods of producing fissionable material (each costing in excess of US$100 million, in dollars of the day) were pursued, with three independent programs continuing to the end of the war [Baxter (1947) 439]. Equally, in the crash effort to develop ICBMs, fully duplicated, concurrent programs (the Atlas and Titan projects) were used to reduce the lead time to product availability [Heppenheimer (1997) 85].

65 Putting aside these exceptional instances (in which parallel efforts were justified by the need to avoid failure), more limited efforts at securing competition "in the market" confine it to particular stages of the acquisition process, relying to a greater or lesser degree on competition "for the market" to inject competitive discipline into the process' other stages.

66 The most widespread form of this mixed architecture uses parallel efforts in the earlier stages of acquisition (generally system development), with production then being allocated to a single source, perhaps through some kind of competitive bidding.

67 In practice, however, such 'design competitions' can only work effectively where the fixed costs involved in design are not themselves very large; where the know-how generated in the development phase is readily transferred between organisations; and where close integration, much less concurrency, is not needed between design and production. These conditions are frequently not met.

68 Even when they are met, the extent to which 'design competitions' really exercise competitive disciplines must largely depend on how effective the subsequent competition "for the market" proves to be, as it is the post-design stages that account for the bulk of costs. Experience shows, however, that competition "for the market" frequently fails to deliver the benefits its proponents claim.

69 To begin with, if competition "for the market" is to be effective, there need to be at least a few potential competitors. This may not be the case in relatively small economies such as Australia's if local content goals are being pursued.

70 Additionally, even if there are two or more competitors, competition "for the market" brings its own distortions. More specifically, depending on the hardness of budget constraints and of contractual commitments more generally, firms will have incentives to 'bid low' (be it by understating costs or by overstating quality), with a view to subsequent contract renegotiation. The fact that the winning tenderer will be the one that is most optimistic (about costs, timeliness and quality) adds a dimension of the "winner's curse" to the outcomes of the competition.[12]

71 These points imply that the efficiency of competition "for the market" depends to a substantial extent on the efficiency of the contractual arrangements that will govern the relation between buyer and seller once the competition closes. For example, if there are soft budget constraints, or if quality is non-verifiable (in whole or in part), competition "for the market" will not remedy the poor outcomes noted above – indeed, it can make them more severe (for example, when it increases the incentives for cost and quality misstatement).

72 This does not mean that competition "for the market" is of no utility. It can serve an important purpose as a means of soliciting seller investment in proposals. Additionally, where there are large numbers of potential suppliers, it provides a structured framework for supplier selection. Finally and importantly, when many independent suppliers compete, the prices they offer will pass back to the buyer any excess profits the suppliers could hope to make from the contractual imperfections – in other words, the gains from any post-contract supplier market power will be capitalised into the competing offers, effectively insuring the buyer against the exercise of that market power. However, the inefficiencies associated with those contractual imperfections will persist, so that poor outcomes in terms of society's overall use of resources will continue to prevail.

73 Given this, considerable attention has been paid to the scope to retain some degree of potential competition "in the market" even once the contract "for the market" has been allocated. More specifically, the threat of second-sourcing, that is of turning from the chosen supplier to an alternative, has been seen as a way of injecting continuing discipline into the supply process.

74 The circumstances in which the threat of second-sourcing is credible are relatively tightly defined. In particular, it must be feasible to transfer some or all of supply to an alternative source, which may be extremely costly if substantial site- or supplier-specific fixed costs are involved in supply.

75 Additionally, the impact of the threat of second-sourcing is complex. As noted above, if there is substantial rivalry for the initial contract, any rents from contractual imperfections will be bid away, in the sense that they will be built into the offers made. As a result, the initial terms will already be rent free, at least in an expectational sense. To the extent to which this is indeed the case, the threat of second sourcing merely increases the risk of opportunistic behaviour by the buyer and hence the initial bid price must rise (for given levels of quality and timeliness). On net, and again assuming effective competition for the initial contract, there cannot be an overall gain in efficiency [see Anton and Yao (1987) and Riordan (1993)].

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[12] The 'winner's curse' refers to the fact that in common value auctions with an unknown common value, the winner of the auction will be the party with the most optimistic assessment of that value. As a result, the information generated by winning is that one's own estimate of the value is likely to be too high – so that winning is a curse.

76 That said, there are two caveats to this view. First, there are circumstances in which suppliers will themselves offer a second sourcing contract as a way of providing insurance to the buyer against the risk of supplier opportunism. This insurance may be cost-effective in increasing the value of the transaction to both sides, and hence allowing an increase in contract price. Second, the presence of a second source may reduce the losses associated with monopsony, most notably the likelihood that in the event of contract extension or renegotiation, mutually advantageous transactions do not proceed because the monopsonist's offer, though in excess of the supplier's avoidable costs, falls below a level the seller is willing to accept (perhaps because of the effect of accepting a low offer on the supplier's reputation for 'toughness').

77 Overall, second sourcing is likely to make a relatively marginal contribution to the extent of competitive disciplines, at least in small markets like Australia's.

78 A further option for increasing the extent of competition is that of reducing the spacing between successive generations of weapons systems. If new systems are developed while the prior generation still has some years of service potential remaining and the realistic option of having its service potential further extended, then there can be a degree of competition between the new system and its predecessor. Obviously, this involves a willingness to bring system renewal forward in time, so as to enhance the degree to which the new system and its predecessor are effective substitutes.

79 The Collins program, in contrast, was carried out in a context where:

> *.. the Oberon class has been run down to the point where there is only one operational boat, HMAS Otama, which will soon need a long and costly major refit if it is to remain in service* [Commonwealth of Australia (1999) 13].

80 However sensible inter-generational competition may seem from an economic perspective, it encounters obvious practical difficulties. In particular, budget financed organisations often have a relatively high discount rate and hence tend to postpone system renewal more than would be optimal were the social discount rate applied. By the time renewal occurs, the current generation may seem a distinctly inferior substitute to its successor, and hence the threat of substitution is not credible. As a result, the extension of the life of existing systems usually serves as a way of securing a degree of insurance against delays in the availability of the successor system, rather than as a means of imposing a competitive constraint.

81 In short, competition, be it "in the market" or "for the market", is far from being a panacea. High fixed costs impede the former. As for the latter, its efficacy depends to a substantial degree on the efficiency of the contracts between the buyer and the chosen seller. To the extent to which these contracts are necessarily incomplete, competition for the right to be the chosen seller cannot resolve the distortions incomplete contracts give rise to, though it can eliminate any excess seller profits these distortions might otherwise create.

Cost reimbursement contracts

82 Moves away from pure cost reimbursement contracts to contracts based on fixed prices have been another important element in attempts to increase the efficiency of the weapons acquisition process. Underpinning these moves is the belief that pure cost reimbursement contracts create incentives for moral hazard, in the form of inducements to pad costs or to not invest to an optimal degree in efforts at cost reduction. In contrast, fixed price contracts will provide 'high powered' incentives for cost reduction, in the sense that the firm will retain any profits made by reducing costs. The firm will therefore have incentives to disclose the asymmetric information it holds with respect to opportunities for cost reduction.

83 In practice, the incentives provided under fixed price contracts may not in fact be as 'high powered' as all that.

84 There are two aspects to this. The first arises when the information the firm generates in one period affects outcomes in subsequent periods – for example, when the price offered to the firm in subsequent periods is reduced in line with information about achieved cost reductions in the current period. This 'ratchet effect' naturally dulls the firm's incentive to achieve cost reductions. The second and practically more important effect arises when adverse consequences eventuate – say when costs prove much higher than was originally expected. If governments are unwilling to allow supplier bankruptcy to occur, and a 'bail out' occurs, then the soft budget constraints will not in fact have been 'hardened.'

85 These difficulties were apparent both in the F-111 and in the C-5A development, which led Lockheed to the verge of bankruptcy. Ultimately, the high perceived costs involved in allowing a major supplier to fail made it difficult for the hard budget constraint to be sustained, presumably diluting the 'high powered' incentives the fixed price contract was intended to provide [see McNaugher (1989) 62].

86 However, even if it is assumed that the buyer can credibly commit to a fixed price, so that the cost-reduction incentives are indeed 'high powered,' it does not follow that fixed price contracts are efficient. Three broad sets of arguments are relevant here.

87 The first is that fixed price contracts may lead to an inefficient, and ultimately unsustainable, allocation of risk.

88 As is widely recognised in the relevant literature, it is important to distinguish asymmetric information from imperfect information. Asymmetric information refers to situations where a player holds information that is not known to the other party. In contrast, imperfect information refers to situations where both parties are uncertain as to the value of particular variables – for example, as to how much it will cost to develop, build and operate a particular weapons system.

89 In many weapons acquisition programs, information will be both asymmetric and incomplete. However, it is likely to be the incomplete element that dominates. Given this, imposing a fixed price shifts substantial risk on to the seller, without its being at all clear that the seller is best placed to manage that risk. In effect, governments, with their ability to pool risk across many competing sources of income, will usually have greater options for efficient insurance than would be available to private suppliers. If the risk is placed on the supplier, then a corresponding (and inefficiently high) risk premium will need to be built into the contract price. Under these circumstances, reliance on fixed price contracts will increase rather than reduce prices over the longer term.

90 Second, a fixed price contract may induce distortions in the allocation of effort. The essence of the incentive provided by the fixed price is that the firm secures the entire return on investment in cost reduction. However, other investments the firm might make are not equally rewarded and may not be separately contractable or in fact contracted for. The firm will then under-invest in these other aspects of performance.[13]

91 Investments in quality exemplify the problem. Under fixed prices, the firm will have no incentive to invest in the non-contractable dimensions of quality. In contrast, under pure cost reimbursement, if costs and quality are correlated, the inducements to ‘scrimp’ on quality would be weaker if not reversed. A firm operating under a fixed price contract may therefore more readily engage actions which lower product quality or increase long term product cost (for example, in the form of higher maintenance outlays) than one operating to pure cost reimbursement.

92 Third, fixed price contracts generate their own forms of opportunistic behaviour. In particular, the buyer under such a contract has strong incentives to exploit opportunities to increase the seller’s costs (subject to not driving the seller into liquidation), for example by interpreting product specifications in ways that shift costs onto the seller. At the same time, particularly when adverse circumstances occur (for example, costs prove to be higher than expected), the seller has incentives to seek to escape from legal liability for supply.

93 Pratt and Whitney’s F-100 engine is a frequently cited illustration of behaviour of this kind [Drewes (1987) 55 and follows]. The engine accumulated stress at a rate unanticipated by its designers or by the Air Force. Contractually, Pratt and Whitney was obligated to correct design flaws, such as those which seemed to cause the engine’s difficulties. However, Pratt and Whitney was able to point to ambiguities in the contract’s specifications and deviations between the intended use and actual use of the engine. As a result, it escaped the liability that the contract seemed designed to create and the needed repairs were funded through supplementary outlays. This outcome followed considerable manoeuvring by both sides and extensive and costly investment in litigation.

94 Like competition, fixed price contracts are therefore no panacea. They put a high value on apparent certainty in terms of the ‘headline cost’, but that certainty may well be obtained at the expense of considerable inefficiency.

Other options

95 Given the limits of the reform proposals set out above, attention has more recently focussed on other options for making the acquisition process work better. While these options are extremely diverse and to some degree overlapping, to the point of forming a somewhat poorly defined shopping list, it is convenient to consider them under three broad headings: the ‘production function’ for system acquisition; contract design; and the wider environment for the weapons acquisition process.

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[13] This is a form of what is referred to as the “multi-tasking” problem.

The production function

96 As with other products, the weapons acquisition process involves a production function that relates inputs (the resources used in the process) to outputs (the goods and services obtained) [Peck and Scherer (1962) 160]. There are reasons to believe that acquisition processes have involved a degree of inefficiency both in terms of outputs and in terms of inputs.

97 On the output side, there appears to have been a tendency, evident in projects such as the Collins class submarine and the Jindalee Operational Radar Network, to seriously under-estimate the cost of seeking high levels of technical sophistication. It is well-known that costs, and the variance of costs around the expected cost level, rise rapidly with system complexity [see for example President's Blue Ribbon Commission on Defense Management (1986) 46; McNaugher (1989) 128]. Specification of simpler systems, less loaded with complex requirements, could well allow substantial cost savings.[14]

98 That these savings would be worth having seems clear when consideration is given to at least some of the factors that have led to the choice of highly technically demanding specifications. For example, in the Collins class submarine, highly sophisticated on-board systems were chosen so as to allow the submarines to be operated with very small crews. However, it is difficult to believe that the costs avoided through smaller crews come close to the added costs caused by the greater sophistication of the required equipment. The marginal rate of transformation between labour inputs and capital (in the form of on-board systems) appears to differ substantially from the price ratio between them, implying an inefficient choice of quality level.

99 On the input side, there is a long-standing concern about whether the appropriate level and mix of human capital is devoted to major system procurement [Peck and Scherer (1962), 86]. In particular, far greater investment is made in the technical aspects of weapons acquisition than to the management of the acquisition process itself. Staffing of the commercial aspects of the acquisition process often involves significantly lower levels of skill (and correspondingly, pay) than seem sensible in view of the amounts at stake [Kelman (2003); see also in respect of the Collins class submarine project Parliament of Australia, Joint Committee of Public Accounts and Audit (1999), ¶ 7.7].

100 In short, less technically demanding projects, better staffed on the commercial side, could well allow for the better use of resources.

Contract design

101 Although the evaluations are inevitably qualified in important respects, more sophisticated approaches to contract design than either pure cost-reimbursement or fixed price contracts seem to be yielding dividends in terms of improved performance for the acquisition process [see for example Drezner and Leonard (2002), Ingols and Brem (1998), Lorell, Lowell, and Levaux (2000) and Smith, Shulman and Leonard (1996)].

102 While these approaches are complicated in their implementation (and not readily reduced to formal modelling), three elements are especially important.

[14] Simplification could also allow more straightforward import competition, that is, competition from imports of existing systems. As noted above, however, there are often cogent arguments for adapting foreign designs to local conditions.

103 First, the approaches involve specifying target outputs, in terms of mission performance, and giving the supplier greater control over the technical means by which those outputs are achieved. This in turn requires extending the supplier's responsibility to later phases in the product's life cycle, so as to ensure that technical specifications are not chosen in such a way as to shift costs from the production phase to the operating phase. In the extreme, the supply contract can be extended to cover the entirety of the system's life (though there are obvious difficulties with doing this when system maintenance and repair must occur in the field).

104 Specifying outputs rather than inputs, and hence giving suppliers a high degree of change control over specifications, allows suppliers to more readily optimise and re-optimise the design as and when technical information comes to hand. This is of obvious potential importance in reducing transactions costs for systems which may have thousands of required design changes in each year of development and testing. It also helps ensure that supplier attention is not focussed on conforming to the observable aspects of specifications, while neglecting opportunities for securing improvements through changes to less readily observed system features.

105 Second, a phased approach is used to pricing; in particular:

- The system development stage remains subject to a cost-reimbursement approach, which may extend to prototype production.

- However, even during system development, suppliers are made aware of a price ceiling, beyond which the system at issue will not be procured. This "must cost" cap, which is based on the approach used in the commercial airframe market, serves to render explicit (both to the system developers and to the community) the reservation price associated with the system's expected military value. If the cap is not met, the project is cancelled.

- If the cap is met, then production price commitments are entered into for initial production lots. These price commitments will reflect cost experience to date and anticipated rates of cost reduction (through learning or other scale effects). They define a binding commitment as to how much will be paid for the first units commissioned into service.

- Price paths are also sought for production runs beyond the initial lots. These price paths are not binding, in the sense that should the buyer seek to exercise the option to obtain these subsequent lots at that price, the seller may at that stage seek a different price. However, the buyer then has the option of securing supply from the seller on a cost-reimbursement basis. In other words, the buyer has a call option either to buy at the bid price or to buy at the cost-reimbursement price. The seller, on the other hand, is not assured of a put option symmetrical to the rights vested in the buyer, but is assured that if the buyer does procure units subsequent to the initial lots, the price for those units will not be lower than specified in the seller's successful non-binding bid.

- Separately, incentive payments are provided if the system's performance exceeds expectations.

106 Third, greater weight is placed in seller selection on sellers' past performance. This allows suppliers to secure an explicit return on investment in reputation and helps convert the acquisition process into a repeated game. Sellers are thereby discouraged from engaging in short term, opportunistic conduct, as the penalties associated with that conduct are increased.

The context in which acquisition occurs

107 Finally, increased attention has been paid to shaping the context in which acquisition occurs in such a way as to enhance the efficiency of the acquisition process. This perhaps inevitably involves a range of relatively 'soft' variables, only some of which have been studied in a formal way by economists. Two such variables stand out.

108 The first is **trust**, or what might be more broadly referred to as the social context of the procurement relationship. For reasons set out above, the weapons acquisition process relies on contracts that are necessarily incomplete. It is known that such contractual incompleteness is least distorting when agents share a broad understanding of goals and of the norms that are acceptable in achieving those goals [see especially Kreps (1990)]. This is because the shared norms and goals reduce the risk of opportunism, and hence the risk loading that affects product costs, and facilitates mutual adjustment to changing circumstances.

109 There is considerable evidence that commonality of goals and norms affects the costs and overall outcomes of weapons acquisitions programs and of complex system procurement more generally. For example, the costs of major nuclear programs appear to have been significantly lower in France, where institutional arrangements make for common socialisation of defence buyers and suppliers, than in the United States or the UK [see Finon (1989), Koloziej (1987) and Simmonot (1978)].

110 However, it is not easy to identify policies that materially affect the relevant dimensions of trust and that are meaningfully within the control of acquisition authorities. Efforts at replicating 'high trust' acquisition processes in cultures that lack the features that make for 'high trust' do not appear to have been especially successful. Additionally, there may be important trade-offs between trust and other dimensions of performance that are highly valued.

111 For example, the relative success (in terms of cost and timely project completion) of the French Fast Breeder Reactor program as compared to its US counterpart appears to have been significantly affected by the very low degree of public scrutiny that characterised the French program, which shielded it from costly modifications that were made elsewhere [Finon (1989)]. A consequence, however, of this lack of transparency and accountability was that the French program continued long after substantial doubts about the value of fast breeder reactors led to termination in other countries. Although the French program was relatively successful on its own terms, it is questionable whether it would pass a social cost-benefit test.

112 Additionally, there are reasons to believe that competition tends to undermine a perception of shared goals and norms. Most simply put, in a competitive environment, suppliers may have stronger incentives to act opportunistically, since they have less assurance that passing up opportunities for short-term gain will yield long-term rewards. Moreover, supplier investments in reputational capital may need to be written off if their relationship with the buyer comes to an end. As a result, there is a tension between subjecting suppliers to competitive pressures and seeking from them types of behaviour more commonly found in repeated games. Clearly, placing greater weight on past supplier performance as a criterion in supplier selection (see paragraph 106 above) is one way of attempting to ease this tension.

113 A second dimension of the context in which acquisition occurs is **monitoring**. Systematic project and program evaluation by authoritative independent parties can serve a range of important functions. These include facilitating conflict resolution by acting as a neutral evaluator of conflicting claims; improving accountability and hence increasing the pressure for good performance; and drawing the lessons from acquisition experience in a timely and rigorous manner, and hence allowing both more and less promising approaches to be identified sooner and more effectively.

114 An obvious example is the important role the Federally Funded Research and Development Corporations ("FFRDCs") play in the United States and, most notably, RAND, the Institute for Defence Analysis and the Centre for Naval Analyses. RAND in particular has pioneered economic analysis of acquisitions programs and continues to act as an important source of rigorous research in this area. It is also striking that Congress increasingly requires rigorous, independent and public evaluations to be carried out, especially for significant development efforts, throughout the acquisition process, such as those implemented for the DarkStar High Altitude Endurance Unmanned Aerial Vehicle.

115 In his masterly study of major British procurement failures, Henderson stressed the role that the lack of transparent, early evaluation and accountability played in ensuring "the unimportance of being right" – that is, the absence of rewards for successful decision-making and for penalties for poor decision-making [Henderson (1977)]. In Australia, while it is true that the Audit Office has been of obvious importance in highlighting performance issues in programs such as the Collins class submarines and the Jindalee Operational Radar Network, no systematic, economic, evaluation of programs is carried out independently from the buyer. Additionally, past reports aimed at drawing more systematic assessments – most notably the then Industry Commission's review of defence procurement [Industry Commission (1994)] – were not well based in an understanding of the economics of the weapons acquisition process and are in any event seriously out of date. The result is an over-emphasis on a few, clearly unsuccessful, cases, with too little information being available or evaluated on acquisition process performance as a whole.

116 Greater attention to the economic evaluation of weapons systems acquisition programs has the potential to yield some gains in terms of program effectiveness. This is all the more the case as new techniques are now coming into use which allow more formal applied modelling of issues such as the optimal sharing of risks in particular acquisitions programs [see for example, Gasmi (2003)]. These techniques can help inform contract design, but require a more systematic approach to applying economic analysis to acquisitions programs than has characterised Australian experience to date.

E. Conclusions

117 The weapons acquisition process is inherently and necessarily imperfect, in the sense that first best efficiency is completely unattainable. Understanding the reasons for this is of some importance, especially because it can help understand both the limits and the potential of reform proposals.

118 Economists have been concerned with developing such an understanding for many years, and the results constitute an impressive and useful body of knowledge. That said, no ‘magic bullets’ have been found, though at least there is a better appreciation of what doesn’t work at all and what may work sometime. Continued efforts at reform seem to be yielding some results, though the need for further, careful evaluation remains.

119 Ultimately, weapons acquisition processes are afflicted by almost all of the pathologies that affect the operation of the public sector – information asymmetry, conflicting goals, non-commensurable objectives and lack of credible commitments, all super-imposed with a high degree of technical complexity and uncertainty [Hogwood and Peters (1985)]. But the disease, though incurable, does not appear fatal, and it may be that economics can help develop ameliorations that are more than merely palliative care.

Henry ERGAS, 5 August 2003

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