Introduction.

During the 1990s two concepts became central to military discourse: The Revolution in Military Affairs, RMA, the way that changes in technology were transforming fighting, and Asymmetric Warfare, the way that opponents would respond to a dominant military power by fighting in ways that the dominant power did not expect or prepare against. Neither concept is new; there have been a series of revolutions in military technology (Kirkpatrick, 2000) and attacking in ways that your opponent did not expect has been the basis of strategy since at least Sun Tzu in the fourth century BC, Newman (2000). However, there has been considerable dispute about exactly how each should be defined in the current context. Definitions of the RMA tended to emphasise the way that improvements in information technology, precision targeting and smart munitions created the possibility of a new form of network-centric warfare. Definitions of asymmetric warfare have emphasised asymmetries in technology, tactics and stakes. Despite having massive technological and military superiority; the US withdrew from Lebanon in 1983 after a suicide bombing killed 241 troops and from Somalia in 1993 after a battle in Mogadishu, in which television covered the brutal treatment of two American corpses and one injured prisoner. This paper discusses some aspects of these concepts emphasising the economic issues involved. We will draw on comparisons between the putative New Economy of defence, the RMA and asymmetric warfare, and the putative New Economy in Civilian life, where changes in technology transforming production and distribution and dominant incumbents, like IBM, were vulnerable to attack by then small competitors, like Intel and Microsoft, following different strategies.

The transformation of the military environment was associated not merely with changes in technology but with changes in resource allocation and the nature of security and conflict. In particular the development of military technology and expenditures have led to the concentration of military power in US hands and this has
provoked responses from other state and non-state actors. We thus begin with a discussion of the current military environment to set the scene. We then discuss technology, resource allocation, security, and finally conflict. Our ultimate aim is to provide formal models of the strategic environment and this paper should be seen as a preliminary discussion of the main features of that environment to suggest aspects that should be included in the theoretical models.

The Military Environment

The changes that have transformed the global military environment over the last decade include:

- US preponderance. In 2001 SIPRI estimated that the US accounted for 36% of world military expenditure of $839bn. The combined expenditure of next four largest spenders, Russia, France, Japan and the UK, was about half that of the USA. It requires the combined total of the next nine largest spenders to match the US. US spending is growing, whereas for most of the rest military expenditure is not growing much.

- Continued escalation of the fixed costs of R&D for major systems, both for platforms and for the infrastructure (e.g. satellites, strategic air assets) and information systems needed to support network-centric warfare. All but the US, thus face structural disarmament as they are unable to afford the fixed costs needed to replace conventional military capability with modern systems comparable to the US. This is a particular problem for the minor powers who have broader military aspirations, in particular the other permanent members of the Security Council: China, France, Russia and the UK.

- Growing fixed costs have also led to increased concentration in the arms industry; however it remains fragmented, dominated by traditional producers. In 1990, the top 5 western firms accounted for 22% of arms production. In 2000, after a wave of concentration, the top 5 accounted for 42%; still a tiny proportion compared with comparable high-technology civil industries, which are typically dominated by three producers or less, e.g. Airbus and Boeing in large civil aircraft or Bombardier and Embraer in regional civil aircraft. Dunne et al. (2002) analyse the evolution of the industry.

- The traditional method of sharing fixed costs, collaboration, has become less effective, with failures and difficulties on a large number of European projects, such as Eurofighter, its main weapon Meteor and the Airbus A400M transport.

- The costs of military technology are high even for the US, e.g. missile defence, and it, like other countries, has tried to use commercial practices and products to reduce costs. This has had mixed success.

- Since the US appears invulnerable in the type of warfare it has chosen to invest in, adversaries have an incentive to resort to other types of warfare: asymmetric warfare, which can exploit other vulnerabilities of the US and its allies. The bombing of the USS Cole in Yemen in 2000 demonstrated US vulnerability to certain sorts of very low-tech attack.

- While governments are trying to commercialise the military, to cut costs, their opponents are trying to militarise the commercial, to produce new weapons. Fertiliser and fuel oil make explosives, commercial aircraft make missiles. The emergence of dual-use technology is a double-edged sword for governments:
procurement costs may well fall, but the weapons become more readily available to terrorists. Not only are the technologies for weapons of mass destruction (WMD) - nuclear, biological and chemical - inherently dual use, but new information technologies have potentially military applications, e.g. they can be used to maintain international terrorist networks and to exploit vulnerabilities in the infrastructure of the US and its allies.

- Conventional military capability retains its utility for antagonists in regional rivalries: India-Pakistan; Greece-Turkey, etc, though even in these cases there are incentives to acquire WMD. However, inter-state war is rare. Of the 34 major armed conflicts in 2001, only one, India-Pakistan was inter-state.
- Intra-state war is common. Within countries traditional military capability may be ineffective in maintaining order and in consequence states in many parts of the world have failed; being unable to maintain a monopoly of the legitimate use of force and provide security of life or property.

Technology

The RMA is potentially the latest of a sequence of technological changes that have transformed the military, Kirkpatrick (2000). Such revolutions usually also change the balance of power, as one group or country adopts the new technology faster than their antagonists and use it to change the way war is fought. The technological changes can involve new products, like the tank, or new processes, forms of organisation, like Blitzkreig, that make better use of existing products. In the military, process innovation tends to be much slower than product innovation, particularly in peace-time. In general, new technologies have been most effective when used in ways that are unexpected by the enemy and have often been associated with the rise of new revisionist powers e.g. the Japanese defeat of the Russians in 1905, through the use of the latest technology and a more effective strategy. Some military revolutions concentrate power, because the equipment is so expensive and specialised that only an elite can afford it; the rise of the armored knight in their siege-proof castles, for instance. Other revolutions disperse power as they put cheap capability into mass hands; the guns that displaced the knights and castles.

Old economy military technology was very centralising; rapid cost growth between generations of weapons means that almost nobody, not even the US, can afford it. Like the New Economy, the RMA was oversold: the way in which conflicts are fought has, so far, stayed pretty much the same. The B52s that bombed Afghanistan are 1950s technology. A core competence for the Royal Marines in Afghanistan remained the ability to carry 60 pound packs and for US special forces the ability to ride horses. Most military equipment is obsolete in commercial terms before it enters service, because it takes on average seven years to develop and deliver it. Eurofighter, not yet in service, is based on early 1980s designs; and when it enters service, it will do so without its main missile, Meteor, which is mired in collaborative politics. Current fighting power is very much old economy, the question is whether this will change and what a new economy military might look like.

It is worth comparing the new military and civilian economies in terms of some core characteristics. New-economy industries tend to have high fixed costs but low
marginal production costs. Software is expensive to develop but cheap to produce in quantity. They tend to have network effects, the more people who use the product the more effective it is. Innovation tends to be a series of winner-take-all races. At any moment in time a single firm, which produced the killer application, tends to dominate the market; but when innovation is rapid their dominance is precarious: as Netscape fell to Microsoft and Yahoo fell to Google. Bresnahan and Greenstein (1999) discuss some of these issues. Most weapons production does not show these characteristics. Although they do have high development costs, they are also so costly to produce that they are limited to small batches with long gaps between generations. A further consequence is that innovation is slow. The defence industry is fragmented and the market leaders are the same old firms who have been producing weapons for decades. The arms industry is still waiting for the killer applications that displace most of the competition, typical of the new economy.

There are some new economy elements. The Global Positioning System, GPS, is a system of military satellites that has spawned a myriad of commercial applications. The system was expensive, but receivers are cheap. GPS was crucial in the Gulf War. For the first time in desert warfare, commanders could rely on soldiers knowing where they were. The wide availability of GPS allowed the allied commanders to use tactics that would have been impossible without it. Nearly all the friendly fire incidents involved vehicles without GPS. GPS was widely available because there was a commercial industry from which the military could quickly buy the GPS receivers that they needed to equip their vehicles. Such symbiosis between the commercial and the military will be central to any new economy armaments, but will raise issues as to who has control of the technology.

Cost is central to the RMA. Mathews and Tredenick (2000) in their collection of essays on managing the RMA conclude ‘ultimately, however, managing the RMA means finding the resources to make it a reality’ (p97) and, ‘a technical revolution is only feasible if it is affordable’ (p4). Some spreadsheet simulations for NATO countries provide the conclusion: ‘Given the RMA is assumed to be characterised by increasing equipment intensity, it appears that no country, including the US, would be able to undertake the RMA without either significant reductions in personnel numbers or significant increases in defence budgets, or some combination of both’ (p113). On the assumption that real defence budgets and personnel are constant, wages grow in line with the economy, there is no real growth in the cost of equipment and that the equipment will have a useful life of 15 years, equipment per service personnel in 2015 would be just over 20% lower in the US and almost 40% lower in the UK.

Government’s attempts to make defence more affordable include acquisition reform; use of commercial-off-the-shelf, COTS, technology; improved logistics and the like. These, it is hoped, will generate a revolution in defence business affairs which will pay for the RMA. The history of past procurement reform does not encourage this optimism by the military, but maybe this time it will be different. A recurring theme in military procurement reform is the attempt to learn from the commercial world, where new technology generate low production costs and high volumes rather than as in the military with high production costs and low volumes. In the commercial world change is rapid, not slowed by long replacement cycles, and most equipment is relatively new compared with much military equipment. The thrust of reform has been to commercialise the military, by importing private sector practices into military
organisation. During the 1991 Gulf War 9% of the ordnance dropped consisted of ‘smart’ (precision-guided) munitions. In Kosovo in 1999, the figure had risen to 29%, but cloud cover hindered employment of the laser guided types. In Afghanistan it was between 60 and 70%, with a large proportion of these being standard dumb bombs, with strap-on guidance kits, that allowed high accuracy from safe bombing heights.

Both the strap-on kits, JDAM (the GPS guided Joint Direct Attack Munition) and WCMD (Wind Corrected Munitions Dispensers) were cheap in military terms because they used more commercial development programmes and commercial components. It had been estimated that under traditional acquisition programmes JDAM would cost $68,000 each. A new system, mandating a maximum price, was used and the final cost was about $18,000 each, Lorel et al. (2000). Of course JDAM is only useful if you already have the legacy systems: B52s and dumb bombs.

The new economy tends to disperse power in consumption, we all have incredibly powerful computers on our desks. But it tends to concentrate power in production, they nearly all have Intel inside. There is an important difference between commercial and military applications in that while pirate copying does happen, in general intellectual property rights tend to be more secure in commercial applications enabling firms like Microsoft and Intel to establish supply side dominance. For military products the role of patents is played largely by arms export controls, which limit exports to technologies below the state of the art. However, if a new military technology becomes available, no government feels constrained from copying it by patents, brand-names or foreign ownership of the technology. Which aspect, the demand side or the supply side, will dominate a new economy military is not clear. At the moment it looks like supply side concentration, with the US as the sole military hyper-power; but it could be the demand side, dispersing cheap and powerful military capabilities, based on converted civilian technology, to all. Anti-globalisation protesters already use the internet to mobilise, with new economy weapons they might be able to deploy more firepower.

**Resource Allocation**

Defence choices are always hard. Defence ministries have to determine: the threats they face; the military capabilities that will deter or defend against those threats; the force structure that will provide that military capability; and the budget to pay for those forces. They have to do this in an environment dominated by well-entrenched vested interests, the Military Industrial Complex. It is often said of economics exam papers, that the questions never change, what changes is what are currently considered to be the right answers. The classic defence economics questions remain the same: how much is enough? How to get the biggest bang for a buck? What is the right mix between labour and capital? How do you maintain a defence industrial base? But the right answers are very different from those considered appropriate during the Cold War.

The structure of the calculation of the level of military spending -how much is enough- is straightforward in principle, if not in practice. There is a potential threat, military expenditure increases security in the face of that threat but it also has opportunity costs in terms of foregone consumption. The optimal choice is to increase
military expenditure to the point where the marginal security benefits of the military expenditure equal the marginal utility costs in terms of foregone consumption. The optimal defence budget will be higher the greater the threat and will be higher the greater the effectiveness of military expenditure in countering the threat. Thus when the Soviet threat was removed at the end of the Cold War, defence spending was reduced. This marginal analysis will not work if there are discontinuities, such as fixed costs, where you get no benefit until you have spent a large amount. In that case it may be that the military expenditure that you can afford is ineffective, since it does not get you over the threshold. Then there is no point in spending on defence and you are in the position of Costa Rica, abolishing the armed forces, or the Danish no-tax party, whose defence policy was an answer machine that said ‘we surrender’ in Russian. What we observe is that countries steadily drop capabilities as the fixed costs become too large for them to play in the game.

The difficulty is for many countries, e.g. most of Western Europe, the threat is not well defined, and for those threats that appear well defined, such as international terrorism or global warming, conventional military capability is not an effective response. Of course, for regional powers involved in enduring hostilities - India and Pakistan, Greece and Turkey – conventional military capability appears to retain its utility. When the threat is not well defined countries tend to look at defence spending as an insurance premium. Historically, in peacetime the UK, which because of its island status faced few direct threats, has been willing to spend about 2% of GDP on defence as a general insurance policy. There is no obvious threat, but it seems prudent to spend something on maintaining a basic military capability and since they are there, the armed forces may as well be used for other purposes. In the case of the UK winning an empire in the 19th century or being a good international citizen in the 21st. Although, there are now no obvious threats, many governments seem to feel that military forces are valuable.

Currently, the public and most politicians in many countries seem to regard the defence budget as a rather uninteresting insurance premium. It is the fixed cost of maintaining a military, and they do not care much about exactly what it is spent on, those are technical details left to the military. The danger in politicians and the public treating defence as an insurance payment they make to the military, is that without combat experience or public scrutiny the military easily become inefficient. Britain largely ignored the army in the long peace after the Napoleonic War, and paid the price in the Crimea.

The choices are currently particularly hard for those powers, which though dwarfed by the US, and which face economic constraints which stop them matching US spending on either forces or technology still aspire to have an extensive military capability. These might be called ‘minor powers’; the other four permanent members of the Security Council - China, France Russia and the UK – being the prime examples. Within the military sector the choices are made harder because of the constraints imposed by the historical structure of their armed forces and arms industry. For most of the minor powers the capital labour balance is crucial. Unlike the US and UK; China France and Russia, traditionally fielded large conscript forces. France has ended conscription, but not cut the size of the number in the armed forces and as a result has squeezed the equipment budget. In Russia conscription remains controversial. But to maintain any technological parity with the US, without
exorbitant expenditure, requires switching to a less labour-intensive force structure, with fewer, better trained and better equipped troops. Of course, there are also non-military reasons for conscription and large armed forces.

The minor powers traditionally provided the bulk of their equipment from national defence industries. Again this seems no longer feasible. The problems are well brought out in the introduction to the UK government’s Defence Industrial Policy (Ministry of Defence Policy Paper No. 5, October 2002):

“In recent years defence has experienced profound change. The global political context has altered dramatically, and the nature of military operations and of equipment has similarly been transformed. A manpower intensive, platform-heavy and predictable doctrine has been replaced by the requirement for sophisticated, rapid and precise military solutions. The UK Government’s response to the new strategic environment, and the drive for efficiency, culminated in the Strategic Defence Review and in particular the Smart Acquisition reforms. These have placed new demands on a defence industry already changing globally in response to new market conditions, and a new emphasis on closer co-operation and openness in our relationship with industry. The ongoing consolidation of the defence and aerospace industries, dominated by a few giant companies and a multiplicity of international joint ventures, has major implications both for the future of an exclusively “national” defence industry and for competition. “

The UK has taken a much more free-market approach to defence procurement than the other minor powers, believing that it will benefit from a more efficient globalised industry. However, the more extensive arms trade that would be associated with a more globalised arms industry raises a set of issues that we have discussed elsewhere, Garcia-Alonso (1999, 2000) Garcia-Alonso & Levine (1997), Garcia-Alonso & Hartley (2000), Levine Sen & Smith (1994), Levine and Smith (1995, 1997a,b, 2000a,b) Levine Mouzakis and Smith (2000).

**Security**

The value of insurance, be it home insurance or the defence budget, is that it buys you security. Be the threat high or low, defence spending itself has no value; it is valuable in that it buys you a military capability that can be used to contribute to your security objectives, be they self-defence or power-projection. While for most rich parts of the world there are no real military threats; for much of the poor parts of the world there is no real security of life liberty and property. Although there are a large number of enduring antagonisms between states, often associated with higher levels of military expenditures (Dunne and Perlo-Freeman (2003) Collier & Hoeffler (2002)), wars between states are relatively rare. Like Stauverman (2002) we may ask why is there so much peace? However, wars within states are common. On the Gleditsch et al. (2002) measures, of the 225 armed conflicts over the period 1946-2001 only 46 were between states. Although they are not confined to poor countries (e.g. the Northern Irish and Basque wars) intra-state wars are much more common in poor countries. Lack of security is a major factor in the economics of poor countries, though it is only relatively recently that it has attracted much attention from economists. Currently the international financial institutions are giving conflict a higher priority, e.g. the World Bank program on Civil War.
Most economists have followed Adam Smith in emphasising people's propensity to truck barter and exchange. But why truck barter and exchange when you can rob, pillage and loot? Again most economists have followed Smith in dealing with this problem by assuming exogenous provision of property rights: that there is a sovereign or state whose duties include protecting the society from the violence or invasion of other societies and establishing an administration of justice. Under these assumptions robbing, pillaging and looting are excluded from the set of possible economic actions. This may be a reasonable first approximation for some times and places, but is certainly not for others, including much of the world today. However, there is now a fairly large literature concerned with endogenous property rights, where agents allocate resources to attack or defence as well as to production and trade. The resulting distribution of property reflects agents ability to protect their resources from others or steal resources from others. The simplest models have individuals who can allocate their time between investment in growing food, stealing food from others and defending the food they have from theft by others. An early example is the work of Earl Thompson (1974, 1979), who looked at the equilibrium distribution of capital among nations, but the literature has grown rapidly in recent years. In this literature the analogy to the production function is the conflict success function, CSF: the inputs are the fighting efforts of the two sides and the outputs are their relative degree of success, Anderton (1992, 2000).

Typically the models will have a number of units each subject to a budget constraint, with production possibilities for various goods, including military ones and exchange possibilities. This literature differs in the form of the CSF, the substantive questions addressed and how the economic elements are modelled, Sandler (2000). This literature has been motivated by a variety of different concerns: attempts to develop better theories of the emergence and nature of the state McGuire and Olson (1996); understand Civil wars, Collier (2000), Gershenson et al. (2000), Sambanis (2002); how economies operate without effective legal structures, Dixit (2002); by desire to integrate the models of production and exchange with models of conflict and struggle, Rider (2002); intervention in conflicts by third parties (Siqueira 2002); concerns with issues of terrorism, organised crime, post-conflict demobilisation and reconstruction, etc.

**Conflict**

We will focus on the issues associated with the CSF. Hirschleifer (2000) provides an excellent discussion, with lots of military and non-military examples, which captures the spirit of the literature. We will use this account for reference, because it is so detailed. The basic structure is that each side makes investments in technology and forces and the CSF then specifies how this determines either the probability of winning or the share of the pie that goes to each side.

It is worth starting with a related but much older literature, which describes what Hirschleifer calls the micro-technology of conflict. This is the Lanchester (1916), model of how the quality and numbers on each side influenced the evolution of particular types of battle. Consider, \( n_a \) riflemen of one side in line, facing \( n_b \) of the other side, each side starts aimed firing at the other with attrition rates \( q_a \) and \( q_b \) (these can be thought of as measures of relative quality, which will depend on the
product of the probability of a kill and the rate at which they can fire); the number of
troops on each side then evolves according the pair of differential equations
\[
\frac{d n_a(t)}{dt} = -q_a n_b(t),
\]
\[
\frac{d n_b(t)}{dt} = -q_b n_a(t).
\]
The first equation says that the number of \( a \) riflemen who are killed is determined
by the number of \( b \) troops shooting and their accuracy. Notice that as one of the \( a \) troops
are hit, this reduces the casualties \( b \) is suffering enabling them to hit more \( a \) troops.
Solving these equations the initial force level at which the sides are equally matched,
in that in combat they would reach zero forces at the same time, is
\[
q_a n_a(0)^2 = q_b n_b(0)^2.
\]
This suggests measuring the relative strengths of the sides by the implicit CSF
\[
S = \frac{S_a}{S_b} = \frac{q_a}{q_b} \left(\frac{n_a}{n_b}\right)^2.
\]
The exponent is often called the Lanchester coefficient and, as discussed below, can
take different values depending on the type of conflict. Another example of the
derivation of an implicit CSF using micro-foundations from the dynamics of a battle
is Intriligator (1976), who considers nuclear exchanges.

One feature of the Lanchester square law formulation is that numbers matter more
than technology. Suppose that side \( a \) replaces, say 1000 riflemen by 200 machine
gunners, who are each 25 times as effective, i.e. now \( q_a = 25q_b \). But five enemy
riflemen would each be targeting each machine gunner, who would on average last
one fifth as long as the rifleman he replaced, so is only five times as effective rather
than 25 times. Bellany (2002) discusses this example in the context of asymmetric
warfare, which he interprets as a significant qualitative asymmetry in the technical
level of sophistication of the armaments employed by each side. He uses the Boer
War as an example, where although the British eventually won, they had great
difficulty in turning their technical superiority in weapons, including machine guns,
into military advantage. Boer leaders, unlike World War I commanders, did not think
it sensible to order their troops forward to be mown down by the opponent’s machine
guns, so the battles were no longer described by this particular law.

It may appear that a limitation of such models is that the stronger side must ultimately
wipe out the weaker, so there is no way to scale the degree of success. This only
seems true because the description of the battle is incomplete, it describes the
evolution of forces, not how the battle ends. For instance, having seen how the battle
is going generals may be able to retreat and regroup; or forces may break and run after
having taken a certain percentage of casualties (in which case a smaller more
determined force may win).

Much military operational analysis takes this form: detailed mathematical (usually
numerical) simulation of the dynamics of a possible battle. This involves detailed
specification of the numbers, types of forces and tactics of each side, the nature of the
environment, how each side will respond to casualties, etc. Such simulations are used
to inform tactics, strategy, and procurement decisions. In the military context, this
leads to arguments about the relative returns of investment in quality, increasing \( q \).
and quantity, increasing n. The military can also compare the simulations with reality. For instance, the Gulf War did not match prior simulations (allied casualties were orders of magnitude lower than predicted) and there is still debate about what aspects of the models were wrong. This suggests a number of questions. What form of battle/conflict is being modelled? How is the relative degree of success measured? What are the inputs (quality and quantity in this case)? What is the form of the resulting function? The battle is described by sets of non-linear differential equations describing the evolution of each side’s forces, these can show chaotic, unpredictable, behaviour providing a mathematical representation of the fog of war.

Hirschliefer argues that the role of the economist is not to replace the technical experts in the micro-technology of conflict, but to address the macro-technology of conflict, making use of such familiar concepts as increasing and decreasing returns, economies of scale and scope, and factor substitution. In doing this the CSF function is treated as basic, rather than being derived from specific scenarios as Lanchester and Intriligator do. In addition, as Hirschliefer (2000, p774-5) recognises the CSF describes the mechanics of attrition, grinding your opponent down; but a lot of warfare is about manoeuvre, using your forces to catch your opponent at a disadvantage a fact emphasised by Luttwak (1987) who he cites. But Luttwak explicitly rejects the production function approach “when it comes to military power, the relationship between material inputs and desired outputs is not proportional; it is in fact very loose, because the making of military strength is dominated by nonmaterial, quite intangible human factors, from the quality of military strategy to the fighting morale of individual servicemen.” It is these intangibles that the CSF lacks and they are the intangibles that are central to asymmetric warfare, where the opponent attacks you in the way that you did not prepare for. In this sense, the CSF can never be exogenously given, but it is chosen as a result of the combatants strategic choices. Ex ante, one side may not know which CSF the opponent will choose.

Consider a slightly more general formulation of the Lanchester model, also discussed by Hirschliefer.

\[
\frac{\partial n_a(t)}{\partial t} = -q_a n_a(t)^\lambda n_b(t)^{1-\lambda}
\]

\[
\frac{\partial n_b(t)}{\partial t} = -q_b n_a(t)^{1-\lambda} n_b(t)^\lambda
\]

which reduces to the Lanchester model if \( \lambda = 0 \). The nature of the tactics used determines \( \lambda \), which measures the diminishing returns to scale to large forces. The case of \( \lambda = 1 \) corresponds to the case, where the sides did not engage, but forces steadily decay either because of disease, common in the past, or logistics failures, a major problem now. The \( q_l \) then measured the two sides relative ability to maintain their force structure. The case of \( \lambda = 1/2 \) corresponds to the case of individual duals or un-aimed positional fire. As discussed by Hirschliefer the larger \( \lambda \) the more decisive the combat tends to be.

The solution is such that the initial forces are equally matched if

\[
q_a n_a(0)^{2(1-\lambda)} = q_b n_b(0)^{2(1-\lambda)}
\]

with an implied conflict success function

\[
S = \frac{S_a}{S_b} = \frac{q_a}{q_b} \left( \frac{n_a(0)}{n_b(0)} \right)^{2(1-\lambda)}
\]
One could then imagine asymmetric warfare as described by a stage game in which the incumbent has to optimise, not knowing what tactics its opponents would adopt, i.e. which value of $\lambda$ it would choose. The attacker then chooses the tactics, $\lambda$, which would put the incumbent at a disadvantage. The US might choose a general-purpose technology of combat, aerial bombing with $\lambda = 1/2$, but this can be indecisive and can be thwarted by specific optimised technologies in particular circumstances. For instance, the opponents can choose to create circumstances that require, for instance, the US to engage in urban fighting if it wishes to prevail, where $\lambda = 0$ and technology is relatively less effective. If the opponent can entrap the US forces into a quagmire, a fear since Vietnam, $\lambda = 1$, and the US forces may self-destruct.

Conclusions

This paper is a preliminary review of the nature of the current military environment: the nature of the technologies, the resource allocation issues, the determination of security and the way we think about conflict. The aim is to suggest ways in which we may model the Revolution in Military Affairs and the threat of asymmetric warfare. The difficulty is that there are multiple dimensions to each of these issues and it is not clear which issues are the most salient or most important. The military decisions have to be made in the face of substantial uncertainty with large information asymmetries. The military decisions are mixed in with concerns of domestic politics and domestic economic interests. There are substantial collective action problems, both within militaries (getting the army, navy air-force and marines to cooperate) and between states (forming coalitions of the willing). Nonetheless there does seem scope for models in which the implicit conflict success function is endogenous, the product of a constrained choice by the actors, allowing us to model manoeuvre, asymmetric warfare, etc.

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