ECONOMIC SCENE

Military manpower and leadership are pluses, but battles are hard to predict.

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DONALD H. RUMSFELD, the defense secretary, and his top generals are vigorously debating the number of troops to deploy in the event of a second Persian Gulf war. Coalition forces numbered 795,000 in the 1991 war. Mr. Rumsfeld has argued that far fewer American troops -- no more than 100,000 -- are needed to defeat Saddam Hussein's armies this time around because of the revolution in military technology and Iraq's weakened state, while the military brass is not so sure, and prefers at least 250,000.

News reports say they have agreed to split the difference and put around 175,000 troops in the region, with 100,000 or more reinforcements available if needed.

What does it take to produce a military victory?

A crucial concept in economics is the production function: certain inputs must be combined to produce desired outputs. This idea has been applied to military battles by Ralph Rotte of the University of Technology in Aachen, Germany, and Christoph Schmidt, president of the Rhine-Westphalia Institute for Economic Research in Essen, Germany. Their study, "On the Production of Victory: Empirical Determinants of Battlefield Success in Modern War," turns up some provocative findings.

Using data from the Army Concepts Analysis Agency, Professors Rotte and Schmidt classify 625 battles according to whether they were won or lost by the attackers. They construct a statistical model, known as a probit equation, to determine which factors make victory more likely. Both objective factors, like the size of the forces, and subjective ones, like troop morale and leadership skills, are used to predict victory. Battles spanning a long sweep of history, from 1600 to 1973, are studied to allow for changes in military technology.

They find that outnumbering one's opponent is a significant determinant of victory -- and that the advantage from having more troops is virtually as strong since the start of World War II as it was from 1600 to 1849, despite changes in technology.

As in many industries, however, there are "declining marginal returns" from manpower. That is, having an additional 10,000 soldiers helps an attacking army less if it already had twice as many troops as the defending army than it would if both sides had been close to parity.

Of course, the downside of a larger deployment is that more troops are in harm's way. In addition, research by Joshua D. Angrist of the Massachusetts Institute of Technology and John H. Johnson IV of the University of Illinois finds that deployment disrupts family life; soldiers deployed in the gulf war in 1991 were more likely to become divorced than those not deployed.

Although the relative number of troops is a determinantof victory, Professors Rotte and Schmidt find that troop morale and leaders' tactical skills are even more important. Because morale and leadership skills are judged ex post facto by military experts who have the benefit of knowing which side won, they are wary about ascribing too much weight to these factors.

In most battles neither side has a clear technological advantage. When there is a difference, the professors find that having the technological edge does not raise the likelihood of victory. Having superior intelligence and the element of surprise, by contrast, count toward victory.

Consider Napoleon's defeat at Waterloo. With 68,000 men, Napoleon faced the Duke of Wellington with a combined English and Prussian force of 137,000. French intelligence underestimated the Prussians' fighting abilities, and Napoleon was surprised by their swift appearance on the battlefield. The Rotte-Schmidt statistical model gives Napoleon only an 18 percent chance of prevailing. They calculate that had the Prussians not arrived, leaving Napoleon to face Wellington's 66,000 men alone, his chances would have risen, but to just 26 percent. The reason for the long odds is that the duke was rated a superior leader at that stage of their careers; had the advantage been reversed, Napoleon would have been predicted to prevail.

So leadership, morale, troop size and intelligence have historically counted for more than technology. Do these conclusions apply to 21st-century conflicts?

There are limits. The prism of history may distort judgments of morale and leadership. Moreover, armies facing an overwhelming opponent may have avoided conflict, leaving only a select sample of battles where the outcome was uncertain. And it is certainly possible that the latest weaponry -- including precision-guided munitions, stealth bombers, thermal imaging, compound armor and drones -- give far more of a technological edge than the innovation of mobile infantry combat gave Napoleon.

Still, the statistics reinforce doubts many defense scholars have about the latest "revolution in military affairs." Stephen D. Biddle of the University of North Carolina at Chapel Hill, for example, cogently argues that technology was only a part of the reason for the decisive victory in 1991; skilled manpower and technology enabled coalition forces to exploit monumental Iraqi mistakes, which may not recur in another invasion. Michael O'Hanlon of the Brookings Institution notes that despite superior technology, America lost in Vietnam and Somalia.

The generals who study past battles have probably drawn the same conclusions through intuition that Professors Rotte and Schmidt draw from statistics. That may explain their insistence on a large force.

So one other conclusion is worth emphasizing: victory is hard to predict. The factors that Professors Rotte and Schmidt identified improve the prediction of which side won by only around 25 percent over random guesses. It is wise to recall Napoleon's assessment on the eve of Waterloo: "I tell you Wellington is a bad general, the English are bad soldiers; we will settle the matter by lunchtime."