MIRVs and the Strategic Balance*

BELLANY[1] claims that the introduction of multiple independently targeted re-entry vehicles (MIRVs) could increase the stability of the strategic balance between the US and the Soviet Union. This conclusion is not warranted, and in fact quite the opposite is true.

The measure of stability adopted by Bellany is based solely on the number of warheads that survive a first strike by the opposing power. I shall present several arguments to show why this criterion is unsatisfactory. In the model in which the forces of the two major powers are assumed to be equal, Bellany's basic equation is

$$X = nN(1-C)^{fnR} \qquad (1)$$

Here N is the number of launchers on each side; n is the MIRV ratio (number of warheads per missile); R is a reliability factor (probability of successful launch); C is the probability that a target missile silo is destroyed by a single warhead; and f is the fraction of its launchers that country A employs in a hypothetical (counterforce) first strike. X is then the number of B's warheads expected to survive such an attack. By maximizing X with respect to n, holding all other parameters fixed, Bellany obtains an "optimum" MIRV ratio.

Does the "optimum" situation thus derived actually entail an increase in stability? Consider the numerical example used by Bellany: $R = 0{\cdot}75$, $f = 1$, $C = 1/2$; for simplicity, take $N = 1{,}000$. The situation with and without MIRV is then as follows

	$n=1$ (no MIRV)	$n=2$	$n=3$
Initial warheads on each side	1,000	2,000	3,000
Warheads B has left after A's first strike	625	706	645

$n = 2$ is the optimum MIRV ratio according to Bellany's criterion. The introduction of MIRV has achieved a modest (I am tempted to say, trivial) increase in the number of surviving warheads, at the cost of doubling the initial number of warheads on each side. Perhaps a would-be first striker will feel somewhat more deterred. But a much more important consideration has been ignored by Bellany. Imagine a crisis situation, in which each side fears the other may attack, even though neither has a true first-strike capability. (I regard this as a more likely prelude to nuclear war than a coldly premeditated first strike.) In such a situation, military leaders will weigh the risks and advantages of a pre-emptive attack against those of waiting and perhaps letting the opponent get in the first blow. Even with a MIRV ratio of only 2, pre-empting will reduce the opponent's force by a factor of almost 3; if the opponent should strike, one's own force will be similarly depleted. The advantage of striking first is always much greater with MIRV than without. This is the very essence of instability.

Bellany has also maximized X with respect to only one parameter, n. If we complete his calculation by similarly finding the optimum value of N, obviously, this value is infinite and, according to Bellany's criterion, the most stable situation is one in which each side possesses an infinite number of launchers, each missile containing some finite number of warheads. If the number of launchers is held fixed, say, by international agreement, the procedure of maximizing only with respect to n becomes more justified. But the other criticisms remain equally valid even in this case.

Equation (1) can be used to demonstrate another reason why MIRV is destabilizing. The values for accuracy, hardness, and so on used by Bellany are fairly representative of present capabilities. The trend in missile technology, however, has been toward ever improving accuracy, and we must take account of the likelihood that targeting errors will be reduced substantially below their present values. The parameter C is extremely sensitive to missile accuracy; it is given by the relation

$$1 - C = 2^{-K/CEP^3} \qquad (2)$$

where CEP is the r.m.s. targeting error and the constant K depends on the yield of the weapon and the hardness of the silo. If $C = 1/2$ when $CEP = 0{\cdot}25$ miles (these are the numbers used by Bellany), then a reduction of CEP to 0·1 mile (not at all outside the range of possibility) increases C dramatically, to more than 99 per cent. Even by Bellany's criterion, the optimum MIRV ratio then falls well below unity. More important, when C is close to unity, X rapidly approaches zero as n increases. The combination of high accuracy and MIRV is extremely dangerous: It can lead to a situation in which each side has a first-strike capability with respect to the other's fixed missiles. This would be about the most unstable situation imaginable.

One can hardly expect countries to deploy MIRVs now and voluntarily dismantle them later, when improved accuracy makes them a potential first-strike weapon. Any agreement to refrain from incorporating higher accuracy in an existing MIRV installation would be subject to the well known difficulties in verification.

I conclude that the introduction of MIRVs, at any ratio, would have a highly destabilizing effect on the strategic balance.

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[1] Bellany, *Nature*, 226, 412 (1970).

MAY I reply to Professor Sartori's points roughly seriatim?

Let me say first that I was careful not to be dogmatic about what actually constituted a more or a less stable balance. My choice of the number of surviving warheads as a measure of stability was made because it seemed plausible that decision makers would think, even in periods of crisis, in terms of numbers of targets threatened—roughly proportional to number of warheads—and of how well they might defend these targets with ABM defences—again closely related to the number of attacking warheads to be engaged. Professor Sartori wishes to substitute this criterion by one where the incentive to strike first is measured by the inverse fraction of total warheads expected to remain after a first-strike attack. He may be right.

Second, I am glad Professor Sartori has been good enough to illustrate my contention that there is an optimum value for the number of MIRV warheads per launcher. That he has gone farther and demonstrated that the number of warheads surviving a first strike is, near the turning-point, a slow moving function of the MIRV number adds weight to my general contention that MIRVs do not necessarily threaten a serious upset to the strategic balance.

Third, my justification for maximizing X with respect to n is simply that the number of launchers, N, is the only parameter at all likely to be fixed at some future date by political agreement, as Professor Sartori himself concedes.

Finally, the fact that, by my criterion, as missile accuracy increases the optimum MIRV number falls below unity merely bears out what Professor Sartori has to say about the effects of increasing accuracy and does not strike me as giving him much cause for complaint on that point. Might I, however, complain that while Professor Sartori's discussion of the effects of increasing accuracy is, as far as it goes, unexceptionable, it does not go far enough? He

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