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ON THE QUANTIFICATION OF SECURITY

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af Bent Sørensen

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Abstract

Der opstilles en simpel model til kvantisering af et samfunds sikkerhed mod overgreb såsom atomkrig, besættelse af fremmed magt, osv.

Som parametre anvendes de eventuelle fjenders evne til at gennemføre deres forehavende, deres intentioner om at gøre det, samt det angrebne samfunds evne til af afværge overfaldet.

Denne opdeling har bl.a. til hensigt at sikre en dybere diskussion af hver af disse størrelser, som modvægt mod vage udsagn om stigende eller faldende sikkerhed. Numeriske eksempler på modellens anvendelse sigter således mere på at åbne en debat om de vurderinger der ligger bag parametervalg, end mod at give et endegyldigt tal for et områdes sikkerhed.

Der gennemregnes 6 eksempler: Destruktiv krig imod USA, USSR, Vesteuròpa og Østeuropa, samt territorial besættelse af hhv. Vest- og Østeuropa.

ON THE QUANTIFICATION OF SECURITY

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ON THE QUANTIFICATION OF SECURITY

ABSTRACT:

A simple model for quantifying the security of a society is proposed. The level of security is described in terms of three time-dependent variables: The CAPABILITY of potential aggressors, their INTENTIONS, and the likelihood that the society in question would be able to successfully defend itself and thereby AVERT an assault. The model is used to assess changes in security since 1945 for the United States, the Soviet Union, Western and Eastern Europe. The security as regards destructive war is found to be again decreasing for all four regions, after a temporary improvement during the 1970ies. The security as regards foreign invasion and occupation of Western Europe is declining after 1980, following a long period of steady improvement. Use of the model for assessing alternative defense policy options and future strategy is discussed.

It is a common belief, that a society possessing a clear military superiority over its potential aggressors enjoys a high level of security. The estimate of security levels is more involved for a situation of two or more societies engaged in an arms race, such that the assignment of superiority is uncertain at any given moment in time, and subject to possible reversal during relatively short time intervals. One society may be superior in one area, but not in other ones, and due to the instability of the balance, it is not even sure that there is any simple relationship between superiority and security.

In a complex situation such as the one described above, overall military strength is a poor indicator of security. One must look into the specific capacities for offense and defense in all the societies that may play a role in a conflict situation. Furthermore, the intentions of potential aggressors have to be assessed, along with the stability or variability of their intentions.

From a professional military point of view, high security is perceived in case one has at one's disposal an across-the-board military capability, offensive as well as defensive, and sufficient to intimidate any possible combination of enemy aggressions (Sienkiewicz, 1981). However, in a situation where the aggressor has similar capabilities, this does not necessarily maximize the security of the society, i.e. the security of all its members and of its basic structure and organization[1].

The security of a society thus depends on the military capabilities and their specific mix for both the socity itself and its potential aggressors. It also depends on strategies for using the military capabilities, and more

generally on political intentions. The present study aims at defining a quantitative measure of security in terms of variables ("parameters") that quantify enemy capabilities and intentions as well as one's own defense ("aversion") capability. The reason for seeking a quantitative - albeit simple - expression of security is that the process of formulating the model, and of choosing its data, forces the analyst to structure his views and present them in a way which is more open to outside assessment than isolated statements on subjective perceptions of security trends usually are.

THE MODEL

In order to arrive at a quantitative model of security, the complex issues involved will have to be disentangled and formulated in well-defined terms. First, security will be defined for a specific society or an interrelated group of societies, and furthermore, security is to be understood as being with respect to a specific type of assault or aggression, such as nuclear war, conventional war or territorial occupation. Once the security with respect to such identifiable events has been evaluated, combinations of offence types can be considered, and to the extent that the list of offences can be made reasonably complete, an overall security may be defined in terms of a weighted sum of individual risks. This last step will not be attempted here, and it involves fundamental questions of methodology, because the individual threats to the security of a society may be of different characters (ranging from death and destruction to police state methods and mind control

excerted by an occupying force), which may well be considered incommensurable.

Consider first the risk of an assault of a given type. "Risk" is defined as the occurrence per unit of time, that is the frequency, of the event in question. The risk will certainly depend on the capacity and intentions of potential aggressors. Malevolent intent does not present any risk if not accompanied by a capability to carry through the offense, and possession of the capability does neither if there is no bad intentions on the part of the "potential aggressors". In order to separate the society's defense capabilities from the offense capabilities of the enemies, the latter will be defined in terms of the force level of the potential aggressors, independent of the status of defense capacities. The quantitative expression of the aggressor capability, to be denoted A, is

A = aggressive capability of potential enemies as a fraction of that which would fully ensure accomplishment of the type of aggressive objective under consideration, and assuming total failure of defense.

Then a second risk parameter, C, is the chance of averting the assault by some kind of defensive action,

C = effectivity of defense, expressed as the probability of successfully averting an attempted aggression of the type considered.

Third, the intentions of the potential agressors have to be quantified. Do we think that an assault is likely to take place within the next year, within the next twenty year, or just how often? The parameter describing the enemy intentions is thus a frequency, B, which may be defined as

B = aggressive intentions of potential enemies, given as the estimated probability per unit of time, that an

assault of the type considered will be attempted.

The risk of an assault with the aggressor reaching his objective, F, may now be stated as the probability of an assault (B), times the capability for carrying it through (A), and not being averted (1-C),

$$F = AB(1-C) \qquad [1]$$

This is obviously the simplest expression describing the considerations made above. A and C are pure numbers, while B and F have dimension of inverse time. More complex models could be constructed, for example to indicate that one considers the capabilities of the enemy as more important for the risk picture than his intentions. Yet the simple model will remain a basic standard of risk estimation[2], against which one would compare more specialized models.

Each of the parameters A, B and C, as well as the risk, F, are for a given type of assault, say the i'th type. Placing i as a subscript on each quantity, the risk expression becomes

$$F_i = A_i B_i (1 - C_i) \qquad [2]$$

The inverse of the risk is the momentary value of the average time lapse, t_i, between assaults of the i'th type. It is this quantity which in the present model will be used as a measure of security with respect to the i'th type of offense, S_i,

$$S_i = t_i = (A_i B_i (1 - C_i))^{-1} \qquad [3]$$

One may define an accumulated risk, R_i, by

$$R_i(t) = \int_{t_0}^{t} A_i B_i (1 - C_i)\, dt' , \qquad [4]$$

which has the form of a probability for an assault reaching its objective within the time interval from t_0 to t. The value of t, say T_i, for which $R_i(T_i) = 1$, would be the mean

time interval between actual incidences of the i'th type of aggression. Its inverse would be a measure of security over a time span beginning at the time t_0, and distinct from the momentary security measure S_i, which pertains to only one point in time. The present study will reject the security measure based on T_i, because the time-integrated probability measure is not considered to adequately represent the mechanisms leading to conflicts in the real world. For example, past periods of enemy intentions and capabilities, which contributed enough to R_i to make it close to unity, but did not actually result in attempted agression, may cause R_i to exceed unity during some later period, for which the momentary measure of risk happens to be extremely small. The impression of low security induced by the accumulative approach is would thus be false. On the other hand, the momentary estimate of security, S_i, is a representation of the actual risk situation, and future changes in the risk picture has to be modelled through the time-dependence of the parameters A_i, B_i and C_i.

The establishment of time series for the three model parameters (for each type of aggression) must for past times be achieved by historical analysis, and - in case of policy or extrapolation studies - by setting up a model of future parameter behavior, as function of policy decisions or by extrapolation of current trends. In both the past and the future cases, this kind of data acquisition involves parameter estimation associated with several sources of uncertainty.

The nature of uncertainty is different for the parameter B_i than for A_i or C_i. Both A_i and C_i depend basically on strength measures, which again derive in part from hardware counts and in part from estimates of the effectiveness of

given societies in using the military hardware at their disposal, or to engage in non-military types of defense. There are clearly uncertainties involved in translating considerations of this nature into a single number, such as the fraction of set objectives that an aggressor could hope to achieve, or the percentage chance that a society has for averting an assault by defensive actions. Still, fixing past and future values of A_i and C_i is basically a technical problem, and one that can be based on the evaluations of competent military professionals.

The parameter B_i describing enemy intentions is quite a different matter. There is no "technically correct" answer as to its proper value. It depends on policy assessment and judgement, and cannot be rigorously settled neither for past or future situations. Different analysts may arrive at very different estimates, depending on personal value systems, and data sources such as political leaders are rarely willing to, or capable of, revealing time-sequences of aggressive intentions in the past.

Yet the value of a security model such as the one presented here is that it separates the "technical" issues from the subjective judgements regarding enemy intentions. In contrast to sweeping statements of enemy intentions, like "The Soviet Union seeks world domination", one is forced to ask precise questions of the form mentioned: Will the Soviet Union attack us during the next year? Will it during the next fifty years? This pressure for quantification can be a very sobering exercise, and the isolation of the most subjective parameter makes it easier to conduct a constructive discussion of its value and trends, between observers with different sets of prejudices.

One further kind of uncertainty involved in the parameter

B_i, as regards projections into the future, is the fact that intentions can change much more rapidly than the physical, hardware-dependent capabilities described by A_i and C_i. In order to study the effect of this overriding source of uncertainty for times beyond the present one, the numerical examples given in the following sections will look at an uncertainty in B_i, which sets in at the present time and increases more and more, as one extends the model further into the future.

DESTRUCTIVE WAR

The type of assault considered in this section is "destructive war", which shall be taken to mean an aggression resulting in casualties of the order of fifty percent of the population in the attacked society. No previous wars have had such death tolls, but present weaponry and in particular nuclear arms have made these destructive wars possible as well as "thinkable", in the sense that both superpowers plan for destructive wars, and seek in the name of deterrence to make it credible that they could carry them through.

The term "destructive war" is presently more or less synonymous with "all-out nuclear war", but it could also be effected with advanced, conventional weapons, or by use of chemical or biological weapons. The security model outlined in the previous section will be applied to the period from 1945 to the present, and will be further used for discussions of security to year 2000. Just after World War II, the arsenal of nuclear weapons did not allow for inflicting "destructive war" on any extended territory, and the possibility of inflicting 50 pct. casualties with

conventional weapons were then small, as reflected in the choice of the "enemy capability" parameter A (In this section the type index "i" is omitted, because only one type of assault is dealt with).

Before looking closer at the parameter choices, the societies for which security is to be estimated have to be defined. The model will be used for four societies/groups of societies: The United States (US), the Soviet Union (SU), Western Europe (WE) and Eastern Europe (EE) not including the Soviet Union.

Consider first the enemy capability, A, for inflicting "destruction" as defined above. In the cases of the US and the SU, the enemy is taken as the other superpower. For WE, the enemy is taken as the SU, at least up to the present time. In the future, one might consider nuclear terrorists or the possibility, that the US might conduct a limited war against the SU "through proxy" in Europe. Neither of these possibilities are considered in the standard scenario for the period 1985-2000. To a small extent, the enemy of the SU could be extended to WE, just after WW II (primarily the United Kingdom), and perhaps again towards year 2000 (France or more likely a new military alliance between France, West Germany, Italy and perhaps the UK). Finally, for EE, the "enemy" may comprise all the three other regions, US, SU and WE. However, while the SU is the main enemy as regards foreign occupation, it is not with respect to nuclear war (the reverse "nuclear war by proxy" scenario is less likely for SU-EE, because of the physical proximity of the two regions). The main enemy for EE as regards destructive war remains the US, with WE going along but not likely constituting an independent threat, except in the future event of a new military alliance in WE.

Fischer (1983) mentions three ways of determining enemy capabilities: 1) counting military expenditures, 2) counting weapons and 3) playing war games (battle simulation). Surely, military expenditures may misrepresent actual capabilities, because good and bad investments are both counted with full weight. Also weapon counts may be deceptive, if the battlefield efficiency of the weapons is poorly known, or if personnel or organizing capacities for using the weapons are lacking in number or quality. A statistical analysis of the outcomes of battle simulations would in theory give the best answer for the combined parameters of attack capability and aversion potential (A and C). However, existing game models are highly idealized and mostly oriented towards testing strategic doctrines or towards tactical training of officers. As measures of capability they are hardly superior to hardware counts. The selection of the parameter A for the present study is therefore primarily based of weapon counts, but an effort is made to avoid the pitfalls mentioned by more detailed assessment of weapon types, qualities and modes of use.

The data parts of Figures 1-4 show the values of A chosen for the four regions, as function of time. By 1949, the US possessed a few hundred nuclear bombs and the SU but a dozen. Deep penetration was possible by air lauch only. Tactical nuclear bombs became deployed in Europe, notably by the US as a countermeasure against SU superiority in numbers of soldiers and conventional arms. This is the reason for letting A increase between the establishment of NATO in 1949 and the mid-fifties, for both WE and EE. The nuclear threat continues to increase for all regions after the introduction of hydrogen bombs in 1953, and the accelerating deployment of strategic launchers, ICBM's, on submarines or land.

After 1960, new qualitative changes took place. US Defense Secretary Robert McNamara introduced the concept of "assured destruction", which was interpreted as the capability to kill one fourth of the SU population and to destroy half of its industry after a first strike by the SU. In terms of weapons this is interpreted as a surviving second strike capability of 1200 megatons of TNT equivalent on about as many independently targeted missile heads (Kaplan, 1982). McNamara further introduced the notion of "flexible response", demanding a much larger arsenal of specialized nuclear weapons, differing in size and precision, to be able to selectively attack military targets, industrial targets and population centers. The time-urgency of strikes against certain military targets made it imperative to improve the command and control capacity, which among other things meant the establishment of a satellite surveillance system. The building up of these capacities took place over the following years, as reflected to some extent in the development of the parameter A for the SU and EE. However, A flattens out because the purpose of the US policy change is not primarily to increase the total destructive power, but rather to add new weapon types - often of relatively low yields - in order to avoid having to use the mass-destruction weapons early in a conflict (counterforce as opposed to countervalue strategy). This development will be reflected in the intent parameter B, but it affects A only insofar as the total capability for destruction is increasing.

During the 1960ies, the SU effort is one of catching up with the US, and to actually produce the nuclear arsenals claimed to be in existence in the late 1950ies. By 1968, the SU had catched up on the number of ICBM launchers, and both

powers began to harden silos and improve accuracy. It is generally agreed, that by 1970 there was an overall parity between the US and the SU, with respect to the number of strategic warheads[3]. For particular weapon systems there were differences. The US SLBM's had been operative since 1966, and the SU did not catch up until 1971. The reason that the parameter A is taken as larger for enemy capacity against the US than against the SU in situations of weapons parity, is purely geographical: It takes a larger megatonnage to destroy half the SU population than to destroy half the US population.

From the beginning of the 1970ies, the capacities were increased by MIRV'ing of ICBM's, and improved accuracy of SLBM's brought these out of the confinement to countervalue uses. None of these qualitative developments have significant influence on the parameter A as it is defined here.

For EE and WE, the enemy capability, A, reached a high value (taken as 0.8) already in the beginning and end of the 1960ies, respectively. Again the difference in the values of A as compared with those of the US and the SU are of geographical origin. From 1979 a worsening of the situation in the two Europes took place, due to the rapid deployment of new SS-20 missiles and later of cruise missiles, due to decreasing warning times and vulnerability of command and control centers (e.g. because of Pershing-2 missiles), and due to an overall increase in the number of targets that may be wiped out in a first strike (Trident 2 and Soviet counterparts). Full deployment of these weapon systems would be completed around 1990. For WE and EE, the value of A has presently reached a level nearly equal to one, and for the US and the SU, it is assumed to remain at 0.7, based on the

consideration that none of the weapon systems existing or proposed can fully ensure destruction of societies which are as dispersed as the US or the SU.

The intentions of potential aggressors, i.e. the parameter B, can be estimated on the basis of an analysis of political statements, intelligence information, published strategy and battlefield conduct material, or by theoretical modelling such as deterrence theory (aimed at modelling the influence on enemy intentions of various force postures, in order to find say the least expensive force posture which is sure to deter the enemy from aggression). Deterministic models of enemy thinking are likely to fail, due to omission of factors such as historical prejudice, leadership psychology and the influence of a large number of smaller events in international policy, which are considered insignificant or too numerous to include in operational models of enemy behavior. The choice of the parameter B shown in Figs. 1-4 is primarily based on public sources stating or exploring national stragegies and political attitudes towards aggressive activities[4].

Despite general political statements on the "inevitability of war resulting from contrasting ideologies", the SU has hardly had any real intentions of attacking the US itself during the period 1945 to now. "Detente" has been seen by Soviet leaders as the only realistic kind of relation with the US (Mamontov, 1979). Towards (parts of) WE, the SU may have had some aggressive intentions until 1949, when NATO was formed and the "nuclear umbrella" of the US became extended to WE. When the McCarthy cold war syndrome spread over the US, a US attack on the SU and EE became (or remained) quite thinkable despite increasing SU nuclear strength. The figure chosen for US

aggressive intentions is 0.2 per year (one in 5 years) in 1948, when there was a US monopoly on nuclear arms, rising to 0.25 y^{-1} in 1950 (Korean war), declining a bit at the death of Stalin, but reaching a new height of 0.3 y^{-1} during the Cuban missile crisis in 1961.

The aggressive intentions of the SU are lower and during the late 1940ies directed mainly towards WE. They increase until 1961, due to the impact of the cold war and due to the confidence associated with increased SU nuclear capability.

The positive contact established between John Kennedy and Nikita Khrushchev lead to decreasing US intentions of destructive war against the SU, and the doctrinal changes brought about by McNamara as a consequence of the shortcomings exposed during the missile crisis must have had a similar effect, although it was until after 1963 (partial test ban agreement), that the SU defacto accepted the doctrine of "mutually assured destruction" (MAD). By 1963, the aggressive intentions of both sides have been estimated as down to 0.1 y^{-1}, and during the following period of detente (to about 1979), the aggressive intentions continued to diminish.

From the late 1970ies, ideas of a successful first strike seem to play a role among US military strategists. The SU has formally disavowed that they would strike first, but an "automated response" in case of US attack is often emphasized (Garthoff, 1981). Since both WE and EE are hosting large numbers of superpower controlled nuclear weapons, the adoption of such strategies by the US and the SU amounts to obvious increases in the risk of Europe being destroyed, so in this way both the US and the SU presently contribute to the "enemy intention" parameter B for WE (and similarly for EE). Furthermore, the US has recently adopted

a strategy calling for preparedness to conduct protracted nuclear wars (Richelson, 1983). The weapon systems and weapon uses envisaged for a protracted nuclear war between the superpowers may add to the probability that EE and WE will be destroyed during such a war. Only if the war could remain limited (in damage), could the European security gain by such strategies, and this possibility seems at present excluded because of lack of SU acceptance. On the contrary, any US efforts to limit a nuclear war to Europe and to selected targets may well enhance the Soviet advantage of a full-scale, destructive attack at an early time during a conflict. The SU aggressive intentions towards WE may well increase, if the SU believes that the US will not react by full-scale nuclear war, but by some limited response, at least initially. For this reason the current development is seen as probably leading towards an increase in the parameter B describing SU aggressive intentions against WE, even if this is not consistent with the general SU perception of the US as the main adversary and WE as a relatively friendly region.

The extrapolation of the model into the future further assumes a rapid increase in US agressive intentions towards the SU, reaching 0.3 y^{-1} by 1995 (and same for EE). The motivation would be a US belief to have regained superiority, due to its efforts to safeguard its control and command structure, an emerging space war capability and the possible deployment of anti-ballistic and worldwide operative anti-submarine defense systems. The reaction of (new) Soviet leaders may be to consider war with the US as unavoidable and then to go for the advantage of a first strike. The various arguments presented above are translated into intention parameters of 0.1 and 0.3 y^{-1} for the US and

WE, respectively. The higher aggressive intentions of the SU towards WE, as a reflection of the possible acceptance by the SU of limited war concepts, clearly constitutes just one of many conceivable models of future SU behavior.

A factor contributing to destructive intentions against the US may towards year 2000 also be terrorist groups, acting e.g. on behalf of small nations mistreated by the US (Central American countries being obvious candidates). If such groups were to become armed with nuclear or advanced biological weapons, they could constitute a noticable destructive threat.

The defense or aversion capability parameter, C, is also shown in Figs. 1-4. The data for estimating C are mostly of the same nature as those used to determine A, but C can not fully be determined by military hardware. It contains components influenced by choice of strategy, as well as components related to defense will and attitudes in the society.

For the US, the drop in C between 1955 and 1980 is associated with the increasing nuclear capability of the SU during that period. The introduction of the flexible response doctrine during the 1960ies and 1970ies[5] could have increased C , because it may be seen as a counter-measure against fully destructive nuclear wars, but this effect is uncertain due to lack of Soviet enthusiasm for the doctrine (it takes two to play a limited nuclear war). As the offensive nuclear arsenals increased in quantity and quality during the period, the actual value of C for both the US and the SU is taken as declining. Sharp drops in the defensive potential occur when the opponent introduces (invulnerable) SLBM's, that is for the SU value of C in 1966, and for the US in 1971.

A further decrease in C takes place 1980-1984, due to shorter warning times and increased vulnerability of command and control facilities (Bracken, 1983).

For WE, the parameter C is influenced by the same events. The initial value after 1945, however, is very low due to the post-war exhaustion. Some improvement is seen as a result of the formation of NATO in 1949. For EE, the defensive capability remains low all the time, due to Soviet control of defense development.

The model of the future behavior of C (1985-2000) assumes rather arbitrarily, that the US succeeds in establishing an effective anti-submarine defence around 1990, and that its deficiencies in command and control survivability are by then eliminated. The SU is then assumed to acquire a similar anti-submarine capability by 1995 and thereby to again nullify the US defence superiority. This situation is repeated, when the US in 1999 acquires a star-war type of missile defense system, followed by the SU one year later. These scenarios are constructed for illustrative purposes only.

Figs. 1-4 show the model results for the security S of each of the four regions, and the effect of assuming an uncertainty in the future values of B (enemy intentions), but no uncertainty in the other parameters. The form given to the uncertainty interval I(t) around B(t) is

$$I(t) = \left[\frac{B(t)}{1 + k(t-t_p)} , B(t)(1 + k(t-t_p)) \right] \qquad [5]$$

where k is taken as 0.1 y^{-1} in the present example (corresponding to an uncertainty interval which after 10 years stretches from B/2 to 2B). The uncertainty sets in

after t_p = 1984 (the present time).

In Fig. 1, the model results for the security of the US between 1945 and 2000 are presented. Before 1960, there was no significant risk of a destructive war against the US, but during the following decade, its security drops rapidly. In 1970 the risk of a destructive assault is estimated to be one in 40 years. The reasons for a declining US security comprise the rising nuclear capability of the SU as well as the diminishing chance of conducting an effective defense against a growing arsenal of nuclear weapons. US security improves between 1970 and 1979, due to declining aggressive intentions by the SU. However, a security corresponding to one destructive assault each 50 years may still be considered as quite uncomfortable. From 1984 to 2000, the scenarios studied do at best lead to a security level more or less staying at the 1984 level, at worst to a decline in security to over 10 pct. "chance" of a destructive assault in a given year (more than once in ten years). It all depends on Soviet reactions to the recent change in US policy, and on the interplay between any further policy changes by the two superpowers.

The security of the SU, shown in Fig. 2, is also impeccable just after WW II, but it starts to drop already during the early 1950ies, because of the US nuclear superiority. During the Cuban missile crisis in 1961, SU security reaches a low of one destructive assault in 20 years, corresponding to a 5 pct. chance of such an event during 1961. During the period of detente, 1963-1979, the risk of assault upon the SU was about one in 40 years. The US policy and increased aggressive intentions since 1980 result in a new drop in SU security. By 1984, the risk of destructive war is 10-15 pct. per year, and in the future,

security may either improve or dwindle towards zero, depending on further changes in US policy.

Fig. 3 shows the model results for WE. Just after WW II, security was high although not as high as that of the US and the SU. Between 1953 and 1961, the security of WE behaves similarly to that of the SU, and between 1961 and 1979 it steadily improves. The calculated values in 1961 and 1979 are practically identical to those of the SU. From 1980 to 1984, WE security drops to a chance of destructive assault amounting to about 5 pct. per year, mainly as a result of the reaction of the SU to the increased aggressivity of the US. It is interesting to note, that the model assigns a greater 1984 security to WE than to the SU, despite more aggressive capability directed against WE and despite its lesser chance of successfully defending itself against a nuclear assault. The reason is that the aggressive intentions associated with the anti-communist orientation of the US since 1980 are much stronger than the aggressive intentions of the SU towards WE. The future security of WE may dwindle towards zero, if the SU should consider a confrontation with the US as unavoidable, and if WE does not successfully disengage itself from the superpower rivalry.

The calculated security of EE is shown in Fig. 4. Its development in time is similar to that of WE, but the absolute level is roughly half of that for WE. The reason is mainly to be found in the similarity of enemy intentions to those directed against the SU, because the combined estimate of enemy capabilities and defense options is no more favorable than that of WE.

FOREIGN OCCUPATION

The type of aggression dealt with in this section is territorial occupation and control of a society by a foreign nation, achived either by military invation or by some other form of coercion. Occupation may follow a destructive war, but the more interesting security problem is that of foreign occupation without massive destruction. The model of security presented in section 2 can be applied in the same way as for destructive war.

In case of the US and the SU, enemy capabilities for occupation without previous destruction are small, and defense prospects are good. Therefore the security will be high no matter which intentions a potential aggressor may have. When translated into the model measure of security, this corresponds to way over 200 years between incidences.

Much more relevant cases are those of WE and EE, for which territorial occupation by the SU constitutes a real threat. Figs. 5 and 6 show the parameter sets used in the analysis for these two regions, along with the model results.

The parameter A describing the capability of the SU for invading WE or EE is taken to be around 0.5 for WE and close to unity for EE. The aversion parameter, C, exhibits more variation: Right after WW II, most of WE were unable to defend itself against a Soviet invasion, and C was low. The formation of NATO led to an upgrading of defensive capability, and the subsequent development of operative conventional forces in WE caused an increase in C, which by 1970 is assumed to have reached a value of about 0.5 (50 pct. chance of averting an invasion or of shaking off an attempt at political coercion). A slight reduction in C is introduced during the following decades, due to WE emphasis

on nuclear weapons and to claimed economic difficulties in maintaining a strong conventional force posture. The assumption is that nuclear weapons are less useful in averting an attempted occupation not accompanied by mass destruction (because the use of nuclear weapons would be likely to escalate the war to a level of assured destruction).

In the case of EE, the defense capability has until now been lower that in WE, due to actual coersive interference by the SU. There are clear setbacks in the value of C at the times of the SU interventions in Hungary (1956) and Czechoslovakia (1968). The current trend of increasing disengagement of the EE countries from the SU is in the model assumed to lead to an increasing foreign occupation aversion capability C, reaching the WE value by year 2000.

The question of US force withdrawal from WE is not considered essential in fixing C for WE, because the indigenous defense capability is presently dominating the chance of averting an invasion with territorial goals. Some may argue that US reinforcement is crucial in case of invation of WE by the SU, but the point of view taken here is, that if the conflict is not settled (by either a de facto occupation or by a successful aversion) by the time that reinforcement could reach WE, then it is certain to develop into a destructive war.

Finally, there is the parameter B describing SU intentions. Intentions of invading WE are considered small, with some increase around 1948 (the temptation created by lack of defense) and around 1961 (general tension). As regards EE, the SU has constantly been seeking to control this "buffer zone", but during most of the period 1945-1985, the SU has found it best to avoid actual occupation if

political coercion could do the job (e.g. in the case of Poland, 1981). The intention for occupation, B, is taken as around 30 pct. per year (once in 3-4 years, in accordance with sequences of actual events including the use of coercive pressures to achive the same ends as with military occupation). The current tendency is for a modest decline, but with great uncertainty concerning the future values of B.

One model of future SU intentions would have a new rise in B as regards occupation of both EE and WE, as a result of the increased (destructive war) intentions of the US towards the SU. The SU leaders may decide, that a conflict is unavoidable, and may try to exploit the advantages of starting, e.g. by full occupation of EE and WE.

The result of the model assumptions described above is that WE security increased from a post-war level of one occupation in 50 years (1945-1960) to a high of one occupation in 200 years (1979). Fig. 5 further shows that a decline in security against occupation of WE takes place between 1979 and 1985, and possibly continues during the next decade, but with clouds of uncertainty deriving from the possible developments in SU intentions.

For EE, the security has been consistently low - around one occupation or similar coercion every 3-4 years - but with signs of a possible improvement during recent years, which may or may not continue in the future.

DISCUSSION

The quantitative model of security discussed in this paper is designed to allow a separate discussion of the key

elements in the analysis of security with respect to given threats. If its results differ from those of alternative methods of analysis, it should therefore be possible to enter a meaningful search for the precise difference in assumptions that gives rise to the disagreement, whether the difference is associated with data selection or with model structure.

One clearcut example of such a check would be the security against destructive war during the Cuban missile crisis in 1961. The present model predicts a 5 pct. chance in that year, that the SU would experience a destructive nuclear war. Does this figure agree with estimates based on political phenomenology? Does it agree with other models of security, that may be proposed?

Accepting the present model assessment, important issues may be raised for discussion: How will the SU respond to the dramatic drop in its security since 1980 (Fig. 2)? The same question may be asked for WE. The model indicates that WE efforts to create conditions of peaceful coexistence with the SU were largely successful from 1960 to 1980 (economic collaboration and German "Ostpolitik"). How can this path be regained? Are the WE and US security interests so different that a European disengagement from the military preparations and strategies of the superpowers is necessary? If so, how should the defense policy of WE be reshaped?

The present model may be used to look into the security implications of various paths, in terms of the parameters chosen to describe alternative options. In WE, there is an ongoing discussion of at least three alternatives: An independent nuclear defense, a strong conventional defense (conventional both in the sense of "non-nuclear" and of "traditional military" defense), and finally a territorial

defence with little offensive capability[6]. The model would be used to trace the development in security for each of the alternatives, along with the uncertainty estimated to surround each option. The alternative security results would be compared to each other and to the "standard" scenario (e.g. as expressed in this work), and if differences in cost can be estimated, it will be possible to determine the least cost of reaching a desired level of security, within the range that can be achieved.

NOTES

1. A similar definition of security is used by the Alternative Defense Commission (1983).

2. It is often denoted "direct risk" in risk analysis (see Sorensen, 1982).

3. Sources include Kaplan (1982), Beer (1981), Thee (1976) and SIPRI Yearbooks (1978-1983).

4. Sources include Ball (1980), Meyer (1984), Sienkiewicz (1981), Garthoff (1981), Douglass (1980), Bracken (1983) and Richelson (1983).

5. Although the concept of limited retaliation was introduced ny McNamara in the early 1960ies, it was not made fully operational until the mid-1970ies, under Defense Secretary James Schlesinger (see Bracken, 1983:66).

6. See, e.g., review by Dankbaar (1984). A discussion of territorial defense in EE may be found in Jones (1981), and basic thoughts on a US defense based on non-offensive weapons in Boston Study Group (1979).

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FIGURE LEGENDS

Fig. 1. Data and model results for destructive war in the United States

Fig. 2. Data and model results for destructive war in the Soviet Union

Fig. 3. Data and model results for destructive war in Western Europe

Fig. 4. Data and model results for destructive war in Eastern Europe

Fig. 5. Data and model results for foreign occupation of Western Europe

Fig. 6. Data and model results for foreign occupation of Eastern Europe

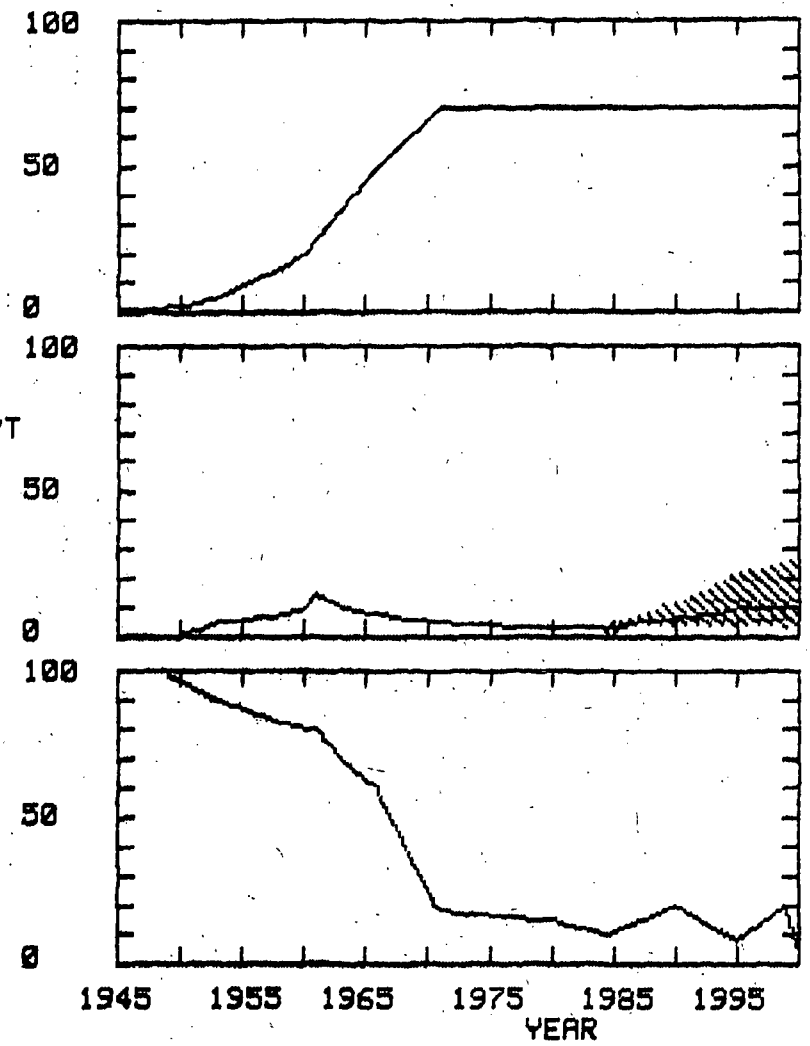
DESTRUCTIVE WAR AGAINST THE UNITED STATES

Data (estimates):

AGGRESSIVE CAPABILITY OF ENEMY (PCT. OF THAT WHICH WOULD FULLY ENSURE THE AGGRESSIVE OBJECTIVE)

AGGRESSIVE INTENTIONS OF ENEMY (PCT. ESTIMATED PROBABILITY THAT ENEMY WILL ATTEMPT AGGRESSION WITHIN ONE YEAR)

PROBABILITY OF SUCCESS IN AVERTING AN ATTEMPTED AGGRESSION (PCT.)



Model result:

SECURITY (AVERAGE YEARS BETWEEN INCIDENCES OF AGGRESSION)

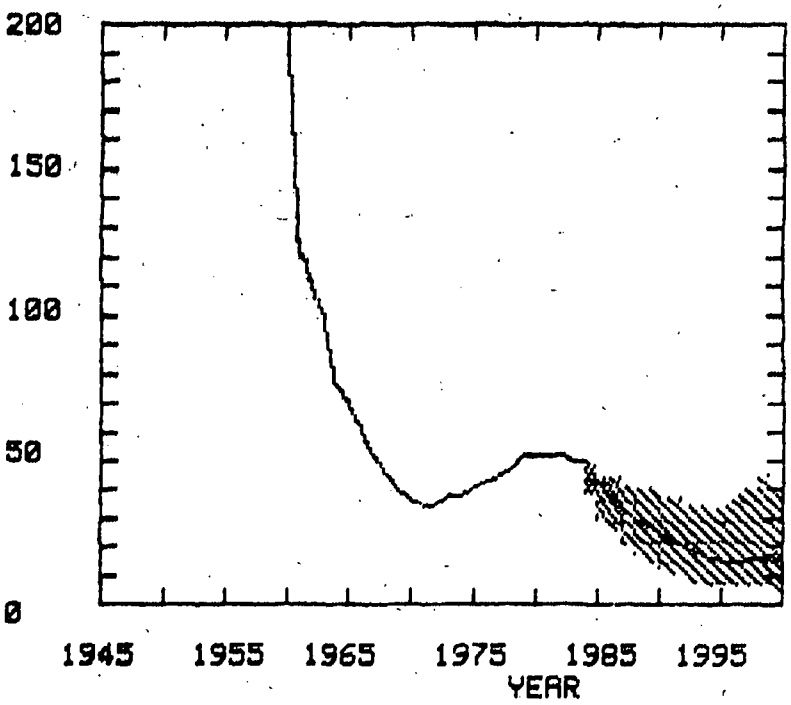


FIG 1

Fig. 1

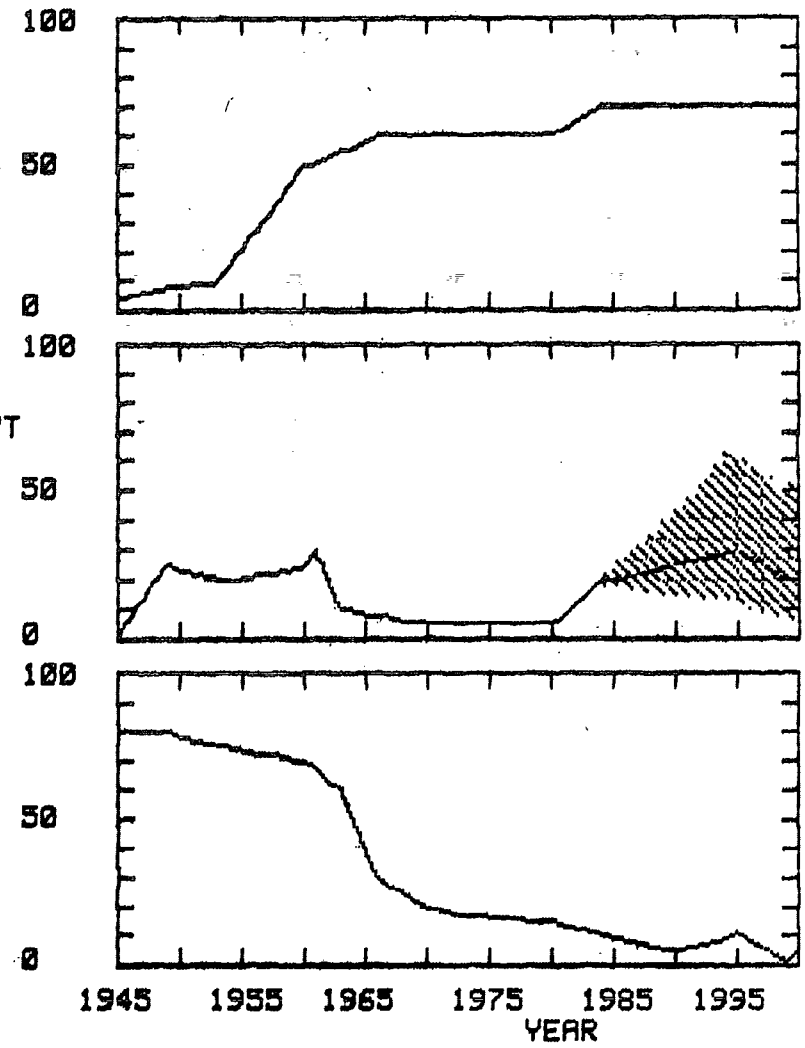
DESTRUCTIVE WAR AGAINST THE SOVIET UNIO

Data (estimates):

AGGRESSIVE CAPABILITY OF ENEMY (PCT. OF THAT WHICH WOULD FULLY ENSURE THE AGGRESSIVE OBJECTIVE)

AGGRESSIVE INTENTIONS OF ENEMY (PCT. ESTIMATED PROBABILITY THAT ENEMY WILL ATTEMPT AGGRESSION WITHIN ONE YEAR)

PROBABILITY OF SUCCESS IN AVERTING AN ATTEMPTED AGGRESSION (PCT.)



Model result:

SECURITY (AVERAGE YEARS BETWEEN INCIDENCES OF AGGRESSION)

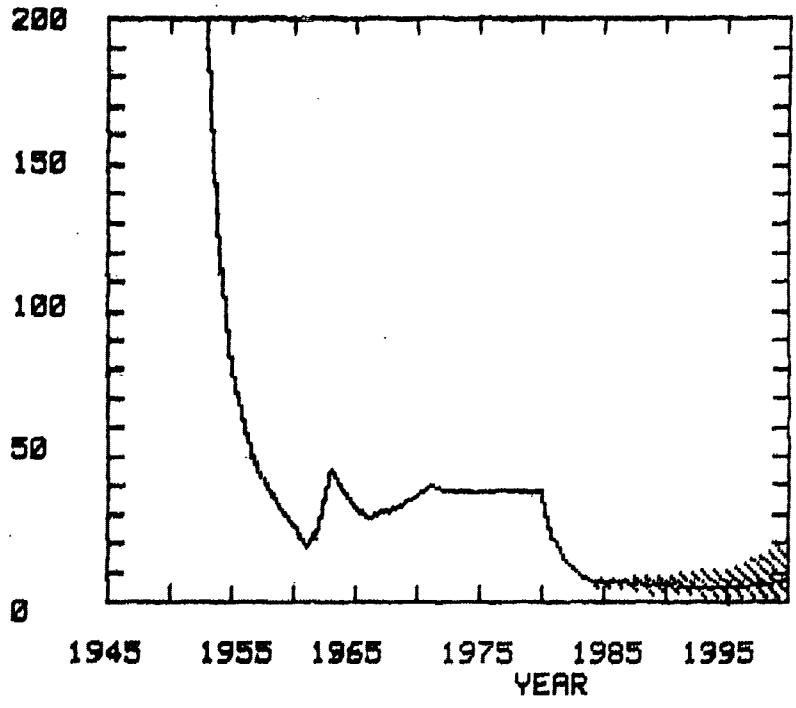


FIG. 2

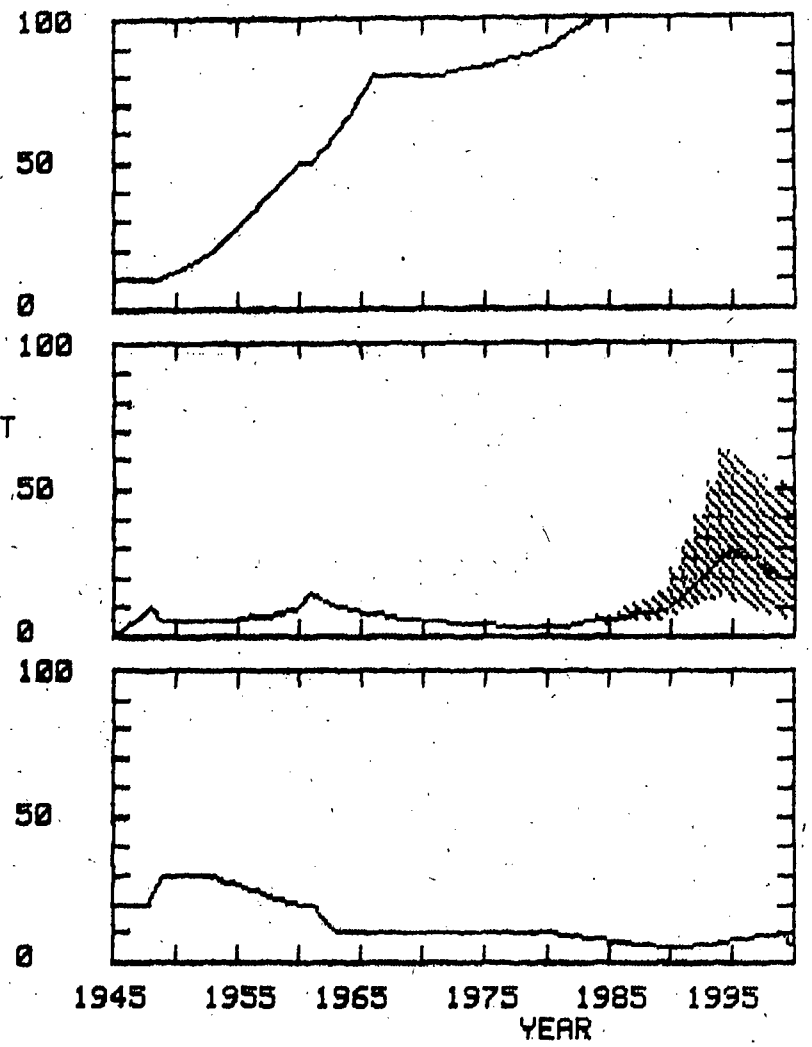
DESTRUCTIVE WAR IN WESTERN EUROPE

Data (estimates):

AGGRESSIVE CAPABILITY OF ENEMY (PCT. OF THAT WHICH WOULD FULLY ENSURE THE AGGRESSIVE OBJECTIVE)

AGGRESSIVE INTENTIONS OF ENEMY (PCT. ESTIMATED PROBABILITY THAT ENEMY WILL ATTEMPT AGGRESSION WITHIN ONE YEAR)

PROBABILITY OF SUCCESS IN AVERTING AN ATTEMPTED AGGRESSION (PCT.)



Model result:

SECURITY (AVERAGE YEARS BETWEEN INCIDENCES OF AGGRESSION)

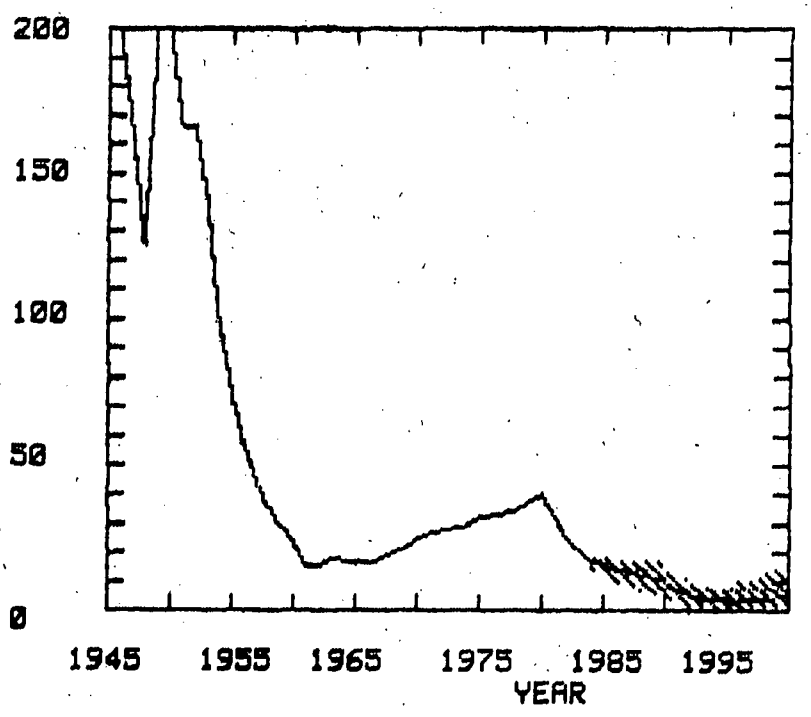


FIG 3

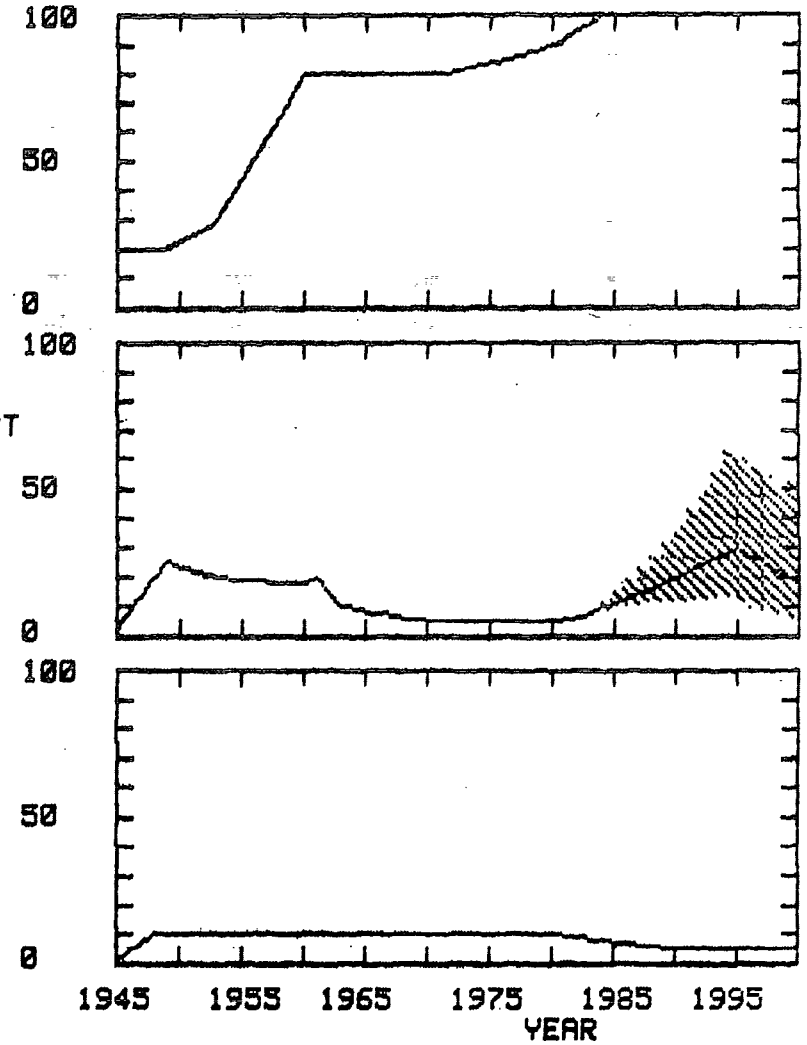
DESTRUCTIVE WAR IN EASTERN EUROPE

Data (estimates):

AGGRESSIVE CAPABILITY OF ENEMY (PCT. OF THAT WHICH WOULD FULLY ENSURE THE AGGRESSIVE OBJECTIVE)

AGGRESSIVE INTENTIONS OF ENEMY (PCT. ESTIMATED PROBABILITY THAT ENEMY WILL ATTEMPT AGGRESSION WITHIN ONE YEAR)

PROBABILITY OF SUCCESS IN AVERTING AN ATTEMPTED AGGRESSION (PCT.)



Model result:

SECURITY (AVERAGE YEARS BETWEEN INCIDENCES OF AGGRESSION)

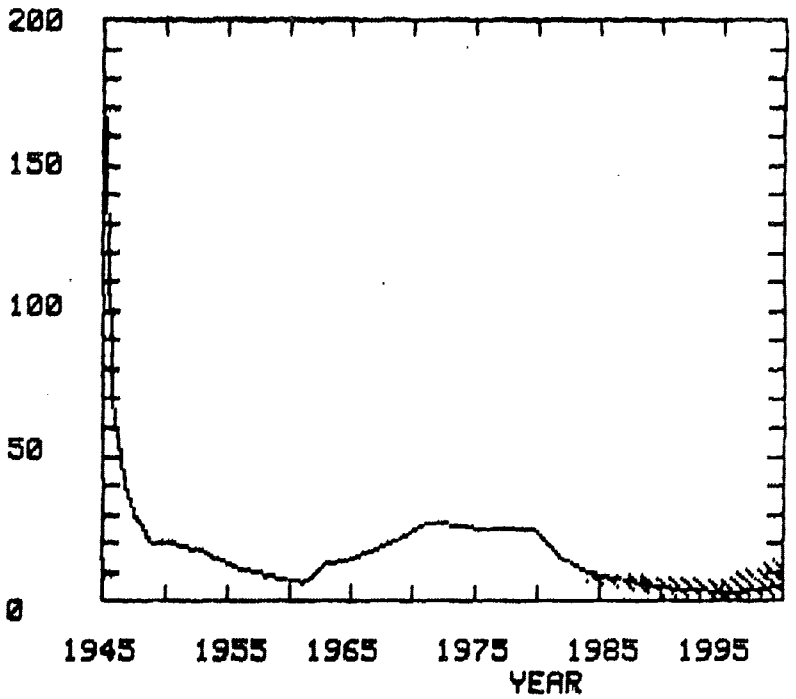


FIG 4

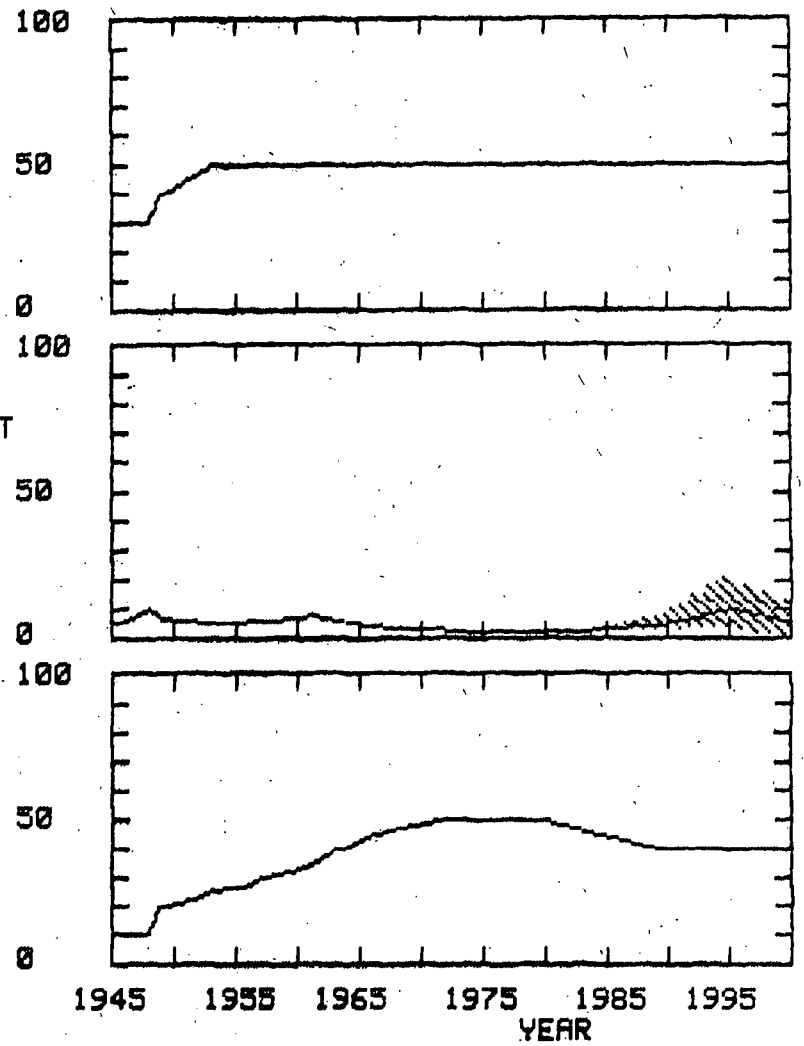
FOREIGN OCCUPATION OF WESTERN EUROPE

Data (estimates):

AGGRESSIVE CAPABILITY OF ENEMY (PCT. OF THAT WHICH WOULD FULLY ENSURE THE AGGRESSIVE OBJECTIVE)

AGGRESSIVE INTENTIONS OF ENEMY (PCT. ESTIMATED PROBABILITY THAT ENEMY WILL ATTEMPT AGGRESSION WITHIN ONE YEAR)

PROBABILITY OF SUCCESS IN AVERTING AN ATTEMPTED AGGRESSION (PCT.)



Model result:

SECURITY (AVERAGE YEARS BETWEEN INCIDENCES OF AGGRESSION)

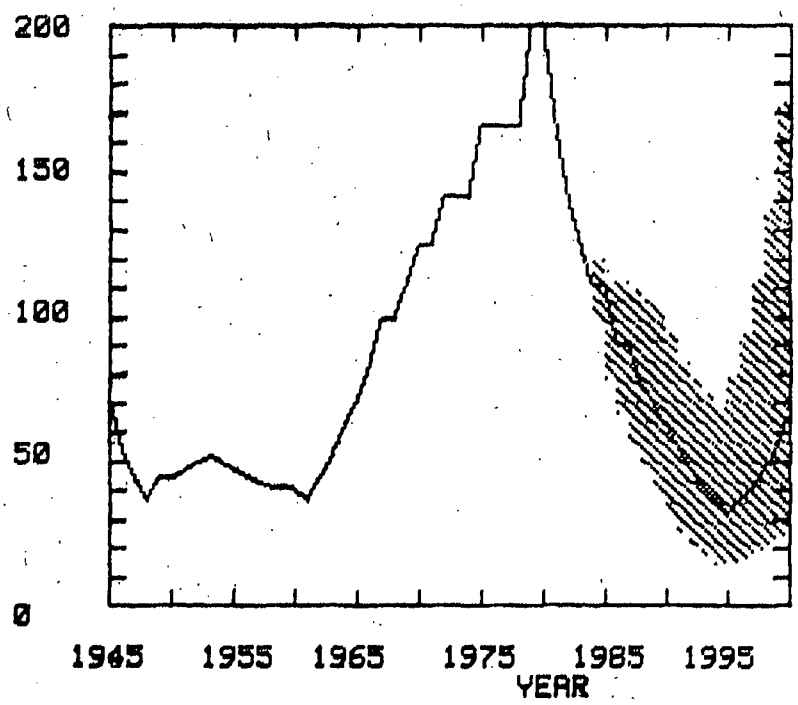


FIG 5

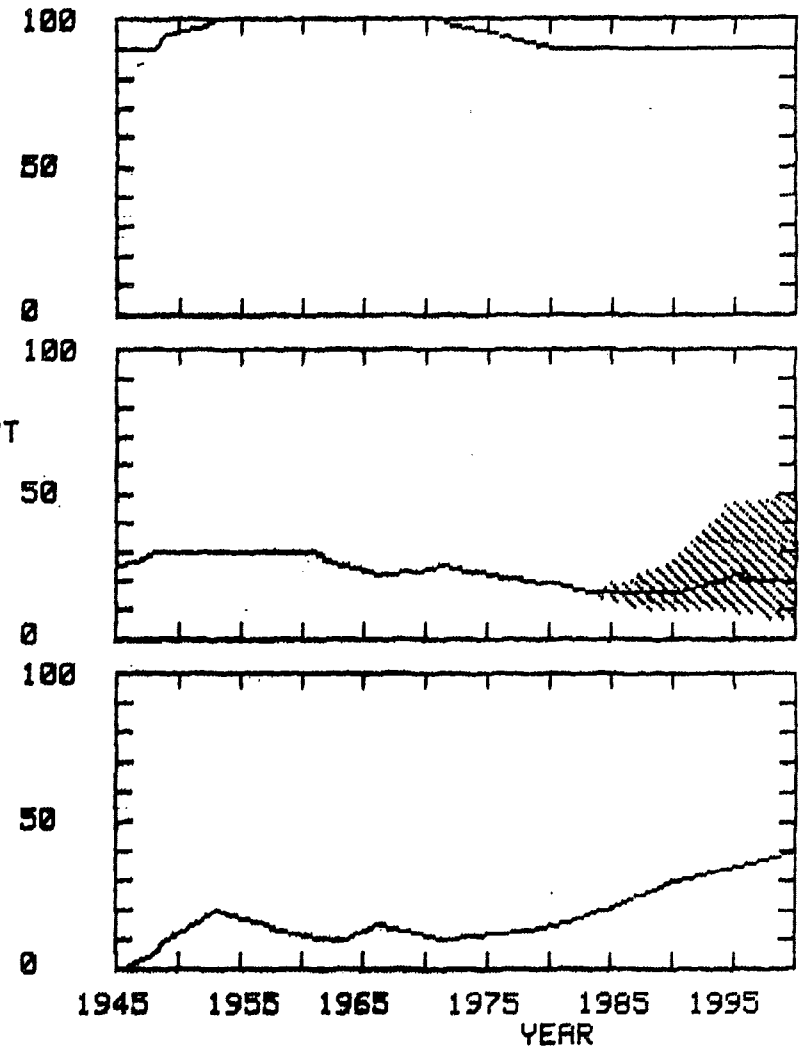
FOREIGN OCCUPATION OF EASTERN EUROPE

Data (estimates):

AGGRESSIVE CAPABILITY OF ENEMY (PCT. OF THAT WHICH WOULD FULLY ENSURE THE AGGRESSIVE OBJECTIVE)

AGGRESSIVE INTENTIONS OF ENEMY (PCT. ESTIMATED PROBABILITY THAT ENEMY WILL ATTEMPT AGGRESSION WITHIN ONE YEAR)

PROBABILITY OF SUCCESS IN AVERTING AN ATTEMPTED AGGRESSION (PCT.)



Model result:

SECURITY (AVERAGE YEARS BETWEEN INCIDENCES OF AGGRESSION)

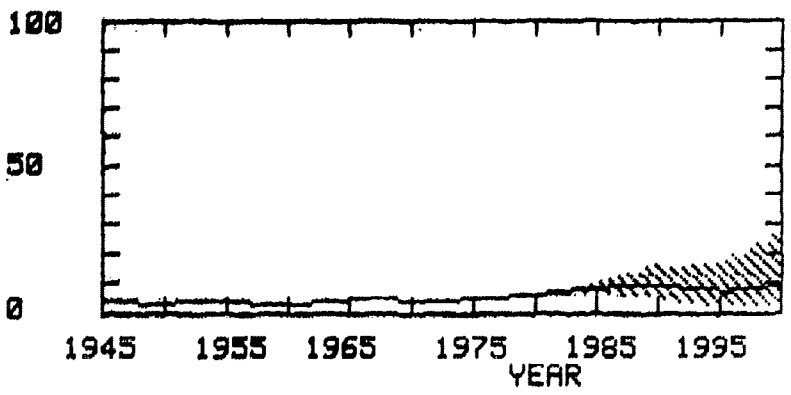


FIG 6

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