Rational Defence Expenditure: The Case of South Asia

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After a broad introduction to India-Pakistan rivalry, optimal defence expenditure is analysed, based on a utilitarian social welfare function. A two nation-state model, with asymmetric information, is constructed, in which defence expenditure is used to build armaments, either to start a war or to counter the external threat. Higher defence expenditure reduces the probability of losing a war and increases that of winning, but must be balanced against a loss of consumption through higher taxes or lower social security payments. Dynamic equilibrium is then analysed. In the final part, empirical application is made to the conflict between India and Pakistan as the two major powers of South Asia. The traditional 'black box', Richardson-type arms race model, where military expenditure of one country depends on its own past military spending ("inertia") as well as the current military spending of its adversary ("threat"), does not perform well empirically, for developing countries, since it fails to take account of various asymmetries. The application of our theoretical model to the India-Pakistan arms race avoids these difficulties in the South Asia context.

March 2006

1. Introduction

India and Pakistan were born as modern nation states in August 1947. Their independence came after almost 200 years of informal British rule and 90 years of formal British colonisation as a single country. This common administrative heritage had considerable influence on government policy, not least on the arms acquisition process. India and Pakistan have been described as ‘diversity in unity’ (i.e. with numerous similarities, but clearly differentiated and antagonised by the state formation process). Although there is a long history of cultural similarity, the creation of the separate states began an arms race, produced three major armed conflagrations, generated numerous small engagements, allowed the acquisition of a competitive nuclear power status, and created various other conflicts which have continued for over fifty years. It is interesting that at the end of the Cold War, and after fundamental structural changes in geo-political relations across the world, when even the definition of security has changed radically, the South Asian sub-continent represents possibly the only example of a classical arms race.

Military expenditure and arms imports in India and Pakistan have reflected their rivalry. The competitive arms race began almost at the birth of these two nation states, since most of the ordnance factories fell to India, and Pakistan had to 'catch up' at the beginning through arms importation. In response, and partly due to the Kashmir war in 1948, Pakistan decided also to have a modest domestic arms production, mostly in small arms, which raised all categories of military spending, from procurement to operations and maintenance to R&D. During the 1950s Pakistan, as a member of various US-sponsored Treaty organisations (for example CENTO), acquired arms through imports. India, on the other hand, following a policy of self-sufficient import substitution industrialization, decided to have some defence industries. After the Sino-Indian war of 1962, India's threat perception widened to include China. With the Indo-Pakistan war of 1965, traditional rivalry continued, and culminated in the 1971 war with the dismemberment of Pakistan and the formation of the state of Bangladesh from the old East Pakistan. The Russian invasion of Afghanistan allowed Pakistan to utilise US concerns to build up a sizeable arsenal in the 1980s. India retaliated through importing Russian armaments and increasing the speed of defence industrialization, particularly in the production of aircraft. The late 1980s saw the nascent space and missile programmes of both countries begin a period of expansion, as the sophistication of warfare created the syndrome of 'invention is the mother of necessity'. Nuclear weapons tests in 1998 brought a new menace of arms rivalry to the sub-continent.

This brief history shows that although other actors (China, Russia, United Sates) have been present in the interaction between India and Pakistan, during their arms acquisition process, in many ways they have been driven by an action-reaction model of the arms race. Yet, it would be simplistic to believe that this was the only reason, indeed even the predominant reason, for their respective military expenditures. A myriad of other factors, which include domestic conflicts, bureaucratic inertia and the importance of the state in economic development, all made some contribution to the armaments process. Data on military expenditures for India and Pakistan are given in Tables 1 and 2.

Table 1: Military Expenditure Data for India

Year	Military Expenditure at Constant Prices (1995 million US $ and exchange rates)	Share of GDP (%)	Share of Central Government Expenditure (%)
1990	7642	2.8	12.9
1991	7134	2.6	12.7
1992	6819	2.4	12.1
1993	7702	2.5	12.6
1994	7765	2.4	12.3
1995	8004	2.3	12.1
1996	8165	2.3	11.7
1997	9098	2.4	13.1
1998	9842	2.4	13.0
1999	10,288	2.4	13.1
2000	11,391	2.5	13.2

Source: SIPRI and authors' estimates

Table 2: Military Expenditure Data for Pakistan

Year	Military Expenditure at Constant Prices (1995 million US $ and exchange rates)	Share of GDP (%)	Share of Central Government Expenditure (%)
1990	3123	6.8	26.8
1991	3349	6.8	27.0
1992	3582	6.7	25.5
1993	3617	6.8	25.0
1994	3444	6.2	23.8
1995	3428	5.8	23.9
1996	3576	5.8	24.2
1997	3431	5.3	24.0
1998	3319	5.2	24.0
1999	3600	5.4	24.5
2000	4010	5.8	26.0

Source: SIPRI and authors' estimates

Military expenditures in India and Pakistan are often explained in one of two ways. First is the formal arms race model, which seeks to explain arms procurement and military force expansion of one country as a response to what the other does. This dyadic response to each other can be captured by econometric models which utilise current and lagged values of own defence spending (to represent strategic inertia) and the opposition's defence spending (to represent strategic threat). These data-based models of the arms race need to be supplemented by an institutional and historical analysis of how the actual expenditures on the military evolved. The basis of these models is the rational actor paradigm where the two states' governments and militaries are rationally

responding to their grievance parameters, external threats, domestic constraints and the inherent dynamics of buying arms subject to technological and economic obsolescence.

A second way of analysing India and Pakistan's military spending (including arms imports) is the so-called *'ad hoc* paradigm'. Here, the military, the bureaucracy, the politicians and planners purchase arms and change defence spending, essentially on a relatively *ad hoc* basis. The proximate cause may be relatively trivial from a strategic point of view, for example, to keep an ordnance factory in business; or it may be profound, related to domestic militarization (the generals wish to keep the forces happy when they seize political power), or to international power status (India's space programme could have been motivated by its desire to play a greater role in world technology politics). Whatever the proximate reasons, the ultimate result is a drift rather than a specified direction in which the armed forces wish to go.

Thirdly, we could assume the rational actor paradigm, where the stylised facts are explained by an optimising model. This is the central viewpoint of the paper and examined formally via the complex model in Section 3.

Finally, no analyses of defence spending in India and Pakistan can be complete without looking at the economic costs of such expenditures. These are two of the poorest countries in the world, and their economies have numerous unmet economic needs, potentially fundable from resource re-allocation. However, the peace dividend argument is not simple either. Unless the precise mechanism by which the resource transfer is expected to affect the economy is clearly formulated, all analytical answers are bound to be tentative. How much the economy would gain if military expenditure were reduced by a specified percentage point is a very difficult question to answer in the context of India and Pakistan.

In Section 2, broad issues of security and development, crucial for developing countries, are discussed. In Section 3, a one-period model is built, and in Section 4 dynamic considerations are introduced. Econometric issues are posed in Section 5, while Section 6 is the conclusion. Nuclearization is discussed in the Appendix.

2. Security and/or Development?

Any model which wishes to study the impact of security on development must satisfy three criteria. First, it must enquire about the welfare effects of defence spending, since the justification given for such outlays and procurement is that security enhances welfare. Even if there is growth retardation and reduction in consumption in the steady state, this may be compensated by the enhancement of welfare produced by higher security. Second, it must ask why the country spends on the military, and what specific security threat motivates defence expenditure. Third, it must be based on a rigorous description of the growth process, with particular attention to the specific characteristics of the country concerned

In a series of models developed through research at the OECD Development Centre (Berthelemy, Herrera and Sen, 1995, Berthelemy, MacNamara and Sen, 1994, Berthelemy and Sen, 1998), we study the impact effect of defence spending on economic growth in India and Pakistan. The models satisfy the three characteristics specified above. First, they assume a specific welfare function, which includes

consumption (both private and public consumption, the latter being provided by public goods) and security. Second, security in turn depends on arms stocks which are dependent on the behaviour and dynamics of the arms race between the countries. Finally, the dynamics are embedded in an endogenous growth model (Barro, 1990).

In these models, the analysis proceeds in three stages. First, an endogenous growth model is constructed where the government through taxation finances military procurement. This leads to many channels through which such arms buying can influence social welfare and national growth. Second, the models simulate a calibrated endogenous growth model. The calibration is done for India and Pakistan, so all dynamic paths can be visualised in terms of real country behaviour. The transitional dynamics are traced for a (very) long term, and terminal transversality conditions are set so that steady state is attained after the end of the terminal period. Realism is thus captured within this simulated framework, and institutional and political factors are built in (for example, the presence of China as a threat to India; emphasising the importance of infrastructure for India and education for Pakistan, often neglected by the five-year plans because of resource constraints; the choice of depreciation rates and rate of time preference, according to intuition of the economy and culture of the sub-continent). Third, policy issues, particularly counter-factual ones, can be dealt with in this framework. This is captured within the simulation exercise by asking what the implications are of a Nash game played by the two countries as opposed to the co-operative solution. What are the impact effects of increasing arms purchase, even if there is no fiscal borrowing or international indebtedness and the country is willing to pay taxes for its security? What sort of welfare gains is possible if there is unilateral arms reduction (as suggested by international analysts)? What if these two antagonistic neighbours go for true arms control (i.e. have a concerted, joint, and simultaneous reduction in military procurement)? These are policy questions which find sensible answers in this type of model.

Dynamic computable general equilibrium models of this type are useful, because they can show the counter-factual and ask policy questions through changing the simulated parameters. Our experiments with these models show that even when welfare effects from security are taken into account, military expenditures in India and Pakistan do have detrimental effects. However, the impact effects on Pakistan are far stronger because the actual *defence burden*, or military expenditure to GDP ratio (varying from 6 to 7 per cent per annum), is so high. The ‘optimum’ military burden (i.e. that level at which social welfare is maximised) appears to be around 5 per cent. Further, a reduction in defence burden by 1 percentage point could lead to the growth rate of GDP rising by 0.3 per cent when all direct and indirect effects are taken together. These values reflect the peace dividend for Pakistan. India also overspends at about 2 to 3 per cent per annum, but the excess is not substantial. The optimum defence burden is approximately 2 per cent of GDP; a cut in the military burden by 1 percentage point could increase India’s GDP growth rate by approximately 0.2 per cent per annum – a reasonable peace dividend for India.

3. The Model

We start with a one-period model, focusing first on a single nation-state. Assume the state consists of individuals 1,…,n. There are two goods, a private *consumption good* and *armaments*. Prices are unity.

Individual i receives income y_i, pays taxes t_i (which may be negative) and consumes c_i, where

(1) $$c_i = y_i - t_i.$$

Individual utility, interpreted as 'well-being', depends on consumption:

(2) $$u_i = u(c_i).$$

Assume $u'>0$ and $u''\leq 0$. Individuals maximize expected utility, i.e. they are risk neutral with respect to well-being.

Taxes are collected by the state in order to fund defence expenditure (d). Thus the state's budget constraint is:

(3) $$\sum t_i = d.$$

Assume:

(4) $$t_i = \omega_i t \qquad (\sum \omega_i = 1).$$

The state chooses d in order to maximise social welfare, determined by a utilitarian social welfare function:

(5) $$W = \sum E u(c_i).$$

As defence expenditure is a response to the external world, assume, for simplicity, two nation-states, A and B. Superscripts will indicate the nation-state concerned.

Base levels for income are k_i^A for y_i^A $(i=1,\ldots,n^A)$, and k_j^B for y_j^B $(j=1,\ldots,n^B)$. Let

(6) $$k^A = \sum k_i^A$$
$$k^B = \sum k_j^B.$$

Assume y_i^A $(i=1,\ldots,n^A)$ has three possible values:

$$y_i^A = (1-\alpha_i)k_i^A - z_i^A \qquad (0\leq\alpha_i\leq 1,\ z_i^A\geq 0)$$
(7) $$y_i^A = k_i^A$$
$$y_i^A = (1+\beta_i^A)k_i^A - z_i^A \qquad (\beta_i^A\geq 0)$$

Similarly, for B:

$$y_j^B = (1-\beta_j)k_j^B - z_j^B \qquad (0\leq\beta_j\leq 1,\ z_j^B\geq 0)$$
(8) $$y_j^B = k_j^B$$
$$y_j^B = (1+\alpha_j^B)k_j^B - z_j^B.$$

Define:

(9) $$\sum \alpha_i k_i^A = \alpha k^A$$
$$\sum \beta_i^A k_i^A = \beta^A k^A$$
$$\sum \beta_j k_j^B = \beta k^B$$
$$\sum \alpha_j^B k_j^B = \alpha^B k^B$$
$$\sum z_i^A = z^A$$
$$\sum z_i^B = z^B$$

We assume:

(10) $$\alpha k^A = \alpha^B k^B$$
$$\beta k^B = \beta^A k^A.$$

The interpretation is as follows: There may be a transfer of αk^A from A to B, or βk^B from B to A. z^A and z^B reflect that such transfers necessitate conflict and destruction of income.

Armaments (a) are related to defence expenditure according to:

(11) $$a^A = \varepsilon^A d^A$$
$$a^B = \varepsilon^B d^B.$$

ε^A and ε^B are identical and independent, non-negative random disturbances of unit mean, with distribution function F and density function f. Prior to choosing levels of defence expenditure, realisations of ε^A and ε^B are observed as private information, by A and B respectively.

The acquisition of armaments is to protect or enhance income, which may also be destroyed in conflict. Destruction of income during conflict is related to armaments by:

(12) $$z^A = \gamma^A a^B$$
$$z^B = \gamma^B a^A.$$

Conditional on conflict taking place, A wins if $a^A > a^B$, and B wins if $a^B > a^A$. Perceived probabilities of winning are, respectively:

(13) $$p^A = \int_0^{\frac{a^A}{d^B}} dF$$
$$p^B = \int_0^{\frac{a^B}{d^A}} dF \ .$$

Constant Marginal Utility

For now, assume u is linear, i.e. u' is constant and u"=0. A and B each makes a rational decision whether or not to instigate conflict, based on whether this, a priori, increases social welfare. The conditions for social welfare to increase are:

(14) $$p^A \beta k^B > (1-p^A)\alpha k^A + \gamma^A d^B \qquad \text{(for A)}$$
$$p^B \alpha k^A > (1-p^B)\beta k^B + \gamma^B d^A \qquad \text{(for B)}.$$

Replacing inequality by equality in (14), we obtain critical values, p^A* and p^B*, for p^A and p^B. Conflict occurs if $p^A > p^A*$ or $p^B > p^B*$.

Losses and Gains when $\varepsilon^A=\varepsilon^B=1$ ($\gamma d^A* = \alpha k^A$ and ($\gamma d^B* = \beta k^A*$)

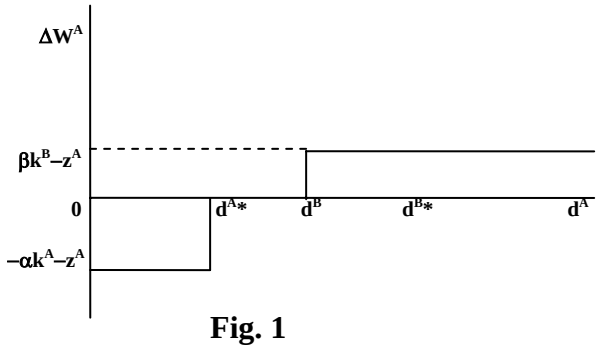

Fig. 1

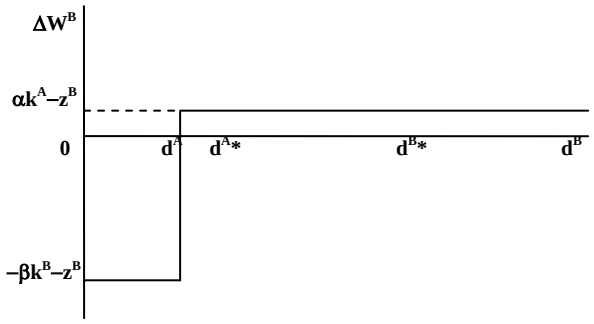

Fig. 2

Figures 1 and 2 describe the situation when there is no uncertainty which side would win a war. In this case, no equilibrium exists. In Fig. 1, A might choose d^A*, but then d^B is not B's best response; B prefers a level of defence expenditure marginally greater than d^A*. However, each of A and B then prefers a level of defence expenditure marginally greater than the other's.

Unconditional Probabilities

A observes ε^A and so a^A. Given d^B, a^A determines p^A. A then chooses conflict if $p^A>p^A*$. After choosing conflict, the probability of A winning is p^A. Thus the unconditional probability of a war that A starts and wins is:

$$\int_{\varepsilon^A*}^{\infty}\int_{0}^{\frac{\varepsilon^A d^A}{d^B}} dF(\varepsilon^B)dF(\varepsilon^A)\,. \tag{15}$$

Here, ε^A* corresponds to p^A* in the sense that, when A observes $a^A*=\varepsilon^A*d^A$, $p^A=p^A*$. The unconditional probability of a war that A starts and loses is:

$$\int_{\varepsilon^A*}^{\infty}\int_{\frac{\varepsilon^A d^A}{d^B}}^{\infty} dF(\varepsilon^B)dF(\varepsilon^A)\,. \tag{16}$$

Similarly, the unconditional probability of a war that B starts and wins is:

$$\int_{\varepsilon^B*}^{\infty}\int_{0}^{\frac{\varepsilon^B d^B}{d^A}} dF(\varepsilon^A)dF(\varepsilon^B)\,; \tag{17}$$

and the unconditional probability of a war that B starts and loses is:

$$\int_{\varepsilon^B*}^{\infty}\int_{\frac{\varepsilon^B d^B}{d^A}}^{\infty} dF(\varepsilon^A)dF(\varepsilon^B)\,. \tag{18}$$

It follows, by adding first (15) and (18), and then (16) and (17), that the unconditional probabilities, first of A losing a war (B winning), and then of A winning a war (B losing), are:

$$p=\int_{\varepsilon^A*}^{\infty}\int_{\frac{\varepsilon^A d^A}{d^B}}^{\infty} dF(\varepsilon^B)dF(\varepsilon^A)+\int_{\varepsilon^B*}^{\infty}\int_{0}^{\frac{\varepsilon^B d^B}{d^A}} dF(\varepsilon^A)dF(\varepsilon^B) \tag{19}$$

$$q=\int_{\varepsilon^A*}^{\infty}\int_{0}^{\frac{\varepsilon^A d^A}{d^B}} dF(\varepsilon^B)dF(\varepsilon^A)+\int_{\varepsilon^B*}^{\infty}\int_{\frac{\varepsilon^B d^B}{d^A}}^{\infty} dF(\varepsilon^A)dF(\varepsilon^B)\,.$$

p and q depend on defence expenditures, d^A and d^B, and also, through ε^A* and ε^B*, on the potential gains and losses described in (14). These have been assumed proportional to 'base' national income, but might alternatively, or as well, relate to other factors, such as population. Disputed territory is one possibility.

Differentiating with respect to d^A and d^B, respectively:

$$
\begin{aligned}
&\frac{dp}{dd^A} = -\int_{\varepsilon^A*}^{\infty} \frac{\varepsilon^A}{d^B} f\left(\frac{\varepsilon^A d^A}{d^B}\right) dF(\varepsilon^A) - \int_{\varepsilon^B*}^{\infty} \frac{\varepsilon^B d^B}{d^{A2}} f\left(\frac{\varepsilon^B d^B}{d^A}\right) dF(\varepsilon^B) \\
&- \frac{d\varepsilon^B*}{dd^A} \int_0^{\frac{\varepsilon^B* d^B}{d^A}} dF(\varepsilon^A) \\
&\frac{dq}{dd^A} = \int_{\varepsilon^A*}^{\infty} \frac{\varepsilon^A}{d^B} f\left(\frac{\varepsilon^A d^A}{d^B}\right) dF(\varepsilon^A) + \int_{\varepsilon^B*}^{\infty} \frac{\varepsilon^B d^B}{d^{A2}} f\left(\frac{\varepsilon^B d^B}{d^A}\right) dF(\varepsilon^B) \\
&- \frac{d\varepsilon^B*}{dd^A} \int_{\frac{\varepsilon^B* d^B}{d^A}}^{\infty} dF(\varepsilon^A) \\
&\frac{dp}{dd^B} = \int_{\varepsilon^B*}^{\infty} \frac{\varepsilon^B}{d^A} f\left(\frac{\varepsilon^B d^B}{d^A}\right) dF(\varepsilon^B) + \int_{\varepsilon^A*}^{\infty} \frac{\varepsilon^A d^A}{d^{B2}} f\left(\frac{\varepsilon^A d^A}{d^B}\right) dF(\varepsilon^A) \\
&- \frac{d\varepsilon^A*}{dd^B} \int_{\frac{\varepsilon^A* d^A}{d^B}}^{\infty} dF(\varepsilon^B) \\
&\frac{dq}{dd^B} = -\int_{\varepsilon^B*}^{\infty} \frac{\varepsilon^B}{d^A} f\left(\frac{\varepsilon^B d^B}{d^A}\right) dF(\varepsilon^B) - \int_{\varepsilon^A*}^{\infty} \frac{\varepsilon^A d^A}{d^{B2}} f\left(\frac{\varepsilon^A d^A}{d^B}\right) dF(\varepsilon^A) \\
&- \frac{d\varepsilon^A*}{dd^B} \int_0^{\frac{\varepsilon^A* d^A}{d^B}} dF(\varepsilon^B).
\end{aligned}
\tag{20}
$$

Equations (20) show that p is positively related to d^A, and q to d^B. An increase in defence expenditure reduces the probability of being attacked and, given conflict, increases the probability of winning. The effect of d^A on q, and likewise d^B on p, is ambiguous. Since an increase in defence expenditure reduces the probability of being attacked, this may, paradoxically, reduce the unconditional probability of winning.

The government of A maximizes:

$$
\begin{aligned}
W^A &= \sum Eu(c_i^A) \\
&= p\sum Eu[(1-\alpha_i)k_i^A - z_i^A - t_i^A] + (1-p-q)\sum Eu(k_i^A - t_i^A) \\
&\quad + q\sum u[(1+\beta_i^A)k_i^A - z_i^A - t_i^A].
\end{aligned}
\tag{21}
$$

The government of B maximizes:

$$
\begin{aligned}
W^B &= \sum Eu(c_i^B) \\
&= q\sum Eu[(1-\beta_i)k_i^B - z_i^B - t_i^B] + (1-p-q)\sum Eu(k_i^B - t_i^B) \\
&\quad + p\sum u[(1+\alpha_i^B)k_i^B - z_i^B - t_i^B].
\end{aligned}
\tag{22}
$$

Differentiating W^A with respect to d^A and W^B with respect to d^B, and equating to zero, we have:

$$
\begin{aligned}
&\frac{dp}{dd^A}(-\alpha k^A - z^A) + \frac{dq}{dd^A}(\beta k^B - z^A) = 1 \\
&\frac{dp}{dd^B}(\alpha k^A - z^B) + \frac{dq}{dd^B}(-\beta k^B - z^B) = 1.
\end{aligned}
\tag{23}
$$

In (23), the effects of increases in defence expenditures on p and q are weighted by potential gains and losses. On the left hand sides are marginal benefits and on the right marginal costs. The solution, $d^A=d^{A*}$ and $d^B=d^{B*}$, is a Bayesian Nash equilibrium.

Diminishing Marginal Utility

Equations (23) express the marginal costs and benefits of defence expenditure in income terms. With diminishing marginal utility, we need to translate these marginal costs and benefits into utility terms.

Note that aggregate gains and losses from conflict are the weights on the left hand sides of (23). Suppose these are randomly allocated, either among all individuals or particular groups of individuals. We are then still able to deal in terms of aggregates. However, gains will have lower average marginal utility than losses. The effect is accentuated if gains go to the rich and losses are more generally distributed.

Marginal costs vary, depending on whether there is no conflict, a war is won or a war is lost. If tax weights, i.e. the ω_i's, are higher for the rich than the poor, marginal costs will be lower, and vice-versa. Higher defence expenditure requires higher taxes, increasing the marginal costs of defence expenditure. However, higher taxes also mean higher marginal benefits, and so higher marginal costs are not an effective constraint on defence expenditure. Capacity constraints, not considered here, may be effective.

4. Dynamics

Consider periods t=1,2, … to a random horizon at t=T, at which conflict first occurs. Focusing first on a single nation-state, let $u_i=u_i(t)$, etc., in period t. Because armaments are durable, defence expenditure in period t contributes also in subsequent periods. Assume:

$$\begin{aligned} a(1) &= \gamma a(0)+d(1) \\ a(2) &= \gamma a(1)+d(2) \\ &\cdot \\ a(T) &= \gamma a(T-1)+d(T) \\ &\cdot \end{aligned} \tag{24}$$

Here, $1-\gamma$ is the rate of depreciation. Assume n is constant and the social welfare function is:

$$\begin{aligned} W &= \sum\sum(1+\delta)^{-t}Eu[c_i(t)] \\ &= \sum\sum(1+\delta)^{-t}Eu[y_i(t)-t_i(t)]. \end{aligned} \tag{25}$$

Starting from an initial level of a(0), the government determines levels of armaments at t=1,…,T, by choosing d(1),…,d(T). The decision whether or not to instigate conflict is now more complex. Once conflict occurs, a new sequence of building armaments begins at t=T+1, with a new initial value that takes account of the destruction of armaments at t=T. The deferral of conflict will have a value, which may be negative. Denote this by v.

Assume constant growth rates of r^A for k^A and r^B for k^B, respectively. Equations (14), the conditions for starting a conflict, are now replaced, for t=1,…,T, by:

(26) $p^A(t)\beta(1+r^B)^t k^B(0) > [1-p^A(t)]\alpha(1+r^A)^t k^A(0) + \gamma^A a^B(t) + v^A(t)$ (for A)

$p^B(t)\alpha(1+r^A)^t k^A(0) > [1-p^B(t)]\beta(1+r^B)^t k^B(0) + \gamma^B a^A(t) + v^B(t)$ (for B).

Equations (26) lead to a dynamic version of (23) in which losses are augmented by $v^A(t)$ and $v^B(t)$ (t=1,…,T), the values placed on deferring conflict. A separate decision on armaments can now be made for each period. Two straightforward consequences are apparent:

(i) Decisions on armaments are independent of the initial levels of armaments.

(ii) If $r^A=r^B=r$, and either $v^A(t)=v^B(t)=0$ or $v^A(t)$ and $v^B(t)$ also grow at rate r (t=1,…,T), then armaments grow at rate r from t=1 onwards. This means defence expenditures grow at rate r from t=2 onwards.

Suppose A and B dispute territory. B is in possession and A contemplates acquiring it through conflict. The prize includes future as well as present returns, so the gains are high. However, should A win, B may try to wrest back the territory and, should A defer conflict, A may yet seize it in the future. All this makes v^A positive. Alternatively, suppose the territory of no economic value, but strategically important. v^A will then be negative.

Let us now invoke the stylized fact that conflict is rare. For the sake of argument, suppose A is small (in terms of income) and B large, and suppose $\alpha=\beta$. In any period, A's gains from winning are large and A's losses from losing are small. Thus B requires a high level of armaments to deter A; conversely, A requires a low level of armaments to deter B.

Suppose $r^A>r^B$ and $v^A=v^B=0$. Then A's armaments will, from period to period, grow faster than k^A and B's will grow slower than k^B. If $r^A<r^B$ and $v^A=v^B=0$, we get the opposite result. Defence expenditure is a 'luxury good' for a fast growing economy, but a 'necessary good' for a slow growing one.

Alliances are an obvious way of economizing on defence expenditures. Combining forces leads to less chance of being attacked and, given conflict, more chance of winning. History shows alliances need not be between nation-states with similar values, but also that they can be unreliable, especially in defence. A disproportionate distribution of potential gains and losses among the members of an alliance is an obvious contributory factor. Reputation building can increase the reliability of alliances, but may not work in extremis, when the focus is on the present to the neglect of the future.

Supranational organizations provide a forum for mediating disputes and, with due regard to realpolitik, a framework of international law. However, faced with rational nation-states, international law achieves little more than 'moral suasion'. Supranational organizations can also broker disarmament. However, more effective in achieving disarmament is technological progress. In terms of our model, nuclear weapons, for example, raise γ^A and γ^B, and so lower the required level of armaments.

5. A Classical Arms Race?: Econometric Results

Military expenditure and arms production in India and Pakistan often take on the picture of a classical arms race between dyadic adversaries. This process can be illustrated or justified in many different ways. Two ways of looking at this issue is either by an historical survey or by a formal empirical model.

The first way of demonstrating the relevance of the arms race model in the case of the sub-continental neighbours is to look at their five decades of history in arms procurement. Even at independence, when India acquired (purely by chance) the major ordnance factories (such as the Gun and Shell factory at Ishapur, famous for the production of the dumdum bullets named after a local neighbourhood, in West Bengal), Pakistan began modest arms industrialization by building its own ordnance factory. During the first decade of independence, for example between 1947-54 (prior to US foreign military aid and the resulting distortion in arms procurement), there is a classic matching of arms importation by the two countries. In 1950, the Indian Navy bought 3 R-class destroyers which were matched by 1 O-class destroyers acquired in 1951 by Pakistan's Navy. In 1953, India acquired about 180 Sherman tanks which were matched by 200 Sherman tanks bought by Pakistan in the very next year. Going to the other end of the historical spectrum, the very latest example of this arms race is the nuclear tests of 1998, and the long history of competitive acquisitions of nuclear technology since the early 1970s, when India exploded her first nuclear device (ostensibly for peaceful purposes) and acquired an 'almost nuclear state' status. Clearly, India being much larger in size and with an arsenal and armed forces about three times that of Pakistan, has often acted as the strategic leader. However, even here the historical evidence is mixed. During the 1980s, the Afghan war and the Soviet threat allowed Pakistan to acquire state of the arts weapons first, and India caught up later. Hence, the action-reaction model explains at least in part their mutual strategic behaviour. This short history is but illustrative; however, it strengthens the rationale behind the general and popular belief that India and Pakistan are engaged in a competitive arms race.

The alternative method of demonstrating an arms race is to utilise military expenditure data and estimate a Richardson-type arms race model. Here, the change in or level of domestic military expenditure (or arms procurement) is made a function of current or lagged value of the other country's military spending to symbolise threat perceptions and demonstrate reaction to the opposition's action; in addition, the lagged value of one's own military expenditure is made an independent variable to represent inertia, or lumpiness of procurement spending, which causes an autoregressive term (less than unity) to affect current levels of defence spending. A constant term is added to explain 'grievance' which could be a catchall term to symbolise the impact of all other factors (including third party security effects such as China for India or Afghanistan for Pakistan). A number of papers in the last ten years have looked at the formal implications of either India or Pakistan's, or both country's, military expenditure in this framework (Ward *et al.*, 1991, Deger and Sen, 1990, Smith *et al.*, 1999, 2000). We briefly describe, in a heuristic manner, the conclusions from the earlier model by Deger and Sen (1991) and the latest econometric model by Smith et al. (1999, 2000). Table 3 summarises the empirical results from the earlier Deger-Sen model. After much data mining, experimenting with various specifications for the relevant equations and checking for suitable diagnostic tests, Deger and Sen (1991) estimated the determinants

of military expenditure in level terms, using a simultaneous equation model for the two countries.

Table 3: Estimation Results for an India-Pakistan Arms Race Econometrics Model Derived from Deger and Sen (1999)

Dependent Variable	Inertia Variable	Threat Variable	Economic Variable	Other Security Variable
Level of India's Military Expenditure	Positive Significant	Positive Non-Significant	Significant	Non-Significant
Level of Pakistan's Military Expenditure	Positive Significant	Positive Significant	Non-Significant	Significant

Source: Deger and Sen (1999)

Looking at the core action-reaction variables in Table 3 (i.e. own country's past military expenditure (inertia) and opposition's past and/or present military expenditure (threat)), India is clearly affected by inertia as well as economic constraints. Interestingly enough, India is not affected by Pakistan's threat. On the other hand, India's military expenditure has a strongly significant impact on Pakistan's defence spending. At the same time, economic constraints do not have a significant impact on Pakistan. Yet, other security variables, as proxied by arms imports, have a strong and positive impact on domestic defence outlays in Pakistan. Table 4 reports results from Smith et al. (1999). They carry out more complex econometric testing, using recent developments in time series econometrics. It is interesting to note that once again, even in this more sophisticated version, Pakistan's threat has an insignificant impact effect on India's military expenditure. However, the relationship is asymmetric. Pakistan does respond to the Indian threat.

Table 4: Estimation Results for an India-Pakistan Arms Race Econometrics Model Derived from Smith et al. (1999)

Dependent Variable	Inertia Variable	Threat Variable	Speed of Adjustment to Disequilibrium	Constant
Change in India's Military Expenditure	Positive Significant	Positive Non-Significant	Fast Significant	High
Change in Pakistan's Military Expenditure	Positive Significant	Positive Significant	Slow Significant	Low

Source: Smith et al. (1999)

How do we explain the various econometric results? It is possible that India behaves relatively autonomously and Pakistan follows. The action-reaction model is asymmetric and India could play a Stackelberg leadership game. One reason could be size. India is much larger in every single indicator, economic, strategic and security-related; hence, autonomous behaviour is to be expected. Pakistan's threat comes from India and India alone, so the action-reaction is extremely marked in the case of Pakistan.

However, it is also important to stress that the sign of the threat coefficient for India (i.e. impact of Pakistan's defence spending) is always positive, even though it is non-significant at standard levels of significance. In other words, Pakistan does exhibit a threat but the impact effect is not statistically significant. India has many strategic interests and, although the importance of Pakistan should not be ignored, it possibly does not play the dominant role in explaining Indian defence procurement. On the other hand, the empirical results seem to demonstrate that Pakistan's obsession with India is real in the sense that it motivates Pakistan's arms procurement policies.

An alternative point of view, far removed from the rational actor paradigm that motivates the Richardson model, is that India procured arms on an *ad hoc* basis and that the history of defence spending is one of random drift (see Smith (1994). However, this is not a precise description of military spending because some rational political calculations were made even though they may have had wider implications compared to a simple arms race. The central point to note is that India's military security interests have always been entwined with wider developmental needs, economic motivations and political aspirations. Military security is only a part of the wider notion of security which includes economic and political considerations. Self-sufficiency in arms production has

been a declared objective of the Indian government since independence; but self-sufficiency in heavy industries and high technology goods production has equally been a central objective of policy makers. The principle of import substituting industrialization was as much applied to steel and heavy engineering as it was to military aircraft or missile systems. Therefore, Indian defence procurement may look random from a purely military point of view. Yet, viewed from a more overarching political economy point of view, it seems quite consistent. India takes into account the threat from Pakistan but gears its military expenditure and defence capability within a much broader framework which includes the imperatives of the economy as well as its aspiration to become a regional and possibly an Asian power. In addition, the strong democratic tradition, the principles of accountability in government spending, the apolitical stance of the military and its reluctance to get involved in internal affairs, greater openness and criticism from an adversarial press, and finally the intense pressure to provide other forms of public goods through the budget, all of these make economic constraints more important in the determination of military spending. For Pakistan, on the other hand, the mechanics are simpler. There is less constraint on the military; defence and military security is akin to Caesar's wife - beyond question. The threat from India is paramount and overwhelming. Hence, the military responds to India and gets what it wants, making the arms procurement process an arms race.

6. Conclusion

Both India and Pakistan have formidable military power - particularly by Third World standards. Yet, they have substantial developmental problems - many of which remain unsolved even after periods of reasonable growth. There remains a contradiction between the “security dilemma” and the “poverty trap”. And both countries have significant unmet developmental needs - at least some of which could be overcome if additional funding was available. Military expenditure reductions offer one way out. The attainment of the peace dividend is not costless (see Hartley and Sandler, 1995 and Intriligator, 1998). Nevertheless, the issue could be academic. Both India and Pakistan overspend, as the simulated growth models demonstrate: therefore the possibility for cuts is present. This is particularly true for Pakistan whose defence burden has hovered between 6 to 7 per cent over the last two decades. However, the prospects for the peace dividend are low.

The paper analyses some of the reasons for the arms race, both within formal and informal frameworks, and concludes that it will continue. The nuclear option adds an element of destabilization in the equation, but does not create any new opportunities such as reductions in conventional military capability. Overall, political methods of arms control are required, but it will take a new generation (as in the East-West conflict) to begin a new era.

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APPENDIX: Nuclear Weapons: To Have or not To Have?

In 1974, India exploded its first nuclear device, akin to the Hiroshima bomb of around 15 kilotons of TNT equivalent, in the deserts of Rajasthan. Since independence, India has been a vociferous proponent of complete and total nuclear disarmament. It has consistently claimed that nuclear weapons programmes of the big powers are a hegemonic device to keep the regional players (like India) out of the high politics that characterize international relations. Yet, it refused to sign the Non-Proliferation Treaty when it opened for signature in 1968, and has been consistently opposed to the treaty as a major non-nuclear state.

For the twenty-five years since the first explosion, India has acquired nuclear technology which has been dual-use in the sense of helping its power programme as well as its potential defence needs. Since the 1980s, Pakistan has followed suit and an action-reaction nuclear arms race developed in the sub-continent. The culmination of this is the infamous multiple nuclear tests, first by India and then by Pakistan, in 1998. Both countries are now formally members of the nuclear club but are yet to sign the NPT. Almost all former near-nuclear states - Argentina, Brazil, South Africa - are now full

signatories; China and France acceded to the NPT in 1991. In many ways, India and Pakistan (and also Israel) are isolated on this question.

It is an important question as to whether India and Pakistan will begin a nuclear arms race in the region. The question keeps surfacing, since they came close to open warfare in 1999 (at the Kashmir border), and clearly the horrific implications of a nuclear war, however limited, must be an option for the defence planners. Both countries have instituted Confidence and Security Building Measures (CSBMs) and the Prime Ministers met *personally* both formally and informally in early 1999. Both countries have claimed that the nuclear option is 'cheap'; that this option may be one way of achieving deterrence without expanding conventional capability much further; and that with a reduction in military expenditure, consequent on the acquisition of nuclear weapons, realisation of the peace dividend becomes a possibility. We consider each in turn.

Data on Pakistan's nuclear spending is non-existent, nor are there any ways of calculating the aggregate costs of India's nuclear programmes. Also, India has a long-standing civil nuclear power programme and often research conducted in one area has implications for the other. However, one set of information is pertinent. This relates to Research and Development (R&D) expenditures by the Government of India (GOI) which are routinely published by the Department of Science and Technology of the GOI. In Table 5 we show the expenditure share, in aggregate R&D, of the three agencies primarily related to the development of military technology. The data for about four decades show an interesting trend. Starting from a small base in the early 1960s, the Defence Research and Development Organisation (DRDO), has expanded enormously; in the late 1950s it had less than 10 per cent of the aggregate GOI expenditures on R&D; in recent years it has risen to over 30 per cent. In relative terms, space research has outflanked nuclear research spending, at least from the mid-1980s. Overall, nuclear programmes are relatively underfunded and currently get only 10 per cent of GOI spending on research. Far more costly, is India's attempt to be self-sufficient in conventional weapons. A related level of expenditures could be space R&D but much of it is now for civilian programmes particularly the attempt (following China) to launch indigenous scientific satellites using domestically produced rocket launchers. Therefore, currently nuclear weapons are not expensive and are therefore not a burden to the economy; most of the costs are sunk and fixed and have already been incurred.

Table 5: R&D Expenditure Shares (Percentages) by Government of India (GOI) Agencies Involved with Defence-Related Research

Fiscal Year	DRDO (%)	DAE (%)	DOS (%)	Aggregate Share (%)
1958/59	7.3	39.1	0	46.4
1970/71	20.4	32.4	0	52.8
1985/86	34.2	10.5	15.8	60.5
1990/91	29.5	12.1	16.7	58.3
1991/92	26.6	11.7	18.0	56.3
1992/93	29.3	11.4	17.9	58.6
1993/94	29.5	10.7	19.5	59.7
1994/95	31.8	10.6	19.2	61.6
1995/96	30.9	10.5	19.8	61.2

Note: All data are for shares in total R&D expenditure of GOI. DRDO: Defence Research and Development Organisation. DAE: Department of Atomic Energy. DOS: Department of Space
Source: Arnett (1998)

Whether the nuclear option will allow India to reduce conventional military armaments is a difficult question to answer. As the arms race models indicate, India's defence expenditure is mainly motivated by domestic considerations (including inertia and economic constraints). Hence, the nuclear capability, which is only relevant at this stage for deterrence against Pakistan, may not be of major importance. Further, self-sufficiency in arms is still a part of aggregate industrial policy. Unless liberalisation has proceeded so far that import-substituting industrialisation will be abandoned, it is possible that domestic arms procurement will remain high for industrial rather than security reasons. Since Pakistan 'follows' India in an action-reaction game, it is difficult to see how it can reduce or stabilise military spending without a major change in Indian behaviour. It is interesting to note that both countries, in their recent budgets, have increased real defence spending by amounts exceeding their current rates of growth.