4. Four-worlds models

4.1 MODELS IN WHICH CHINA IS CONSIDERED AS W4

The unrealistic results obtained in Section 3.4, where China was taken as part of the Third World, constitute an argument in favour of a different model, where China is considered a world of its own called W4. There are convincing arguments in favour of such a procedure. China combines two characteristics, being underdeveloped (as W3) and communist-ruled (as W2'). Moreover, it is less armed than the Soviet Union and, since 1960, is not an ally of the Soviet Union. Its need for development is much stronger than that of the Warsaw Pact countries; and it has its own problems with Taiwan, Vietnam and South-East Asia generally. In the present chapter the optimum values of all variables so far considered for three 'worlds' will now be considered for four 'worlds'. The advantage of doing so is, of course, that the Second and the Third World are now more homogeneous than in Chapter 3. Since in Chapters 2 and 3 we did not obtain very different results using the three alternative welfare functions, we shall only use the logarithmic welfare function. Again the pure Lagrange method to find optimum values will be applied. The coefficients α_{ij} linking welfare and security have been only partly measured which forces our first attempt to use them in our model to be a crude approximation only. Moreover, we shall introduce the 'mixed' coefficients α_{12} and α_{21} only for the First and Second World, since their relevance far surpasses the impact on general security of the relevance of the armament levels of the Third and Fourth World. For the latter, our model will be simpler, and only one-index coefficients α_3 and α_4 will be used to indicate the link between their armament and world welfare-in-security.

The level of security assistance v_{12} will we assumed to be 1 per cent of W1 income, hence 39 billion 1975 US $. This is done because preparatory studies with a free v_{12} often led to unrealistic results.

4.2 FOUR WORLDS OPTIMUM WITH LOGARITHMIC WELFARE FUNCTIONS

It seems appropriate to spell out in detail how the optima considered in cases A, B and C, as studied in Chapter 3, are defined. In the most general case, C, it is assumed that, by negotiations between the four worlds considered, their governments succeed to agree on the values of all expenditures (non-military y and military a) which maximize total welfare, and on the transfers v_{12} and v_{13} from the First to, respectively, the Second and the Third World necessary to attain that goal. With regard to 'security aid' v_{12} as defined earlier, we assume it will be 1 per cent of the income 3880 bn 1975 US $, so as to avoid unrealistic values obtained in Section 3.4. This optimum will be obtained by maximizing world welfare Ω:

$$\Omega = \ln(y_1 + 1) + 0.56 \ln (y_2 + 0.56) + 2.85 \ln (y_3 + 2.85) + 1.30 \ln (y_4 + 1.30) + \alpha_{11} \ln (a_1 + 1) - \alpha_{12} \ln (\alpha_2 + 1) + 0.56\alpha_{22}(a_2 + 0.56) - 0.56\, \alpha_{12} \ln (a_1 + 0.56) + 2.85\, \alpha_3 \ln(a_3 + 2.85) + 1.30\, \alpha_4 \ln(a_4 + 1.30) + \lambda_1(3880 - y_1 - a_1 - 39 - v_{13}) + \lambda_2(1252 - y_2 - a_2 + 39) + \lambda_3(1999 - y_3 - a_3 + v_{13}) + \lambda_4(790 - y_4 - a_4) + \mu(a_1 - a_2)$$

under the restrictions

$$3880 = y_1 + a_1 + 39 + v_{13} \quad \text{(R1)}$$
$$1252 = y_2 + a_2 - 39 \quad \text{(R2)}$$
$$1999 = y_3 + a_3 - v_{13} \quad \text{(R3)}$$
$$790 = y_4 + a_4 \quad \text{(R4)}$$

These restrictions are found in the expression for Ω behind the Lagrange multipliers λ_i (i = 1. 2. 3. 4). An additional restriction on the armament expenditures a_1 and a_2 is added, namely, that they are equal ('equal strength' of First and Second World).

The maximum conditions are obtained by differentiating Ω with regard to each of the variables and putting these derivatives equal to zero:

$$\frac{1}{y_1 + 1} - \lambda_1 = 0 \quad (4.21) \qquad \frac{\alpha_{11}}{a_1 + 1} - \frac{\alpha_{12}}{a_1 + 0.56} - \lambda_1 - \mu = 0 \quad (4.22)$$

$$\frac{0.56}{y_2 + 1} - \lambda_2 = 0 \quad (4.23) \qquad \frac{-\alpha_{12}}{a_2 + 1} + \frac{\alpha_{22}}{a_2 + 0.56} - \lambda_2 + \mu = 0 \quad (4.24)$$

$$\frac{2.85}{y_3 + 2.85} - \lambda_3 = 0 \quad (4.25) \qquad \frac{2.85\alpha_3}{a_3 + 2.85} - \lambda_3 = 0 \quad (4.26)$$

$$\frac{1.30}{y_3 + 1.30} - \lambda_4 = 0 \quad (4.27) \qquad \frac{1.30\alpha_4}{a_4 + 1.30} - \lambda_4 = 0 \quad (4.28)$$

$$-\lambda_1 + \lambda_3 = 0 \quad (4.29)$$

We have based our estimates of the coefficients α used on the figures of Table 4 of Appendix II. There we find a figure of 0.043 for the ratio between armament expenditures and real national income for W1, which for us implies that $\alpha_{11} = 0.043$. Similarly, $\alpha_{22} = 0.090$. For the α_{12} we assume it is one-half of α_{22} which means $\alpha_{12} = 0.045$. Similarly, $\alpha_{21} = 0.5\ \alpha_{11} = 0.022$. The values for α_3 and α_4 have been chosen equal to the ratios of armament expenditure to income for W3, hence $\alpha_3 = 0.049$ and $\alpha_4 = 0.083$. All these figures are again halved in order to reflect the impact of the conclusion of an arms reduction agreement. For the solution of the system of equations it appears possible to find the variables for China with the aid of equations (4.27) and (4.28) in which only these variables appear. Together with (R4) they yield

$$y_4 = 790 \quad \text{and} \quad a_4 = 30 \text{ (rounded to units of 1 bn 1975 US \$).}$$

This would not have been independent of, for instance, the armament expenditures of the superpowers if we had introduced these as co-determinants of China's welfare.

For the W1 and W2 figures we are able to eliminate these referring to W3, and for the solution of y_1, y_2 and $a_1 = a_2 = a$ we find:

$$\frac{0.018}{a + 0.78} = \frac{1}{y_1 + 1} + \frac{0.56}{y_2 + 0.56} \quad (4.210)$$

Adding up (R1) and (R3) and using (4.25) and (4.26) we find:

$$y_1 = 1490.5 - 0.255\ a \quad (4.211)$$
$$y_2 = 1291 \quad - \quad a \quad (4.212)$$

By trial and error we find the solution for a and the two ys. The complete solution will be shown in Table 4.31.

4.3 THE SEPARATE NEGOTIATIONS ON DISARMAMENT AND DEVELOPMENT W3

In a similar way we shall now determine the partial optimum situations resulting from separate negotiations between W1 and W2 and of those between W1 and W3. The former deal with military expenditures and are aimed at maximum welfare-in-security of W1 and W2. Only the terms in Ω for these two worlds and only the restrictions valid for W1 and W2 will be used. The separate negotiations between W1 and W3 deal with development assistance and only the terms in Ω referring to W1 and W3 are considered. Since the superpowers' military expenditures are not a subject for negotiation in this case, the two extreme values for a_1, 0 and 167, will be considered, and indicated as cases (i) and (ii). Zero, of course, means total disarmament of the superpowers, 167 means maintenance, on both

Table 4.31 Results of negotiations between (A) W1 and W2, (B) W1 and W3 and (C) between all three worlds W1, W2 and W3 to maximize welfare-in-security of the worlds concerned by an appropriate choice of (A) military expenditure and (B) development assistance. In case B(i) the superpowers are supposed to disarm and in Case B (ii) to maintain 1975 level of W1. Amounts rounded to bn 1975 US$ real purchasing power. D: actual 1975 figures

Variable	A	B(i)	B(ii)	C	D
y_1	3316	1433	1411	1407	3699
y_2	1266	.	.	1276	1866
y_3	.	4140	4022	4237	1901
y_4	760	760	760	760	727
a_1	25	0	167	15	167
a_2	25	0	167	15	182
a_3	.	287	297	101	98
a_4	30	30	30	30	30
v_{12}	39	39	39	39	0
v_{13}	.	2428	2302	2339	14

sides, of the 1975 value of W1 armament expenditures (cf. Appendix II, Table 4).
The results of all negotiations are shown in Table 4.31.

4.4 COMPARISON OF THE RESULTS OF SECTIONS 4.2 AND 4.3

As in Chapter 3, we shall now draw conclusions about the impact of separate negotiations on armament and development expenditures. We do this by comparing columns A and B, respectively, with C.

In column A armament expenditures are $ 10 bn higher than in column C. The results obtained in column B strongly depend on what is assumed on military expenditure by the superpowers. If we take the average of B(i) and B(ii), amounting to $ 2365 bn development assistance, this is $ 26 bn more than the figure in column C. For the extremes (i) and (ii), $ 63 bn more or less are obtained. Considering the average of (i) and (ii) as a separate case we may conclude from Table 4.31 that in three out of four cases separate negotiations lead to more armament expenditure or development assistance than is obtained if negotiations about both issues are conducted jointly. As observed, this simply reflects the old truth that a dollar cannot be spent twice.

4.5 SOLVING THE OPTIMALITY PROBLEM OTHERWISE

As mentioned, in many preparatory studies where the amount of security assistance v_{12} was chosen as a free variable which could play its role in the optimization process, unrealistic values for it were found: sometimes high negative values, meaning that W2 would pay security assistance to W1, and sometimes high positive values, which is not very likely either. For this reason a more sophisticated model was studied which saves the possibility of treating v_{12} as a free variable. For the sake of completeness some information is added. In addition to the restrictions already used, an equation was introduced that can be seen as a purchase (or demand) equation of restriction in armament a_2 of W2 and runs:

$$v_{12} = \varphi\left(\frac{113}{a_2} - 1\right) \tag{4.51}$$

Here 113 is the value of a_2 in 1975. A reduction in a_2 can be used by W2 to buy some security assistance v_{12}. How much depends on the value of φ, of course. Within a range from 0.5 and 3 it appears that the effect on the other variables in our models is extremely modest.

It seems appropriate to repeat here that our empirical knowledge of the coefficients α_{ij} and α_i ($i = 1, 2$) is very restricted, and the assumptions we made were meant mainly as illustrations of the order of magnitude – both of the coefficients and, of course, of the unknown variables of our main problems. In the latter parts of our book models and variables will be used whose meaning is clear and simple.

4.6 SUMMARY AND CONCLUSIONS OF CHAPTERS 3 AND 4

We are now in a position to summarize the results of Chapters 3 and 4, as announced at the end of Chapter 3.

A clear answer to our main question in these chapters was given by Tables 3.21, 3.22 and 3.23. In all three cases – where varying welfare functions had been used – we got the clear answer that separate negotiations on armament reduction between the superpowers or between W1 and W2 would lead to higher armament expenditures and security assistance than world-wide negotiations. In all three cases we also found that separate negotiations between the First and the Third World would bring considerably more development assistance. In these calculations China was considered as a communist nation and not as an underdeveloped country. In an attempt (Tables 3.41 and 3.42) to consider China as a developing country and not as a communist country, our results became unrealistic, since in the world-wide negotiations the optimum was located at considerably negative values of security assistance. This led us to consider, in Chapter 4, China as separate 'world' (W4). Since China is a very big country, especially when measured by the size of its population, the model changes considerably.

The answers are less outspoken as in Tables 3.21–3.23. The differences between columns (A) and (C) or (B) and (C) in Table 4.31 – which now summarizes our findings – are much smaller than the corresponding differences in Tables 3.21–3.23. But in three out of four cases, column (A) shows higher military expenditures than column (C) and column (B) shows higher development assistance than column (C). The differences are much smaller than in Tables 3.21–3.23, but this also is due to the

avoidance, in the models used in Chapter 4, of models supplying excessive figures in security assistance. Our main result cannot deny that a negative relationship between expenditures for armament and expenditures for development exist.

In the later chapters the importance of this relationship is accentuated by the conclusion that the increase needed in development assistance is of the same – very large – order as the desirable reduction in armament expenditure.