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UN peacekeeping as a public good: analyses of the UN member states' peacekeeping financial contribution behavior

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UN peacekeeping as a public good: Analyses of the UN member states' peacekeeping financial contribution behavior

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CHAPTER 1 INTRODUCTION

1.1 UN Peacekeeping as a Public Good

Since the Congo crisis of the early 1960s, UN peacekeeping operations have suffered from such problems as poor pre-operational planning, slow budgetary process, inefficient logistics system and shortage of well-trained personnel. For decades, these inadequacies have undermined the effectiveness of large-scale peacekeeping operations. The most serious problem faced by the United Nations today is, however, the lack of financial support from its member states. The expansion of UN peacekeeping activities since the end of the Cold War has increased the severity of this problem, even to the point of jeopardizing the existence of the organization. As the total UN peacekeeping expenditures increased from approximately $266 million in 1988 to $3,364 million in 1995, the total peacekeeping arrears increased from approximately $355.2 million to $1,723.9 million.

The maintenance of world peace could be seen as a public good since it provides benefits that are both nonexcludable and nonrival. Benefits are nonexcludable if the providers are unable to prevent anyone from enjoying them, unless exclusion mechanisms that require prohibitively high outlay are employed. Benefits of a good are said to be nonrival if the enjoyment of the benefits gained from a good by an individual does not reduce another individual's enjoyment of the benefits gained from the same unit of the good (Cornes and Sandler 1996). For the purpose of maintaining international peace and security, UN peacekeeping is likely to create purely public benefits. For example, the benefits provided by UN Emergency Force II (1973–79), which averted a direct

superpower confrontation in the Middle East, were enjoyed by nations and their citizens all over the world, regardless of who financed the operation or how many nations received the benefits from it. Nonexcludability of benefits creates a problem of free riding, or more precisely, easy riding. Each country's reliance on the contributions of others, and its failure to take into account the spillover benefits its contribution confers on others will result in the underprovision, or suboptimality of total peacekeeping efforts.

As opposed to public benefits, contributor-specific benefits are received by a country only from its own contribution. For example, a country can be recognized by the international community as a promoter of world peace, when it generously supports peacekeeping or humanitarian aid (e.g., Norway). Because it is recognized by other nations as one of the largest beneficiaries of Middle East stability, Japan receives contributor-specific benefits in the form of international approval when it supports peacekeeping operations in the region, and it would suffer international disapproval if it decides not to contribute its support.

If it is assumed that peacekeeping efforts produce only purely public benefits, and that each country's demand for peacekeeping is positively correlated with its national income, the pure public good model of collective action predicts that wealthy member states assume disproportionate burden in terms of the percentage of income contributed (Olson and Zeckhauser 1966; Sandler and Hartley 1995). This would not be the case if peacekeeping efforts produce not only public benefits, but also contributor-specific benefits. The joint product model, in which an activitiy (e.g. peacekeeping) is allowed to produce multiple benefits with varying degrees of publicness, includes both pure public good model and pure private good model as two extremes. As the ratio of contributor-specific benefits to the sum of public benefits and contributor-specific benefits increases, that is, as the share of private benefits produced by peacekeeping increases, the total level of peacekeeping efforts approaches optimality. This follows because private goods can be efficiently traded across markets as traders reveal their true preferences. In this

case, disproportionate burden sharing by wealthy member states would not result.

As an attempt to survey the change in suboptimality of UN peacekeeping efforts, Chapter 2 of this dissertation examines the financial burden-sharing patterns of selected UN member states for the period of 1975–96. Using non-parametric statistical tests, this chapter studies the rank correlation between gross domestic product (GDP) and share of GDP devoted to UN peacekeeping for four different subsets of UN member states.

Since the early 1990s, there have been several large-scale non-UN-led peace operations, such as Operation Desert Shield/Storm during the Gulf War, NATO-led multinational Implementation Force (IFOR), and Stabilization Force (SFOR) in Bosnia and Herzegovina. In order to gain a more accurate picture of peacekeeping burden shared by countries in the 1990s, the burden sharing of these non-UN-led operations are also studied in Chapter 2.

In Chapter 3, a reduced-form UN peacekeeping contribution function is derived using a joint-product model, in which peacekeeping efforts are assumed to produce contributor-specific benefits as well as purely public benefits. In this model, a representative country's utility depends on the level of nation-specific non-peacekeeping activities, the level of its contribution to UN peacekeeping, and the level of total peacekeeping contribution received by the United Nations. The country allocates its resources between peacekeeping contribution and non-peacekeeping activities in order to maximizes its utility. To ascertain what determines the contribution level of each member state, the contribution functions are estimated for a sample of 25 UN member states for the period of 1975–96. The variables on which each country's contribution function depends include other countries' contributions, or *spillin*. Consequently, each country's contribution is tied to contribution decision of other contributing countries, so that the disturbance term is correlated among the contributors' equations. That is, the presence of spillin in the contribution function makes the error terms dependent on one another. The two-stage least square method is used to get rid of this simultaneity problem.

Virtually every UN peacekeeping operation established in and after 1973 is/was financed through separate assessment account.[1] All UN member states are required to contribute assessed amounts towards each account. Possible effects of this peacekeeping special assessments on countries' financial contributions are discussed in Chapter 4. It is argued that, even without effective sanctions against undercontribution, the existence of assessments increases a country's contribution by increasing its contributor-specific benefits. Incorporating this assessment effect into a utility function will shift up the country's downward sloping contribution curve for each operation as long as the contribution does not exceed the assessment.

Although peacekeeping operations create benefits which are both globally nonexcludable and nonrival, the valuation of the benefits often varies across countries. For example, consider operations in the Middle East. The countries in the region as well as oil-dependent industrialized countries are likely to place more value on such operations than oil-exporting countries in the other regions. A country's valuation of public benefits created by a peacekeeping operation depends on, among other things, proximity, the amount of trade done with the region, and the nature of the conflict, such as the possibility of the conflict leading to a direct military confrontation of the superpowers (during the Cold War), or potential involvement of nuclear weapons.[2] The UN peacekeeping assessment scale is, however, based solely on the ability to pay of each member state, and not on its valuation of benefits received. A theoretical possibility of increasing the total contribution of each country by redistributing its assessments across operations according to the value placed on each operation by the country is also discussed in Chapter 4.

The following three sections in this chapter are intended to be an introduction to the

[1]The UN Good Offices Mission in Afghanistan and Pakistan (UNGOMAP) established in 1988 was financed through the UN regular budget.

[2]Bobrow and Boyer (1997) discuss the difference in the benefits of a peacekeeping operation received by the countries within and outside the conflict area.

basic structures of UN peacekeeping. They discuss the UN organs involved in peacekeeping, the main characteristics of various types of peacekeeping operations, the 50-year history of UN peacekeeping, and the financing methods used by the United Nations for its peacekeeping operations.

1.2 Establishment of UN Peacekeeping Operations

The United Nations is composed of six principle organs: the General Assembly, the Security Council, the International Court of Justice, the Economic and Social Council, the Trusteeship Council, and the Secretariat headed by the Secretary General. Of these, the Security Council, the Secretariat, and the General Assembly are involved in the process of establishing and conducting UN peacekeeping operations.

1.2.1 The Security Council

As a first step toward the establishment of a new UN peacekeeping operation, a proposal by the Secretary General or UN member states is referred to the Security Council, which consists of 15 members, for its preliminary approval. The approval requires a majority of nine votes, including the concurring votes of the five permanent members. The permanent members include China, France, Russia, the United Kingdom and the United States. Ten non-permanent members with a two-year term are recommended by the General Assembly, and selected by the Security Council based on their geographical representation. The Security Council is the UN organ which bears the primary responsibility for the maintenance of international peace and security; Chapter VI of the UN Charter stipulates that the Security Council may seek pacific settlement of disputes, while Chapter VII authorizes the Security Council to take military action if necessary. It is mandatory for the UN member states to abide by the Security Council resolutions. The Security Council is the only UN organ with such a power.

1.2.2 The Secretariat and Secretary General

Once the Security Council authorizes establishment of a peacekeeping operation, the Secretariat, headed by the Secretary General, lays a detailed mission plan, and prepares a budget. The Secretary General and Secretariat personnel are so-called international civil servants, and may not directly work for the interests of any particular government. In 1992, the Department of Peacekeeping Operations was created in the Secretariat in order to improve its efficiency.

Under the UN Charter, Article 99, "the Secretary General may bring to the attention of the Security Council any matter which in his opinion may threaten the maintenance of international peace and security." With this privilege, the Secretary General has traditionally undertaken political and diplomatic initiatives on numerous occasions. Also, during the Cold War, the Secretary General has acted as intermediary when the permanent members of the Security Council were divided on issues and were not able to adopt resolutions (Hill and Malik 1996).

1.2.3 The General Assembly

The Secretariat submits the peacekeeping operation budget to the Advisory Committee on Administrative and Budgetary Questions (ACABQ), the budget review unit of the General Assembly's Fifth Committee, for approval. The ACABQ recommends the budget to the Fifth Committee, which includes all UN member states. The Fifth Committee is one of the six General Assembly committees, and deals with administrative and budgetary matters. Finally, the Fifth Committee submits the budget to the General Assembly for consensus approval.

During the Korean War, the use of veto by the Soviet Union brought the Security Council to deadlock. In order to ensure the continuation of the UN-sanctioned peace enforcement operation in Korea, in 1950, the General Assembly adopted *the Uniting for*

Peace Resolution. This resolution authorizes the General Assembly to make recommendations to member states for collective security measures when the Security Council fails to act because of lack of unanimity among its permanent members.

1.3 Four Types of Peace Operations

There are a variety of ways of categorizing UN peacekeeping operations.[3] Durch (1996) suggests that operations be classified into four types: traditional peacekeeping operations, multidimensional peace operations, humanitarian interventions, and peace enforcement.

1.3.1 Traditional Peacekeeping Operations

Traditional peacekeeping operations involve deployment of impartial military personnel who monitor a cease-fire, investigate minor disputes, and attempt to defuse tensions between former belligerents. These operations are set up with the consent of parties involved in the conflict, and only if they agree on a cease-fire. The peacekeepers are equipped with light armaments, and are allowed to use their force only in self-defense. Once the host nation consent is lost, or the cease-fire is broken, the peacekeepers are withdrawn.

1.3.2 Multidimensional Peace Operations

Multidimensional peace operations are far more complicated than traditional peacekeeping, and involve assisting a nation with political transition toward democracy. The operation requires civilian personnel as well as military, for tasks such as maintenance

[3]For example, Diehl *et al.* (1998) classify peacekeeping operations in the following 12 categories: traditional peacekeeping, observation, collective enforcement, election supervision, humanitarian assistance during conflict, state/nation building, pacification, preventive deployment, arms control verification, protective services (e.g., safe heavens, no-fly zones), intervention in support of democracy, sanctions enforcement.

of law and order, repatriation and resettlement of refugees and displaced persons, the reorganization of domestic military forces, and the conduct of general election (UN Department of Public Information 1996).

1.3.3 Humanitarian Interventions

Humanitarian interventions are operations whose main purpose includes delivering of food and medical supplies to non-combatants suffering in military conflict areas. The intervention often requires use of limited amount of force as local parties involved in the conflict try to prevent humanitarian aid from reaching their enemies.

1.3.4 Peace Enforcement Operations

In peace enforcement operations, military forces are deployed in order to create a cease-fire between belligerents. Three characteristics seen in traditional peacekeeping operations, namely, impartiality of military personnel, host nation consent, and use of force only in self-defense, are all absent in such operations, and as a consequence, the risk of suffering heavy casualties is relatively high. Commonly, peace enforcement operations are sanctioned by the United Nations, but led by a member state or a group of member states such as NATO, and not by the United Nations.

1.4 History of UN Peacekeeping

1.4.1 The Cold War Period

Fourteen UN peacekeeping operations were established during the Cold War, and twelve of which are/were traditional peacekeeping involving monitoring cease-fires or acting as buffers between belligerents. The very first operation in which the United Nations used impartial military observers was the UN Special Committee on the Balkans

(UNSCOB: 1947–52).[4] UNSCOB was set up to investigate military support of Greek communist guerrillas by Albania, Bulgaria and Yugoslavia. Deadlock in the Security Council, created by the Soviet Union's use of the veto, led the General Assembly to authorize the establishment of UNSCOB. The next two operations, the UN Truce Supervision Organization (UNTSO: 1948 to date) and the UN Military Observer Group in India and Pakistan (UNMOGIP: 1949 to date), have all the main characteristics of traditional peacekeeping. They are classic observer missions. UNTSO military observers have monitored cease-fires between Israel and its neighboring countries, while UNMOGIP was established after a cease-fire agreement between India and Pakistan.

The UN Emergency Force I (UNEF I: 1956–67) was established to supervise withdrawal of French, Israeli and British troops from Egypt, and then to create a buffer between the Egyptian and Israeli forces. The purpose of UNEF I was to secure, rather than just to monitor, the cease-fire (Hill and Malik: 1996). At its peak strength, UNEF I consisted of 6,073 military personnel, while UNTSO and UNMOGIP consisted of 572 and 102 military observers, respectively. Creation of UNEF I was authorized by the General Assembly through the application of the Uniting for Peace Resolution; the Security Council found itself deadlocked as the two of its permanent members, France and the United Kingdom, were directly involved in the conflict. UNEF I successfully oversaw the withdrawal of foreign forces from Egypt, and monitored a cease-fire until 1967.

Established to supervise the withdrawal of Belgian forces from the Congo, and to assist the Congolese government to restore law and order, the UN Operation in the Congo (ONUC: 1960–64) was initially designed to follow the key principles of traditional peacekeeping. As the civil war in the Congo intensified, however, its mandate was strengthened, and ONUC became a peace enforcement operation. The number of military personnel reached 19,828 in 1961, and by the end of mission, the UN lost a total

[4]Impartial military personnel of UNSCOB were never allowed by either Albania or Yugoslavia on their territory. This lack of consent by some of the countries involved in the dispute led some to argue that UNSCOB did not qualify as a peacekeeping operation.

of 250 personnel, including the Secretary General Dag Hammarskjold.

Between 1962 and 1965, the United Nations established five new traditional peacekeeping operations: two large-scale operations and three small-scale observer missions. Small-scale operations were the UN Yemen Observation Mission (UNYOM: 1963–64), the Mission of the Representative of the Secretary General in the Dominican Republic (DOMREP: 1965–66) and the UN India-Pakistan Observation Mission (UNIPOM: 1965–66). Large-scale operations are/were the UN Security Force in West New Guinea (UNSF: 1962–63) and the UN Peacekeeping Force in Cyprus (UNFICYP: 1964 to date). UNSF with maximum strength of 1,576 military personnel monitored a cease-fire between Indonesia and the Netherlands in the territory under the UN Temporary Executive Authority (UNTEA: 1962–63). It successfully maintained security until the full administrative authority was transferred to Indonesia in 1963. UNFICYP was initially established to prevent a recurrence of inter-communal violence between the Greek Cypriots and Turkish Cypriots. Since the Turkish invasion of Cyprus in 1974, its mandate has also included the maintenance of a buffer zone between the areas controlled by the Cyprus National Guard and by Turkish Forces.

During 1973–87, the United Nations launched only three new peacekeeping operations, all of which are/were in the Middle East. Following the 1973 Middle East War, the UN Emergency Force II (UNEF II: 1973–79) re-established a buffer zone between Egypt and Israel, and averted a military confrontation between the United States and the Soviet Union. After an Agreement on Disengagement between Israeli and Syrian forces on the Golan Heights in 1974, the UN Disengagement Observer Force (UNDOF: 1974 to date) was established to supervise the implementation of the agreement. The UN Interim Force in Lebanon (UNIFIL: 1978 to date) has been set up to confirm the withdrawal of Israeli forces from southern Lebanon. Without full cooperation of Israel, however, UNIFIL has been unsuccessful in fulfilling its original purpose, showing a limitation of traditional peacekeeping.

To summarize, following a successful, first ever large-scale peacekeeping operation, UNEF I, the United Nations undertook even larger ONUC, which turned out to be one of the most costly operations in terms of finances and lives. After ONUC, five new operations were established in the 1960s. Four of them were short-term operations, completed in less than two years. All of the operations set up in the 1970s were established with the initiatives of the United States. After these three Middle East operations, the United Nations did not authorize any new operations for ten years, until 1988.

1.4.2 The Post-Cold War Period

Starting with the UN Good Offices Mission in Afghanistan and Pakistan (UNGOMAP: 1988–90), which monitored the withdrawal of Soviet troops from Afghanistan, the United Nations engaged in ten new operations by the end of 1991.[5] Not only the number, but also the complexity of operations were to increase during this period: six of these operations were multidimensional, rather than traditional peacekeeping.

The first multidimensional peace operation, the UN Transitional Assistance Group (UNTAG: 1989–90), supervised the independence of Namibia through free and fair elections. At its peak strength, UNTAG consisted of 4,493 military personnel, 1,500 police and 2,000 civilians. The tasks of military personnel included confinement of South African troops in Namibia and South African People's Organization (SWAPO) troops in Angola and Zambia to base, and supervision of subsequent withdrawal of South African troops from Namibia. The UN civilian police (CIVPOL) monitored the South West African Police (SWAPOL), and the civilian personnel monitored elections.

An even larger multidimensional peace operation was the UN Transitional Authority in Cambodia (UNTAC: 1992–93), which immediately followed the UN Advanced Mission in Cambodia (UNAMIC: 1991–92). At its peak strength, 15,991 military personnel

[5]Not every post-Cold War operations are discussed in this section. For a complete list of operations, see Table 1.1.

and 3,359 civilian police were deployed in order to ensure the implementation of the Agreements on the Comprehensive Political Settlement of the Cambodia Conflict, also known as the Paris Peace Accords signed in October 1991. The supervision of withdrawal of foreign troops, the demobilization of the four Cambodian factions' military forces, the maintenance of law and order, the protection of human rights, the repatriation and resettlement of the Cambodian refugees and displaced persons, the rehabilitation of essential infrastructure, and the conduct of free and fair general elections were included in the UNTAC's mandate.

Besides UNTAC, the peacekeeping operations established in 1992 included the UN Protection Force (UNPROFOR: 1992–95), the UN Operation in Somalia I (UNOSOM I: 1992–93), and the UN Operation in Mozambique (ONUMOZ: 1992–94). Initially UNPROFOR's task was to ensure the demilitarization of the three UN Protected Areas (UNPAs) in Croatia. It's mandate was soon extended to include monitoring of areas around UNPAs, so-called pink zones, protection of the Sarajevo Airport and support of the UN High Commissioner for Refugees (UNHCR) on its delivery of humanitarian relief throughout Bosnia and Herzegovina. UNPROFOR also monitored the no-fly zone in Bosnia and Herzegovina, and the UN safe areas established around five Bosnian towns and the city of Sarajevo. Without cooperation of parties directly involved in the conflict, the Security Council authorized the UN member states to take peace enforcement measures nationally or through regional arrangements if necessary to support UNPROFOR. NATO has played a large role during the conflict; its forces monitored and enforced the no-fly zone as well as the UN arms embargo and sanctions, and protected the UN safe areas. UNPROFOR was also deployed in the Former Yugoslav Republic of Macedonia (FYROM) in 1993 to prevent the conflict from spreading into the territory. This was the first time the United Nations deployed its forces before any military clash had occurred, and it is called preventive deployment, or a tripwire force. Its purpose is to symbolize the international community's will to act against aggression (Durch 1996). It is likely

that the inclusion of US troops has contributed to the effectiveness of the force in the FYROM. At its peak strength, UNPROFOR consisted of 38,614 troops, 637 military observers and 671 civilian police. In 1995, UNPROFOR was separated into three operations: UNPROFOR in Bosnia and Herzegovina (1995), the UN Confidence Restoration Operation in Croatia (UNCRO: 1995–96), the UN Preventive Deployment Force in FYROM (UNPREDEP: 1995–99). After the signing of the Bosnia Peace Agreement in December 1995, the NATO-led 60,000 troop-strong multinational Implementation Force (IFOR: December 1995–96) took over from UNPROFOR in Bosnia and Herzegovina. IFOR was followed by the NATO Stabilization Force (SFOR: December 1996 to date) with approximately 31,000 troops.

UNOSOM I's mandate included monitoring of a cease-fire in Mogadishu, the capital of Somalia, and protection of humanitarian convoys and distribution centers throughout Somalia. As in the case of operations in the former Yugoslavia, the United Nations did not have the support of the Somali factions involved in the civil war. In December 1992, the US-led peace enforcement operation, the Unified Task Force (UNITAF: 1992–93) with approximately 37,000 troops was established to support UNOSOM I. In May 1993, UN-led peace enforcement operation, UNOSOM II took over from UNOSOM I and UNITAF. In October, the US Rangers under US command conducted a raid in South Mogadishu with the intention of capturing key aides of General Aidid who were suspected of complicity in attacks on UN personnel and facilities. During the raid, 18 US soldiers were killed and 75 others were wounded. Losing support of both participating member states and Somali population, UNOSOM II withdrew in March 1995 without accomplishing its ultimate goal of organizing democratic elections and establishing a national government. At its peak strength, UNOSOM II consisted of approximately 28,000 military and police personnel.

Operations in the former Yugoslavia and Somalia demonstrated the difficulties and complexity of operations conducted without local consent. In such a case, humanitarian

interventions by the United Nations require peace enforcement operations, for which the United Nations often must rely on coalitions of its member states. As Carment and James (1998a) point out, "UN involvement may *increase* complexity and exacerbate tensions that cannot be managed, let alone resolved, through an underfunded and underequipped third party." A total of 207 UNPROFOR personnel and 147 UNOSOM II personnel were killed during the operations.

Another example of peace enforcement operation was the US-led multinational force (MNF: 1994–95) in Haiti, which prompted the departure of the Haitian coup leaders and the return of President Aristide. The UN Mission in Haiti (UNMIH: 1993–96) was fully deployed in March 1995, taking over from MNF. UNMIH (maximum strength: 6,065 troops and military support personnel, 847 civilian police) assisted the Haitian government in the professionalization of its military forces, the creation of a separate police force and the organization of legislative elections. Three smaller scale missions, namely, the UN Support Mission in Haiti (UNSMIH: 1996–97), the UN Transition Mission in Haiti (UNTMIH: 1997) and the UN Civilian Police Mission in Haiti (MIPONUH: 1997 to date) followed UNMIH.

Following the failure of UNOSOM II, the member states' unwillingness to commit themselves to a non-traditional peacekeeping operation with possibilities of suffering heavy casualties was demonstrated most clearly during the UN Assistance Mission for Rwanda (UNAMIR: 1993–96). Originally UNAMIR was established to support the implementation of the Arusha Peace Agreement between the Hutu-dominated Rwandan government and the Tutsi-dominated Rwandese Patriotic Front (RPF). The agreement was never fully implemented however, as the fight between the RPF and the government force resumed in April 1994 after the Hutu extremists started killing its political opponents and a large number of Tutsi civilians. The UN member states were extremely reluctant to contribute their troops upon the Secretary General's requests, allowing the massacre of 500,000 to 800,000 civilians as a result. (Carment and James 1998b)

Table 1.1 UN-led peacekeeping operations: 1947–99

Operation	Location	Duration
UNSCOB UN Special Committee on the Balkans	Greece	1947–52
UNTSO UN Truce Supervision Organization	Middle East	1948 to date
UNMOGIP UN Military Observer Group in India and Pakistan	State of Jammu and Kashmir	1949 to date
UNEF I UN Emergency Force I	Sinai Peninsula	1956–67
UNOGIL UN Observation Group in Lebanon	Lebanon	1958
ONUC UN Operation in Congo	Zaire	1960–64
UNSF/UNTEA UN Security Force in West New Guinea (West Irian)/UN Temporary Executive Authority	West Irian	1962–63
UNYOM UN Yemen Observation Mission	Border between Yemen and Saudi Arabia	1963–64
UNFICYP UN Peacekeeping Force in Cyprus	Cyprus	1964 to date
DOMREP Mission of the Representative of the Secretary General in the Dominican Republic	Dominican Republic	1965–66
UNIPOM UN India-Pakistan Observation Mission	India and Pakistan	1965–66
UNEF II UN Emergency Force II	Sinai Peninsula	1973–79
UNDOF UN Disengagement Observer Force	Golan Heights	1974 to date
UNIFIL UN Interim Force in Lebanon	Southern Lebanon	1978 to date

SOURCE: United Nations Department of Peacekeeping Operations, Internet site, http://www.un.org/Depts/dpko/.

Table 1.1 (Continued)

Operation	Location	Duration
UNGOMAP UN Good Offices Mission in Afghanistan and Pakistan	Afghanistan and Pakistan	1988–90
UNIIMOG UN Iran-Iraq Military Observer Group	Border between Iran and Iraq	1988–91
UNAVEM I UN Angola Verification Mission I	Angola	1989–91
UNTAG UN Transition Assistance Group in Namibia	Namibia	1989–90
ONUCA UN Observer Group in Central America	Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua	1989–92
UNIKOM UN Iraq-Kuwait Observation Mission	Border between Iraq and Kuwait	1991 to date
UNAVEM II UN Angola Verification Mission II	Angola	1991–95
ONUSAL UN Observer Mission in El Salvador	El Salvador	1991–95
MINURSO UN Mission for the Referendum in Western Sahara	Western Sahara	1991 to date
UNAMIC UN Advance Mission in Cambodia	Cambodia	1991–92
UNPROFOR UN Protection Force	Former Yugoslavia	1992–95
UNTAC UN Transitional Authority in Cambodia	Cambodia	1992–93
UNOSOM UN Operation in Somalia	Somalia	1992–93
ONUMOZ UN Operation in Mozambique	Mozambique	1992–94
UNOSOM II UN Operation in Somalia II	Somalia	1993–95
UNOMUR UN Observer Mission Uganda-Rwanda	Border between Uganda and Rwanda	1993–94

Table 1.1 (Continued)

UNOMIG UN Observer Mission in Georgia	Georgia and Abkhazia	1993 to date
UNOMIL UN Observer Mission in Liberia	Liberia	1993–97
UNMIH UN Mission in Haiti	Haiti	1993–96
UNAMIR UN Assistance Mission for Rwanda	Rwanda	1993–96
UNASOG UN Aouzou Strip Observer Group	Aouzou Strip	1994
UNMOT UN Mission of Observers in Tajikistan	Tajikistan	1994 to date
UNAVEM III UN Angola Verification Mission III	Angola	1995–97
UNCRO UN Confidence Restoration Operation in Croatia	Croatia	1995–96
UNPREDEP UN Preventive Deployment Force	Macedonia	1995–99
UNMIBH UN Mission in Bosnia and Herzegovina	Bosnia and Herzegovina	1995 to date
UNTAES UN Transitional Administration for Eastern Slavonia, Baranja and Western Sirmium	Croatia	1996–98
UNMOP UN Mission of Observers in Prevlaka	Prevlaka Peninsula (Croatia)	1996 to date
UNSMIH UN Support Mission in Haiti	Haiti	1996–97
MINUGUA UN Verification Mission in Guatemala	Guatemala	1997
MONUA UN Observer Mission in Angola	Angola	1997–99
UNTMIH UN Transition Mission in Haiti	Haiti	1997
MIPONUH UN Civilian Police Mission in Haiti	Haiti	1997 to date

Table 1.1 (Continued)

UNPSG UN Police Support Group	Croatia	1998
MINURCA UN Mission in the Central African Republic	The Central African Republic	1998 to date
UNOMSIL UN Mission of Observers in Sierra Leone	Sierra Leone	1998 to date

1.5 Financing of UN Peacekeeping

1.5.1 UN Regular Budget

Six of the peacekeeping operations established during the period of 1947–65, namely, UNSCOB, UNTSO, UNMOGIP, UNOGIL, DOMREP and UNIPOM, as well as UNGOMAP established in 1988 are/were financed through the UN regular budget. UNTEA/UNSF and UNYOM were financed by the countries most directly involved, while UNFICYP had been financed solely by voluntary contributions until 1992. The assessment scale for the UN regular budget is based on ability to pay, or income, of each member state. The United Nations uses a ten-year average of Gross Domestic Product with adjustments which make the scale progressive with respect to per capita income (e.g. low-per-capita-income allowance).[6] A ceiling, or maximum assessment share (currently 25 percent) has been applied to the United States. A floor, or minimum assessment share (currently 0.01 percent) has been applied to about half of the member states since the late 1960s.

1.5.2 Special Assessments

In 1973, the General Assembly adopted a resolution which set up a special assessment account for financing of UNEF II, and except for UNGOMAP, this has been the

[6]See Officer (1996) for details.

financing method used for all the following UN-sanctioned and UN-led peacekeeping operations.[7] For this assessment purpose, the UN member states are divided into four groups: Group A, the five permanent members of the Security Council; Group B, other developed countries; Group C, wealthy developing countries; and Group D, other developing countries. Group A countries pay about 22 percent more than their UN regular budget contribution share (Durch 1993). Group B countries pay the same share as their contributions to the regular budget. Group C countries pay 20 percent of their regular budget contribution share, and Group D countries pay 10 percent of their regular budget contribution share. With this financing method, approximately 97 percent of peacekeeping costs are assigned to less than 30 countries which belong to Group A and Group B. For each operation financed through its own special assessment account, member states receive separate assessment letters from the General Assembly. Non-UN-led peace enforcement operations (e.g., UNITAF in Somalia, the NATO-led operations in the former Yugoslavia), as well as Operation Desert Shield/Storm during the Gulf War were financed by the participating member states, and not through special assessment accounts.

1.5.3 UN Peacekeeping Expenditures

Table 1.2 shows the UN peacekeeping expenditures during the period of 1947–97. The expenditures stayed under $10 millions until 1956. As the United Nations established UNEF I in 1956, and ONUC in 1960, the expenditures increased from $9 millions in 1956 to $127 millions in 1963. As ONUC ended in 1964, and UNEF I in 1967, the expenditures decreased, and stayed at approximately $24 millions during 1968–72. They started increasing again in the early 1970s as the United Nations established UNEF II in 1973, UNDOF in 1974, and UNIFIL in 1978. UNEF II ended in 1979. UNDOF and

[7]Before UNEF II, UNEF I and ONUC were also financed through special assessments, the apportionment rules of which were different from the one developed for UNEF II. See Mills (1990) for details.

Table 1.2 UN peacekeeping expenditures: 1947–97

(in millions of US dollars)

The Cold War period		The post-Cold War period	
Year	Expenditures	Year	Expenditures
1947	0	1988	266
1948	4	1989	635
1949	7	1990	464
1950	7	1991	490
1951	6	1992	1,767
1952	6	1993	3,059
1953	6	1994	3,342
1954	6	1995	3,364
1955	6	1996	1,840
1956	9	1997	1,300
1957	26		
1958	30		
1959	26		
1960	76		
1961	126		
1962	126		
1963	127		
1964	91		
1965	45		
1966	45		
1967	37		
1968	24		
1969	24		
1970	24		
1971	24		
1972	24		
1973	37		
1974	131		
1975	153		
1976	153		
1977	153		
1978	202		
1979	186		
1980	141		
1981	141		
1982	141		
1983	141		
1984	141		
1985	141		
1986	242		
1987	240		

SOURCE: Global Policy Forum, Internet site, http://www.globalpolicy.org.

UNIFIL still continue as of 1999.

With the end of the Cold War, ten new operations were established during the period of 1988–91. The peacekeeping expenditures increased from $266 millions in 1988 to $635 millions in 1989, decreased to $464 millions in 1990, and increased again to $490 millions in 1991. Four new operations, including the three most expensive operations in UN history (UNPROFOR, UNTAC and UNOSOM) were established in 1992, increasing the peacekeeping expenditures to $1,767 millions. The expenditures increased further to $3,364 millions in 1995, and then decreased to $1,840 millions in 1996, as UNPROFOR and UNOSOM II ended in 1995. As indicated during UNAMIR, the member states have become very reluctant to support new large-scale operations in the second half of the 1990s, keeping the UN peacekeeping expenditures well below the 1993–95 level as a result. This trend is expected to continue in the near future.

1.5.4 Troop Contributions

While soldiers participating in UN-led peacekeeping operations receive salaries from their own governments according to their national military rank, member states contributing these soldiers are compensated by the United Nations currently at a flat rate of approximately $1,000 per month for each soldier, regardless of rank. Actual per-person costs, however, vary widely across troop contributing countries, from as little as $280 up to $4,400 per month (Durch 1993). Therefore the current reimbursement scheme gives less developed countries a strong financial incentive to contribute their troops. The United Nations can reimburse troop contributors only after it receives sufficient financial contributions from its member states. Wealthier countries tend to be the last to get reimbursed, giving them even less incentive to contribute their expensive troops.[8]

[8]Bobrow and Boyer (1997) analyze troop contribution patterns of UN member states in recent years.

1.6 Concluding Remarks

Limited by the discord among the permanent members of the Security Council, only 14 peacekeeping operations were established by the United Nations during the Cold War period. Majority of such operations are/were traditional peacekeeping which require pre-established cease-fire.

With the end of the Cold War, the United Nations emerged as a major player for the world peace, establishing the next fourteen operations within five years (1988–92). Unlike the operations during the Cold War period, many of these early post-Cold War operations are categorized as multidimensional operations, humanitarian interventions, and/or peace enforcement operations. The renewed hope for the United Nations disappeared quickly, however, as some of these ambitious operations ended with failure or with only small success, revealing the limitation of UN peacekeeping.

Although the number and complexity of UN peacekeeping operations increased dramatically in the late 1980s and early 1990s, the financing methods used by the United Nations remained unchanged; the organization continues to rely on the contributions from its member states. Compared to the tax systems used by national, state, and local governments to finance public goods, the assessment system used by the United Nations is more prone to the problem of suboptimality of contributions. When UN peacekeeping creates globally public benefits, which is nonexcludable by definition, each member state's reliance on the contributions of others, and its failure to take into account the spillover benefits its contribution confers on others will result in the underprovision of total peacekeeping efforts. This collective action problem associated with UN peacekeeping is the topic of the following three chapters of this dissertation.

CHAPTER 2 SHARING THE FINANCIAL BURDEN FOR UN PEACEKEEPING

2.1 Olson's Exploitation Hypothesis

In his book, *the Logic of Collective Action* (1965), Olson argues that, in a small group composed of heterogeneous members, a member who places the highest value to a pure public good tends to bear a disproportionate share of the burden of providing the good.[1] Olson and Zeckhauser (1966) apply this so-called exploitation hypothesis to an analysis of international organizations, and argue that a member state which places high absolute value to a pure public good provided by the organization will pay a share of the costs that is larger than its share of the benefits.[2]

When the tastes of member states are assumed to be identical, it can be shown that an wealthy member state tends to contribute a larger share of its national income to an alliance-wide pure public good. Using a simple, one private good and one public good model, Andreoni (1988) demonstrates that, given identical preferences, a group member i will contribute $W_i - W^*$ out of its wealth W_i to the public good if $W_i > W^*$, and contribute zero if $W_i \leq W^*$. That is, W^* is a critical level of wealth such that group members with wealth greater than W^* will contribute, and members with wealth

[1] As Olson (1965) points out, this member will not bear *all* the burden of the pure public good when the income effect is taken into account. The public good is assume to be a normal good in order to assure the existence of a unique Nash equilibrium.

[2] Olson wrote, "The moral overtones of the word 'exploitation' are unfortunate; no general moral conclusions can follow from a purely logical analysis. Since the word 'exploitation' is, however, commonly used to describe situations where there is a disproportion between the benefits and sacrifices of different people, it would be pedantic to use a different word here." (1965)

equal to, and smaller than W^* will not. W^* is a function of the total public good contributed by all members, and it is same for all i.[3] Assuming a positive contribution, the share of i's wealth contributed to the public good is $1 - \frac{W^*}{W_i}$. By differentiating this expression with respect to i's wealth, we get $\frac{W^*}{W_i^2}$, which is positive. Therefore, as i's wealth increases, the share of its wealth contributed to the public good also increases.

Using Spearman rank correlation tests, Olson and Zeckhauser (1966) examined whether a disproportionate burden sharing by wealthy countries had existed among the NATO members in 1964. They tested the null hypothesis (H_0) of no positive correlation between GNP and defense budget as a share of GNP, and were able to reject (H_0) at the .05 level of significance. Following their study, the traditional burden-sharing measure used in the literature examines the rank correlation between defense burden (a share of national income devoted to defense) and national income. A significant and positive correlation indicates the existence of disproportionate burden sharing predicted by the exploitation hypothesis.[4]

As discussed in Chapter 1, UN peacekeeping is likely to create not only public benefits, but also contributor-specific benefits. In this case, a member state which receives relatively large contributor-specific benefits from each unit of its contributions will share the larger burden of UN peacekeeping, compared to the case in which only purely public benefits are present.[5] As a result, the exploitation hypothesis may no longer hold, and the disproportionate burden sharing by wealthy countries would become less apparent as the ratio of the contributor-specific benefits to the public benefits increases. Therefore, one way to examine the publicness of the total benefits created by UN peacekeeping is to study the correlation between GDP and share of GDP devoted to UN peacekeeping

[3]Both the public and private goods are assumed to be normal in order to assure the existence of a unique Nash equilibrium.

[4]Non-parametric studies of military alliance burden sharing include Russett (1970), Starr (1974), Sandler and Forbes (1980), and Khanna and Sandler (1996, 1997).

[5]The joint product model and its implications on optimal alliance size, financing, stability, and burden sharing are discussed by Sandler (1977).

(PK/GDP). In this chapter, Kendall rank correlation tests are used for this purpose. Four different subsets of UN member states are selected based on the NATO membership, UN peacekeeping assessment scale, and political system. Based on the Kendall correlation coefficients and PK/GDP ranks, the burden-sharing patterns of the four samples are analyzed.[6] According to the test results, a disproportionate burden sharing by wealthy countries existed in the 1990s for a sample which includes only the NATO member states. Although the focus of this chapter is UN peacekeeping, non-UN-financed peace operations are also discussed.

2.2 Samples and Data

In order to measure the UN peacekeeping burden, annual data on GDP and the contributions made toward all the special assessment accounts plus the UNFICYP voluntary contribution account for the period of 1975–96 were collected for four samples of UN member states. The first sample contains only the NATO member states. Spain is included from 1982, the year it joined NATO. The second sample contains 15 major contributors, and the third sample contains 20 major contributors. The countries in these two samples were selected based on their peacekeeping assessment shares for 1996. The fourth sample is a subset of the third sample, and it includes 15 democratic countries. The sample countries' special assessment account payment data were taken from the UN (1976–97) *Status of Contributions* . The UNFICYP voluntary contribution account payment data were taken from the biennial UN (various years) *Financial Report.* The 1975–95 GDP figures at market prices in current US dollars were taken from the World Bank (1997) *World Development Indicators 1997.* The 1996 GDP figures were taken from the International Monetary Fund (IMF) (1998a) *International Finan-*

[6] Although we use the term, *samples* to describe the sets of countries selected for the rank correlation tests, these *samples* are by no means *random* samples of the UN member states. Also, it should be noted that, by including *all* the NATO countries, the NATO *sample* could be considered as the *population* rather than a sample. See McCloskey and Ziliak (1996) for details.

Table 2.1 Sample compositions

NATO sample	Sample 2	Sample 3	Sample 4
Belgium	Australia	Australia	Australia
Canada	Belgium	Austria	Belgium
Denmark	Canada	Belgium	Canada
France	China	Brazil	Denmark
West Germany (1975-89)	France	Canada	Finland
Unified Germany (1990-96)	West Germany (1975-89)	China	France
Greece	Unified Germany (1990-96)	Denmark	West Germany (1975-89)
Iceland	Italy	Finland	Unified Germany (1990-96)
Italy	Japan	France	Italy
Luxembourg	Netherlands	West Germany (1975-89)	Japan
Netherlands	Spain	Unified Germany (1990-96)	Netherlands
Norway	Sweden	Italy	Norway
Portugal	Ukraine	Japan	Spain
Spain (1982-96)	United Kingdom	Netherlands	Sweden
Turkey	United States	Norway	United Kingdom
United Kingdom	USSR (1975-91) [1]	Spain	United States
United States	Russia (1992-96)	Sweden	
		Sweden	
		Ukraine	
		United Kingdom	
		United States	
		USSR (1975-91) [1]	
		Russia (1992-96)	

1. Belarus and Ukraine are excluded from "USSR" in Sample 2 and Sample 3 since they contributed to the United Nations separately.

cial Statistics.[7] In order to examine the correlation between GDP and PK/GDP while isolating the influence of population differences across the sample countries, the data on population were needed. The 1975–95 population figures were taken from the World Bank (1997).[8] The 1996 figures were estimated by using the annual growth rate for each sample country during the period of 1992–95.

2.3 Statistical Tests for Disproportionate Peacekeeping Burden Sharing

Kendall rank correlation tests were used to test the following hypotheses:

H_0: There will be no significant correlation between a country's GDP and its share of GDP devoted to UN peacekeeping (PK/GDP).

H_1: There will be a significant correlation between the variables specified in H_0.

A significant *positive* correlation between GDP and PK/GDP, if found, suggests that a large share of purely public benefits characterizes UN peacekeeping. Kendall rank correlation coefficient (τ_{12}) and Kendall partial rank correlation coefficient ($\tau_{12,3}$) which holds sample countries' populations constant were examined for the four samples. This partial correlation coefficient adjusts for the population influence, if any, and then tests the degree of association between GDP and PK/GDP ranks. Because the samples include countries with vastly different populations, this variable may affect the association between GDP and PK/GDP, which we are interested in isolating.

[7]There were some missing GDP figures that had to be estimated or taken from a comparable data source. The 1975–89 figures for West Germany were taken from the World Bank (1995) *World Data 1995* . The 1990 figure for unified Germany was taken from the UN (1996a) *Statistical Yearbook 1994* . The 1975–86 figures for the USSR and Ukraine were estimated (backcasted) by using the annual growth rate of each country/republic during the period of 1987–90. The 1996 figure for Ukraine was estimated (forecasted) by using the annual growth rate during the period of 1992–95.

[8]The 1975–89 figures for West Germany were taken from the IMF (1997a) *International Financial Statistics Yearbook.*

The results for the NATO sample, Sample 2, Sample 3, and Sample 4 are shown in Table 2.2, 2.3, 2.4, and 2.5, respectively. For the NATO sample, neither of the Kendall tau and Kendall partial tau shows consistent rank correlation between GDP and PK/GDP during the 1975–90 period. None of the coefficients are significant at the .10 level during this period.[9] A consistent positive rank correlation between the two variables appears in the early 1990s, starting in 1992, however. In 1992 and 1994, the Kendall tau were positive and significant at the .10 level. In 1994 and 1995, the Kendall partial tau were positive and significant at the either .10 or .05 level. For Sample 2 and Sample 3, the Kendall tau shows no consistent rank correlation between GDP and PK/GDP throughout the period of 1975–96. The Kendall partial tau, however, shows a positive rank correlation between the two variables in the early 1980s and early 1990s. For Sample 2, the null hypothesis was rejected in favor of the alternative hypothesis in 1981 and 1991 at the .05 level of significance. For Sample 3, the null hypothesis was rejected in 1981, 1983 and 1991 at the .10 level of significance. For Sample 4, neither of the Kendall tau and Kendall partial tau shows consistent rank correlation between GDP and PK/GDP throughout the period of 1975–96. None of the coefficients are significant at the .10 level.

2.4 GDP Ranks and PK/GDP Ranks

Table 2.6, 2.7, and 2.8 show the GDP ranks, PK/GDP ranks, and squares of the differences between the two ranks for the NATO sample, Sample 2, and Sample 4, respectively, during the period of 1980–96.[10]

For example, in 1980, West Germany's GDP was the second highest, and its share

[9]Kendall rank correlation coefficient is asymptotically normally distributed under the null hypothesis of independence, and for a sample size greater than ten, the normal distribution provides a satisfactory approximation (Kendall 1970). The same could be said for Kendall partial rank correlation coefficient (Hoflund 1963).

[10]Sample 3 is not discussed here because the statistical test results for the sample are very similar to the results for Sample 2.

Table 2.2 Kendall rank correlation between GDP and PK/GDP: NATO, 1975–96

Year	τ_{12}	$\tau_{12,3}$	Year	τ_{12}	$\tau_{12,3}$
1975	0.08571	0.13287	1986	0.15000	0.28422
	(0.45)	(0.69)		(0.81)	(1.54)
1976	0.14286	0.04683	1987	0.10000	0.21948
	(0.74)	(0.24)		(0.54)	(1.19)
1977	0.14286	0.09942	1988	0.01667	0.11480
	(0.74)	(0.52)		(0.09)	(0.62)
1978	0.04762	0.12056	1989	0.10000	0.26682
	(0.25)	(0.63)		(0.54)	(1.44)
1979	0.23810	0.25493	1990	0.06667	0.08626
	(1.24)	(1.32)		(0.36)	(0.47)
1980	0.06667	0.14578	1991	0.18333	0.23951
	(0.35)	(0.76)		(0.99)	(1.29)
1981	0.04762	0.15600	1992	0.33333*	0.30188
	(0.25)	(0.81)		(1.80)	(1.63)
1982	0.03333	0.18394	1993	0.13333	0.23220
	(0.18)	(0.99)		(0.72)	(1.25)
1983	0.06667	0.23468	1994	0.31667*	0.34227*
	(0.36)	(1.27)		(1.71)	(1.85)
1984	-0.03333	0.14302	1995	0.28333	0.36327**
	(-0.18)	(0.77)		(1.53)	(1.96)
1985	-0.11667	0.05413	1996	0.21667	0.26509
	(-0.63)	(0.28)		(1.17)	(1.43)

Numbers in parentheses are z-values.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.

Table 2.3 Kendall rank correlation between GDP and PK/GDP: Sample 2, 1975–96

Year	τ_{12}	$\tau_{12,3}$	Year	τ_{12}	$\tau_{12,3}$
1975	0.00952	0.01905	1986	-0.10476	0.02412
	(0.05)	(0.10)		(-0.54)	(0.13)
1976	0.10476	0.03839	1987	-0.29524	-0.24016
	(0.54)	(0.20)		(-1.53)	(-1.25)
1977	-0.19139	-0.12736	1988	-0.27619	-0.23883
	(-0.99)	(-0.66)		(-1.44)	(-1.24)
1978	0.06667	0.20693	1989	-0.27619	-0.21653
	(0.35)	(1.08)		(-1.44)	(-1.13)
1979	-0.05742	-0.04416	1990	0.06667	-0.01309
	(-0.30)	(-0.23)		(0.35)	(-0.07)
1980	0.00952	0.19223	1991	0.29524	0.38276**
	(0.05)	(1.00)		(1.53)	(1.99)
1981	0.22967	0.37689**	1992	0.22967	0.28864
	(1.19)	(1.96)		(1.19)	(1.50)
1982	0.27619	0.29842	1993	0.10476	0.23819
	(1.44)	(1.55)		(0.54)	(1.24)
1983	0.04762	0.28868	1994	-0.08571	0.01962
	(0.25)	(1.50)		(-0.45)	(0.10)
1984	0.02857	0.27680	1995	-0.04762	0.02351
	(0.15)	(1.44)		(-0.25)	(0.12)
1985	-0.10476	0.07927	1996	-0.1619	-0.08447
	(-0.54)	(0.41)		(-0.84)	(-0.44)

Numbers in parentheses are z-values.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.

Table 2.4 Kendall rank correlation between GDP and PK/GDP: Sample 3, 1975–96

Year	τ_{12}	$\tau_{12,3}$	Year	τ_{12}	$\tau_{12,3}$
1975	-0.0686	-0.00144	1986	-0.07368	0.08602
	(-0.42)	(-0.01)		(-0.45)	(0.53)
1976	-0.03158	0.03097	1987	-0.21053	-0.11085
	(-0.19)	(0.19)		(-1.30)	(-0.68)
1977	-0.14248	-0.03864	1988	-0.14737	-0.10465
	(-0.88)	(-0.24)		(-0.91)	(-0.65)
1978	-0.07368	0.19049	1989	-0.13684	-0.07238
	(-0.45)	(1.17)		(-0.84)	(-0.45)
1979	-0.13193	-0.04279	1990	0.10526	0.04942
	(-0.81)	(-0.26)		(0.65)	(0.30)
1980	-0.06316	0.20291	1991	0.11579	0.28285*
	(-0.39)	(1.25)		(0.71)	(1.74)
1981	0.03694	0.28254*	1992	0.10026	0.21707
	(0.23)	(1.74)		(0.62)	(1.34)
1982	-0.01053	0.16154	1993	-0.01053	0.18388
	(-0.06)	(1.00)		(-0.06)	(1.13)
1983	-0.01053	0.27204*	1994	-0.09474	0.05044
	(-0.06)	(1.68)		(-0.58)	(0.31)
1984	-0.05263	0.22834	1995	-0.02105	0.08512
	(-0.32)	(1.41)		(-0.13)	(0.52)
1985	-0.14737	0.09448	1996	-0.01053	0.07019
	(-0.91)	(0.58)		(-0.06)	(0.43)

Numbers in parentheses are z-values.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.

Table 2.5 Kendall rank correlation between GDP and PK/GDP: Sample 4, 1975–96

Year	τ_{12}	$\tau_{12,3}$	Year	τ_{12}	$\tau_{12,3}$
1975	-0.02857	0.11542	1986	-0.18095	0.05241
	(-0.15)	(0.60)		(-0.94)	(0.27)
1976	0.04762	0.05113	1987	-0.29524	-0.11653
	(0.25)	(0.27)		(-1.53)	(-0.61)
1977	-0.20000	-0.12355	1988	-0.20000	-0.08661
	(-1.04)	(-0.64)		(-1.04)	(-0.45)
1978	-0.16190	0.00433	1989	-0.14286	-0.03553
	(-0.84)	(0.02)		(-0.74)	(-0.18)
1979	-0.08571	0.07715	1990	0.20000	0.00437
	(-0.45)	(0.40)		(1.04)	(0.02)
1980	-0.23810	-0.09913	1991	0.08571	0.01712
	(-1.24)	(-0.52)		(0.45)	(0.09)
1981	-0.04762	0.08702	1992	0.06667	-0.18991
	(-0.25)	(0.45)		(0.35)	(-0.99)
1982	-0.02857	0.02548	1993	-0.14286	-0.15390
	(-0.15)	(0.13)		(-0.74)	(-0.80)
1983	-0.06667	0.16616	1994	-0.29524	-0.15592
	(-0.35)	(0.86)		(-1.53)	(-0.81)
1984	-0.14286	0.02016	1995	-0.10476	-0.02096
	(-0.74)	(0.10)		(-0.54)	(-0.11)
1985	-0.18095	-0.08254	1996	-0.12381	-0.20872
	(-0.94)	(-0.43)		(-0.64)	(-1.08)

Numbers in parentheses are z-values.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.

Table 2.6 GDP rank, PK/GDP rank, and squared rank difference: NATO, 1980-96

Country	1980			1981			1982			1983			1984			1985		
United States	1	4	9	1	8	49	1	7	36	1	12	121	1	11	100	1	12	121
Germany [1]	2	11	81	2	5	9	2	4	4	2	8	36	2	8	36	2	4	4
France	3	13	100	3	7	16	3	12	81	3	2	1	3	6	9	3	13	100
United Kingdom	4	6	4	4	1	9	4	3	1	4	3	1	4	3	1	4	5	1
Italy	5	9	16	5	14	81	5	11	36	5	9	16	5	13	64	5	10	25
Canada	6	1	25	6	10	16	6	8	4	6	13	49	6	12	36	6	11	25
Spain [2]							7	14	49	7	14	49	7	14	49	7	14	49
Netherlands	7	12	25	7	9	4	8	10	4	8	11	9	8	4	16	8	7	1
Belgium	8	3	25	8	12	16	9	13	16	9	1	64	9	1	64	9	1	64
Turkey	9	15	36	9	15	36	10	15	25	10	15	25	11	16	25	10	16	36
Denmark	10	7	9	11	2	81	12	1	121	12	7	25	12	7	25	12	6	36
Norway	11	2	81	10	6	16	11	5	36	11	6	25	10	10	0	11	9	4
Greece	12	5	49	12	3	81	13	6	49	13	4	81	13	5	64	13	3	100
Portugal	13	14	1	13	13	0	14	16	4	14	16	4	14	15	1	14	15	1
Luxembourg	14	8	36	14	4	100	15	2	169	15	5	100	15	2	169	15	2	169
Iceland	15	10	25	15	11	16	16	9	49	16	10	36	16	9	49	16	8	64
Total			522			530			684			642			708			800

1. West Germany (1980-89) and unified Germany (1990-96).
2. Spain joined NATO in 1982.

Table 2.6 (Continued)

Country	1986			1987			1988			1989			1990			1991		
United States	1	13	144	1	13	144	1	13	144	1	11	100	1	9	64	1	6	25
Germany	2	6	16	2	4	4	2	8	36	2	6	16	2	8	36	2	7	25
France	3	1	4	3	6	9	3	5	4	3	3	0	3	2	1	3	2	1
United Kingdom	5	4	1	5	2	9	5	2	9	5	5	0	5	3	4	5	1	16
Italy	4	12	64	4	12	64	4	10	36	4	12	64	4	13	81	4	13	81
Canada	6	11	25	6	9	9	6	11	25	6	10	16	6	7	1	6	9	9
Spain	7	14	49	7	14	49	7	15	64	7	14	49	7	14	49	7	14	49
Netherlands	8	5	9	8	8	0	8	6	4	8	4	16	8	10	4	8	4	16
Belgium	9	2	49	9	3	36	9	3	36	9	1	64	9	5	16	9	11	4
Turkey	12	15	9	12	16	16	12	16	16	10	15	25	10	16	36	10	16	36
Denmark	10	8	4	10	7	9	10	9	1	11	7	16	11	11	0	11	8	9
Norway	11	3	64	11	1	100	11	4	49	12	8	16	12	4	64	12	3	81
Greece	13	7	36	13	5	64	13	1	144	13	13	0	14	1	169	14	12	4
Portugal	14	16	4	14	15	1	14	14	0	14	16	4	13	15	4	13	15	4
Luxembourg	15	9	36	15	10	25	15	7	64	15	2	169	15	6	81	15	5	100
Iceland	16	10	36	16	11	25	16	12	16	16	9	49	16	12	16	16	10	36
Total			550			564			648			604			626			496

Table 2.6 (Continued)

Country	1992			1993			1994			1995			1996		
United States	1	1	0	1	11	100	1	6	25	1	13	144	1	13	144
Germany	2	9	49	2	8	36	2	10	64	2	10	64	2	7	25
France	3	3	0	3	3	0	3	13	100	3	1	4	3	4	1
United Kingdom	5	2	9	5	1	16	4	1	9	4	2	4	4	9	25
Italy	4	12	64	4	5	1	5	7	4	5	4	1	5	3	4
Canada	7	4	9	6	4	4	6	2	16	6	3	9	6	5	1
Spain	6	14	64	7	13	36	7	3	16	7	8	1	7	2	25
Netherlands	8	7	1	8	9	1	8	9	1	8	7	1	8	8	0
Belgium	9	5	16	9	12	9	9	4	25	9	12	9	9	1	64
Turkey	10	16	36	10	16	36	10	8	4	10	6	16	10	11	1
Denmark	11	10	1	11	7	16	11	16	25	11	16	25	11	14	9
Norway	12	8	16	12	10	4	12	5	49	12	9	9	12	12	0
Greece	14	13	1	14	14	0	13	15	4	13	15	4	13	16	9
Portugal	13	15	4	13	15	4	14	14	0	14	14	0	14	15	1
Luxembourg	15	6	81	15	6	81	15	11	16	15	5	100	15	10	25
Iceland	16	11	25	16	2	196	16	12	16	16	11	25	16	6	100
Total			376			540			374			416			434

Table 2.7 GDP rank, PK/GDP rank, and squared rank difference: Sample 2, 1980–96

Country	1980			1981			1982			1983			1984			1985		
United States	1	4	9	1	5	16	1	4	9	1	10	81	1	7	36	1	10	81
Japan	2	11	81	2	10	64	2	10	64	2	9	49	2	10	64	2	11	81
Germany [1]	3	8	25	3	2	1	3	2	1	3	5	4	3	6	9	3	2	1
France	4	10	36	4	4	0	4	9	25	4	2	4	4	5	1	4	12	64
United Kingdom	5	5	0	5	1	16	5	1	16	5	3	4	6	2	16	6	3	9
Italy	6	7	1	6	11	25	6	7	1	7	6	1	7	11	16	7	6	1
USSR (Russia) [2]	7	12	25	7	12	25	7	13	36	6	14	64	5	12	49	5	8	9
Canada	8	1	49	8	7	1	8	5	9	8	11	9	8	8	0	8	9	1
Spain	9	14	25	10	15	25	10	15	25	11	12	1	11	14	9	11	14	9
China	10	15	25	9	15	36	9	8	1	9	13	16	9	13	16	9	15	36
Netherlands	11	9	4	12	6	36	12	6	36	12	8	16	12	3	81	12	5	49
Australia	12	3	81	11	8	9	11	11	0	10	7	9	10	9	1	10	7	9
Sweden	13	6	49	13	3	100	13	3	100	13	4	81	13	4	81	13	4	81
Belgium	14	2	144	14	9	25	14	12	4	14	1	169	14	1	169	15	1	196
Ukraine	15	13	4	15	13	4	15	14	1	15	15	0	15	15	0	14	13	1
Total			558			383			328			508			548			628

1. West Germany (1980–89) and unified Germany (1990–96).
2. USSR (1980–90) and Russia (1991–96). Belarus and Ukraine are excluded from "USSR" since they contributed to the United Nations separately.

Table 2.7 (Continued)

Country	1986			1987			1988			1989			1990			1991		
United States	1	12	121	1	12	121	1	12	121	1	11	100	1	10	81	1	4	9
Japan	2	13	121	2	13	121	2	14	144	2	14	144	2	3	1	2	9	49
Germany	3	7	16	3	6	9	3	7	16	3	7	16	3	8	25	3	5	4
France	4	2	4	4	7	9	4	5	1	4	4	0	4	4	0	4	2	4
United Kingdom	6	4	4	6	3	9	6	3	9	6	6	0	6	5	1	6	1	25
Italy	5	11	36	5	11	36	5	10	25	5	12	49	5	13	64	5	11	36
USSR (Russia)	7	1	36	7	1	36	7	1	36	7	1	36	7	1	36	7	14	49
Canada	8	10	4	8	10	4	8	11	9	8	9	1	8	7	1	8	6	4
Spain	10	15	25	9	15	36	9	15	36	9	15	36	9	15	36	9	12	9
China	9	14	25	10	14	16	10	13	9	10	13	9	10	14	16	10	13	9
Netherlands	11	5	36	11	9	4	12	6	36	12	5	49	12	11	1	12	3	81
Australia	12	8	16	12	8	16	11	9	4	11	10	1	11	9	4	11	7	16
Sweden	13	6	49	13	5	64	13	8	25	13	8	25	13	12	1	13	8	25
Belgium	14	3	121	14	4	100	14	4	100	14	3	121	14	6	64	14	10	16
Ukraine	15	9	36	15	2	169	15	2	169	15	2	169	15	2	169	15	15	0
Total			650			750			740			756			500			336

Table 2.7 (Continued)

Country	1992			1993			1994			1995			1996		
United States	1	1	0	1	9	64	1	7	36	1	13	144	1	12	121
Japan	2	10	64	2	12	100	2	13	121	2	11	81	2	14	144
Germany	3	8	25	3	7	16	3	11	64	3	10	49	3	8	25
France	4	3	1	4	2	4	4	12	64	4	2	4	4	5	1
United Kingdom	6	2	16	6	1	25	5	2	9	5	3	4	6	4	4
Italy	5	11	36	5	6	1	6	9	9	6	7	1	5	10	25
USSR (Russia)	9	15	36	10	10	0	10	1	81	12	1	121	10	1	81
Canada	8	4	16	7	4	9	7	3	16	8	4	16	8	6	4
Spain	7	13	36	8	13	25	9	5	16	9	9	0	9	3	36
China	10	12	4	9	14	25	8	14	36	7	14	49	7	13	36
Netherlands	11	7	16	11	8	9	11	10	1	10	8	4	12	9	9
Australia	12	6	36	12	5	49	12	8	16	11	6	25	11	11	0
Sweden	13	9	16	14	3	121	14	4	100	14	5	81	14	7	49
Belgium	14	5	81	13	11	4	13	6	49	13	12	1	13	2	121
Ukraine	15	15	0	15	15	0	15	15	0	15	15	0	15	15	0
Total			383			452			618			580			656

Table 2.8 GDP rank, PK/GDP rank, and squared rank difference: Sample 4, 1980–96

Country	1980			1981			1982			1983			1984			1985		
United States	1	5	16	1	7	36	1	6	25	1	13	144	1	10	81	1	12	121
Japan	2	14	144	2	13	121	2	12	100	2	11	81	2	13	121	2	13	121
Germany [1]	3	11	64	3	3	0	3	3	0	3	7	16	3	7	16	3	2	1
France	4	13	81	4	6	4	4	10	36	4	2	4	4	5	1	4	14	100
United Kingdom	5	6	1	5	1	16	5	2	9	5	3	4	5	2	9	5	3	4
Italy	6	9	9	6	14	64	6	9	9	6	8	4	6	14	64	6	8	4
Canada	7	1	36	7	9	4	7	7	0	7	14	49	7	11	16	7	11	16
Spain	8	15	49	8	15	49	8	15	49	9	15	36	9	15	36	9	15	36
Netherlands	9	12	9	10	8	4	10	8	4	10	10	0	10	3	49	10	6	16
Australia	10	4	36	9	10	1	9	13	16	8	9	1	8	12	16	8	9	1
Sweden	11	8	9	11	5	36	11	5	36	11	4	49	11	4	49	11	4	49
Belgium	12	3	81	12	12	0	12	14	4	12	1	121	12	1	121	12	1	121
Denmark	13	7	36	14	2	144	14	1	169	14	6	64	14	6	64	14	5	81
Norway	14	2	144	13	4	81	13	4	81	13	5	64	13	8	25	13	7	36
Finland	15	10	25	15	11	16	15	11	16	15	12	9	15	9	36	15	10	25
Total			740			576			554			646			704			732

1. West Germany (1980–89) and unified Germany (1990–96).

Table 2.8 (Continued)

Country	1986			1987			1988			1989			1990			1991		
United States	1	13	144	1	13	144	1	13	144	1	11	100	1	9	64	1	5	16
Japan	2	14	144	2	14	144	2	14	144	2	14	144	2	1	1	2	11	81
Germany	3	7	16	3	5	4	3	6	9	3	5	4	3	7	16	3	6	9
France	4	1	9	4	6	4	4	4	0	4	2	4	4	2	4	4	2	4
United Kingdom	6	4	4	6	2	16	6	1	25	6	4	4	6	3	9	6	1	25
Italy	5	12	49	5	12	49	5	10	25	5	13	64	5	14	81	5	14	81
Canada	7	10	9	7	10	9	7	11	16	7	9	4	7	6	1	7	8	1
Spain	8	15	49	8	15	49	8	15	49	8	15	49	8	15	49	8	15	49
Netherlands	9	5	16	9	9	0	10	5	25	10	3	49	10	10	0	10	4	36
Australia	10	8	4	10	8	4	9	9	0	9	10	1	9	8	1	9	9	0
Sweden	11	6	25	11	4	49	11	7	16	11	7	16	11	12	1	11	10	1
Belgium	12	2	100	12	3	81	12	2	100	12	1	121	12	5	49	12	13	1
Denmark	13	9	16	13	7	36	13	8	25	14	6	64	14	11	9	13	7	36
Norway	14	3	121	14	1	169	15	3	144	15	8	49	15	4	121	15	3	144
Finland	15	11	16	15	11	16	14	12	4	13	12	1	13	13	0	14	12	4
Total			722			774			726			674			406			488

Table 2.8 (Continued)

Country	1992			1993			1994			1995			1996		
United States	1	1	0	1	12	121	1	8	49	1	15	196	1	14	169
Japan	2	13	121	2	14	144	2	15	169	2	13	121	2	15	169
Germany	3	10	49	3	9	36	3	13	100	3	12	81	3	8	25
France	4	3	1	4	3	1	4	14	100	4	1	9	4	4	0
United Kingdom	6	2	16	6	1	25	5	1	16	5	2	9	6	3	9
Italy	5	14	81	5	7	4	6	10	16	6	7	1	5	10	25
Canada	8	4	16	7	5	4	7	3	16	7	3	16	7	5	4
Spain	7	15	64	8	15	49	8	5	9	8	10	4	8	2	36
Netherlands	9	8	1	9	10	1	9	12	9	9	9	0	10	9	1
Australia	10	7	9	10	6	16	10	9	1	10	6	16	9	12	9
Sweden	11	12	1	12	4	64	12	4	64	12	4	64	12	7	25
Belgium	12	5	49	11	13	4	11	6	25	11	14	9	11	1	100
Denmark	13	11	4	13	8	25	13	11	4	13	8	25	13	11	4
Norway	14	9	25	14	11	9	14	7	49	14	11	9	14	13	1
Finland	15	6	81	15	2	169	15	2	169	15	5	100	15	6	81
Total			518			672			796			660			658

of GDP devoted to UN peacekeeping was ranked eleventh among the NATO members. Therefore the squared rank difference was $(2-11)^2 = 81$. The closer the GDP rank and PK/GDP rank of a country is, the smaller will be the squared rank difference. When there is a perfect positive correlation between the rank orderings of the two variables, the squared rank differences will be zero for all the sample countries. [11]

Among the NATO members, France and the United Kingdom contributed relatively large shares of their GDP to UN peacekeeping during the first half of the 1990s, France in 1994 being an exception. Canada and Italy have also climbed up the PK/GDP ranking since 1992 and 1993 respectively. United States and Germany, on the other hand, contributed relatively small shares of their GDP during the same time period, except for the United States in 1992. Among the smaller NATO members, Greece has fallen to the near bottom of the PK/GDP ranking in the 1990s.

In Sample 2, Japan has been contributing relatively small share of its GDP to UN peacekeeping throughout the 1980s and 1990s, except for 1990. Belgium, one of the smallest countries in Sample 2, contributed relatively large share of its GDP for the most years in the 1980s. Also, the USSR and Ukraine were ranked first and second, respectively in terms of PK/GDP during the late 1980s until the collapse of the Soviet Union in 1991. Since 1994, Russia has been again ranked first. Not significant, yet strong *negative* correlation between GDP and PK/GDP observed in the late 1980s for Sample 2 could be attributed to the low PK/GDP ranking of the two wealthiest countries, the United States and Japan, and the high ranking of the two poorest countries in the sample, Belgium and Ukraine.

The correlation between GDP and PK/GDP for Sample 4 during the 1990s is weak, especially compared to the results for the NATO sample. From Table 2.6 and 2.8, it is clear that the exclusion of small NATO members ranked low in terms of PK/GDP, such

[11] Spearman rank correlation coefficient (r_s) could be calculated by the formula, $1 - \frac{6\sum d^2}{n(n^2-1)}$, where $\sum d^2$ is the sum of squared rank differences, and n is the sample size.

as Greece and Portugal, and the inclusion of Japan and Finland are the main causes of this result. Finland, a country with the smallest GDP in the sample, has climbed up the PK/GDP ranking in the 1990s. Adding Sweden to the sample also contributed to the low correlation between the two variables in 1994 and 1995.

2.5 Analysis of the Test Results

The most interesting result of the rank correlation tests is the evidence of increased disproportionate burden sharing among the NATO members in the first half of the 1990s. It should be noted that during this period, the total UN peacekeeping expenditures increased sharply from approximately $490 million in 1991 to $3,364 million in 1995, due mainly to three large-scale operations, UNTAC (1992–93), UNPROFOR (1992–95), and UNOSOM II (1993–95), of which UNPROFOR in the former Yugoslavia being by far the most expensive. As the total UN peacekeeping expenditures decreased to $1,840 million in 1996, both of the Kendall tau and Kendall partial tau decreased somewhat, from 0.28333 to 0.21667, and from 0.36327 to 0.26509, respectively. For the NATO sample, there appears to be a direct relationship between the size of UN peacekeeping expenditures and disproportionate burden sharing.

For the other samples, it is rather difficult to identify any clear trend in burden sharing. As discussed at the beginning of this chapter, the exploitation hypothesis predicts that an wealthy country contributes a larger share of its GDP to the provision of public good *when the tastes of member states are assumed to be identical* . If the group is composed of countries with heterogeneous tastes, it is not necessarily an wealthy country who places relatively high value to the public good, and therefore we can not always expect to see strong positive correlation between GDP and PK/GDP. Being composed of not only the NATO countries, but also Asian countries, communist countries and non-NATO European countries, Sample 2, 3, and 4 are less homogeneous in terms of

geographic location and political system, compared to the NATO sample. This fact should be taken into account when the test results for these samples are studied. Unlike the deterrence effects created by a military alliance, a country's valuation of public benefits of regional peace created by a UN peacekeeping operation could be highly dependent on the distance between the country and the conflict area. In some cases, an operation could be even considered as a local public good, rather than a global public good if valuation of the benefits by countries in distant regions is extremely small. When sample countries are not homogenous in terms of geographic location and/or political system, disproportionate burden sharing by wealthy countries might not be observed even if the ratio of public benefits to the total benefits of UN peacekeeping is large.

Although the NATO sample shows increased disproportionate burden sharing by wealthy member states in the 1990s, the United States still bears relatively small burden, especially compared to France and the United Kingdom, two other permanent members of the Security Council. An explanation for this finding is a possible, relatively wide gap between positions taken by the United Nations and by the United States on various issues. When a gap between them widens, the US valuation of the public benefits created by the United Nations is likely to become smaller, and as a result, the United States is likely to bear smaller burden than predicted by the exploitation hypothesis. In this case, the low PK/GDP ranking of the United States does not necessarily imply a small ratio of public benefits to the total benefits of UN peacekeeping. The United Nations, which was composed of 51 countries when established in 1945, increased its membership to 185 countries by the end of 1998, mostly by adding more and more developing countries in Africa and Asia. With each member state having one vote in the General Assembly, the more universal the United Nations becomes, the less likely it is that the interests of developed member states are represented by the organization. As the gap between positions taken by the United Nations and by major financial contributors widens, there is a greater possibility of United Nations finding itself in serious financial difficulty. For

smaller, and more homogeneous organizations such as NATO, this problem is expected to be less significant.

One way to correct the problem is to adopt a voting rule which gives each member state a voting power proportional to its share of financial contributions, as done by the financial organizations of the UN system (Frey and Gygi 1990). For example, in the IMF, the voting shares of the United States, Germany, Japan, France, and the United Kingdom as of April 1998 are 17.78, 5.53, 5.53, 4.98, and 4.98 percent, respectively (IMF 1998b). The adoption of such a voting rule by the General Assembly and Security Council is likely to narrow the interest gap between the United Nations and its major financial contributors, although strong opposition by Russia, China, and other developing countries are expected.[12] Also, the correction of the problem would not solve the suboptimality problem associated with the publicness of the UN peacekeeping benefits.

2.6 The Gulf War and Other Non-UN-financed Peace Operations

In response to the Iraqi invasion of Kuwait in August 1990, UN-authorized and US-led massive multinational military forces were assembled in Saudi Arabia (Operation Desert Shield), and launched attacks against Iraqi forces in January 1991 (Operation Desert Storm), which ended with the liberation of Kuwait in February 1991. Although the total costs of US forces deployment reached approximately $61 billion, $53 billion, or 87 percent of the costs was financed by Kuwait, Saudi Arabia, Japan, Germany and other US allies as shown in Table 2.9 (US Department of Defense 1992, Appendix P).

[12] An amendment to the Foreign Relations Authorization bill introduced in 1985 by the junior senator from Kansas, Nancy Kassebaum (the Kassebaum amendment) called for withholding of 20 percent of US assessed contributions to the United Nations until the General Assembly adopts weighted voting on budgetary matters. The United Nations responded with General Assembly Resolution 41/213, which introduced consensus-approval to the budget-setting process of the General Assembly. See Gregg (1993) for details.

France and the United Kingdom contributed troops and equipment.

Table 2.9 Foreign contributions to US Desert Shield/Storm costs

	(in millions of US dollars)	
	1990	1991
Kuwait	$2,506	$13,552
Saudi Arabia	2,503	13,500
Japan	1,676	8,332
Germany	955	5,500
UAE	1,000	3,088
Korea	80	171
Others	3	26
Total	$8,724	$44,169

SOURCE: US Department of Defense (1992) Appendix P.

Since the Gulf War, from time to time, the United Nations relied on smaller-scale peace operations led by the United States, France, or NATO: US-led UNITAF in Somalia, NATO-led peace operations in the former Yugoslavia, French-led Operation Turquoise in Rwanda, US-led MNF in Haiti. Table 2.10 shows the US expenditures on these non-UN-led operations and the support for UN-led operations during the fiscal years 1992–95. From the table, it is clear that the payments toward the special assessment accounts are only a fraction of total US peacekeeping expenditures for the regions. After the termination of UNPROFOR in December 1995, NATO established IFOR, which was later succeeded by SFOR. Through IFOR and SFOR, the United States expended approximately $2,489 million in the fiscal year 1996, and $2,271 million in the fiscal year 1997 (US General Accounting Office 1998).[13]

Due to limited data availability, only assessed contributions to UN-led (UN-financed) peacekeeping were considered for testing of disproportionate burden sharing in the previous sections. However, since the wealthiest countries have contributed greatly to the

[13]These figures are the Department of Defense's incremental costs for military operations in and around Bosnia and Herzegovina. They do not include the expenditures of the US civilian agencies. The United States provides approximately 25 percent of SFOR's 31,000 troops.

Table 2.10 US expenditures for peace operations in Somalia, former Yugoslavia, Rwanda, and Haiti: 1992–95 fiscal years

(in millions of US dollars)

Fiscal year	1992	1993	1994	1995
Somalia	$ 92.9	$1124.8	$913.3	$ 92.1
(Paid US assessment for UNOSOM)	(0.0)	(40.9)	(330.9)	(16.9)
Former Yugoslavia	126.7	408.7	959.0	692.5 [1]
(Paid US assessment for UNPROFOR)	(76.4)	(70.1)	(459.7)	(179.8)
Rwanda	22.1	24.8	261.4	265.4
(Paid US assessment for UNOMUR and UNAMIR)	(0.0)	(0.0)	(34.0)	(75.5)
Haiti	79.7	30.4	530.8	875.8
(Paid US assessment for UNMIH)	(0.0)	(0.0)	(0.5)	(51.9)

1. The figure does not include costs related to the IFOR deployment.
SOURCE: US General Accounting Office (1996).

Gulf War and other non-UN-led (non-UN-financed) operations, the findings for UN-led operations clearly underestimate the disproportionate burden sharing for peace operations in the 1990s. As a rough attempt to show this conjecture, for the NATO sample and Sample 4, some informed adjustments to the PK/GDP rankings are made, and then the rank correlation between GDP and PK/GDP are recalculated. To adjust for the Gulf War effort in 1990 and 1991, the Japanese and German contributions to the US forces deployment were added to their respective UN peacekeeping assessed contributions. In Sample 4, the United States now receives a PK/GDP rank of 1 in both 1990 and 1991. Japan receives a rank of 2 in 1990 and 3 in 1991. Germany receives a rank of 3 in 1990 and 2 in 1991. The United Kingdom receives a rank of 4, and France receives a rank of 5 in both 1990 and 1991. In the NATO sample, the United States receives a PK/GDP rank of 1, Germany a rank of 2, the United Kingdom a rank of 3, and France a rank of 4 for both 1990 and 1991. For the period of 1992–96, a PK/GDP rank of 1 is assigned to the United States, a rank of 2 to the United Kingdom, a rank of 3 to France, and a rank of 4 to Germany for both the NATO sample and Sample 4. These assignments correspond to the rank of troop deployment for IFOR, as reported by the US Department of Defense (1996), and the countries' UN peacekeeping efforts.

The test results are shown in Table 2.11. For the NATO sample, the 1990 and 1991 coefficients are significant at the .10 level, and the 1992–96 coefficients are significant at the .05 level. For Sample 4, the 1990 and 1991 coefficients are significant at the .05 level. Although the adjustments are necessarily ad hoc, it still is informed and quite suggestive that a much greater degree of disproportionate peacekeeping burden sharing by wealthy countries existed in the 1990s.

Table 2.11 Kendall rank correlation between GDP and PK/GDP: NATO and Sample 4, adjusted for non-UN-financed operations: 1990–96

Year	NATO sample (τ_{12})	Sample 4 (τ_{12})
1990	0.33333*	0.42857**
	(1.80)	(2.23)
1991	0.35000*	0.39048**
	(1.89)	(2.03)
1992	0.41667**	0.18095
	(2.25)	(0.94)
1993	0.40000**	0.20000
	(2.16)	(1.04)
1994	0.65000**	0.20000
	(3.51)	(1.04)
1995	0.58333**	0.31429
	(3.15)	(1.63)
1996	0.55000**	0.29524
	(2.97)	(1.53)

Numbers in parentheses are z-values.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.

2.7 Concluding Remarks

This chapter examined the patterns of UN peacekeeping financial burden sharing among the selected member states during the period of 1975–96. Non-parametric statistical tests were used to study the rank correlation between GDP and a share of GDP devoted to UN peacekeeping. The test results show that, for the NATO sample, wealthy member states were assuming a disproportionate burden of UN peacekeeping in the 1990s. This indicates, according to Olson's exploitation hypothesis, an increased ratio of public benefits to the total benefits created by UN peacekeeping, and, increased suboptimality of the UN peacekeeping efforts during that time period.

The examination of the PK/GDP ranks reveals that, even among the NATO sample in the 1990s, the United States was bearing relatively small burden of UN peacekeeping. As of February 28, 1998, UN member states owe approximately $1,538 million for UN peacekeeping arrears, and of which, 59.6 percent is owed by the United States (US General Accounting Office 1998). In other words, the single most serious financial threat faced by UN peacekeeping is the undercontribution of the wealthiest country, and not the free-riding of smaller countries. If the UN peacekeeping expenditures are to be maintained at, or increased beyond the early 1990s level, the United Nations should seriously consider the adoption of IMF-type voting rule, or more realistically, the reduction of its financial dependence on the United States.

Mainly due to its poor logistics, the United Nations is not capable of conducting successful Chapter VII peace enforcement operations. When such operations are needed, it must rely on coalitions of its member states. During the 1990s, the United States led Operation Desert Shield/Storm and other enforcement operations in Somalia and Haiti. It has also participated in the NATO operations in the former Yugoslavia. When these non-UN-financed operations are considered, the United States and other wealthy countries seemed willing to share large burden. As far as the Gulf War is concerned,

however, it should be noted that these oil-dependent industrialized countries are likely to place more value to peace in the Middle East than other non-Middle Eastern countries do.

CHAPTER 3 UN PEACEKEEPING CONTRIBUTION FUNCTION

3.1 Introduction

In the previous chapter, non-parametric statistical tests are used to study the patterns of UN peacekeeping financial burden sharing among selected UN member states. The purpose of this chapter is to go beyond the use of simple rank correlation to explain financial support of UN peacekeeping by member states. Since the seminal study by Olson and Zeckhauser (1966), an extensive literature has developed to investigate military expenditures of countries facing a common threat. In many of these studies, it is assumed that a country's military expenditures depend on such variables as the country's national income, the relative price of defense, the military expenditures of its allies, and the military expenditures of its enemies. The expenditure function is estimated for each country, using time-series data and parametric statistics. Murdoch and Sandler (1984), for instance, present a joint product model of military alliances, in which a representative ally allocates its resources between a military activity and a nonmilitary activity. In their model, an ally's arsenal jointly produces alliance-wide public good (deterrence) and a nation-specific good (e.g. internal security, the development of an arms industry). The derived demand function for the military activities is estimated for nine NATO member states, using the seemingly unrelated regression method. Using full income approach, Sandler and Murdoch (1990) derive system of demand equations for distinguishing between Nash-Cournot and Lindahl behavior, and between pure public

and joint product model. Then, they apply the techniques to the NATO alliance, and estimate the military expenditure functions for ten NATO member states, using the two-stage least square estimation method.[1]

Using a similar approach, we derive a reduced-form UN peacekeeping contribution function based on a joint product model of peacekeeping in which both contributor-specific and global public benefits are present. Next, these contribution functions are estimated for a sample of 25 UN member states for the period of 1975–96. The sample includes the five permanent members of the Security Council, sixteen Group B countries, and four Group C countries. A contribution function is estimated for each country, while accounting for the simultaneity problem associated with public good allocation problems. Pooling restrictions are also tested to ascertain whether the efficiency of the estimates can be increased for some sample countries whose coefficients are statistically indistinguishable from one another. Finally, contribution functions are re-estimated for the appropriately pooled sample.

3.2 Theoretical Model

To derive a peacekeeping contribution function, we assume an n-nation model in which each country is represented by a unitary actor who maximizes utility by allocating money between peacekeeping and all other activities. The ith country's utility depends on three essential commodities: a private nation-specific characteristic (y_i), a contributor-specific characteristic (x_i) derived from peacekeeping activities, and a global purely public characteristic (Z) also derived from peacekeeping activities. The private characteristic y_i represents benefits associated with all activities other than peacekeeping. UN peacekeeping can be financed by voluntary contributions (e.g., contributions

[1] A simultaneous equation method is used also by Hilton and Vu (1991), and Murdoch, Sandler, and Hansen (1991) for NATO, by McGuire (1982) for the US-Israeli alliance, and by Okamura (1991) for the US-Japanese alliance.

to UNFICYP), special assessments, or the UN regular budget. The sum of contributions to special assessment accounts and UNFICYP voluntary contribution account will be treated as *discretionary* contributions, denoted by q_i for the ith country. For the n-nation sample, total discretionary contributions are

$$Q = q_i + \tilde{Q}_i, \tag{3.1}$$

where $\tilde{Q}_i$ reflects peacekeeping *spillins* equal to the sum of such contributions to UN peacekeeping activities by the other $n-1$ countries.

In terms of final commodities, the ith country's utility function is

$$U^i = U^i(y_i, x_i, Z, Q^R, E_i), \tag{3.2}$$

where Q^R is the global security associated with the residual, exogenous support of UN peacekeeping coming from the UN regular budget, payments by the non-sample countries, and any other unspecified sources. E_i is a taste-shifting parameter. It can involve any factor that influences the utility derived from peacekeeping such as the country's trading position or openness. The public characteristic Z derives from the country's own discretionary peacekeeping contributions and those of the other $n-1$ countries, so that

$$Z = z_i + \tilde{Z}_i, \tag{3.3}$$

where $\tilde{Z}_i = \sum_{j \neq i}^{n} z_j$ denotes the spillins of global security coming from discretionary peacekeeping contributions by the other countries.

To transform the utility function from final commodities or characteristics to observable activities, we must specify the underlying relationship or technologies for these characteristics and the activities that produce them. A unit of the private good y_i is assumed to produce a unit of the characteristic y_i. Similarly, a unit of Q^R yields a unit of the security characteristic Q^R. Discretionary peacekeeping is depicted as giving joint

products, x_i and z_i. In particular, a fixed proportions relationship relates discretionary peacekeeping and its contributor-specific and public characteristics, so that

$$x_i = \alpha q_i \qquad (i = 1, ..., n) \tag{3.4}$$

and

$$z_i = \gamma q_i \qquad (i = 1, ..., n) \tag{3.5}$$

with α and γ being positive parameters. By substituting (3.5) into (3.3), we can write the public characteristic Z in terms of discretionary peacekeeping:

$$Z = \gamma \left(q_i + \tilde{Q}_i \right). \tag{3.6}$$

Finally, the substitution of (3.6) and (3.4) into (3.2) expresses the ith country's utility function in terms of the observable activities:

$$U^i = U^i(y_i, \alpha q_i, \gamma(q_i + \tilde{Q}_i), Q^R, E_i). \tag{3.7}$$

A few remarks about the utility function (3.7) are useful. First, each country's utility function is assumed increasing and strictly concave in its 5 arguments. Second, because we are primarily interested in the empirical exercise of estimating the associated contribution functions for discretionary peacekeeping q_i for the n countries and cannot observe the fixed proportion parameters per se, we shall normalize them to equal one. Thus, the basic utility function is represented as

$$U^i = U^i(y_i, q_i, q_i + \tilde{Q}_i, Q^R, E_i) \tag{3.8}$$

for each sample country. Third, in the utility function, we choose to treat the source of funding for peacekeeping — discretionary or exogenous — as influencing the substitutability of peacekeeping activities.

Each country faces two kinds of constraints when choosing y_i and q_i to maximize utility. The first is the budget constraint,

$$I_i = y_i + p_i q_i, \tag{3.9}$$

where p_i is the ith country's relative price of discretionary peacekeeping, and I_i is the ith country's income or GDP. In (3.9), the country's income is allocated between discretionary peacekeeping and all other activities, whose price is normalized to one. The second kind of constraint consists of the two exogenous factors — discretionary and nondiscretionary peacekeeping spillins. The former is held constant for the ith country at the best-response level of the other $n-1$ countries, and the latter is just treated as a constant.

When the utility function (3.8) is maximized subject to the budget constraint (3.9) and to the exogeneity of $\tilde{Q}_i$ and Q^R, the first-order condition can be solved implicitly to obtain the peacekeeping contribution function,

$$q_i = max\{q_i(I_i, \tilde{Q}_i, Q^R, p_i, E_i), 0\}. \qquad (i = 1, ..., n) \tag{3.10}$$

If a country provides a positive contribution to peacekeeping, then $q_i(\bullet)$ applies to (3.10), otherwise $q_i = 0$. Since the sample countries are the primary contributors to peacekeeping, we shall focus on the *interior solution*, where each country contributes a positive amount.[2] A Nash equilibrium is reached when the first-order conditions associated with the n countries' constrained optimization problems are satisfied simultaneously. Another way of characterizing this equilibrium is to require that the n contribution functions in (3.10) and the associated demand functions for activity y be simultaneously satisfied. The decision-making process is modeled as a Nash equilibrium so as to stress the autonomy that countries often exercise in deciding their annual contributions to peacekeeping despite the UN peacekeeping assessment formula.

Since jointly produced contributor-specific and purely public outputs, derived from peacekeeping, may be complementary, the coefficient on the discretionary spillin term in an estimated contribution function may be positive unlike the case where only a purely public output exists. This follows because an increase in discretionary spillins

[2]This assumption holds for all sample countries, except for China (1975–81), Portugal (1975, 1977), and Spain (1977, 1979, 1981).

may increase the desire for the contributor-specific benefit associated with peacekeeping activities. Another reason for expecting a positive coefficient on the spillin term stems from the peacekeeping assessment formula. As the United Nations increases its peacekeeping activity, it will assign its member states greater payment obligations, so that increased peacekeeping contributions by the other sample countries should be accompanied, to some extent, with the country's own increase in peacekeeping contributions, even if the country does not strictly adhere to its institutionalized obligation. Because of the absence of nation-specific activities being associated with exogenous spillins Q^R, the sign of its coefficient is more difficult to predict, and is dependent on the consumption relationship among the goods. If Q^R is complementary with the other goods, then its coefficient is likely to be positive. The influence of income is invariably positive for public goods, but is less clear-cut for peacekeeping, because the need for these activities is based on exogenous factors behind the number and degree of conflicts worldwide. When peacekeeping is required, the world may be in either recession or boom. As long as peacekeeping remains such a minuscule portion of GDP, most countries can meet their obligations even during recessionary times, thus limiting any significant relationship between peacekeeping contributions and income. Since assessment shares rarely vary annually with a contributor's income, this is another factor that limits the influence of income. If a proxy for the price of peacekeeping could be found, then its impact would be negative. Finally, a country's amount of world trade (its sum of exports and imports) is used as a taste parameter, in the belief that countries with a larger stake in world trade are more concerned about global stability, and are more willing to support peacekeeping. Therefore a positive coefficient is anticipated on the trade term in the contribution functions.

Rather than Nash behavior (zero-conjectural variation), countries may be following a non-Nash matching behavior (nonzero-conjectural variation). If this were the case,

then $\frac{d\tilde{Q}_i^e}{dq_i} = \sigma_i$.[3] If countries responded to this matching rate, then their utility function would be

$$U^i = U^i(y_i, q_i, q_i + \sigma_i q_i, Q^R, E_i). \tag{3.11}$$

When the underlying peacekeeping contribution function is derived, it is no longer dependent on $\tilde{Q}_i$; the relevant contribution function is (3.10) without the discretionary spillin term. Therefore, a simple empirical test can ascertain whether or not non-Nash matching behavior applies by examining the significance of the coefficient of the $\tilde{Q}_i$ term in the estimated contribution functions.

3.3 Empirical Representation

The econometric specification corresponding to the contribution function (3.10) is given by

$$\ln q_{it} = \beta_{1i} + \beta_{2i} \ln GDP_{it} + \beta_{3i} \ln SPILL_{it} + \beta_{4i} \ln Q_t^R + \beta_{5i} \ln TR_{it} + \mu_{it}, \tag{3.12}$$

for each country, where prices have been dropped from the functions, because we have no information on the relative price of peacekeeping compared with all other activities. If the price of peacekeeping has changed in the same proportion as the prices of the other goods, then dropping price creates no biases. According to function (3.12), each country's discretionary peacekeeping (q) is determined by its GDP, discretionary peacekeeping spillins ($SPILL$), the residual peacekeeping spending (Q^R), and the country's trade (TR), measured by the sum of exports and imports. For all variables except Q^R, the first subscript indicates the country, while the second denotes the time period. Since Q^R is the same for all countries in a given year, its only subscript indicates the

[3] If countries are simply following their peacekeeping assessments, $q_i = \omega_i(PKbudget)$ for $i = 1, ..., n$, where ω_i is the ith country's assessment rate, and $PKbudget$ is the total UN peacekeeping assessments. In this case, $\frac{dQ_i^e}{dq_i} = 0$.

time period. The β_{ki}s, $k = 1, ...5$, represent the constant and the four unknown coefficients for the ith country, while μ_{it} denotes the random disturbance term. After trying both linear and log-linear specifications, we picked the latter because of its superior performance. The equations have different parameters β_{ki} for each country because of differences in political and economic conditions; however, the variables that influence the level of contributions are believed to be the same across countries.

Since the contribution function (3.10) describe behavior at a Nash equilibrium, all countries essentially demand the same *total* discretionary contributions toward peacekeeping. In essence, the determination of the $SPILL$ variable is not independent of the q_is. Thus, the $SPILL$ variable, defined as the difference between total discretionary contributions and individual discretionary contributions, is a random variable likely to be correlated with the disturbance term. An instrumental variable estimation procedure, therefore, is utilized to get rid of this simultaneity bias. The $SPILL$ variable is estimated as a function of all exogenous variables in the system as follows:

$$\ln SPILL_{it} = \theta_0 + \sum_{j=1}^{n} \theta_j \ln GDP_{jt} + \delta \ln Q_t^R + \sum_{j=1}^{n} \varphi_j \ln TR_{jt} + \nu_{it}, \tag{3.13}$$

for each country where ν_{it} is the disturbance term, and the other Greek symbols are unknown parameters.

Equations (3.12)–(3.13) are estimated as a system of equations for each of the 25 sample countries. Because time-series data are utilized, there is the possibility that adjacent disturbances are correlated. To address autocorrelation, we first fit equations (3.12)–(3.13) and then test the null hypothesis that the autocorrelation coefficient (ρ) is zero. If the test results warrant correcting for autocorrelation, then the estimate of ρ, $\hat{\rho}$ is used to transform the variables in (3.12), where the first observation is transformed by $\sqrt{1-\hat{\rho}^2}$. Equations (3.12)–(3.13) are then refitted using the two-stage least square method.

Once autocorrelation is corrected, if necessary, there are a couple of hypotheses that are tested for the best empirical representation of (3.12). In particular, we test whether the coefficients on the $SPILL$ and Q^R variables are the same across all sample countries. An F-test is used to evaluate the null hypothesis,

$$H_{01} : \beta_{3i} = \beta_{4i}. \qquad (i = 1, ..., n)$$

This test indicates whether the discretionary spillins and residual peacekeeping spending are perfect substitutes. Since the 25 sample countries are diverse according to income levels, stages of development, and other political economic factors, the coefficients on the GDP and TR variables are anticipated to vary across countries. However, some countries may display similar responses to $SPILL$ and Q^R depending on their role in UN peacekeeping operations. A logistical means for grouping countries so as to test the equivalence of these coefficients across countries is to rely on the countries' UN peacekeeping assessment scale *vis-à-vis* their regular budget assessment scale. Countries with similar UN assessment ratios have either identical free-riding incentives or else analogous peacekeeping responsibilities *vis-à-vis* the United Nations. Three groups are germane: (1) Security Council permanent members, whose UN assessment ratio (denoted by UNR) between peacekeeping and the regular budget exceeds one; (2) Group B countries, whose UNR equals one; and (3) Group C countries, whose UNR is less than one. For $SPILL$, we test

$$H_{02} : \beta_{3i} = \beta_{3j} \qquad (i \neq j)$$

for various subgroupings of countries. When coefficients across countries in a subgroup are not statistically different, then we can impose equality restrictions on these coefficients, and reduce the number of coefficients to be estimated, thereby increasing the efficiency of the estimators.

3.4 Sample and Data

The sample consists of the current sixteen NATO member states and the following nine additional countries: Australia, Japan, Sweden, Austria, China, Finland, Iceland, New Zealand, and an *augmented* Russian Federation (henceforth called Russia), which consists of the USSR for 1975–91 and the combination of Russia, Ukraine, and Belarus for 1992–96.[4] Data for these three countries are combined after 1991, so that we can splice together a proxy country that closely corresponds to the earlier peacekeeping contributor, the USSR.[5] The end to the Cold War also poses a problem for putting together a consistent time series for Germany. To accomplish this goal, we use data for West Germany for 1975–89 and unified Germany for 1990–96. For 1975–85, the 25 country sample's annual share of discretionary peacekeeping contributions averaged 96.5 percent; for 1986–96, the sample's annual share of these contributions averaged 96.1 percent. Even though the sample includes less than 15 percent of UN members, it still accounts for almost all of the discretionary contributions to peacekeeping.

As in Chapter 2, the data on discretionary peacekeeping contributions (PK) in current year dollars come from two sources. Annual data for 1975–96 on the actual contributions made to all special assessment accounts by each sample country are drawn from the UN (1976–97) *Status of Contributions*, and the data for 1975–96 on the voluntary contributions to the UNFICYP account are from the biennial UN (various years) *Financial Report*. For each sample country, these two contributions are then summed to yield PK in current dollar terms. Constant dollar PK figures are derived by applying the appropriate price deflators[6] For the ith country in year t, $SPILL_{it}$ consists of the

[4]Although we use the term, *sample* to describe the set of countries selected for the regression analysis, this *sample* is by no means a *random* sample of the UN member states.

[5]Russia, Ukraine, and Belarus were the only ex-Soviet republics that contributed to peacekeeping during 1992–96.

[6]US GDP deflators with a base year of 1987 are used. The deflators for 1975–93 are taken from World Bank (1995), while the deflators for 1994–96 come from adjusting US GDP deflators with a base year of 1990, given by the International Monetary Fund (IMF) (1997c) *International Financial Statistics, September*.

sum of the real PK figures for the other 24 sample countries during year t. GDP figures at market prices in current US dollars are drawn from the World Bank (1995) *World Data 1995* for 1975–93, and from the World Bank (1997) *World Development Indicators 1997* for 1994–95.[7] GDP for 1996 are estimated by applying the 1992–95 annual growth rate to 1995 GDP for all sample countries.

To obtain residual peacekeeping spending (Q^R) for the sample countries, we first need total annual UN peacekeeping spending for 1975–96. These figures are estimated from expenditures listed for each peacekeeping mission in the UN (various years) *Financial Report.* For each mandate period, peacekeeping spending is apportioned to the appropriate calendar year, since these mandate periods vary among missions and do not coincide with a calendar year.[8] From each year's total peacekeeping spending, we deduct the sample countries' actual contributions to the special assessment accounts and the UNFICYP account to arrive at the annual Q^R figure. As in the case of discretionary peacekeeping contributions, GDP and Q^R are converted to constant 1987 US dollars by applying the requisite US GDP deflators.

Countries' trade figures (TR) for 1975–95 are derived from import and export figures listed in UN (1987, 1989, and 1996b) *International Trade Statistics Yearbook.*[9] The 1996 figures are derived from import and export figures listed in IMF (1997b) *International*

[7]The 1990 figure for unified Germany is taken from the UN (1996a) *Statistical Yearbook 1994*. The 1975–86 figures for the USSR are estimated (backcasted) by using the annual growth rate for the USSR during 1987–90.

[8]For instance, one-sixth of the expenditure for the UN Interim Force in Lebanon (UNIFIL) during its mandate period (August 1, 1987 to January 31, 1988) is assigned to 1988, and the rest to 1987.

[9]Belgium trade figures are derived by subtracting Luxembourg figures from Belgium-Luxembourg figures. For Russia (1992–95) and Luxembourg (1975–92), the figures are calculated from data in IMF (1996) *International Financial Statistics Yearbook*. For Austria (1995), Belgium-Luxembourg (1995), and Luxembourg (1993–95), the figures are calculated from data in IMF (1997b). For Sweden (1996), the figure is calculated from data in IMF (1997c). The figures are estimated for Austria (1996), Belgium (1986–88), Luxembourg (1986–88), Greece (1995–96), the USSR (1991), and augmented Russia (1996). We calculate the average of four years — two years before and after the missing data point and use this average for the missing value. When two or more consecutive data points are missing, the first missing value is estimated based on the average calculated value for the previous four years, and then this estimated value is used to get the next missing value and so on. For augmented Russia (1996), the growth rate for 1994–95 is used because earlier years are not representative.

Financial Statistics, April. All trade figures are in constant 1987 US dollars to coincide with the constant dollar representations of the other variables.

Ideally, we intend to use the UN assessment ratios ($UNRs$) as a proxy for the relative price of peacekeeping. Unfortunately, $UNRs$ show virtually no variation over time, so that they cannot be used in the time-series regressions. They, however, identify pooling restrictions from which to derive restricted models.

3.5 Estimation Results

Based on equations (3.12)–(3.13), we use the two-stage least square method to estimate peacekeeping contribution functions for each of the 25 sample countries during 1975–96. Since there is evidence of autocorrelation in some of the estimated equations of the sample countries, we correct this autocorrelation for any country's equation if the Durbin-Watson statistic either indicates autocorrelation or is in the uncertain range.

These estimates are displayed in Table 3.1 for each sample country. As expected, GDP is typically not a significant determinant of a country's peacekeeping contributions. Canada, Spain, and the United States display a negative and significant income response at the .05 level, while Finland shows a negative and significant income response at the .10 level. For some countries, the increase in peacekeeping contributions, necessitated by a greater need for peacekeeping activities at the start of the 1990s, happened to coincide with a recessionary period. Also, the strong negative coefficient observed for the United States could be at least partially explained by the fact that the Reagan administration substantially reduced its financial support for the United Nations based on the advice given by conservative think-tanks such as the Heritage Foundation, during the US economic boom of the 1980s. All other GDP coefficients are insignificant at the .10 level.

The most important determinant of the contribution to discretionary peacekeeping

Table 3.1 Autocorrelation-corrected two-stage least square estimates of UN peacekeeping contribution functions: 1975–96

	Regressors				
Country	Constant	$\ln GDP$	$\ln SPILL$	$\ln Q^R$	$\ln TR$
Belgium	0.825	0.106	1.135**	-0.062	-0.578
	(0.12)	(0.22)	(3.38)	(-0.48)	(-1.07)
Canada+	6.228	-1.043**	0.895**	0.183**	0.301*
	(1.32)	(-2.27)	(12.88)	(2.55)	(1.90)
Denmark+	-1.849	-0.067	0.999**	0.058	-0.228
	(-0.72)	(-0.23)	(9.97)	(0.59)	(-1.01)
France+	-3.710	-0.324	0.908**	0.054	0.475*
	(-0.75)	(-0.73)	(6.29)	(0.46)	(1.73)
Germany+	-0.669	-0.033	1.025**	0.103	-0.132
	(-0.22)	(-0.10)	(9.76)	(1.07)	(-0.52)
Greece+	-1.850	-0.009	0.153	0.149	0.058
	(-0.55)	(-0.03)	(1.55)	(1.53)	(0.49)
Iceland	-3.728	-0.906	0.936**	-0.058	0.515
	(-1.19)	(-1.61)	(6.86)	(-0.34)	(1.36)
Italy+	-1.093	-0.239	1.113**	0.002	0.040
	(-0.30)	(-0.49)	(8.46)	(0.02)	(0.11)
Luxembourg	-7.092**	-0.239	1.078**	0.087	0.108
	(-4.81)	(-0.99)	(9.21)	(0.89)	(0.51)
Netherlands	-3.783	-0.066	0.875**	0.175*	0.041
	(-1.17)	(-0.25)	(7.33)	(1.64)	(0.19)
Norway+	-4.052	0.602	0.913**	0.004	-0.662**
	(-1.21)	(1.32)	(12.07)	(0.06)	(-2.67)
Portugal+	-0.64	-3.935	1.359	1.238	2.579
	(-0.02)	(-0.89)	(0.78)	(0.82)	(1.16)
Spain+	11.821	-9.872**	0.240	0.285	9.628**
	(0.47)	(-3.83)	(0.22)	(0.36)	(6.52)
Turkey+	0.277	-1.310	0.932*	-0.158	0.819**
	(0.03)	(-1.42)	(1.76)	(-0.47)	(2.18)
United Kingdom+	0.096	-0.246	0.943**	0.105*	0.044
	(0.04)	(-0.96)	(15.42)	(1.80)	(0.28)
United States+	64.703**	-5.147**	1.108**	0.267**	0.853
	(2.81)	(-2.57)	(7.29)	(2.20)	(1.39)
Australia	-0.322	-0.255	0.961**	0.070	-0.059
	(-0.06)	(-0.49)	(10.29)	(0.75)	(-0.31)
Japan+	-4.241**	-0.149	1.082**	0.011	0.299**
	(-3.16)	(-0.91)	(19.22)	(0.28)	(2.40)
Sweden+	0.343	-0.107	1.029**	-0.031	-0.295*
	(0.15)	(-0.45)	(12.79)	(-0.35)	(-1.65)
Russia+	8.835	-1.274	1.573	-3.685*	1.543
	(0.18)	(-0.35)	(1.05)	(-1.66)	(0.46)
Austria+	-4.487	-0.058	1.136**	-0.185	0.047
	(-1.28)	(-0.13)	(7.85)	(-1.36)	(0.18)
China+	-51.002	-1.787	-0.819	-0.028	6.861**
	(-0.88)	(-0.32)	(-0.51)	(-0.02)	(3.31)
Finland	-1.187	-0.781*	1.161**	-0.181	0.452
	(-0.43)	(-1.85)	(9.62)	(-1.41)	(1.40)
Ireland+	-7.693**	-0.084	0.978**	0.055	0.209
	(-5.19)	(-0.54)	(7.07)	(0.43)	(1.08)
New Zealand	-9.393	0.124	0.889**	0.150	0.225
	(-1.27)	(0.14)	(3.76)	(0.71)	(0.47)

Numbers in parentheses are t-values.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.
+ indicates data corrected for autocorrelation.

is the discretionary spillin variable, as shown in Table 3.1. For 19 out of 25 sample countries, the $SPILL$ coefficients are positive and significant at the .05 level, and for 1 country it is positive and significant at the .10 level. For these countries, the $SPILL$ coefficients vary from 0.875 (the Netherlands) to 1.161 (Finland). If countries displayed no discretion whatsoever and always paid their peacekeeping assessments, then their $SPILL$ coefficients should be one, indicating that a 10 percent increase in everyone else's contributions is accompanied with a 10 percent increase in the country's own contributions.[10] The strong positive showing for the $SPILL$ coefficient is also indicative of a complementarity between the jointly produced contributor-specific and public benefits derived from discretionary peacekeeping contributions. If countries are following a non-Nash matching behavior, their $SPILL$ coefficients should be 0. The high t-values found for the $SPILL$ coefficients imply that this alternative characterization does not apply.

The residual peacekeeping spending, Q^R, are a positive and significant influence on discretionary peacekeeping contributions for Canada (.05 level), the Netherlands (.10 level), the United Kingdom (.10 level), and the United States (.05 level), and a negative and significant influence for just Russia (.10 level). It appears that $SPILL$ and Q^R do not possess similar estimated coefficients, which is confirmed by an F-test on the equality of β_3 and β_4 for the full sample. The F-statistic is 23.906 with a *prob* value of 0.0001. For all countries except Russia, discretionary peacekeeping contributions show a very small (typically positive) response to Q^R in Table 3.1.

In the right-most column of Table 3.1, the coefficients of the trade variable are

[10]If all sample countries always pay their peacekeeping assessments, for any assessment rate (ω_i) for the ith country,

$$\frac{\partial \ln q_i}{\partial \ln \tilde{Q}_i} = \frac{\partial q_i}{\partial \tilde{Q}_i}\frac{\tilde{Q}_i}{q_i} = \frac{\frac{\partial q_i}{\partial PKbudget}}{\frac{\partial \tilde{Q}_i}{\partial PKbudget}}\frac{\tilde{Q}_i}{q_i} = \frac{\varpi_i}{1-\varpi_i}\frac{(1-\varpi_i)(PKbudget)}{\varpi_i(PKbudget)} = 1,$$

where $PKbudget$ is the total UN peacekeeping assessments.

listed and provide some support for the hypothesis that countries with greater trading interests are more supportive of peacekeeping. Six countries — Canada, France, Spain, Turkey, Japan, China — have positive and significant TR coefficients at the .10 level or better. This coefficient for the United States and Finland is also positive and not too far from the .10 significance level. Only Norway and Sweden have negative and significant coefficients.

In Table 3.2, we report the results for the F-tests of the equality of the $SPILL$ coefficient, β_3, for five different groups of contributors, based on the value of the UN assessment ratio. For the full sample, we can reject the null hypothesis that the $SPILL$

Table 3.2 F-test on equality of $SPILL$ coefficient over various subgroups

(5% significance level)

Group of countries	Sample F-value	Critical F-value	Decision
Full sample	3.735	1.52	Reject H_0
Security Council [1] ($UNR > 1$)	0.5794	3.23	Unable to reject H_0
Group B countries with $\beta_3 < 1$ [2] ($UNR = 1$)	0.288	1.91	Unable to reject H_0
Group B countries with $\beta_3 > 1$ [3] ($UNR = 1$)	0.178	2.17	Unable to reject H_0
Scandinavian [4]	1.208	2.76	Unable to reject H_0

H_0: $\beta_{31} = \beta_{3j}$ for all j in the designated subgroup.
1. Excludes China and Russia.
2. Canada, Denmark, Germany, Iceland, the Netherlands, Norway, Australia, Ireland, New Zealand.
3. Belgium, Italy, Luxembourg, Japan, Sweden, Austria, Finland.
4. Norway, Denmark, Sweden, Iceland

coefficients are equal; however, we cannot reject the equality of $SPILL$ coefficients for three of the five permanent members of the Security Council. Russia and China are excluded from this test, because their $SPILL$ coefficients are insignificant. To find an

appropriate pooling restriction, we break the Group B countries ($UNR = 1$) into two subgroups — those with $\beta_3 < 1$ and those with $\beta_3 > 1$.[11] The first group includes Canada, Denmark, Germany, Iceland, the Netherlands, Norway, Australia, Ireland, and New Zealand, while the second group includes Belgium, Italy, Luxembourg, Japan, Sweden, Austria, and Finland. Based on these two subgroupings, we are unable to reject the null hypothesis that the estimated $SPILL$ coefficients are equal among countries within a subgroup. The first group is fairly homogeneous with respect to five of its nine members by including three Scandinavian countries along with two south Pacific countries. We also test the equality of coefficients for the four Scandinavian countries — Denmark, Iceland, Norway, Sweden — and are unable to reject the null hypothesis of equality of $SPILL$ coefficients. There is no reason to test the equality of this coefficient for the Group C countries ($UNR < 1$), since three of their four $SPILL$ coefficients are insignificant. Only Turkey had a significant $SPILL$ coefficient among the Group C countries in the sample.

To increase the efficiency of our estimates, we restrict the coefficients on the $SPILL$ variable to be equal within three groups of countries — three of the five permanent Security Council members, Group B countries with $\beta_3 < 1$, Group B countries with $\beta > 1$ — and reestimate the entire 25 equation system for these pooling restrictions. The reestimated equations for those countries whose coefficient estimates are affected by the restrictions are reported in Table 3.3, grouped according to the three sets of restrictions. As anticipated, the significance of the estimated coefficients increases owing to the pooling restrictions. Group B countries whose β_3 exceeds one, appear to have an extra commitment to peacekeeping and include three neutral countries (Austria, Finland, Sweden), Japan and others. They responded even more fully to increases in the discretionary peacekeeping contributions of other countries than did the permanent

[11]Spain was a Group C country for most of the sample period. It switched from Group C to Group B status in 1992.

Table 3.3 Restricted and autocorrelation-corrected two-stage least square estimates of UN peacekeeping contribution functions: 1975–96

Country	Regressors				
	Constant	$\ln GDP$	$\ln SPILL$	$\ln Q^R$	$\ln TR$
Security Council [1] ($UNR > 1$)					
France	-2.562	-0.372	0.958**	0.027	0.422*
	(-0.66)	(-0.88)	(18.15)	(0.29)	(1.79)
United Kingdom	0.323	-0.246	0.958**	0.095*	0.022
	(0.15)	(-0.96)	(18.15)	(1.74)	(0.14)
United States	52.422**	-4.254**	0.958**	0.344**	0.784
	(2.64)	(-2.34)	(18.15)	(3.56)	(1.29)
Group B countries ($UNR = 1, \beta_3 < 1$)					
Canada	6.228	-1.018**	0.914**	0.169**	0.271**
	(1.32)	(-2.25)	(27.05)	(3.02)	(2.13)
Denmark	-3.104	-0.037	0.914**	0.109	-0.119
	(-1.44)	(-0.13)	(27.05)	(1.38)	(-0.62)
Germany	-2.897	-0.052	0.914**	0.200**	0.073
	(-1.52)	(-0.23)	(27.05)	(2.73)	(0.45)
Iceland	-3.834	-0.923*	0.914**	-0.036	0.551*
	(-1.25)	(-1.66)	(27.05)	(-0.32)	(1.78)
Netherlands	-2.993	-0.091	0.914**	0.151*	-0.008
	(-1.31)	(-0.36)	(27.05)	(1.92)	(-0.06)
Norway	-3.569	0.483	0.914**	0.031	-0.594**
	(-1.39)	(1.31)	(27.05)	(0.53)	(-3.08)
Australia	-1.293	-0.213	0.914**	0.103	-0.005
	(-0.26)	(-0.41)	(27.05)	(1.46)	(-0.03)
Ireland	-8.171**	-0.089	0.914**	0.099	0.278**
	(-7.49)	(-0.58)	(27.05)	(1.05)	(2.16)
New Zealand	-8.924	-8.924	0.914**	0.134	0.201
	(-1.53)	(-1.53)	(27.05)	(0.92)	(0.48)
Group B countries ($UNR = 1, \beta_3 > 1$)					
Belgium	-0.052	0.132	1.084**	-0.047	-0.511*
	(-0.01)	(0.30)	(29.22)	(-0.56)	(-1.66)
Italy	-1.365	-0.256	1.084**	0.021	0.087
	(-0.39)	(-0.54)	(29.22)	(0.22)	(0.29)
Luxembourg	-7.022**	-0.245	1.084**	0.083	0.104
	(-7.91)	(-1.11)	(29.22)	(1.12)	(0.52)
Japan	-4.194**	-0.153	1.084**	0.010	0.298**
	(-3.83)	(-0.99)	(29.22)	(0.27)	(2.41)
Sweden	0.742	-0.062	1.084**	-0.075	-0.389**
	(0.34)	(-0.27)	(29.22)	(-1.11)	(-2.94)
Austria	-5.305*	-0.004	1.084**	-0.151	0.079
	(-1.95)	(-0.01)	(29.22)	(-1.49)	(0.30)
Finland	-1.365	-0.893**	1.084**	-0.119	0.605**
	(-0.49)	(-2.31)	(29.22)	(-1.34)	(2.67)

Numbers in parentheses are t-values.
Pooling restriction for each subgrouping involves equality of spillin coefficient.
* indicates significantly different from zero at the .10 level for a two-tailed test.
** indicates significantly different from zero at the .05 level for a two-tailed test.
1. Security Council pooling excludes China and Russia whose $\ln SPILL$ coefficient was not significant.

members of the Security Council.

Interestingly, there is a preponderance of negative coefficients on the GDP variable in Table 3.3, with significant coefficients (.10 level) displayed by just four sample countries — the United States, Canada, Iceland, and Finland. For the pooled estimates, trade is a significant positive determinant of peacekeeping contributions for six countries and a significant negative determinant for three countries — Norway, Belgium (.10 level) and Sweden. In Table 3.3, the $SPILL$ coefficient requires little further discussion, except to underscore the rather high t-values owing to pooling restrictions. As before, the Q^R variable indicates some complementarity with discretionary peacekeeping.

3.6 Analysis of the Estimation Results

Insignificance of the GDP coefficients for the most sample countries suggests that countries' economic fluctuations affect their peacekeeping contributions very little, unlike in the case of military expenditures. Besides method of financing, there are two important differences between peacekeeping and national defense. First, the share of GDP devoted to peacekeeping is tiny, compared to the share of GDP devoted to national defense. This does not necessarily mean that countries are unconcerned with the levels of their peacekeeping assessments. The United States, for instance, has been demanding its assessment share to be reduced from current 31 percent to 25 percent. Second, the urgency of peacekeeping is generally greater when the Security Council (or the General Assembly in some cases) authorizes such an action, than the urgency of peacetime military build-up. Postponement of an establishment of peacekeeping operation by one year could bring disastrous consequences, while postponement of purchase of a war-ship by one year during peacetime is unlikely to have significant effects on the country's national security. The relative inexpensiveness and the urgent nature of peacekeeping are behind the insignificance of the GDP coefficients. If, in the future, the United Nations is to

maintain large-scale stand-by peacekeeping forces for rapid deployments, a country's financial contributions to such forces would probably be dependent on fluctuations in its GDP.

According to the estimation results, the key determinant of a country's peacekeeping contributions is the contributions from the other sample countries. Apparently, the positive and significant $SPILL$ coefficients found for 20 out of 25 sample countries indicate the absence of free-riding; countries seem to be responsive to the need for peacekeeping. However, what truly matters to the United Nations is *how* responsive these countries are. In other words, the success of UN peacekeeping operations depends, at least partially, on how closely the member states comply with their assessments. The positive and significant $SPILL$ coefficients would be observed even when every sample country contributes only 50 percent of its assessments throughout the sample period.[12] In such a case, however, most peacekeeping operations are likely to fail due to insufficient funding. Nevertheless, the closeness of the $SPILL$ coefficients to one is indicative of the importance of the assessment shares.

The exogenous peacekeeping spillin (Q^R) could be decomposed into three parts: the expenditures on the regular-budget-financed peacekeeping operations, the contributions from the non-sample countries to the special assessment accounts, and the difference between the UN expenditures on the special-assessment-account-financed peacekeeping operations and the total contributions to the special assessment accounts. The possible reason why $SPILL$ and Q^R do not possess similar estimated coefficients is that the correlations between q_i and the two components of Q^R, namely the first and the third, are different from the correlation between q_i and $SPILL$. First, while $SPILL$ and q_i

[12]In this case, the spillin coefficients would be still one, since

$$\frac{\partial \ln q_i}{\partial \ln \tilde{Q}_i} = \frac{\partial q_i}{\partial \tilde{Q}_i}\frac{\tilde{Q}_i}{q_i} = \frac{\frac{\partial q_i}{\partial PKbudget}}{\frac{\partial \tilde{Q}_i}{\partial PKbudget}}\frac{\tilde{Q}_i}{q_i} = \frac{.5\varpi_i}{.5(1-\varpi_i)}\frac{.5(1-\varpi_i)(PKbudget)}{.5\varpi_i(PKbudget)} = 1.$$

finance the same set of operations, the first component of Q^R and q_i finance different set of operations. Therefore, the correlation between $SPILL$ and q_i is likely to differ from the correlation between the first component of Q^R and q_i. Second, although both $SPILL$ and the third component of Q^R finance the same set of peacekeeping operations, $SPILL$ is assessed contributions, while the third component of Q^R is not. As mentioned earlier, as long as countries respond to the change in their peacekeeping assessments at least to some degree, q_i and $SPILL$ are likely to be positively correlated. Since the third component of Q^R is not assessed contributions but the residual peacekeeping expenditures of the United Nations, the correlation between this component of Q^R and q_i is likely to differ from the correlation between $SPILL$ and q_i.

The TR coefficients were significant and positive for six countries, significant and negative for two countries, and insignificant for seventeen other countries. The insignificance of the coefficients for the majority of the sample countries could be explained by two factors: unimportance of the conflict areas as a country's trade partners, and the impact of a regional conflict on a country's trade with the region. First, with a major exception of the Middle East, many of the regions which require peacekeeping have very limited amounts of trade with the sample countries (e.g. Angola, Cambodia, the former Yugoslavia, Haiti, Rwanda, Somalia). Second, when a conflict area is a country's trade partner, the country's amount of trade with the region is likely to decrease as the conflict intensifies, and is likely to increase as the regional peace is established. In such a case, the country's trade with the region would be negatively correlated with the level of UN peacekeeping effort in the region.

3.7 Concluding Remarks

In this chapter, a reduced-form UN peacekeeping contribution function was derived using a joint-product approach. The function was estimated with the two-stage least

square method, for each of the 25 sample countries for the period of 1975–96. Although the approach used here is common in the military expenditure literature, the estimation results found for peacekeeping contributions are quite different from the ones typically found for defense expenditures; a country's peacekeeping contributions react strongly and positively to spillins, and very little to the country's income fluctuations. Assessment-based financing, the insignificance of the share of national income devoted to peacekeeping, and the urgency of peacekeeping are likely to be the determinants of such findings.

Peacekeeping often requires quick response to the changing nature of a conflict; a change in the timing of troop deployment by a few months could mean a difference between success and failure of the entire operation. In this sense, peacekeeping is more comparable to fighting small-scale wars around the globe than peacetime military build-up of allied countries. Due to this urgent nature of peacekeeping, once an assessment letter from the General Assembly is received, a country is required to pay the assessed amount within 30 days. Although a country's peacekeeping assessments remain a minuscule portion of its national income, prompt payment of the amount due seems to be a difficult task for many countries. In this chapter, we focused our study on the *amount* of peacekeeping contributions. The *promptness* of contributions should also be studied in the future.

Despite the absence of effective sanctions against nonpayment, assessment shares seem to be an important determinant of countries' peacekeeping contributions. In order to improve the estimation further, a country's assessments should be explicitly included in the model. This will be the topic of the next chapter.

CHAPTER 4 EFFECTS OF UN PEACEKEEPING SPECIAL ASSESSMENTS

4.1 Introduction

In the previous chapter, a reduced-form UN peacekeeping financial contribution function was derived using a joint-product approach, and then estimated for each of the 25 sample countries, using the two-stage least square method. From the estimation results, it is clear that the assessments are an important determinant of actual peacekeeping contributions, despite the fact that there are no effective sanctions against nonpayment. The purpose of this chapter is to incorporate the assessments into a peacekeeping contribution function, and to explore the possibility of increasing a UN member state's incentive to contribute by adjusting its assessment for each peacekeeping operation.

Following a discussion of the basics of UN peacekeeping special assessment system, we study the effectiveness of the system empirically through observing the change in the patterns of member states' financial contributions to UNFICYP, which had been financed solely by voluntary contributions until 1992, and since then, financed mainly by special assessments. The number of contributing countries and the amount contributed by each country have changed considerably with the creation of UNFICYP special assessment account in 1992. A possible explanation for these changes is presented, and based on the hypothesis, assessments are incorporated into a member state's utility function. Derived financial contribution curves for an individual peacekeeping operation and equilibrium levels of contributions are graphically illustrated. It is argued that the

existence of assessments will shift up a downward sloping contribution curve, and create a *contribution-ceiling* , beyond which a country is unlikely to contribute.

As discussed in Chapter 1, the valuation of public benefits created by a peacekeeping operation is likely to vary across countries depending on the location and the nature of the operation. Using a two-state, two-peacekeeping operation model, we examine whether the United Nations could increase total peacekeeping contributions to each operation by adjusting the assessments according to each member state's valuation of peacekeeping public benefits.

4.2 Development of UN Peacekeeping Financing

The term, *peacekeeping* does not appear anywhere in the UN Charter. Neither do the rules on the financing of peacekeeping. As Hill and Malik (1996) point out, peacekeeping *developed* during the Cold War period as a tool which prevents the two superpowers from getting involved directly in regional conflicts. The financing methods of peacekeeping also developed during the same period. The first three peacekeeping operations, UNSCOB (1947–52), UNTSO (1948 to date), and UNMOGIP (1949 to date) are/were financed through the biennial UN regular budget, just like other UN activities. The next, larger-scale operation, UNEF I (1956–67) as well as ONUC (1960–64) were financed through assessment accounts. Although these assessment accounts were set up separately from the regular budget, member states were assessed based on the regular budget assessment scale with small adjustments. Due to withholding of payment to the UNEF I and ONUC accounts by some member states, the United Nations found itself in serious financial crisis. In order to cover the short-falls, $169 million of bonds were issued in 1962. Also, the next two operations, UNSF/UNTEA (1962–63) and UNYOM (1963–64) were financed solely by countries most directly involved, and UNFICYP (1964 to date) had been financed through voluntary contributions. After financing the next two

small-scale observer missions, DOMREP (1965–66) and UNIPOM (1965–66) through the regular budget, the United Nations established a special assessment account in order to finance UNEF II (1973–79). All the following peacekeeping operations except for UNGOMAP (1988–90) have been financed through similar special assessment accounts.

4.3 Special Assessments

The advantage of using separate special assessment accounts rather than the UN regular budget is that the United Nations does not have to wait until the General Assembly approves the next biennial regular budget to request member states the fund for newly established operations and for unexpected expansions of ongoing operations. This is crucial because only a very limited amount of cash reserve is currently available for peacekeeping. As the Independent Advisory Group on UN Financing (1993) points out, the disadvantage of separate special assessment accounts is that it is difficult for member states to respond promptly to assessment requests since they receive the assessment letters through out their budgetary cycles. If the United Nations is to decrease the frequency of assessment requests, the UN Peacekeeping Reserve Fund must be increased substantially. If the current assessment system is to be maintained, each member state should create a cash reserve of its own.

The special assessment scale assigns approximately 97 percent of the total assessments to less than 30 member states which belong to Group A and Group B (see Chapter 1). Furthermore, approximately 80 percent of the total assessments is assigned to the seven wealthiest member states.

Since the very first peacekeeping assessment account was established for UNEF I, the United Nations has been suffering from undercontributions by its member states. Table 4.2 shows the peacekeeping arrears for each year during 1980–96. The arrears stayed relatively constant during the 1980s, the average being $275.9 millions. As the

Table 4.1 UN peacekeeping assessment shares: 1996

Member state	Assessment (%)
United States	31
Japan	15
Germany	9
France	8
United Kingdom	7
Russia	6
Italy	5
Canada	3
Spain	2
176 others	14
Total	100

SOURCE: United Nations (1997), *Status of Contributions as at December 1996.*

Table 4.2 UN peacekeeping arrears: 1980–96

(in millions of US dollars)

Year	Arrears
1980	260.8
1981	214.0
1982	208.4
1983	291.6
1984	323.5
1985	262.1
1986	312.3
1987	363.0
1988	355.2
1989	444.2
1990	346.2
1991	357.8
1992	664.3
1993	992.8
1994	1,286.4
1995	1,723.9
1996	1,633.0
1997	1,574.1
1998	1,593.9

SOURCE: Global Policy Forum, Internet Site, http://www.globalpolicy.org.

Cold War ended, and the special assessments increased in the first half of the 1990s, the arrears also increased from $346.2 millions in 1990 to $1723.9 millions in 1995.

The only sanction against nonpayment of assessed contributions is Article 19 of the UN Charter, which states that "a Member of the United Nations which is in arrears in the payment of its financial contributions to the Organization shall have no vote in the General Assembly if the amount of its arrears equals or exceeds the amount of the contributions due from it for the preceding two full years." In order to avoid the application of Article 19, a member state simply needs to keep its arrears below the amount it was assessed for the preceding two years. For instance, although the United States owes nearly $1.7 billion ($620 million for the regular budget and slightly more than $1 billion for peacekeeping and tribunals) as of February 1999, it needs to contribute only $250 million by the end of 1999 in order to avoid losing its General Assembly vote in 2000. The United States avoided losing its General Assembly vote in 1999 by contributing the minimum required amount of approximately $350 million by the end of 1998, reducing its arrears from approximately $1.7 billion (February 1998) to $1.3 billion (December 1998). The United Nations does not have the authority to charge interest on late payment. Moreover, even if the United States (or any other permanent member of the Security Council) loses its vote in the General Assembly under Article 19, it would still have a veto power in the Security Council.

As of March 1999, there are 37 member states without their vote in the General Assembly[1]. The application of Article 19 is not automatic, however; the United Nations has occasionally chosen not to impose the sanction. For instance, in the early 1960s, dissatisfied with the handling of the Congo crisis by ONUC, the Soviet Union and France

[1]They are Afghanistan, Bosnia and Herzegovina, Burundi, Cambodia, Cape Verde, Central African Republic, Congo, Democratic Republic of the Congo, Dominica, Ecuador, Equatorial Guinea, Gambia, Georgia, Grenada, Guinea, Guinea-Bissau, Haiti, Honduras, Iraq, Kyrgyzstan, Liberia, Mauritania, Mongolia, Nicaragua, Niger, Republic of Moldova, Rwanda, Saint Vincent and the Grenadines, Sao Tome and Principe, Seychelles, Sierra Leone, Somalia, Togo, Turkmenistan, Vanuatu, Yemen, and Yugoslavia (United Nations Office of the Spokesman for the Secretary-General, Internet site, http://www.un.org/News/ossg/.)

refused to pay their assessed contributions. When the Soviet Union accumulated the equivalent of two years' arrearages, the General Assembly avoided the application of Article 19 by proceeding for two sessions without any vote. As Fetherston (1994) points out, "had there been such a vote, the Soviet Union would probably have left the UN, along with its satellite states and other sympathetic states."

4.4 Effectiveness of Special Assessment System

As we can see from the arrears accumulated by member states, the special assessment system combined with Article 19 does not provide all member states with enough incentives to make timely payments of full assessed contributions. This does not necessarily mean complete ineffectiveness of the special assessment system, however. Table 4.3 shows the monthly arrears of selected member states for 1998. Canada and the United Kingdom accumulated only a very small arrears throughout the year, and entered 1999 without arrears for both peacekeeping special assessment accounts and the regular budget. Others, with an exception of the United States, also kept their arrears well below the Article 19 limit.

One way of showing the effectiveness of special assessment system is to compare member states' contribution patterns under the assessment system to the patterns under voluntary contribution system. Since its inception in 1964, UNFICYP had been financed solely by voluntary contributions until 1992. It is the only peacekeeping operation for which a voluntary contributions were used as a primary financial source. As Mills (1990) states, "the difficulties inherent in ensuring continued operations on such an uncertain financial basis are, with the benefit of experience, now so widely understood that this type of approach is unlikely to be used another time." No more than 35 countries contributed to the UNFICYP voluntary contribution account in any biennial period during 1975–91, and the United Nations had fallen ten years behind in reimbursing troop-

Table 4.3 Monthly peacekeeping (PK) and regular budget (Reg) arrears: 1998

(in millions of US dollars)

Country		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
United States	PK	940	1,004	958	958	966	966	943	1,041	1,073	961	978	976
	Reg	671	671	619	619	569	569	569	569	563	513	316	316
Japan	PK	89	137	14	14	19	19	19	89	107	97	98	98
	Reg	189	189	142	142	142	142	142	142	0	0	0	0
Germany	PK	10	36	10	10	10	10	10	47	20	10	15	9
	Reg	51	51	51	51	51	51	0	0	0	0	0	0
France	PK	9	28	22	22	23	22	2	28	36	21	24	5
	Reg	0	0	0	0	0	0	0	0	0	0	0	0
Italy	PK	5	20	20	20	7	7	5	21	22	22	9	3
	Reg	57	57	57	57	57	0	0	0	0	0	0	0
United Kingdom	PK	0	17	0	0	2	0	0	19	6	0	3	0
	Reg	27	27	27	0	0	0	0	0	0	0	0	0
Russia	PK	136	146	128	128	129	129	129	139	125	124	126	126
	Reg	28	0	0	0	0	0	0	0	0	0	0	0
Canada	PK	0	8	0	0	0	0	0	9	3	0	1	0
	Reg	0	0	0	0	0	0	0	0	0	0	0	0
Spain	PK	0	7	7	7	1	1	0	8	11	11	4	4
	Reg	27	27	0	0	0	0	0	0	0	0	0	0

SOURCE: Global Policy Forum, Internet Site, http://www.globalpolicy.org.

contributing countries, losing their support as a result (James 1995). In order to improve the situation, the UNFICYP special assessment account was set up with the Security Council Resolution 831 of May 1993, and the phase out of the voluntary contribution account was began. While 33 member states plus Switzerland voluntarily contributed during the 1990–91 period, 81 member states contributed through the special assessment account in 1994.[2] Considering the fact that the situation in Cyprus has changed very

Table 4.4 Number of countries which financially contributed towards UNFICYP: 1976–96

Year	Contributing countries
1976–77	34
1978–79	34
1980–81	34
1982–83	32
1984–85	35
1986–87	32
1988–89	34
1990–91	34
1992–93	55
1994	82
1995	93
1996	98

SOURCES: United Nations (1994–97), *Status of Contributions*. United Nations (various years), *Financial Report*.

little since the invasion by Turkey in 1974, it is safe to assume that this increase in the number of contributors is due to the establishment of special assessment account. Although the total amount contributed in each year did not change very much since 1993, there was a noticeable change in the distribution of contributions across member states. The change was in general accordance with the assessment scale. For instance, Japan, France and Canada have increased their annual contributions substantially, while the United Kingdom has done quite the opposite. Germany, France, and the United

[2]Switzerland continued to contribute through the voluntary contribution account.

Kingdom have contributed their annual assessments in full every year since 1993.

If keeping the General Assembly vote is the only incentive for a member state to comply with assessments, the country is likely to accumulate arrears, and maintain them slightly under the Article 19 limit. Currently, the United States is the only major contributor showing such a behavior. Member states which accumulate no arrears, or maintain relatively low arrears, and contribute more under the special assessment system must have extra incentives to contribute. In other words, it must be the case that the special assessment system increases contributor-specific benefits or undercontributor-specific damages of member states, even without sanctions.

From not voluntarily contributing towards the peacekeeping operation in Cyprus, Japan might suffer some damages in its relationship with European countries and the United States, although the stability of Cyprus has very little direct influence on Japan. The damages would become larger if there are formal assessments, and Japan refuses to comply.

For each mandate period, a UN peacekeeping operation has target expenditures, or target total contributions, which are required for the level of peacekeeping activities unanimously approved by the General Assembly. With a special assessment system, each member state bears formal responsibilities of achieving this target. If Japan undercontributes, the members, including Japan, immediately realize that the level of peacekeeping activities considered necessary by the United Nations is now unachievable due to Japan's undercontribution. On the other hand, with a voluntary contribution system, as long as Japan makes some contributions, it is difficult for the members, including Japan, to agree on whether Japan is responsible for the United Nations not being able to achieve that level of peacekeeping activities. Special assessment system provides member states with a common yardstick; they observe how much of assessed amounts each country contributes, or how much of formal responsibilities each country fulfills, and it becomes easier for them to blame countries which are less willing to

Table 4.5 Annual financial contributions towards UNFICYP by selected UN member states: 1976–96

(in US dollars)

Year	United States	Japan	Germany	France	United Kingdom	Italy	Canada
1976–77	12,000,000	300,000	1,000,000	0	3,276,190	580,000	0
1978–79	6,725,000	350,000	1,000,000	0	3,105,887	487,184	0
1980–81	8,925,000	250,000	1,040,230	0	3,836,592	200,000	0
1982–83	11,250,000	600,000	946,133	0	3,801,087	600,000	0
1984–85	6,747,655	400,000	839,441	0	2,320,205	400,000	0
1986–87	8,803,153	400,000	1,424,955	0	2,467,996	700,000	0
1988–89	8,718,000	200,000	1,586,359	0	2,109,362	457,693	0
1990–91	6,668,650	600,000	1,678,950	170,469	2,735,788	417,259	0
1992	10,855,000	200,000	2,144,699	88,496	2,990,814	200,000	0
1993	10,855,000	1,256,648	2,902,600	731,621	3,528,895	200,000	263,928
1994	5,855,879	2,699,935	1,936,582	1,643,585	1,375,141	1,294,436	674,465
1995	6,346,340	2,828,418	1,812,622	1,590,326	1,325,436	971,191	622,454
1996	2,810,875	1,676,792	1,989,393	1,740,238	1,444,212	564,634	682,565

SOURCES: United Nations (1994-97), *Status of Contributions.* United Nations (various years), *Financial Report.*

contribute. As a result, undercontributor-specific damages increase, and each member state's incentives to contribute increase.

Ceteris paribus, these *assessment effects* are likely to be stronger for a group with smaller membership size. Although the United Nations consists of 185 countries as of 1999, the seven wealthiest member states finance nearly 80 percent of the UN peacekeeping budget, as mentioned earlier. This highly skewed assessment scale allows them to ignore the tiny financial responsibilities imposed on *each* of the other 178 countries, and to interact with each other as if the membership size of the United Nations is eight: the seven wealthiest countries plus the others combined. For instance, the criticism against the United States which has accumulated arrears close to its Article 19 limit is much stronger than the criticism against each of the smaller member states whose arrears has already exceeded their Article 19 limits. This is simply due to the enormous difference in the sizes of their arrears, which stems from the highly skewed assessment scale.

4.5 Theoretical Models

In the previous chapter, a member state's contribution function was derived for the entire UN peacekeeping activities. Here, instead, a country's contribution to *each* peacekeeping operation is studied. For simplicity, it is assumed that peacekeeping activities itself creates only purely public benefits. Also, the residual peacekeeping expenditures coming from the UN regular budget and taste-shifting parameter are ignored in order to focus on the effects of special assessment system on member states' contributions.

Two different models are presented in the order of increasing complexity. In Model 1, we consider a single member state's contribution to a single peacekeeping operation. With this model, the basic effects of special assessments on a country's contribution is analyzed. In Model 2, we consider two member states' contributions to two peacekeeping operations. With this model, we explore the possibility of increasing total contributions

to each operation by adjusting each member state's assessments, while holding its total assessments constant. In the both models, each country is represented by its central government, which maximizes its utility by allocating its revenue between peacekeeping and all other activities.

4.5.1 Model 1

Consider a UN member state i, whose utility depends on the level of nation-specific non-peacekeeping activities (y_i) and the level of a peacekeeping operation (C). In this model, the United Nation is assumed to conduct only a single peacekeeping operation. The operation is financed by voluntary contributions from n member states, including i. Country i faces a budget constraint,

$$R_i = y_i + c_i, \tag{4.1}$$

where R_i is the revenue of its central government, and c_i is its contribution to the operation. The prices of y_i and c_i are assumed to be one. Country i maximizes its utility function,

$$U^i = U^i(y_i, C), \tag{4.2}$$

with respect to (4.1). (4.2) is increasing and strictly concave in its both arguments.

Since the operation is financed by n countries,

$$C = c_i + \sum_{j \neq i}^{n} c_j. \tag{4.3}$$

$\sum_{j \neq i}^{n} c_j$ is held constant for country i at the best-response level of the other $n-1$ countries. From the first-order conditions of country i, we obtain

$$\frac{\frac{\partial U^i}{\partial C}}{\frac{\partial U^i}{\partial y_i}} = 1. \tag{4.4}$$

Country i's peacekeeping contribution curve is illustrated in Figure 4.1. The height

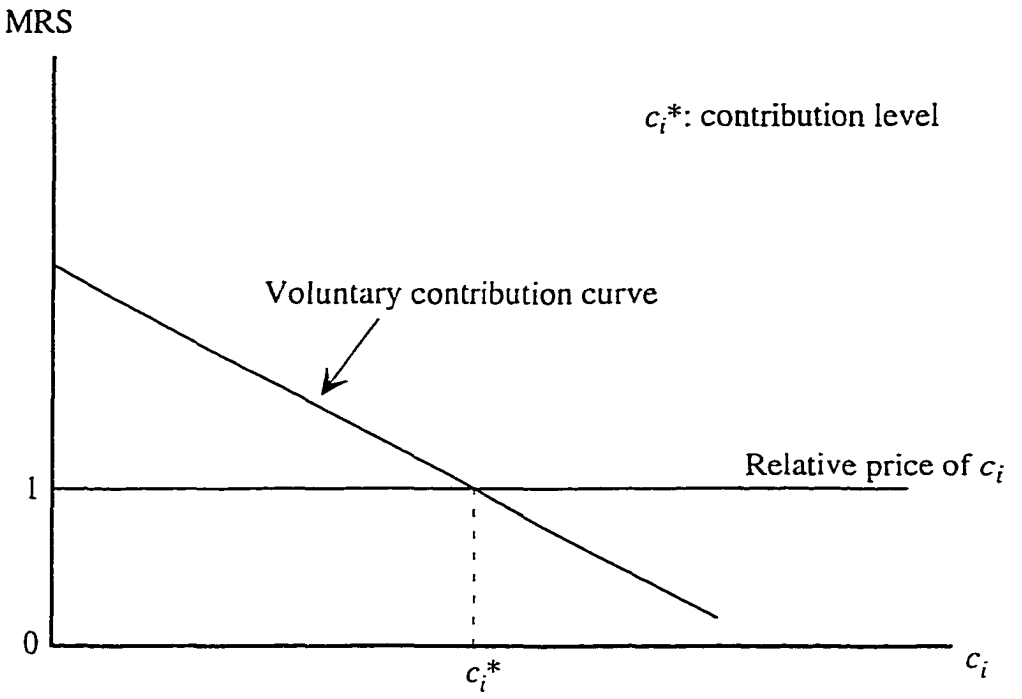

Figure 4.1 Country i's contribution curve (with no assessment)

of the contribution curve is $\frac{\frac{\partial U^i}{\partial C}}{\frac{\partial U^i}{\partial y_i}}$, which is a decreasing function of c_i. At the utility maximizing contribution level, c_i^*, (4.4) is satisfied.

Until 1992, the maximum contributions made voluntarily by Japan for UNFICYP was \$600,000 per year (the 1990–91 two-year period). After the creation of the UNFICYP special assessment account, Japan was assessed \$2,699,935 in 1994 and \$2,828,418 in 1995, and contributed the full amount by the end of each year (See Table 4.5). If Japan decides the amount of its contributions by equating the marginal benefit of contributions to the marginal cost (\$1), the marginal benefit of \$600,000 contribution in 1994 and 1995 must have been much higher than the marginal benefit of \$600,000 contribution (\$1) in the 1990–91 period, and it is likely that this was mainly due to the newly created special assessment account.

Going back to the model, let us suppose that the United Nations switches the financing method of operation C from voluntary contributions to special assessments imposed on n member states. With this change, now country i's utility depends not only on y_i and C, but also on its assessment ($\bar{c}_i$) and contribution (c_i) in the form of an *assessment effect function*,

$$\alpha^i = \alpha^i(\bar{c}_i, c_i), \tag{4.5}$$

when $\bar{c}_i \geq c_i$. α^i is increasing in $\bar{c}_i$, and decreasing in c_i. The utility function of country i becomes

$$U^i = U^i(y_i, C, \alpha^i(\bar{c}_i, c_i)) \qquad \textit{when } \bar{c}_i \geq c_i, \tag{4.6}$$

$$U^i = U^i(y_i, C) \qquad \textit{when } \bar{c}_i < c_i.$$

(4.6) is non-increasing in α^i (and $\bar{c}_i$), and increasing and strictly concave in y_i, C and c_i. By introducing $\alpha^i(\bar{c}_i, c_i)$ into the utility function, we are able to see the effects of contributor-specific benefits (or undercontributor-specific damages) associated with the creation of special assessment system. When $\bar{c}_i \geq c_i$, country i maximizes (4.6) subject to its budget constraint (4.1) and a *contribution ceiling*, $\bar{c}_i \geq c_i$. The Lagrangian function becomes

$$L_i = U^i(y_i, C, \alpha^i(\bar{c}_i, c_i)) + \lambda_i[R_i - y_i - c_i] + \mu_i[\bar{c}_i - c_i]. \tag{4.7}$$

From the first-order conditions, we obtain

$$\frac{\frac{\partial U^i}{\partial C}}{\frac{\partial U^i}{\partial y_i}} + \frac{\frac{\partial U^i}{\partial \alpha^i}\frac{\partial \alpha^i}{\partial c_i} - \mu_i}{\frac{\partial U^i}{\partial y_i}} = 1. \tag{4.8}$$

Figure 4.2 illustrates country i's peacekeeping contribution curve and its utility maximizing contribution level, c_i^*, at which, (4.8) is satisfied. Introducing an assessment effect function shifts the contribution curve up vertically by $\frac{\frac{\partial U^i}{\partial \alpha^i}\frac{\partial \alpha^i}{\partial c_i}}{\frac{\partial U^i}{\partial y_i}}$, and creates a contribution ceiling, or a kink at the point where the contribution reaches $\bar{c}_i$. The fact that

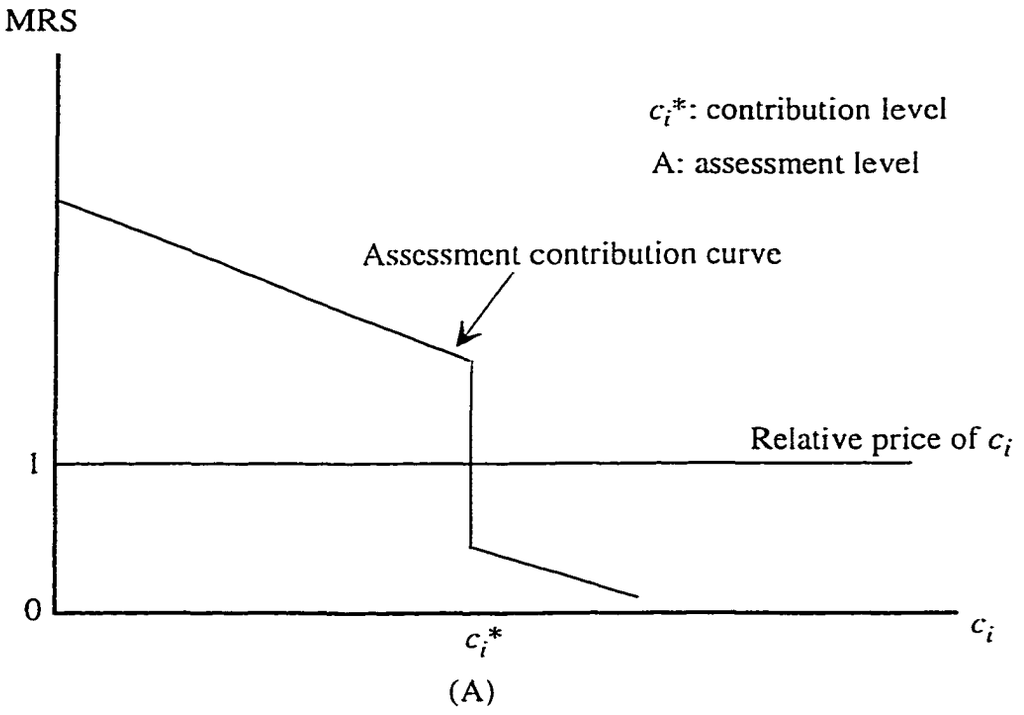

Figure 4.2 Country i's contribution curve (with assessment)

many countries choose to contribute the exact assessed amounts each year, not even a penny more or less, is explained by this kink.

Although country i is contributing the full assessed amount in Figure 4.2, this does not always have to be the case. When the vertical shift of the contribution curve is relatively small, and/or the assessment is set too large, the country tends to undercontribute. Likewise, when $\frac{\frac{\partial U^i}{\partial C}}{\frac{\partial U^i}{\partial y_i}}$ is sufficiently large, and/or the assessment is set too small, the country is likely to overcontribute. In reality, no member state overcontributes intentionally to special assessment accounts. Instead, some member states make cash or in-kind voluntary contributions.[3]

[3]Since 1973, with an exception of UNFICYP, voluntary contributions in cash toward a peacekeeping operation have been used to meet the operation's start-up costs. When assessed contributions sufficient for the maintenance of the operation are received, they are repaid to the donor(s).

Until 1992, the minimum contributions made voluntarily by the United Kingdom for UNFICYP was $2,109,362 per year (the 1988–89 two-year period). After the creation of the UNFICYP special assessment account, the United Kingdom was assessed $1,375,141 in 1994 and $1,325,436 in 1995, and contributed the exact assessed amount by the end of each year (See Table 4.5). In other words, the United Kingdom has *reduced* its annual contribution to UNFICYP after the creation of special assessment account. In order to explain this reduction, we need to take into account the impact on UK contribution of an increase in other countries' contributions.

Again, returning to the model, let us suppose that $\sum_{j\neq i}^{n} c_j^*$ increases as the United Nations alter the financing method from voluntary contribution to special assessments. With the assumption of strict quasiconcavity, $\frac{\frac{\partial U^i}{\partial C}}{\frac{\partial U^i}{\partial y_i}}$ must decrease as $\sum_{j\neq I}^{n} c_j^*$ increases. In this case, $\bar{c}_i$ being smaller than the level of country i's initial voluntary contribution is a sufficient condition for i's contribution reduction. Figure 4.3 illustrates the case. As $\sum_{j\neq I}^{n} c_j^*$ increases, the voluntary contribution curve with the height of $\frac{\frac{\partial U^i}{\partial C}}{\frac{\partial U^i}{\partial y_i}}$ shifts down. The level of country i's contribution decreases from c_v to c_i^* as the United Nations switch the financing method of operation C from voluntary contributions to assessments.

4.5.2 Model 2

Given the fact that the United Nations is composed of sovereign nations, improving the compliance of its member states to their assessments by imposing tougher penalties is rather difficult. According to the contribution model developed above, it is possible for the United Nations to increase its member states' contributions simply by increasing their assessments. In fact, as Independent Advisory Group on UN Financing (1993) reports, "the U.N. Secretariat seems to have overbudgeted for some peacekeeping missions so that some extra cash is available for other missions, and for the regular budget." This can not be a long-term solution for the organization's financial crisis, however. As soon as the member states realize the over-budgeting practice by the Secretariat, the

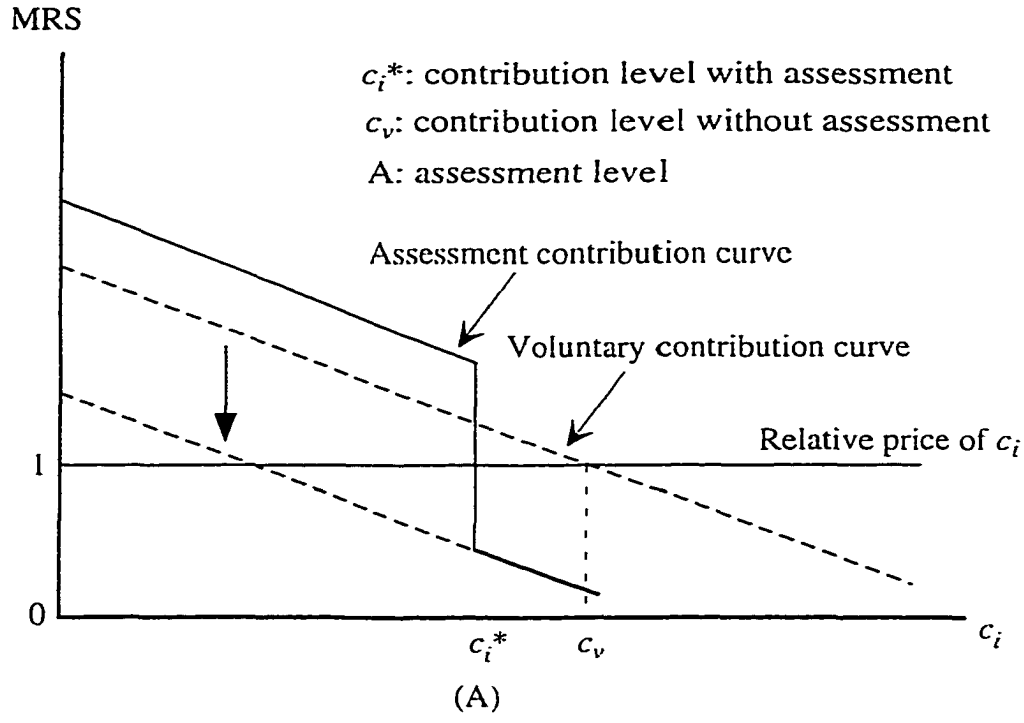

Figure 4.3 Country i's contribution curves (with and without assessment)

assessment effect functions will be affected, and their contributions are likely to decrease.

As long as the United Nations choose to depend on direct contributions from its member states for its financing, it needs to explore the possibilities of improving the assessment compliance without depending on tougher penalties nor over-budgeting. One tool which the organization is able to use without facing strong opposition, and yet might have some impact on each member's contribution incentives is assessment share adjustments. The UN peacekeeping assessment scale is based solely on the ability to pay of each member state, and not on its valuation of benefits received. For example, under the 1996 assessment scale, Japan and Germany were required to finance, respectively 15 percent and 9 percent of every on-going operation financed through special assessments, regardless of the location and nature of the operation. Considering proximity, however,

Japan is likely to place greater value on the stability of Asia than that of Eastern Europe, while Germany is likely to place greater value on the stability of Eastern Europe than that of Asia.

Using the contribution model developed above, we now examine the effects on the assessment compliance of adjusting assessment shares across countries for each peacekeeping operation. Consider two hypothetical UN member states, J and G. Each country's utility depends on the level of nation-specific non-peacekeeping activities (y), the level of a peacekeeping operation (A), the level of another operation (E), and on assessment effect functions for the two operations. The utility function is

$$U^i = U^i(y_i, A, E, \alpha^i(\overline{A}_i, A_i), \varepsilon^i(\overline{E}_i, E_i)), \qquad (i = J, G) \tag{4.9}$$

where α^i and ε^i are assessment effect functions associated with operation A and E, respectively. An assessment effect function depends on the country's assessment ($\overline{A}_i$ for α^i, $\overline{E}_i$ for ε^i) and its contribution (A_i for α^i, E_i for ε^i). It is increasing in the assessment, and decreasing in the contribution. The two operations are financed by J and G, that is,

$$A_J + A_G = A, \tag{4.10}$$

$$E_J + E_G = E. \tag{4.11}$$

(4.9) is non-increasing in α^i and ε^i, and increasing and strictly concave in y_i, A, E, A_i, and E_i. For simplicity, it is assumed that a country never overcontributes. The assessments conform to the following *assessment rules.*

$$\overline{A}_J + \overline{A}_G = \overline{A}, \tag{4.12}$$

$$\overline{E}_J + \overline{E}_G = \overline{E}, \tag{4.13}$$

$$\overline{A}_J + \overline{E}_J = \left(\frac{I_J}{I_J + I_G}\right)(\overline{A} + \overline{E}), \tag{4.14}$$

$$\overline{A}_G + \overline{E}_G = \left(\frac{I_G}{I_J + I_G}\right)(\overline{A} + \overline{E}), \tag{4.15}$$

where $\overline{A}$ and $\overline{E}$ are the total assessments for operation A and E, and I_J and I_G are the national income of countries J and G, respectively. (4.12) and (4.13) indicate that the two operations are financed through assessments imposed on countries J and G. (4.14) and (4.15) indicate that each country's *total* assessment is based on its national income share. Notice that it is different from the assessment rule used by the United Nations; a country's assessment for *each* operation does not have to be based on the country's income share. $\overline{A}$, $\overline{E}$, I_J, and I_G are assumed to be fixed hereafter.

By differentiating the assessment rules, (4.12), (4.13), (4.14), and (4.15), we obtain

$$\frac{\partial \overline{A}_G}{\partial \overline{A}_J} = -1, \tag{4.16}$$

$$\frac{\partial \overline{E}_G}{\partial \overline{E}_J} = -1, \tag{4.17}$$

$$\frac{\partial \overline{E}_J}{\partial \overline{A}_J} = -1, \tag{4.18}$$

$$\frac{\partial \overline{E}_G}{\partial \overline{A}_G} = -1. \tag{4.19}$$

Additionally, from (4.17) and (4.18), we obtain

$$\frac{\partial \overline{E}_G}{\partial \overline{A}_J} = 1. \tag{4.20}$$

(4.16), (4.18), and (4.20) are the *assessment adjustment rules* with respect to $\overline{A}_J$. If $\overline{A}_J$ is to be increased by one, $\overline{A}_G$ and $\overline{E}_J$ need to be reduced by one, while $\overline{E}_G$ needs to be increased by one.

Each country maximizes its utility function, (4.9), subject to its budget constraint,

$$R_i = y_i + A_i + E_i, \qquad (i = J, G) \tag{4.21}$$

and its contribution ceilings, $\overline{A}_i \geq A_i$ and $\overline{E}_i \geq E_i$. R_i is the revenue of its central government. The spillins (A_G and E_G for J, A_J and E_J for G) are held constant at the

best response levels of the spillin provider. The prices of y_i, A_i and E_i are assumed to be one. The Lagrangian function is

$$L_i = U^i(y_i, A, E, \alpha^i(\overline{A}_i, A_i), \varepsilon^i(\overline{E}_i, E_i)) + \lambda_i[R_i - y_i - A_i - E_i] \tag{4.22}$$

$$+\mu_i[\overline{A}_i - A_i] + \varphi_i[\overline{E}_i - E_i] \qquad (i = J, G)$$

The first-order conditions for $i = J, G$ are

$$\frac{\partial L_i^*}{\partial y_i} = \frac{\partial U^{i*}}{\partial y_i} - \lambda_i^* = 0, \tag{4.23}$$

$$\frac{\partial L_i^*}{\partial A_i} = \frac{\partial U^{i*}}{\partial A} + \frac{\partial U^{i*}}{\partial \alpha^i}\frac{\partial \alpha^{i*}}{\partial A_i} - \lambda_i^* - \mu_i^* = 0, \tag{4.24}$$

$$\frac{\partial L_i^*}{\partial E_i} = \frac{\partial U^{i*}}{\partial E} + \frac{\partial U^{i*}}{\partial \varepsilon^i}\frac{\partial \varepsilon^{i*}}{\partial E_i} - \lambda_i^* - \varphi_i^* = 0, \tag{4.25}$$

$$\frac{\partial L_i^*}{\partial \lambda_i} = R_i - y_i^* - A_i^* - E_i^* = 0, \tag{4.26}$$

$$\mu_i^*\frac{\partial L_i^*}{\partial \mu_i} = \mu_i^*(\overline{A}_i - A_i^*) = 0, \qquad \mu_i^* \geq 0, \qquad (\overline{A}_i - A_i^*) \geq 0, \tag{4.27}$$

$$\varphi_i^*\frac{\partial L_i^*}{\partial \varphi_i} = \varphi_i^*(\overline{E}_i - E_i^*) = 0, \qquad \varphi_i^* \geq 0, \qquad (\overline{E}_i - E_i^*) \geq 0. \tag{4.28}$$

The effects of assessment adjustments on each country's contributions are studied using a comparative statics analysis with respect to $\overline{A}_J$. From a first-order condition (4.23) for country J and the assessment adjustment rules with respect to $\overline{A}_J$, we obtain

$$\frac{\partial^2 U^{J*}}{\partial y_J^2}\frac{\partial y_J^*}{\partial \overline{A}_J} + \left(\frac{\partial^2 U^{J*}}{\partial y_J \partial A} + \frac{\partial^2 U^{J*}}{\partial y_J \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J}\right)\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial^2 U^{J*}}{\partial y_J \partial A}\frac{\partial A_G^*}{\partial \overline{A}_J} \tag{4.29}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial y_J \partial E} + \frac{\partial^2 U^{J*}}{\partial y_J \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\frac{\partial E_J^*}{\partial \overline{A}_J} + \frac{\partial^2 U^{J*}}{\partial y_J \partial E}\frac{\partial E_G^*}{\partial \overline{A}_J}$$

$$\frac{\partial^2 U^{J*}}{\partial y_J \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial \overline{A}_J} - \frac{\partial^2 U^{J*}}{\partial y_J \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial \overline{E}_J} - \frac{\partial \lambda_J^*}{\partial \overline{A}_J} = 0.$$

From a first-order condition (4.24) for country J and the assessment adjustment reules with respect to $\overline{A}_J$, we obtain

$$\left(\frac{\partial^2 U^{J*}}{\partial A \partial y_J} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial y_J}\right)\frac{\partial y_J^*}{\partial \overline{A}_J} + \left(\frac{\partial^2 U^{J*}}{\partial A^2} + \frac{\partial^2 U^{J*}}{\partial A \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J}\right)\frac{\partial A_J^*}{\partial \overline{A}_J} \tag{4.30}$$

$$+\left(\frac{\partial U^{J*}}{\partial \alpha^J}\frac{\partial^2 \alpha^{J*}}{\partial A_J^2} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial A} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^{J2}}\frac{\partial \alpha^{J*}}{\partial A_J}\right)\frac{\partial A_J^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A^2} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial A}\right)\frac{\partial A_G^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A \partial E} + \frac{\partial^2 U^{J*}}{\partial A \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial E} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\frac{\partial E_J^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A \partial E} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial E}\right)\frac{\partial E_G^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A \partial \alpha^J} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^{J2}}\right)\frac{\partial \alpha^{J*}}{\partial \overline{A}_J} - \left(\frac{\partial^2 U^{J*}}{\partial A \partial \varepsilon^J} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial \varepsilon^J}\right)\frac{\partial \varepsilon^{J*}}{\partial \overline{E}_J}$$

$$+\frac{\partial U^{J*}}{\partial \alpha^J}\frac{\partial^2 \alpha^{J*}}{\partial A_J \partial \overline{A}_J} - \frac{\partial \lambda_J^*}{\partial \overline{A}_J} - \frac{\partial \mu_J^*}{\partial \overline{A}_J} = 0.$$

From a first-order condition (4.25) for country J and the assessment adjustment reules with respect to $\overline{A}_J$, we obtain

$$\left(\frac{\partial^2 U^{J*}}{\partial E \partial y_J} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial y_J}\right)\frac{\partial y_J^*}{\partial \overline{A}_J} \tag{4.31}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E \partial A} + \frac{\partial^2 U^{J*}}{\partial E \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial A} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J}\right)\frac{\partial A_J^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E \partial A} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial A}\right)\frac{\partial A_G^*}{\partial \overline{A}_J} + \left(\frac{\partial^2 U^{J*}}{\partial E^2} + \frac{\partial^2 U^{J*}}{\partial E \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\frac{\partial E_J^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial U^{J*}}{\partial \varepsilon^J}\frac{\partial^2 \varepsilon^{J*}}{\partial E_J^2} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial E} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^{J2}}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\frac{\partial E_J^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E^2} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial E}\right)\frac{\partial E_G^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E \partial \alpha^J} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial \alpha^J}\right)\frac{\partial \alpha^{J*}}{\partial \overline{A}_J} - \frac{\partial^2 U^{J*}}{\partial E \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial \overline{E}_J} - \frac{\partial U^{J*}}{\partial \varepsilon^J}\frac{\partial^2 \varepsilon^{J*}}{\partial E_J \partial \overline{E}_J}$$

$$-\frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^{J2}}\frac{\partial \varepsilon^{J*}}{\partial \overline{E}_J}-\frac{\partial \lambda_J^*}{\partial \overline{A}_J}-\frac{\partial \varphi_J^*}{\partial \overline{A}_J}=0.$$

From first-order conditions (4.26)–(4.28) for country J and the assessment adjustment reules with respect to $\overline{A}_J$, we obtain

$$-\frac{\partial y_J^*}{\partial \overline{A}_J}-\frac{\partial A_J^*}{\partial \overline{A}_J}-\frac{\partial E_J^*}{\partial \overline{A}_J}=0, \tag{4.32}$$

$$-\mu_J^*\frac{\partial A_J^*}{\partial \overline{A}_J}+(\overline{A}_J-A_J^*)\frac{\partial \mu_J^*}{\partial \overline{A}_J}+\mu_J^*=0, \tag{4.33}$$

$$-\varphi_J^*\frac{\partial E_J^*}{\partial \overline{A}_J}+(\overline{E}_J-E_J^*)\frac{\partial \varphi_J^*}{\partial \overline{A}_J}-\varphi_J^*=0. \tag{4.34}$$

From a first-order condition (4.23) for country G and the assessment adjustment rules with respect to $\overline{A}_J$, we obtain

$$\begin{aligned}&\frac{\partial^2 U^{G*}}{\partial y_G^2}\frac{\partial y_G^*}{\partial \overline{A}_J}+\frac{\partial^2 U^{G*}}{\partial y_G \partial A}\frac{\partial A_J^*}{\partial \overline{A}_J}+\left(\frac{\partial^2 U^{G*}}{\partial y_G \partial A}+\frac{\partial^2 U^{G*}}{\partial y_G \partial \alpha^G}\frac{\partial \alpha^{G*}}{\partial A_G}\right)\frac{\partial A_G^*}{\partial \overline{A}_J}\\&+\frac{\partial^2 U^{G*}}{\partial y_G \partial E}\frac{\partial E_J^*}{\partial \overline{A}_J}+\left(\frac{\partial^2 U^{G*}}{\partial y_G \partial E}+\frac{\partial^2 U^{G*}}{\partial y_G \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial E_G}\right)\frac{\partial E_G^*}{\partial \overline{A}_J}\\&-\frac{\partial^2 U^{G*}}{\partial y_G \partial \alpha^G}\frac{\partial \alpha^{G*}}{\partial \overline{A}_G}+\frac{\partial^2 U^{G*}}{\partial y_G \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial \overline{E}_G}-\frac{\partial \lambda_G^*}{\partial \overline{A}_J}=0.\end{aligned} \tag{4.35}$$

From a first-order condition (4.24) for country G and the assessment adjustment rules with respect to $\overline{A}_J$, we obtain

$$\begin{aligned}&\left(\frac{\partial^2 U^{G*}}{\partial A \partial y_G}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial y_G}\right)\frac{\partial y_G^*}{\partial \overline{A}_J}+\left(\frac{\partial^2 U^{G*}}{\partial A^2}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial A}\right)\frac{\partial A_J^*}{\partial \overline{A}_J}\\&+\left(\frac{\partial^2 U^{G*}}{\partial A^2}+\frac{\partial^2 U^{G*}}{\partial A \partial \alpha^G}\frac{\partial \alpha^{G*}}{\partial A_G}\right)\frac{\partial A_G^*}{\partial \overline{A}_J}\\&+\left(\frac{\partial U^{G*}}{\partial \alpha^G}\frac{\partial^2 \alpha^{G*}}{\partial A_G^2}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial A}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^{G2}}\frac{\partial \alpha^{G*}}{\partial A_G}\right)\frac{\partial A_G^*}{\partial \overline{A}_J}\\&+\left(\frac{\partial^2 U^{G*}}{\partial A \partial E}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial E}\right)\frac{\partial E_J^*}{\partial \overline{A}_J}\\&+\left(\frac{\partial^2 U^{G*}}{\partial A \partial E}+\frac{\partial^2 U^{G*}}{\partial A \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial E_G}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial E}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial E_G}\right)\frac{\partial E_G^*}{\partial \overline{A}_J}\end{aligned} \tag{4.36}$$

$$-\left(\frac{\partial^2 U^{G*}}{\partial A \partial \alpha^G}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^{G2}}\right)\frac{\partial \alpha^{G*}}{\partial \overline{A}_G}+\left(\frac{\partial^2 U^{G*}}{\partial A \partial \varepsilon^G}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial \varepsilon^G}\right)\frac{\partial \varepsilon^{G*}}{\partial \overline{E}_G}$$

$$-\frac{\partial U^{G*}}{\partial \alpha^G}\frac{\partial^2 \alpha^{G*}}{\partial A_G \partial \overline{A}_G}-\frac{\partial \lambda_G^*}{\partial \overline{A}_J}-\frac{\partial \mu_G^*}{\partial \overline{A}_J}=0.$$

From a first-order condition (4.25) for country G and the assessment adjustment rules with respect to $\overline{A}_J$, we obtain

$$\left(\frac{\partial^2 U^{G*}}{\partial E \partial y_G}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial y_G}\right)\frac{\partial y_G^*}{\partial \overline{A}_J}+\left(\frac{\partial^2 U^{G*}}{\partial E \partial A}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial A}\right)\frac{\partial A_J^*}{\partial \overline{A}_J} \tag{4.37}$$

$$+\left(\frac{\partial^2 U^{G*}}{\partial E \partial A}+\frac{\partial^2 U^{G*}}{\partial E \partial \alpha^G}\frac{\partial \alpha^{G*}}{\partial A_G}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial A}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial \alpha^G}\frac{\partial \alpha^{G*}}{\partial A_G}\right)\frac{\partial A_G^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial^2 U^{G*}}{\partial E^2}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial E}\right)\frac{\partial E_J^*}{\partial \overline{A}_J}+\left(\frac{\partial^2 U^{G*}}{\partial E^2}+\frac{\partial^2 U^{G*}}{\partial E \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial E_G}\right)\frac{\partial E_G^*}{\partial \overline{A}_J}$$

$$+\left(\frac{\partial U^{G*}}{\partial \varepsilon^G}\frac{\partial^2 \varepsilon^{G*}}{\partial E_G^2}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial E}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^{G2}}\frac{\partial \varepsilon^{G*}}{\partial E_G}\right)\frac{\partial E_G^*}{\partial \overline{A}_J}$$

$$-\left(\frac{\partial^2 U^{G*}}{\partial E \partial \alpha^G}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial \alpha^G}\right)\frac{\partial \alpha^{G*}}{\partial \overline{A}_G}+\frac{\partial^2 U^{G*}}{\partial E \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial \overline{E}_G}+\frac{\partial U^{G*}}{\partial \varepsilon^G}\frac{\partial^2 \varepsilon^{G*}}{\partial E_G \partial \overline{E}_G}$$

$$+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^{G2}}\frac{\partial \varepsilon^{G*}}{\partial \overline{E}_G}-\frac{\partial \lambda_G^*}{\partial \overline{A}_J}-\frac{\partial \varphi_G^*}{\partial \overline{A}_J}=0.$$

From a first-order condition (4.26)–(4.28) for country G and the assessment adjustment rules with respect to $\overline{A}_J$, we obtain

$$-\frac{\partial y_G^*}{\partial \overline{A}_J}-\frac{\partial A_G^*}{\partial \overline{A}_J}-\frac{\partial E_G^*}{\partial \overline{A}_J}=0, \tag{4.38}$$

$$-\mu_G^*\frac{\partial A_G^*}{\partial \overline{A}_J}+(\overline{A}_G-A_G^*)\frac{\partial \mu_G^*}{\partial \overline{A}_J}-\mu_G^*=0, \tag{4.39}$$

$$-\varphi_G^*\frac{\partial E_G^*}{\partial \overline{A}_J}+(\overline{E}_G-E_G^*)\frac{\partial \varphi_G^*}{\partial \overline{A}_J}+\varphi_G^*=0. \tag{4.40}$$

We are able to solve (4.29)–(4.40) when we impose the following conditions on the assessment effect functions for $i=J,G$:

$$\frac{\partial \alpha^i}{\partial \overline{A}_i}=-\frac{\partial \alpha^i}{\partial A_i}, \tag{4.41}$$

$$\frac{\partial^2 \alpha^i}{\partial A_i \partial \overline{A}_i} = -\frac{\partial^2 \alpha^i}{\partial A_i^2}, \tag{4.42}$$

$$\frac{\partial \varepsilon^i}{\partial \overline{E}_i} = -\frac{\partial \varepsilon^i}{\partial E_i}, \tag{4.43}$$

$$\frac{\partial^2 \varepsilon^i}{\partial E_i \partial \overline{E}_i} = -\frac{\partial^2 \varepsilon^i}{\partial E_i^2}. \tag{4.44}$$

(4.41) and (4.43) imply that the assessment effect functions are simple peacekeeping arrears. That is,

$$\alpha^i = \overline{A}_i - A_i, \tag{4.45}$$

$$\varepsilon^i = \overline{E}_i - E_i. \tag{4.46}$$

for $i = J, G$. These are the only set of assessment effect functions which satisfies the conditions (4.41)–(4.44).

By solving (4.29)–(4.40) under the conditions (4.41)–(4.44), we obtain

$$\frac{\partial y_J^*}{\partial \overline{A}_J} = 0, \tag{4.47}$$

$$\frac{\partial y_G^*}{\partial \overline{A}_J} = 0, \tag{4.48}$$

$$\frac{\partial A_J^*}{\partial \overline{A}_J} = 1, \tag{4.49}$$

$$\frac{\partial A_G^*}{\partial \overline{A}_J} = -1, \tag{4.50}$$

$$\frac{\partial E_J^*}{\partial \overline{A}_J} = -1, \tag{4.51}$$

$$\frac{\partial E_G^*}{\partial \overline{A}_J} = 1, \tag{4.52}$$

$$\frac{\partial \lambda_J^*}{\partial \overline{A}_J} = \frac{\partial \mu_J^*}{\partial \overline{A}_J} = \frac{\partial \varphi_J^*}{\partial \overline{A}_J} = \frac{\partial \lambda_G^*}{\partial \overline{A}_J} = \frac{\partial \mu_G^*}{\partial \overline{A}_J} = \frac{\partial \varphi_G^*}{\partial \overline{A}_J} = 0. \tag{4.53}$$

See Appendix for the intermediate steps.

From (4.49)–(4.52), we obtain

$$\frac{\partial A_i^*}{\partial \overline{A}_J} + \frac{\partial E_i^*}{\partial \overline{A}_J} = 0, \qquad (i = J, G) \tag{4.54}$$

$$\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial A_G^*}{\partial \overline{A}_J} = 0, \tag{4.55}$$

$$\frac{\partial E_J^*}{\partial \overline{A}_J} + \frac{\partial E_G^*}{\partial \overline{A}_J} = 0. \tag{4.56}$$

These results indicate that the redistribution of assessments across the countries and operations have no impact on each country's total contributions ($A_i^* + E_i^*$ for $i = J, G$), nor on total contributions to each operation ($A_J^* + A_G^*$, $E_J^* + E_G^*$), when the conditions (4.41)–(4.44) are satisfied. In other words, the United Nations would not be able to improve its financial situation by the assessment redistribution.

(4.45) and (4.46) can be incorporated into a utility function in a variety of ways. For example, consider the following utility functions:

$$U^J = y_J^\beta A^\gamma E^\eta - \rho(\overline{A}_J - A_J + 1)^\theta (\overline{E}_J - E_J + 1)^\sigma, \tag{4.57}$$

$$U^G = y_G^\beta A^\eta E^\gamma - \rho(\overline{A}_G - A_G + 1)^\sigma (\overline{E}_G - E_G + 1)^\theta, \tag{4.58}$$

where $\theta > \sigma > 1 > \beta > \gamma > \eta > 0$, and $\rho > 0$. Notice that country J places greater value on operation A than E, while country G places greater value on operation E than A. These utility functions incorporate the assessment effect functions (4.45) and (4.46), and also possess all the properties assumed for the utility function (4.9).

As before, each country maximizes its utility subject to its budget constraint (4.21) and contribution ceilings, $\overline{A}_i \geq A_i$ and $\overline{E}_i \geq E_i$. Suppose $R_J = R_G = 10,000$, $\beta = 0.97$, $\gamma = 0.02$, $\eta = 0.01$, $\theta = 1.2$, $\sigma = 1.1$, $\rho = 0.5$, and initially, $\overline{A}_J = \overline{A}_G = \overline{E}_J = \overline{E}_G = 1,000$.

When the first-order conditions for the two countries are solved simultaneously, we get $A_J = 1,000$, $E_J = 881.86$, $A_G = 881.86$, and $E_G = 1,000$. When the assessments

are redistributed as $\overline{A}_J = 1,100$, $\overline{E}_J = 900$, $\overline{A}_G = 900$, and $\overline{E}_G = 1,100$, the levels of contributions change to $A_J = 1,100$, $E_J = 781.86$, $A_G = 781.86$, and $E_G = 1,100$. As shown by the comparative statics analysis above, there would be no change in each country's total contribution nor total contribution received by each operation.

This *neutrality* of assessment redistribution would not be observed once the assessment effect functions assume different forms, however. For example, consider the following utility functions:

$$U^J = y_J^\beta A^\gamma E^\eta - \rho \left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1 \right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1 \right)^\sigma, \tag{4.59}$$

$$U^G = y_G^\beta A^\eta E^\gamma - \rho \left(\frac{\overline{A}_G - A_G}{\overline{A}_G} + 1 \right)^\sigma \left(\frac{\overline{E}_G - E_G}{\overline{E}_G} + 1 \right)^\theta, \tag{4.60}$$

where $\theta > \sigma > 1 > \beta > \gamma > \eta > 0$, and $\rho > 0$. (4.59) and (4.60) possess all the properties assumed for the utility function (4.9), and incorporate assessment effect functions

$$\alpha^i = \frac{\overline{A}_i - A_i}{\overline{A}_i}, \tag{4.61}$$

$$\varepsilon^i = \frac{\overline{E}_i - E_i}{\overline{E}_i}, \tag{4.62}$$

which do not satisfy the conditions (4.41)-(4.44) since

$$\frac{\partial \alpha^i}{\partial \overline{A}_i} = \frac{A_i}{\overline{A}_i^2}, \tag{4.63}$$

$$\frac{\partial \alpha^i}{\partial A_i} = -\frac{1}{\overline{A}_i}, \tag{4.64}$$

$$\frac{\partial \varepsilon^i}{\partial \overline{E}_i} = \frac{E_i}{\overline{E}_i^2}, \tag{4.65}$$

$$\frac{\partial \varepsilon^i}{\partial E_i} = -\frac{1}{\overline{E}_i}. \tag{4.66}$$

Suppose $R_J = R_G = 10,000$, $\beta = 0.97$, $\gamma = 0.02$, $\eta = 0.01$, $\theta = 1.2$, $\sigma = 1.1$, $\rho = 750$, and initially, $\overline{A}_J = \overline{A}_G = \overline{E}_J = \overline{E}_G = 1,000$.

When the first-order conditions for the two countries are solved simultaneously, we get $A_J = 1,000$, $E_J = 434.848$, $A_G = 434.848$, and $E_G = 1,000$. When the assessments are redistributed as $\overline{A}_J = 1,100$, $\overline{E}_J = 900$, $\overline{A}_G = 900$, and $\overline{E}_G = 1,100$, the levels of contributions change to $A_J = 1,100$, $E_J = 900$, $A_G = 900$, and $E_G = 1,100$; each country's total contribution and total contribution received by each operation increase from 1434.848 to 2000.

It is interesting to see each country *increase* its contribution to the operation to which it places smaller value as its assessment for the operation *decreases* . Intuitively, this is mainly due to the fact that the absolute value of $\frac{\partial \alpha^i}{\partial A_i}$ $\left(or\ \frac{\partial \epsilon^i}{\partial E_i}\right)$ increases as $\overline{A}_i$ $\left(or\ \overline{E}_i\right)$ decreases. That is, as far as the assessment effect functions are concerned, the marginal benefit of contribution increases as the assessment decreases. This, in turn, translates into an increase in the marginal utility of contribution under a certain condition. From (4.59),

$$\frac{\partial^2 U^J}{\partial E_J \partial \overline{E}_J} = -\frac{\rho\sigma}{\overline{E}_J^2}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^{\theta}\left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-1}\left(\frac{2\overline{E}_J - \sigma E_J}{2\overline{E}_J - E_J}\right). \tag{4.67}$$

See Appendix for the intermediate steps. From (4.67), we obtain

$$\frac{\partial^2 U^J}{\partial E_J \partial \overline{E}_J} < 0 \quad iff \quad 2\overline{E}_J > \sigma E_J. \tag{4.68}$$

Similarly, from (4.59) and (4.60), we obtain

$$\frac{\partial^2 U^J}{\partial A_J \partial \overline{A}_J} < 0 \quad iff \quad 2\overline{A}_J > \theta A_J, \tag{4.69}$$

$$\frac{\partial^2 U^G}{\partial A_G \partial \overline{A}_G} < 0 \quad iff \quad 2\overline{A}_G > \sigma A_G, \tag{4.70}$$

$$\frac{\partial^2 U^G}{\partial E_G \partial \overline{E}_G} < 0 \quad iff \quad 2\overline{E}_G > \theta E_G. \tag{4.71}$$

Since $\overline{E}_J \geq E_J$, $\overline{A}_G \geq A_G$, $\overline{A}_J \geq A_J$, and $\overline{E}_G \geq E_G$,

$$\frac{\partial^2 U^J}{\partial E_J \partial \overline{E}_J} < 0 \quad and \quad \frac{\partial^2 U^G}{\partial A_G \partial \overline{A}_G} < 0 \quad if \quad \sigma < 2, \tag{4.72}$$

$$\frac{\partial^2 U^J}{\partial A_J \partial \overline{A}_J} < 0 \quad and \quad \frac{\partial^2 U^G}{\partial E_G \partial \overline{E}_G} < 0 \quad if \quad \theta < 2. \tag{4.73}$$

On the other hand, from (4.59) and (4.60), we obtain

$$\frac{\partial^2 U^i}{\partial y_i \partial \overline{A}_i} = \frac{\partial^2 U^i}{\partial y_i \partial \overline{E}_i} = 0. \qquad (i = J, G) \tag{4.74}$$

Therefore, when $\theta < 2$ (or $\sigma < 2$), ceteris paribus, a small decrease in assessment shifts the contribution curve up, and the level of contribution is likely to increase if the contribution ceiling is not binding initially.[4] On the other hand, if a contribution ceiling is binding initially, a small *increase* in assessment is likely to increase the level of contribution, as in the case of A_J and E_G above, even though the contribution curve shifts down. As a result, when the assessments are redistributed as above, the contribution to each operation by each country could increase.

This is illustrated in Figure 4.4. The top diagram shows a case in which the contribution ceiling is not binding initially (e.g., E_J, A_G). As the assessment decreases, the contribution curve shifts up, and the level of contribution, c_i^*, increases. The bottom diagram shows a case in which the contribution ceiling is binding initially (e.g., A_J, E_G). As the assessment increases, the contribution curve shifts down, and the level of contribution increases.

Redistributing the assessment in the opposite way, that is, increasing the assessment for a operation with non-binding contribution ceiling and decreasing the assessment for a operation with binding contribution ceiling could decrease the level of contribution to each operation by each country.

When θ (or σ) is sufficiently large, ceteris paribus, a decrease in assessment will shift the contribution curve down, and decrease the level of contribution. Likewise, an increase in assessment will shift the contribution curve up, and increase the level of

[4]Here, we are focusing on the effects of a change in a country's assessment on its own contribution. Other changes, such as the other country's contribution are ignored.

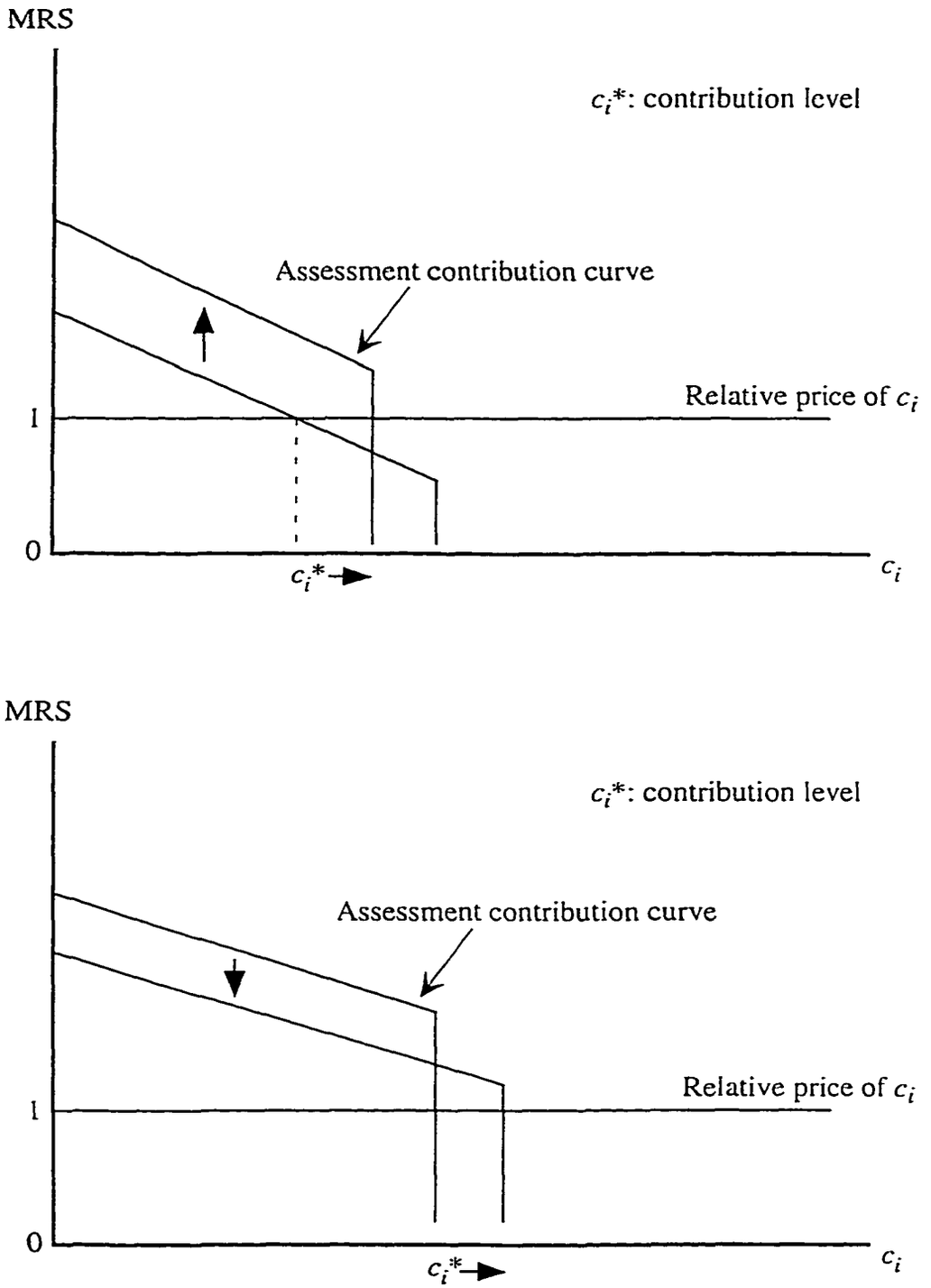

Figure 4.4 Assessment Redistribution

contribution. The effect of assessment redistribution on the total contribution becomes ambiguous in this case.

Using the utility functions (4.59) and (4.60), Suppose $R_J = R_G = 10,000$, $\beta = 0.97$, $\gamma = 0.02$, $\eta = 0.01$, $\theta = 5.2$, $\sigma = 4.1$, $\rho = 160$, and initially, $\overline{A}_J = \overline{A}_G = \overline{E}_J = \overline{E}_G = 1,000$. When the first-order conditions for the two countries are solved simultaneously, we get $A_J = 1,000$, $E_J = 897.476$, $A_G = 897.476$, and $E_G = 1,000$. When the assessments are redistributed as $\overline{A}_J = 1,020$, $\overline{E}_J = 980$, $\overline{A}_G = 980$, and $\overline{E}_G = 1,020$, the levels of contributions change to $A_J = 1,020$, $E_J = 886.393$, $A_G = 886.393$, and $E_G = 1,020$. From (4.68)–(4.71), $\frac{\partial^2 U^J}{\partial A_J \partial \overline{A}_J} > 0$, $\frac{\partial^2 U^J}{\partial E_J \partial \overline{E}_J} > 0$, $\frac{\partial^2 U^G}{\partial A_G \partial \overline{A}_G} > 0$, and $\frac{\partial^2 U^G}{\partial E_G \partial \overline{E}_G} > 0$ in this case. Although each country's total contribution and total contribution received by each operation increase from 1897.476 to 1906.393, E_J and A_G decreases by 11.083.

Although there are other possible forms for assessment effect functions, simple arrears $\left(\overline{A}_i - A_i, \overline{E}_i - E_i\right)$ and the ratio of arrears to assessment $\left(\frac{\overline{A}_i - A_i}{\overline{A}_i}, \frac{\overline{E}_i - E_i}{\overline{E}_i}\right)$ are the most reasonable. Given the fact that the United Nations choose to publicize each major contributor's arrears, rather than its arrears-to-assessment ratio, simple arrears are likely to be a better choice for an assessment effect function. Put differently, it might be possible for the United Nations to influence its member state's assessment effect functions to some degree by changing its emphasis, for example, from simple arrears to arrears-to-assessment ratio. When the assessment effect functions take the form of arrears-to-assessment ratio, however, the impact of assessment redistribution depends on the specifics of each country's utility function as shown above.

In the model, it was assumed that there are only two operations financed by just two member states. In reality, there are currently 15 on-going operations financed by 185 countries. The gap in the number of contributing countries could be narrowed when only the seven major contributors are considered for assessment redistribution. The assessment shares of the rest could be left untouched. The gap in the number of assess-

ment accounts could be narrowed if the United Nations reorganizes its special assessment accounts into a few regional peacekeeping assessment accounts: Asia account, Europe account, etc. Ogata and Volcker of the Independent Advisory Group on UN Financing (1993) propose creation of a single unified peacekeeping budget, which include an unappropriated margin for new and unexpected operations as well as projections for the cost of ongoing operations. The idea of regional peacekeeping accounts falls in between the Ogata-Volcker proposal and the current special assessment system. The assessment redistribution might be extended to the UN regular budget, also. For example, when there are large operations in Europe, but not in Asia, Japan's regular budget assessment share could be increased, while European countries' shares are reduced.

4.6 Concluding Remarks

This chapter focused on the effects of UN peacekeeping assessments on member states' contributions. The change in the patterns of member states' financial contributions to UNFICYP after the creation of special assessment account strongly suggests that the existence of assessment, although with a very mild penalty for noncompliance, can not be ignored when a country's contribution behavior is studied.

The fact that many countries keep their arrears well below their Article 19 limits indicates that losing their General Assembly vote is not the only cost associated with undercontribution. It was argued that the formal responsibilities placed on a member state by the assessment system increases the damages the country suffers when it undercontributes. The damages could be associated with the country's status in the global community or its relationship with other countries.

This country-specific damages of undercontribution were incorporated into a utility function as assessment effect functions. The introduction of assessment effect functions affects a country's contribution by shifting up its contribution curves, and by creating

contribution-ceilings. These changes in a country's contribution curves create a theoretical possibility of increasing each country's total contribution by redistributing its assessments across operations. The last section of this chapter showed that this possibility exists when the assessment effect functions are not in the form of simple arrears. Due to the limitations of computer software used, comparative statics (4.29)–(4.40) could not be solved without imposing the conditions (4.41)–(4.44) . Also, the first-order conditions for (4.59) and (4.60) could not be solved for the same reason. In order to study the effects of assessment redistribution further, these problems must be overcome. Particularly the possibility of unintentionally decreasing each country's total contribution through assessment-redistribution must be examined.

CHAPTER 5 CONCLUSIONS

In this dissertation, UN peacekeeping was analyzed as a public good. Chapter 2 examined the change in the ratio of contributor-specific benefits to pure public benefits created by UN peacekeeping efforts during the period of 1975–96. Based on Olson's exploitation hypothesis, burden-sharing patterns of four different subsets of UN member states were studied in order to determine the change in the share of contributor-specific benefits. The main findings are summarized as following.

- There is evidence of increased disproportionate burden sharing by wealthy countries for the NATO sample in the first half of 1990s. This indicates the increased share of pure public benefits created by UN peacekeeping, which, in turn, implies increased suboptimality of UN peacekeeping efforts during that period. There appears to be a direct relationship between the size of UN peacekeeping expenditures and disproportionate burden sharing.

- There is no clear evidence of disproportionate burden sharing for other samples, which are composed of countries less homogeneous in terms of geographic location and political system. The exploitation hypothesis requires the tastes of members to be identical. The relative heterogeneity of these samples in terms of location and political system should be taken into account when the test results for them are studied.

- As far as non-UN-led peace enforcement operations in the 1990s are concerned, the United States and other wealthy countries seem willing to share large financial

burden. Considering the enormous sizes of these operations, it is clear that the findings for UN-led operations underestimates the disproportionate burden sharing for peace operations in the 1990s.

In Chapter 3, a UN peacekeeping contribution function was derived using a joint-product approach, and was estimated with the two-stage least square method, for each of the 25 sample countries for the period of 1975–96. The main findings are summarized as following.

- Peacekeeping contributions of the majority of the sample countries react strongly and positively to spillins. 20 of the 25 sample countries show positive and statistically significant spillin response.
- Typically a country's peacekeeping contributions reacts very little to its income fluctuations. Four of the 25 sample countries show negative and statistically significant income response, while no countries show positive and significant response.
- Although some countries' peacekeeping contributions react positively to their trade-ratio fluctuations, majority (17) of the 25 sample countries show insignificant trade-ratio response.

The first two of the above results are quite different from the ones found in military alliance studies. The following are considered to be the rationale for the differences.

- UN peacekeeping is financed by assessments, while military build-up of allied countries are not.
- The share of national income devoted to peacekeeping by each country is tiny, compared to the share devoted to national defense.
- Peacekeeping often requires quick response to the changing nature of a conflict. In this sense, peacekeeping is more comparable to fighting small-scale wars around the globe than peacetime military build-up of allied countries.

Chapter 4 analyzed the effects of special assessment system on UN member states' peacekeeping contributions. Member states' actual contribution patterns under the assessment system were examined, and a theoretical model which explains those patterns was developed. The possibility of increasing each member state's total contribution by redistributing its assessments across peacekeeping operations was also studied. The main points of the chapter are summarized as following.

- The formal responsibilities placed on a country by the assessment system increases the damages the country suffers when it undercontributes. The damages could be associated with the country's status in the global community or its relationship with other countries.

- The assessment system shifts up a country's contribution curve, and creates contribution-ceiling, beyond which the country is unlikely to contribute.

- Assuming that undercontributor-specific damages received by each country are a function of financial hardship imposed on the United Nations by the country, rather than a function of percentage of its financial responsibility unfulfilled, it is theoretically impossible for the United Nations to increase each country's total contribution by redistributing its assessments across operations.

As discussed in Chapter 3, for a peacekeeping operation to be successful, it requires rapid deployment of adequately equipped personnel to the conflict area, which is often infeasible due to slow and inadequate responses of member states to the UN requests. To deal with the problem, the United Nations has created the Stand-by Arrangements system in 1994. Under this system, participating UN member states are expected to provide resources necessary for peacekeeping upon requests from the Secretary General, within an agreed response time. The number of countries which indicated their willingness to participate in the system has now reached 85.

As implied by the large number, however, under the current agreement, the participating member states retain the right to refuse a request for contributing to a specific mission. In 1994, for example, when the mandate of UNAMIR was extended, none of the 19 countries participating in the arrangements at that time agreed to contribute their forces (Hill and Malik 1996).[1]

If the United Nations is to play a significant role in future large-scale peacekeeping operations, it would need to create and maintain its own adequately equipped and trained stand-by forces with necessary power-projecting capacity. This would not be possible unless the organization acquires more stable and substantial revenue sources than the current assessment system. There have been a number of studies on alternative financing of peacekeeping and other UN activities recently. Many of them are based on global taxes imposed on negative externalities such as carbon combustion emissions, and fees imposed on global commons such as the deep ocean bed.[2] Given the potential benefits and risks of the United Nations with *automaticity* , or automatic inflow of funds, the study on various alternative financing methods should be continued further, and it would be the next research topic of the author.

[1]Given this and other limitations of the Stand-by Arrangement System, in 1996, Austria, Canada, Denmark, the Netherlands, Norway, Poland, and Sweden agreed to support the establishment of Multinational UN Stand-by Forces High Readiness Brigade (SHIRBRIG), which now also includes Argentina, Portugal, Romania, and Spain. For details, visit SHIRBRIG Internet site, http://ftp.shirbrig.dk/.

[2]Mendez (1992) discusses a number of other global taxes and fees proposed at the UN fora. The discussions of global taxes and fees have not been taking place at the UN fora since 1997, however, due to strong opposition by the United States, whose voluntary contributions to the UN agencies are now conditional upon the organization not engaged in any effort to implement or impose any taxation on United States persons in order to raise revenue for the United Nations or any of its specialized agencies.

APPENDIX

Chapter 4: Comparative statics results (4.47)–(4.53) — intermediate steps

Assuming (4.41)–(4.44) allows us to rearrange (4.29)–(4.40) as following. From (4.29), we obtain

$$\frac{\partial^2 U^{J*}}{\partial y_J^2}\frac{\partial y_J^*}{\partial \overline{A}_J} + \frac{\partial^2 U^{J*}}{\partial y_J \partial A}\left(\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial A_G^*}{\partial \overline{A}_J}\right) + \frac{\partial^2 U^{J*}}{\partial y_J \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J}\left(\frac{\partial A_J^*}{\partial \overline{A}_J} - 1\right) \tag{A.1}$$

$$+\frac{\partial^2 U^{J*}}{\partial y_J \partial E}\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + \frac{\partial E_G^*}{\partial \overline{A}_J}\right) + \frac{\partial^2 U^{J*}}{\partial y_J \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J}\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + 1\right) - \frac{\partial \lambda_J^*}{\partial \overline{A}_J} = 0.$$

From (4.30), we obtain

$$\left(\frac{\partial^2 U^{J*}}{\partial A \partial y_J} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial y_J}\right)\frac{\partial y_J^*}{\partial \overline{A}_J} \tag{A.2}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A^2} + \frac{\partial^2 U^{J*}}{\partial A \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J}\right)\left(\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial A_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial U^{J*}}{\partial \alpha^{J*}}\frac{\partial^2 \alpha^{J*}}{\partial A_J^2} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial A} + \frac{\partial \alpha^J}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^{J2}}\frac{\partial \alpha^J}{\partial A_J}\right)\left(\frac{\partial A_J^*}{\partial \overline{A}_J} - 1\right)$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A \partial E} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial E}\right)\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + \frac{\partial E_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial A \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J} + \frac{\partial \alpha^{J*}}{\partial A_J}\frac{\partial^2 U^{J*}}{\partial \alpha^J \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + 1\right)$$

$$-\frac{\partial \lambda_J^*}{\partial \overline{A}_J} - \frac{\partial \mu_J^*}{\partial \overline{A}_J} = 0.$$

From (4.31), we obtain

$$\left(\frac{\partial^2 U^{J*}}{\partial E \partial y_J} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial y_J}\right)\frac{\partial y_J^*}{\partial \overline{A}_J} \tag{A.3}$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E \partial A} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial A}\right)\left(\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial A_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial \alpha^J}\frac{\partial \alpha^{J*}}{\partial A_J}\right)\left(\frac{\partial A_J^*}{\partial \overline{A}_J} - 1\right)$$

$$+\left(\frac{\partial^2 U^{J*}}{\partial E^2} + \frac{\partial^2 U^{J*}}{\partial E \partial \varepsilon^J}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + \frac{\partial E_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial U^{J*}}{\partial \varepsilon^J}\frac{\partial^2 \varepsilon^{J*}}{\partial E_J^2} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^J \partial E} + \frac{\partial \varepsilon^{J*}}{\partial E_J}\frac{\partial^2 U^{J*}}{\partial \varepsilon^{J2}}\frac{\partial \varepsilon^{J*}}{\partial E_J}\right)\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + 1\right)$$

$$-\frac{\partial \lambda_J^*}{\partial \overline{A}_J} - \frac{\partial \varphi_J^*}{\partial \overline{A}_J} = 0.$$

From (4.32)–4.34), we obtain

$$\frac{\partial y_J^*}{\partial \overline{A}_J} + \frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial E_J^*}{\partial \overline{A}_J} = 0, \tag{A.4}$$

$$\mu_J^*\left(1 - \frac{\partial A_J^*}{\partial \overline{A}_J}\right) + (\overline{A}_J - A_J^*)\frac{\partial \mu_J^*}{\partial \overline{A}_J} = 0, \tag{A.5}$$

$$-\varphi_J^*\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + 1\right) + (\overline{E}_J - E_J^*)\frac{\partial \varphi_J^*}{\partial \overline{A}_J} = 0. \tag{A.6}$$

From (4.35), we obtain

$$\frac{\partial^2 U^{G*}}{\partial y_G^2}\frac{\partial y_G^*}{\partial \overline{A}_J} + \frac{\partial^2 U^{G*}}{\partial y_G \partial A}\left(\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial A_G^*}{\partial \overline{A}_J}\right) + \frac{\partial^2 U^{G*}}{\partial y_G \partial \alpha^G}\frac{\partial \alpha^G}{\partial A_G}\left(\frac{\partial A_G^*}{\partial \overline{A}_J} + 1\right) \tag{A.7}$$

$$+\frac{\partial^2 U^{G*}}{\partial y_G \partial E}\left(\frac{\partial E_J^*}{\partial \overline{A}_J} + \frac{\partial E_G^*}{\partial \overline{A}_J}\right) + \frac{\partial^2 U^{G*}}{\partial y_G \partial \varepsilon^G}\frac{\partial \varepsilon^G}{\partial E_G}\left(\frac{\partial E_G^*}{\partial \overline{A}_J} - 1\right) - \frac{\partial \lambda_G^*}{\partial \overline{A}_J} = 0.$$

From (4.36), we obtain

$$\left(\frac{\partial^2 U^{G*}}{\partial A \partial y_G} + \frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial y_G}\right)\frac{\partial y_G^*}{\partial \overline{A}_J} \tag{A.8}$$

$$+\left(\frac{\partial^2 U^{G*}}{\partial A^2} + \frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial A}\right)\left(\frac{\partial A_J^*}{\partial \overline{A}_J} + \frac{\partial A_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial U^{G*}}{\partial \alpha^G}\frac{\partial^2 \alpha^{G*}}{\partial A_G^2}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial A}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^{G2}}\frac{\partial \alpha^{G*}}{\partial A_G}\right)\left(\frac{\partial A_G^*}{\partial \overline{A}_J}+1\right)$$

$$\left(\frac{\partial^2 U^{G*}}{\partial A \partial E}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial E}\right)\left(\frac{\partial E_J^*}{\partial \overline{A}_J}+\frac{\partial E_G^*}{\partial \overline{A}_J}\right)$$

$$\left(\frac{\partial^2 U^{G*}}{\partial A \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial E_G}+\frac{\partial \alpha^{G*}}{\partial A_G}\frac{\partial^2 U^{G*}}{\partial \alpha^G \partial \varepsilon^G}\frac{\partial \varepsilon^{G*}}{\partial E_G}\right)\left(\frac{\partial E_G^*}{\partial \overline{A}_J}-1\right)$$

$$-\frac{\partial \lambda_G^*}{\partial \overline{A}_J}-\frac{\partial \mu_G^*}{\partial \overline{A}_J}=0.$$

From (4.37), we obtain

$$\left(\frac{\partial^2 U^{G*}}{\partial E \partial y_G}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial y_G}\right)\frac{\partial y_G^*}{\partial \overline{A}_J} \tag{A.9}$$

$$+\left(\frac{\partial^2 U^{G*}}{\partial E \partial A}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial A}\right)\left(\frac{\partial A_J^*}{\partial \overline{A}_J}+\frac{\partial A_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial^2 U^{G*}}{\partial E \partial \alpha^G}\frac{\partial \alpha^G}{\partial A_G}+\frac{\partial \varepsilon^G}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial \alpha^G}\frac{\partial \alpha^{G*}}{\partial A_G}\right)\left(\frac{\partial A_G^*}{\partial \overline{A}_J}+1\right)$$

$$+\left(\frac{\partial^2 U^{G*}}{\partial E^2}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial E}\right)\left(\frac{\partial E_J^*}{\partial \overline{A}_J}+\frac{\partial E_G^*}{\partial \overline{A}_J}\right)$$

$$+\left(\frac{\partial U^{G*}}{\partial \varepsilon^G}\frac{\partial^2 \varepsilon^{G*}}{\partial E_G^2}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^G \partial E}+\frac{\partial \varepsilon^{G*}}{\partial E_G}\frac{\partial^2 U^{G*}}{\partial \varepsilon^{G2}}\frac{\partial \varepsilon^{G*}}{\partial E_G}\right)\left(\frac{\partial E_G^*}{\partial \overline{A}_J}-1\right)$$

$$-\frac{\partial \lambda_G^*}{\partial \overline{A}_J}-\frac{\partial \varphi_G^*}{\partial \overline{A}_J}=0.$$

From (4.38)–(4.40), we obtain

$$\frac{\partial y_G^*}{\partial \overline{A}_J}+\frac{\partial A_G^*}{\partial \overline{A}_J}+\frac{\partial E_G^*}{\partial \overline{A}_J}=0, \tag{A.10}$$

$$-\mu_G^*\left(\frac{\partial A_G^*}{\partial \overline{A}_J}+1\right)+\left(\overline{A}_G-A_G^*\right)\frac{\mu_G^*}{\partial \overline{A}_J}=0, \tag{A.11}$$

$$\varphi_G^*\left(1-\frac{\partial E_G^*}{\partial \overline{A}_J}\right)+\left(\overline{E}_G-E_G^*\right)\frac{\partial \varphi_G^*}{\partial \overline{A}_J}=0. \tag{A.12}$$

It is fairly easy to see that the above 12 equations can be solved simultaneously to get (4.47)–(4.53). A computer-aided calculation confirms that the solution is unique.

Chapter 4: Equation (4.67) — intermediate steps

From (4.59), we obtain

$$\frac{\partial U^J}{\partial E_J} = \gamma y_J^\alpha A^\beta E^{\gamma-1} + \frac{\rho\sigma}{\overline{E}_J}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-1}$$

$$\begin{aligned}
\frac{\partial^2 U^J}{\partial E_J \partial \overline{E}_J} &= -\frac{\rho\sigma}{\overline{E}_J^2}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-1} \\
&\quad + \frac{\rho\sigma(\sigma-1)}{\overline{E}_J}\frac{E_J}{\overline{E}_J^2}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-2} \\
&= -\frac{\rho\sigma}{\overline{E}_J^2}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-1} \\
&\quad \times \left(1 - \frac{(\sigma-1)E_J}{\overline{E}_J}\left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{-1}\right) \\
&= -\frac{\rho\sigma}{\overline{E}_J^2}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-1} \left(1 - \frac{(\sigma-1)E_J}{2\overline{E}_J - E_J}\right) \\
&= -\frac{\rho\sigma}{\overline{E}_J^2}\left(\frac{\overline{A}_J - A_J}{\overline{A}_J} + 1\right)^\theta \left(\frac{\overline{E}_J - E_J}{\overline{E}_J} + 1\right)^{\sigma-1} \left(\frac{2\overline{E}_J - \sigma E_J}{2\overline{E}_J - E_J}\right).
\end{aligned}$$

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