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Kobi Kagan • Asher Tishler • Avi Weiss

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An Evaluation of Strategic Arms Limitation Agreements Model, with an Application to the Israeli-Syrian Conflict

Kobi Kagan[1], Asher Tishler[2], Avi Weiss[1,3]

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Abstract

This study evaluates the order of magnitude of the monetary cost of achieving an international strategic terror weapons (TWP) limitation agreement in an asymmetric arms race, with an application to the Israeli-Syrian conflict. It extends the Kagan, Tishler and Weiss (2005) framework and develops a model of resource allocation between consumption and security goods in a non-cooperative (Cournot) arms race between a developed country and a less developed country. The model is used to predict the optimal mix of weapons of the two countries engaged in the arms race, and to evaluate the applicability of international and dyad strategic TWP limitation agreements. Applying the model to the arms race between Israel and Syria demonstrates its use. The results show that if considered from a purely monetary perspective, such an agreement is within reach.

[1] Department of Economics, Bar Ilan University

[2] Faculty of Management, Tel Aviv University

[3] IZA, Bonn, Germany

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1. Introduction

Some of the most visible arms races are currently taking place between developed and less developed countries, which, unable to compete financially and technologically, are adopting an asymmetric response, and arming themselves with terror weapons (TWP)[1]. This acquisition of TWP by such countries as Iran, North Korea and Syria, apparently in the hope of achieving the ability, or a perception of the ability, to deter the significantly stronger opponent, and the willingness to use them, has become known as state-sponsored terror. The September 11 terrorist attacks and Iraq's use of chemical warfare during the war with Iran have demonstrated that TWP are no longer a mere threat; rather, there are several countries and organizations that will not hesitate to use them.

This study considers the possibility of achieving an international strategic TWP limitation agreement in such an asymmetric arms race, and estimates the order of magnitude of the cost of such an agreement in the Israeli-Syrian conflict.[2] To this end, we extend the resource allocation model of Kagan, Tishler and Weiss (2005, hereinafter KTW) to include consumption goods in addition to security goods. We employ the KTW model in an arms race[3] between a developed country that is

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[1]Weapons of mass destruction (WMD) are divided into four major categories: chemical, biological, radiological, and nuclear. TWP are WMD that can attack, contaminate and affect only a relatively small area (TWP do not include fully developed nuclear weapons, see Cordesman, 2004).

[2] The underlying model and ensuing empirical evaluation are constructed under the (limiting) assumption that the conflict results from strategic concerns only (i.e., from concern for the welfare of the countries' citizens), and disregards other considerations that come into play, such as ideological issues and grievance effects. To the extent that these other issues play an important role, our estimates should be seen as understatements of the true cost of such an agreement. Nevertheless, they demonstrate that if and when the ideological barrier is breached, a peaceful settlement may well be attainable.

[3] See Brito and Intriligator (1995), Levine and Smith (1995, 1997), Garcia-Alonzo (1999), Golde and Tishler (2004) and Mantin and Tishler (2004) for review and analyses of arms races.

characterized by state-of-the-art technology and high GDP and a less developed country with a much lower technological ability and GDP. This type of arms race is called an *asymmetric* arms race (in contrast to the *symmetric* arms race that takes place between countries with similar capabilities). Following KTW and Hirshleifer (1991, 2000), the model is developed under the assumption that the two countries compete in a non-cooperative Cournot game[4]. We then show how to apply the framework of the model for the assessment of various arms limitation agreements. Finally, we apply the model to the Israeli-Syrian arms race[5], using actual data related to this conflict.

The assessment of the cost of achieving TWP limitation agreements between two rival countries will be cast within the framework of the optimal budget allocation of the two rivals. Two types of allocations will be considered. One allocation, drawn directly from KTW, is between significantly different types of weapon systems that may contribute very differently to the security level of the countries involved in an arms race, a subject to which scant attention has been paid in the economic literature[6].

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[4] Most of the economic literature on the terror phenomenon analyzes the interrelationship between a terrorist organization (as opposed to state-sponsored terror) and the country fighting against it (see, for example, Endres and Sandler, 2002, Trajtenberg, 2006). US law defines terrorism as follows: "The term ‘terrorism’ means premeditated, politically motivated violence perpetrated against noncombatant targets, by subnational groups or clandestine agents, usually intended to influence an audience". (Title 22 of US Code, section 2656f(d)). With the exception of KTW (2005), the academic literature that analyzes state-sponsored terror (as opposed to terrorist organizations) does not do so by means of formal game theoretic models (see Roxborough, 2003; Hartley and Sandler, 1999).

[5] For a comprehensive literature review on the use of game theory to analyze terror, see Sandler and Arce (2003). They consider game theory an effective means to study the interactions and choices of action strategies for different types of players: state and terrorist organizations, various countries that cooperate with terrorist organizations and different terrorist organizations that cooperate with each other.

[6] Setter and Tishler (2006a, 2006b) study optimal defense budget allocation in a decision problem setting.

The analysis demonstrates that the less developed country coerces the developed one into allocating enormous resources in order to effectively counter the threat of TWP. The second type of allocation is an extension of the KTW analysis that we add to the equation in order to incorporate the issue of arms limitation agreements. Thus, we model the welfare function of each country as a function of its security *and* other civilian government services, the government role being to optimally allocate its *overall* budget into civilian services and security, where security is a function of conventional weapon systems and TWP (for the less developed country) or conventional weapon systems and anti-TWP (for the developed country). This setup permits the consideration of substitution between civilian services and security.

One of the novelties of this framework (and its concurrent limitation) is its separation of the security aspect of state-sponsored terror from other terrorist-related phenomena, such as nationalistic and religious fundamentalism.[7] This setup is useful to achieve a monetary evaluation of the applicability of international strategic TWP limitation agreements. Such agreements, in which the less developed country refrains from acquiring new TWP, or even reduces its existing stock of TWP, are achieved by a monetary transfer from a global power such as the USA to the less developed country, or by a monetary transfer between the parties to the conflict – from the developed to the less developed country. Applying the model to the asymmetric arms race between Israel and Syria demonstrates its use, and shows that, absent ideological and historical considerations, an economic solution could be within reach in this particular conflict. The simulations of the Israeli-Syrian conflict also yield a surprising result – namely, that a TWP limitation agreement will have a spillover effect in that it will also lead to a lowering of conventional arms purchases by Syria.

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[7] See Footnote 2.

This paper is organized as follows. The model of an asymmetric arms race with possible substitution between security and consumption of other government services is developed in Section 2. Section 3 presents the methodology of obtaining a solution of the model under a strategic TWP limitation agreement between the two rivals for three situations: (a) without any suitable monetary compensation to the less developed country, (b) with monetary compensation from a third party (the USA, for example), and (c) with a monetary transfer (compensation) from the developed to the less developed country. Section 4 presents the Israeli and Syrian military apparatus, history and relevant data, and describes the calibration of the model. Section 5 applies the model to the arms race between Israel and Syria, and Section 6 concludes.

2. A Model of an Arms Race[8]

Our basic model describes an asymmetric arms race between two countries: a developed (wealthy) Western country and a less developed country. Due to insufficient financial resources and technological and human infrastructure, the less developed country cannot purchase sufficient quantities of expensive (and effective) modern weapon systems to achieve what it considers a proper security level. Therefore, this country arms itself with less expensive TWP, in addition to some conventional, possibly modern, weapon systems. The developed country does not acquire TWP for use against its rival due, among other reasons, to its cultural and social beliefs. Generally, any country that accumulates TWP and intends to use them is subject to economic and social sanctions[9]. Developed countries, which normally maintain an open local market and significant international trade, cannot afford the

[8] The allocation of the budget into different weapon systems is similar to that of KTW. Hence, parts of the model description are taken directly from KTW.
[9] See, for example, the 2007 decision by the UN's Security Council to impose economic sanctions on Iran in response to Iran's nuclear power policy.

political and economic risks that accompany the purchase and intent to use of TWP. On the other hand, several of the less developed countries that acquire TWP suffer anyway from economic isolation and relatively closed local markets. Hence, these countries may find the economic and political loss that derives from their possession of TWP more acceptable than the lack of what they consider proper security. The developed country reacts to its (less developed) rival's accumulation of TWP by developing and acquiring highly sophisticated (and very expensive) weapon systems that can counter the threat of TWP.

The objective of the government of each country is to maximize its social welfare function, which depends on its consumption of civilian services and on its security level. Each government’s attitude to a war that might be waged is embedded in the parameters of the welfare function[10]. Thus, we describe each country's budget allocation between civilian consumption goods (education, municipal authorities, legal system, health, etc.) and security, where the latter is a function of the quantities of the types of weapon systems in the country's arsenal, and those of its adversary. The less developed country, denoted by **x**, purchases some conventional weapon systems and some (relatively cheap) TWP. The wealthy developed country, denoted by **y**, purchases conventional weapon systems and, in addition, modern (and very expensive) weapon systems which can effectively counter the TWP of its less developed rival.

Formally, country **x**'s welfare function depends upon its civilian government consumption, C_x, and on its security level, S_x. Specifically, country **x**'s welfare function is defined as follows:

[10] We assume that the model describes an arms race, but does not include the governments' responses to the possible results of a war.

$$U_x\left(C_x, S_x\right) = C_x{}^w S_x{}^{1-w} \qquad (1)$$

where $0 < w < 1$ is a parameter that represents the importance that country **x** accords to civilian consumption, relative to its security level. Country **x**'s security level, S_x, is as defined by KTW, that is:

$$S_x = \left(\beta \left[\frac{x_1 + X_1}{y_1 + Y_1} \right]^{\alpha} + (1-\beta) \left[\frac{x_2 + X_2}{y_2 + Y_2} \right]^{\alpha} \right)^{\frac{1}{\alpha}} \qquad (2)$$

where x_1 denotes the purchase of the conventional weapon systems and x_2 stands for the acquisition of new TWP[11]. X_1 and X_2 represent the existing stock (at the beginning of the period, prior to the acquisition of x_1 and x_2) of the two types of weapons. y_1, y_2, Y_1 and Y_2 are the equivalent purchases and existing stocks of the two types of weapon systems that are held by country **y**. The significance that country **x** accords to the use of conventional weapon systems (relative to TWP weapon systems) is given by the (constant) preference parameter β, and the constant parameter α expresses the degree of technical substitution between the two types of weapons held by country **y.** We assume that $0 < \beta < 1$, $\alpha < 0$. The requirement that $\alpha < 0$ ensures that the optimal solution of country **x** is indeed a maximum. Note that the security level of country **x**, S_x, depends on two ratios: (a) the amount of conventional weapons that country **x** holds divided by the amount of conventional

[11] The use of the CES (constant elasticity of substitution) function as a utility or a capability function is common in economics. It is used in the defense literature when a measure of an aggregate capability is needed in models with heterogeneous defense goods (see, for example, Garcia-Alonso, 1999; Setter and Tishler, 2006a,b). The CES function, in contrast to the Cobb-Douglas function, can obtain any value of elasticity of substitution, and in a model with only two goods it is *flexible* (see Tishler and Lipovetsky, 1997).

weapons that country **y** possesses, and (b) the amount of TWP that country **x** holds divided by the amount of anti-TWP weapon systems that country **y** possesses. The higher each ratio, the higher the security level of country **x**. That is, the security level of country **x** depends on its own and its rival's stocks of weapon systems, as well as on the composition of these weapons.

Formally, the decision problem of country **x** is described as follows:

$$\underset{\{C_x, x_1, x_2\}}{Max}\ U_x = C_x^{\ w}\left(\left(\beta\left[\frac{x_1 + X_1}{y_1 + Y_1}\right]^{\alpha} + (1-\beta)\left[\frac{x_2 + X_2}{y_2 + Y_2}\right]^{\alpha}\right)^{\frac{1}{\alpha}}\right)^{1-w} \tag{3}$$

$$s.t.$$

$$(a)\quad C_x + p_1 x_1 + p_2 x_2 = I_x$$

$$(b)\quad y_i, Y_i \ are\ given$$

where the prices, p_i, are in units of civilian consumption, and the price of one unit of **x**'s civilian consumption is set to equal 1. Country **x**'s government budget is denoted by I_x. The solution of decision problem (3) yields the reaction functions of country **x.** That is:

$$x_1 = \frac{I_x + p_1 X_1 + p_2 X_2}{\frac{w}{1-w}\frac{p_1}{\beta}\left[\beta + \frac{(1-\beta)}{N_x^{\ \alpha}}\left(\frac{y_1 + Y_1}{y_2 + Y_2}\right)^{\alpha}\right] + \left(p_1 + p_2/N_x\right)} - X_1$$

$$x_2 = \frac{I_x + p_1 X_1 + p_2 X_2}{\frac{w}{1-w}\frac{p_2}{(1-\beta)}\left[(1-\beta) + \beta N_x^{\ \alpha}\left(\frac{y_2 + Y_2}{y_1 + Y_1}\right)^{\alpha}\right] + \left(p_1 N_x + p_2\right)} - X_2 \tag{4}$$

$$C_x = w\left(I_x + p_1 X_1 + p_2 X_2\right)$$

where,

$$N_x \equiv \left[\frac{\beta}{(1-\beta)} \left(\frac{y_2 + Y_2}{y_1 + Y_1} \right)^{\alpha} \frac{p_2}{p_1} \right]^{\frac{1}{1-\alpha}} \tag{5}$$

Note that the optimal values of x_1 and x_2 depend on the ratio of the quantities of weapons held by country **y**, $(y_2 + Y_2)/(y_1 + Y_1)$, and not directly on the values of y_1, y_2, Y_1 and Y_2. This result is due to the homothetic structure of the country **x** security function, S_x. It is tedious but straightforward to show that the acquisition of each weapon system, x_i, declines when its price rises and increases when the price of the other weapon system rises (the two types of weapons are substitutes). In addition, x_i is larger the smaller is X_i and the larger is X_j. An increase in country **x**'s government budget results in an increase in the acquisition of both types of weapon systems, x_1 and x_2, as well as in the civilian consumption, C_x.

It is straightforward to demonstrate that the smaller the technical elasticity of substitution, $1/(1-\alpha)$, the closer is country **x**'s ratio of weapon quantities (initial stocks plus new acquisitions) to that of its rival, country **y**. When the elasticity of technical substitution approaches zero (when $\alpha \to -\infty$), **x**'s reaction functions become independent of weapon prices (at the limit, when the elasticity of technical substitution approaches zero, the CES function approaches a fixed proportions function).

Country **y** purchases two types of weapon systems: conventional weapon systems, y_1, and advanced weapon systems, y_2, that are designed to counter country **x**'s TWP. Country **y**'s decision problem is symmetric to that of country **x**. That is,

$$\underset{\{C_y, y_1, y_2\}}{Max} U_y = C_y^{\,v} \left(\left(\gamma \left[\frac{y_1 + Y_1}{x_1 + X_1} \right]^{\delta} + (1-\gamma) \left[\frac{y_2 + Y_2}{x_2 + X_2} \right]^{\delta} \right)^{\frac{1}{\delta}} \right)^{1-v} \tag{6}$$

$s.t.$

$(a)\ \ C_y + q_1 y_1 + q_2 y_2 = I_y$

$(b)\ \ x_i, X_i \ \ are\ given$

where q_1 and q_2 are the unit prices of y_1 and y_2, respectively. I_y is country **y**'s defense budget. The significance that country **y** accords to the use of conventional weapon systems (relative to anti-TWP weapon systems) is given by the preference (constant) parameter γ, and the constant parameter δ expresses the degree of technical substitution between the two types of weapons held by country **y**. We assume that $0 < \gamma < 1$ and $\delta < 0$.

The solution of problem (6) yields the reaction functions of country **y.** That is:

$$y_1 = \frac{I_y + q_1 Y_1 + q_2 Y_2}{\frac{v}{1-v}\frac{q_1}{\gamma}\left[\gamma + \frac{(1-\gamma)}{N_y^{\,\delta}} \left(\frac{x_1 + X_1}{x_2 + X_2} \right)^{\delta} \right] + \left(q_1 + q_2 / N_y \right)} - Y_1$$

$$y_2 = \frac{I_y + q_1 Y_1 + q_2 Y_2}{\frac{v}{1-v}\frac{q_2}{(1-\gamma)}\left[(1-\gamma) + \gamma N_y^{\,\delta} \left(\frac{x_2 + X_2}{x_1 + X_1} \right)^{\delta} \right] + \left(q_1 N_y + q_2 \right)} - Y_2 \tag{7}$$

$$C_y = v\left(I_y + q_1 Y_1 + q_2 Y_2 \right)$$

where

$$N_y \equiv \left[\frac{\gamma}{1-\gamma} \left(\frac{x_2 + X_2}{x_1 + X_1} \right)^{\delta} \frac{q_2}{q_1} \right]^{\frac{1}{1-\delta}} \tag{8}$$

The equilibrium of the model can be obtained by a simultaneous solution of the reaction functions of **x** and **y** (expressions (4) and (7)). An analytical expression of the equilibrium solution does not exist due to the nonlinear structure of the reaction functions. It is possible, however, to analytically characterize some of the equilibrium properties. These properties, for the simpler model that does not include allocation between security and civilian goods, are given in Proposition 1 of KTW, and are brought here again for completeness[12]:

a. Country **x**'s optimal solution does not depend on the values of Y_i, $i = 1, 2$, or on I_y. Country **y**'s optimal solution does not depend on the values of X_i, $i = 1, 2$, or on I_x.

b. The optimal acquisitions of country **x**, x_1 and x_2, are linear functions of **x**'s defense budget, I_x. The optimal acquisitions of country **y**, y_1 and y_2, are linear functions of **y**'s defense budget, I_y.

c. At the equilibrium, the security function of country **x**, S_x, is a linear function of **x**'s defense budget, I_x, and the security function of country **y**, S_y, is a linear function of **y**'s defense budget, I_y.[13]

These results imply that changes in weapon prices can alter the optimal mix of the weapon systems, while changes in defense budgets may change the optimal

[12] These properties are the result of the homothetic structure of the CES capability function. The CES functions are commonly used in economics and, in many situations, yield good empirical predictions. These results assume an internal equilibrium in which each country purchases both types of weapons. It is easily extended to include situations in which a country's initial stock is not in equilibrium, and the country thus decides, for a period, to invest in only one of the weapon types.

[13] This property results, in addition to the homothetic structure of the CES capability function, from the specification in which each country's welfare is linearly homogeneous in C and S.

quantities (purchases) of the weapon systems, but do not affect their ratios (optimal mix). For the same reason, the optimal solution of country **x** (**y**) does not depend on I_y (I_x), and the security function of country **x** (**y**), at the equilibrium, is a linear function of **x**'s (**y**'s) defense budget**.** Finally, the optimal solutions, x_1, x_2, y_1 and y_2, depend on all the parameters (α, β, γ and δ) and on all the prices in the model. Moreover, the optimal solutions x_1 and x_2 depend on country **x**'s initial stocks X_1 and X_2, and the optimal solutions y_1 and y_2 depend on country **y**'s initial stocks Y_1 and Y_2.

While an explicit analytical solution of the equilibrium cannot be obtained, it is not difficult to evaluate it by a numerical optimization method. Hence, in Section 4 we use the relevant data for Israel and Syria to analyze and characterize the equilibrium solution with and without arms limitation agreements.

3. An Evaluation of Strategic Arms Limitation Agreements: Methodology

This section presents the methodology for obtaining a quantitative answer to two questions: (i) With or without a gradual reduction of the existing stock, can a freeze on new acquisitions of TWP be reached by the two rivals under international sponsorship? (ii) With or without a gradual reduction of the existing stock, can a freeze on new acquisitions of TWP be reached by the two rivals without international sponsorship?

Undoubtedly, a freeze on new TWP acquisition (with or without a gradual elimination of the existing stock of TWP), as a result of international pressure (say), will hurt the less developed country that possesses TWP and benefit its arms race rival. The question that needs to be asked here is, therefore, whether country **x** can be financially compensated sufficiently for it to voluntarily freeze new acquisitions of TWP, with or without a gradual reduction of the existing stock. Here we review two compensation sources[14]: financial compensation granted by a superpower (e.g., the USA or the European Union) that is not a side to the arms race (but may benefit from the subsequent reduction of international conflicts), and an agreement between country **x** and country **y**, in which **y** grants **x** financial compensation in return for keeping $x_2 \equiv 0$ (or even for a gradual reduction of country **x**'s existing stock of TWP).

Thus, in the rest of this section we show how to evaluate the solution of the model in four situations:

(a) An arms race between country **x** and country **y** without any agreement.

(b) An arms race in which country **x** cannot acquire new TWP.

(c) An arms race in which country **x** chooses not to acquire any new TWP (and, possibly, gradually reduces its existing stock of TWP), provided it receives monetary compensation from an international sponsor (the European Union and/or the USA, say) that ensures its level of social welfare does not diminish as a result of its decision to cease the acquisition of new TWP.

(d) An arms race in which country **x** chooses not to acquire new TWP (and, possibly, gradually reduces its existing stock of TWP), provided it receives monetary compensation from country **y** that ensures its level of social welfare

[14] This assumption is based on the observation that many international arms control and limitation agreements have been successfully enforced (see SIPRI, 2003). Treaty verification might involve some costs. Sandler and Hartley (2001) discuss the decrease of the average cost for verifying and enforcing arms limitation agreements between countries that are members of military alliances.

does not diminish as a result of its decision to cease the acquisition of new TWP[15].

3.a An arms race without restrictions

The decision problem of country **x** is given by expression (3) and that of country **y** by expression (6). The optimal solution can be obtained by simultaneously solving (4) and (7), the first-order conditions of (3) and (6), respectively. We denote the optimal weapon purchases by x_1^0, x_2^0, y_1^0 and y_2^0, and welfare by U_x^0 and U_y^0.

3.b A freeze on new TWP acquisition without compensation

Suppose that country **x** allocates its budget between civilian consumption and conventional weapon systems only. That is, country **x** ceases the acquisition of new TWP due, say, to political (and/or other) pressures from certain international powers, but continues to maintain the initial stock of TWP that is already in its arsenal. Assume that no further restrictions are imposed on countries **x** and **y**. Thus, the country **x** decision problem is given by:

$$\begin{aligned} &\underset{\{C_x, x_1\}}{Max} U_x = C_x{}^w \left(\left(\beta \left[\frac{x_1 + X_1}{y_1 + Y_1} \right]^{\alpha} + (1-\beta) \left[\frac{X_2}{y_2 + Y_2} \right]^{\alpha} \right)^{\frac{1}{\alpha}} \right)^{1-w} \\ &s.t. \\ &(a)\ C_x + p_1 x_1 = I_x \\ &(b)\ y_i, Y_i \ are\ given \end{aligned} \tag{9}$$

[15] Generally, the arms limitation agreement yields a positive surplus. The way in which this surplus is divided between the two rivals (using the Nash bargaining solution, or some other approach) does not affect the results of this paper.

Country **y** is aware of country **x**'s freeze on new TWP and its decision to continue to maintain its initial stock of TWP. Hence, the country **y** decision problem is as follows:

$$\underset{\{C_y, y_1, y_2\}}{Max} U_y = C_y^{\,v} \left(\left(\gamma \left[\frac{y_1 + Y_1}{x_1 + X_1} \right]^{\delta} + (1-\gamma) \left[\frac{y_2 + Y_2}{X_2} \right]^{\delta} \right)^{\frac{1}{\delta}} \right)^{1-v} \tag{10}$$

$$s.t.$$
$$(a) \quad C_y + q_1 y_1 + q_2 y_2 = I_y$$
$$(b) \quad x_1, X_i \ are \ given, x_2 = 0$$

It is straightforward to demonstrate that the unilateral limitation on new TWP by country **x** (setting $x_2 = 0$) results in a decrease of its level of social welfare and an increase in country **y**'s level of social welfare. This result explains the tendency of less developed countries to acquire and, if necessary, use TWP, and it is due to the substantial economic advantage of the developed country, which may opt for a very large defense budget (relative to the defense budget of country **x**), and the price disparity between the very expensive anti-TWP weapon systems and the relatively inexpensive TWP.

3.c A freeze on new acquisition (or even a gradual reduction of existing stock) of TWP with compensation by an international sponsor

Suppose that a world power (for example, the USA or the European Union) decides to shoulder the cost of the arms limitation agreement between countries **x** and **y** and that the agreement is not violated by country **x**. The donating country gives the less developed country a grant which amounts to a share A_x of **x**'s initial government budget. We start by analyzing a freeze on new TWP acquisitions. That is, $x_2 = 0$

holds, and country **x** allocates its increased budget between civilian consumption and conventional weapon systems, while maintaining its initial stock of TWP, X_2. The compensation is assumed to be just sufficient to leave the receiving country indifferent between accepting the grant and limitations and not accepting them. Thus, country **x's** decision problem is given by:

$$\underset{\{C_x, x_1, A_x\}}{Max}\ U_x^{\ A} = C_x^{\ w}\left(\left(\beta\left[\frac{x_1 + X_1}{y_1 + Y_1}\right]^{\alpha} + (1-\beta)\left[\frac{X_2}{y_2 + Y_2}\right]^{\alpha}\right)^{\frac{1}{\alpha}}\right)^{1-w}$$

$$\begin{aligned}
&s.t. \\
&(a)\ \ C_x + p_1 x_1 = \left(1 + A_x\right) I_x \qquad (11)\\
&(b)\ \ y_i, Y_i \ \ are\ given \\
&(c)\ \ U_x^{\ A} = U_x^{\ 0}
\end{aligned}$$

Country **y**'s decision problem does not change when $x_2 = 0$ and is given by expression (10). Note that the values of y_1 and y_2 in (11) will be different from those previously considered since the equilibrium conditions will change.

The optimal solution with an exogenous gradual reduction of the existing stock of TWP by country **x**, X_2, in addition to setting $x_2 = 0$, is obtained by setting the required value of X_2 to a prescribed level, X_2^*, which is lower than its level in problems (10) and (11). That is, setting $X_2^* = \lambda X_2$, $0 \le \lambda < 1$. The compensation level will, of course, have to be increased in order to keep the country indifferent.

3.d A freeze on new acquisition (or even a gradual reduction of existing stock) of TWP with compensation by country y

Assume that country **y**, rather than an international sponsor, compensates country **x** for its agreement to cease acquisition of new TWP (that is, to set $x_2 = 0$). Country **x's** decision problem is given by:

$$\underset{\{C_x, x_1, A_y\}}{Max}\ U_x^{\ A} = C_x^{\ w}\left(\left(\beta\left[\frac{x_1 + X_1}{y_1 + Y_1}\right]^{\alpha} + (1-\beta)\left[\frac{X_2}{y_2 + Y_2}\right]^{\alpha}\right)^{\frac{1}{\alpha}}\right)^{1-w}$$

$$\begin{aligned} & s.t. \\ & (a)\quad C_x + p_1 x_1 = I_x + A_y I_y \\ & (b)\quad y_i, Y_i \ are\ given \\ & (c)\quad U_x^{\ A} = U_x^{\ 0} \end{aligned} \tag{12}$$

where A_y denotes the share of its budget that country **y** donates to country **x**. This compensation constitutes an additional income of $A_y I_y$ for country **x**. Clearly, the compensation that **x** receives from **y** will be deducted from government **y**'s budget. Thus, the country **y** decision problem (including the budget transfer to country **x**) is as follows:

$$\underset{\{C_y, y_1, y_2\}}{Max}\ U_y = C_y^{\ v}\left(\left(\gamma\left[\frac{y_1 + Y_1}{x_1 + X_1}\right]^{\delta} + (1-\gamma)\left[\frac{y_2 + Y_2}{X_2}\right]^{\delta}\right)^{\frac{1}{\delta}}\right)^{1-v}$$

$$\begin{aligned} & s.t. \\ & (a)\quad C_y + q_1 y_1 + q_2 y_2 = \left(1 - A_y\right) I_y \\ & (b)\quad x_1, X_i \ are\ given \end{aligned} \tag{13}$$

Note that the solution must satisfy the rationality constraint $U_y \geq U_y^0$; that is, for country **y** to be willing to pay country **x**, it must end up no worse off than without the transfer payment.

The optimal solution with an exogenous gradual reduction of the existing stock of TWP by country **x**, X_2, in addition to setting $x_2 = 0$, is obtained, similarly to the procedure in Section 3c, by setting X_2 to a prescribed level, X_2^*, which is lower than its level in problems (12) and (13). That is, setting $X_2^* = \lambda X_2$, $0 \leq \lambda < 1$. Once again, the compensation level will have to be increased to keep country **x** indifferent.

For an application of the four different equilibrium types defined in this section and derivation of the minimum compensation to attain a voluntary freeze on the acquisition of new TWP, or even a gradual reduction in the existing TWP stock, we next present data on the Israeli-Syrian arms race, and estimate the parameters of the corresponding welfare functions.

4. Background, Data and Calibration of the Model Parameters

We start with a brief description of the Syrian and Israeli military apparatus and history, present the relevant data and then proceed with calibration of the model.

4.1 Background – Syria

The Israel-Egypt Peace Accord of 1979 led Syria's President Assad, with growing Soviet military assistance, to seek a "strategic balance" between Syria and Israel. As a result, Syrian expenditure on arms imports increased from $650 million in 1977 to $2.7 billion in 1980. In the mid-1980s, Syria's defense expenditure was about 20% of its GDP and half of its civilian expenditure (see Winckler, 1999).

According to IISS (2002, 2003), throughout the 1980s and up to 1991, Syria received an annual grant of $700 million, on average, from oil-producing countries in the Persian Gulf, with a peak of $1.5-2 billion in 1991 (which it received in return for its participation in the Gulf War). The termination of Soviet assistance, following the collapse of the USSR at the end of the 1980s, and the diminishing monetary transfers from the Persian Gulf countries in 1992 forced Syria into an economic depression and led it to reassess its strategic balance policy. The result was a reduction of Syrian defense expenditures from $8 billion (in 1995 prices) in 1985 to about $3 billion in 1999 (WMEAT, 1998, 2003), and a decline in the share of defense expenditure in

GDP from a high of 20% in 1985 to 7% in 1999 (Even, 1999). Furthermore, Syria started stockpiling non-conventional weapon systems (TWP).

The Syrian emphasis on aerial command, manpower, ground-to-air missile batteries, and improved mobility in the 1980s (Brom and Shapir, 2002) changed, with Chinese and North-Korean assistance, into acquiring TWP, and building silos, sheltered storage and launching facilities for stationary ground-to-ground Scud C missiles in the 1990s (according to Shoham, 2002a, 2000b, the Syrian military had about 1,000 missiles in its arsenal by the beginning of the 21st century).

Pine (2000) estimated the annual expenditure of Syria on TWP at about \$1-\$2 billion. Considering the relatively low cost of accumulating the low-technology (ground-to-ground) Scud ballistic missiles and biological and chemical weapons (BCW), we believe that this estimate is too high. Nevertheless, it indicates that expenditure on TWP was the largest and most important part of the Syrian defense budget during the 1990s.

4.2 Background – Israel

Without Soviet assistance, the conventional arms race with Syria has faded, while the US funding of the Israeli army has continued under a strategic umbrella, which the Arab world has interpreted as a sign that the USA will intervene in Israel's favor in the event of an all-out war with the Arab world. The US military assistance to Israel and Israel’s ever-growing technological advantage has been translated into the development of unique advanced weapon systems, to which Syria has failed to produce an adequate response. Ben-Zvi (2003) estimates that, thanks to its effective investment in developing an army based on state-of-the-art technologies, Israel has achieved effective deterrence capabilities to the Arab countries' conventional weapons, but has no effective deterrence capabilities to counter TWP. This weakness explains Syria's motivation to accumulate TWP.

Israel's defense budget has not significantly changed over the last 20 years, though, thanks to the country’s economic growth during the last three decades, the share of its defense budget in GDP has decreased from 14% in 1982 to 6% in 2004. However, the share of procurement in Israel's defense budget has been reduced due to the gradual increase in overhead expenses such as compensation payments and payments to widows, and the costs of rehabilitating the IDF disabled (Ben-Zvi, 2003). Gordon (2003), nevertheless, estimates that Israel has a 33% advantage in the face of any possible alignment of an Arab aerial coalition, and a 6.5-fold advantage in its attacking capabilities relative to the Syrian Air Force.

In summary, it seems that the Arab world perceives Israel's aerial and intelligence power as the most dominant of its military advantages. Thus, the response of several Arab countries, and particularly Syria, to Israel's large advantage in human capital and sophisticated conventional weapon systems has been the accumulation and intent to use of TWP.

4.3 Data and calibration of the model for the Israeli-Syrian arms race

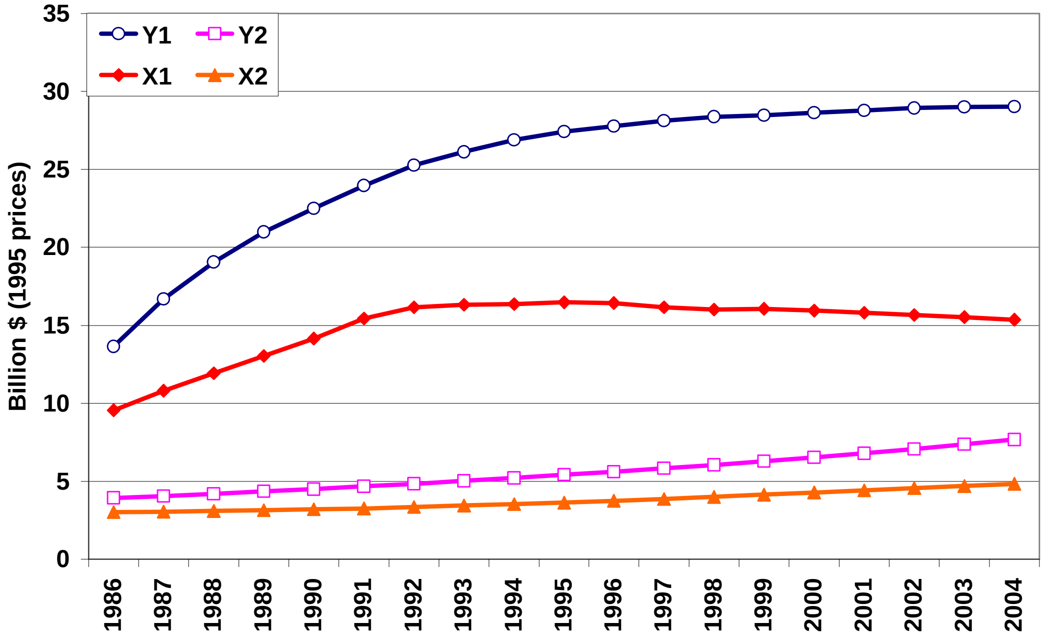
The analysis of the model is carried out using the relatively small set of available public data and is based on different sources (for example, SIPRI, 2004, 2005; WMEAT, 1999, 2003; Brom and Shapir, 2002; Shoham, 2002a, b; International Financial Statistics – IFS, various years; and more) and fact-based assumptions about the development of the IDF, the Syrian army, and the trends in the international weapon markets (see Kagan, 2005). Figure 1 presents the evolution of the stocks of weapons, as defined in this study, by the two countries during 1986-2004[16]. As already noted, the growth in conventional weapon systems in Syria, in fact, stopped in 1991. The annual acquisition of conventional weapon systems by Syria since 1991 only compensates for the depreciation of the existing stocks. Israel increased its conventional weapon systems during 1985-2004, albeit at a decreasing rate (possibly, in response to the Syrian halt in the accumulation of conventional weapons). Figure 2 presents the relative power balance, for both types of weapons, between Israel and Syria from 1986 to 2004. Clearly, except during 1991-2, when Syria enjoyed substantial military aid as compensation for its participation in the Gulf War, Israel's advantage over Syria in stocks of weapon systems increased throughout the period. The real prices (in 1995 US$) of the four types of weapon systems that we

[16] WMEAT (1999, 2003) is the main source for Syrian and Israeli defense data expenditure during 1985-1999. The rates of change in defense expenditure available in SIPRI (2003, 2004, 2005) were used to update these data until 2003. We assumed that Syria's 2004 defense expenditure is identical to that of 2003, and Israel's defense expenditure in 2004 was taken from The Israeli Government Budget (2005). Using Shoham (2002b) and the Jaffee Center, *The Middle East Military Balance*, (1983-2005), we estimated that Syria spends about 40% of its military expenditure on procurement. Israeli official budget data (see, for example, Israeli Government budget, 2005) specify the percentage of the annual defense budget spent on procurement. The breakdown of the Israeli and Syrian stocks of weapon systems into conventional and other systems was achieved by inspecting the very detailed series of weapon systems of these countries, available in The Middle East Military Balance, Jaffee Center (1983-2005), and by our own estimations based on public defense publications (Aviation Week, Jane's Defense International Review), and more. We assumed annual depreciation rates of 3% (about a 30-year life-cycle period) on conventional weapon systems, 1% on Syria's TWP (these weapons employ older technologies, develop very little over time, and their specifications have not changed much over the last 20 years) and about 3% on the Israeli anti-TWP systems. Price indices of conventional weapon systems were estimated by constructing time series of the prices of two major weapon systems (the F16 fighter plane and the Mercava main battle tank) for which public data for several years between 1983 and 2004 are available (Setter and Tishler, 2006b, use a similar methodology to construct price indices of weapon systems of the US military). The annual rate of change of the price of the sophisticated anti-TWP weapon systems was assumed to be about 5% since it follows the rate of change of wages of Israeli engineers working in the high-tech sector (R&D constitutes a large part of the cost of these weapon systems).

analyze here are depicted in Figure 3.[17] The fast increase in the price of anti-TWP during 1985-2004 is noticeable, as is the fact that TWP weapons had the smallest price increase.

As a reliable econometric estimation of the parameters of the model is impossible due to the scarcity of reliable data, we chose to *calibrate* (rather than estimate) the model's parameters by using the relatively small set of public data available to us. The calibration was achieved by using a nonlinear regression to obtain the best fit (in terms of least squares) of the reaction functions (4) for Syria and (7) for Israel at the equilibrium point.

Figure 1
Stocks of weapon systems in Syria and Israel: 1986-2004



[17] Figures 1-3 present the same information as Figures 3-5 in KTW, with additional data for 2003 and 2004.

Figure 2
Relative power balance between Israel and Syria: 1986-2004

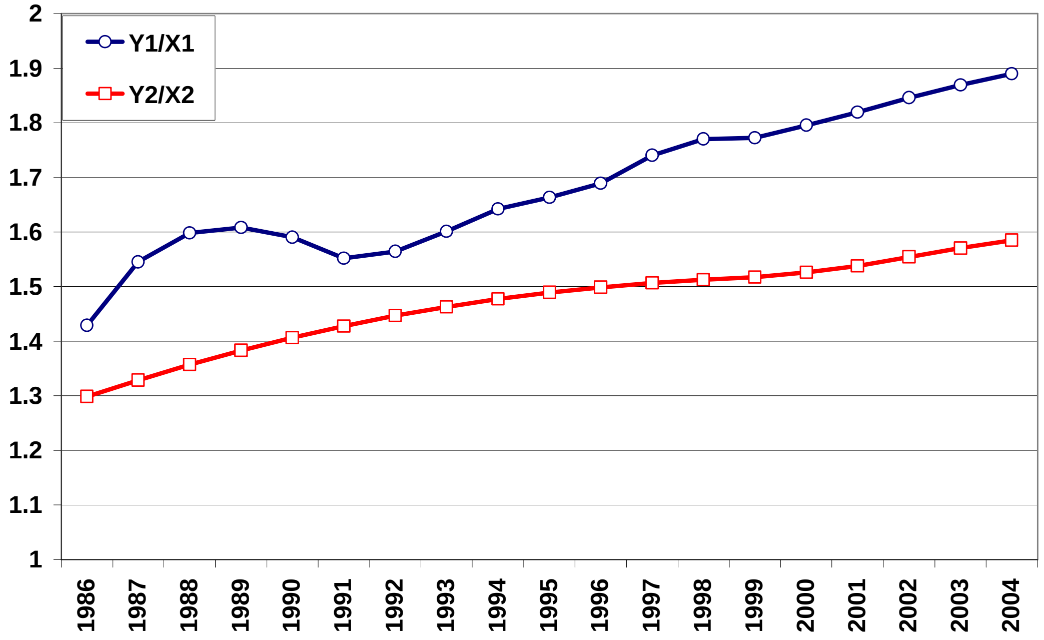
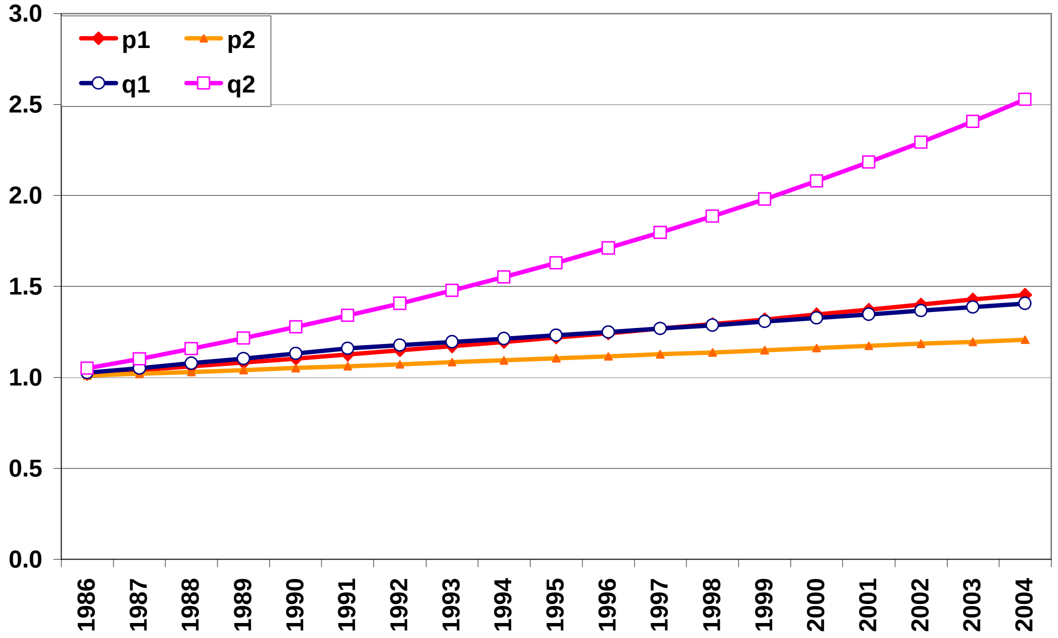


Figure 3
Price indices of weapon systems: 1986-2004



The calibration was carried out on aggregated data. That is, we used quantity and price data for the averages of four periods of two or three years each (1995-7, 1998-9, 2000-2, 2003-5)[18]. The following parameter values were obtained by this calibration process: $\alpha = -9.90$, $\beta = 0.37$, $\delta = -1.45$, $\gamma = 0.73$.

The calibration results suggest that Syria prefers to invest in TWP ($1-\beta = 0.63$), but also continues to invest in conventional weapons ($\beta = 0.37$), whereas Israel prefers to spend most of its military resources on conventional weapons ($\gamma = 0.73$) and invests a smaller share of its military budget on the very expensive anti-TWP weapon systems ($1-\gamma = 0.27$).

The elasticity of substitution between the two types of weapon systems in Syria is rather low. This is an interesting and plausible result. It emphasizes the extremely low substitution possibilities, in an all-out war, between conventional weapon systems and TWP. Actually, weapons such as Scud missiles (without chemical and biological warheads) feature very low efficiency and accuracy and, like some of the anti-TWP weapons, are of little use in a conventional war. The elasticity of substitution between the two types of weapon systems employed by Israel (conventional weapons and anti-TWP) is larger $\{1/[1-(-1.45)] = 0.4\}$, which is reasonable since we estimate that about a third of the Israeli Air Force may be directed to countering Syrian TWP (the planes and systems may be used conventionally or as anti-TWP weapon systems).

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[18] The calibration was obtained, separately for each country (see (4) and (7)) by minimizing the sum of squares of the residuals in the two reaction functions for each country, using the aggregated data, and assuming the same residual variance for both reaction functions. Thus, we use eight data points (four periods and two functions) to estimate two parameters. Actual shares were used to obtain w (see (4)) and v (see (7)).

5. Monetary costs of Strategic Arms Limitation Agreements: Israel and Syria

This section presents the optimal solutions, for the period 2003-2005, to the possibilities discussed in Sections 4a, 4b, 4c and 4d for the following values of the exogenous variables and parameters (see expressions (3) and (6)), based on the data discussed above[19]:

<u>Syria</u>: Parameters: $\alpha = -9.90,\ \beta = 0.37,\ w = 0.5$

Variables: $X_1 = 15.4,\ X_2 = 4.8,\ I_x = 25.9,\ p_1 = 1.52,\ p_2 = 1.27$

<u>Israel</u>: Parameters: $\delta = -1.45,\ \gamma = 0.73,\ \nu = 0.43$

Variables: $Y_1 = 29.0,\ Y_2 = 7.7,\ I_y = 82.4,\ q_1 = 1.58,\ q_2 = 2.70$

Table 1 shows the equilibrium solutions in four situations: (a) No constraints on either country (the solution of (3) and (6)). (b) Syria abstains, without any compensation, from purchasing new TWP, but maintains its initial stock of TWP (the solution of (9) and (10)). (c) Syria opts to abstain from purchasing new TWP, maintains its initial stock of TWP and receives compensation from, say, the USA (the solution of (11) and (10)). (d) Syria opts to abstain from purchasing new TWP, maintains its initial stock of TWP and receives compensation from Israel (the solution of (12) and (13)). The results show that in all cases the accumulation of both TWP and anti-TWP declines. When Syria receives compensation it opts to reduce its conventional weapons in addition to reducing its TWP while Israel reduces its purchase of the expensive anti-TWP weapons and increases its purchase of conventional weapons. The reduction in Syria's purchase of conventional weapons in this case may initially seem strange. It happens because Syria's initial purchases of

[19] Data are for 2003-2005 (see Figures 1-3). Stocks (X_1, X_2, Y_1, Y_2) and price indices are computed as averages over 2003-2005. The budgets (I_x, I_y) are for a 3-year period.

TWP were a way to spend a modest amount of its own resources to gain a relatively high level of security. That is, an arms race with Israel based on conventional weapons was too expensive for Syria. However, when new TWP is not an option, the average price that Syria has to pay for new weapons is higher than the price it paid prior to the freeze on TWP (compare p_1 and p_2 in Figure 3). At the optimal solution, a dollar spent on weapons and a dollar spent on government civilian expenditures must yield identical marginal utility. In fact, setting $x_2 = 0$ reduces Syria's marginal utility obtained from one dollar spent on weapons, prompting Syria to reduce x_1 (which raises its marginal utility) and increase its civilian government consumption (which reduces its marginal utility from government civilian expenditure), yielding the desired equality in the marginal utilities of dollars spent on weapons and on civilian consumption. As a result, Syria's security level declines but its expenditure on government civilian consumption increases. Israel responds to the decline in Syria's TWP by reducing its very expensive anti-TWP weapons and increasing its (less expensive) conventional weapons, thus achieving a small increase in its security level. Obviously, Israel's welfare increases when Syria opts to stop acquiring TWP in response to proper compensation from the USA. However, Israel's welfare increases even when it has to shoulder the compensation to Syria. That is, *both countries will enjoy a higher welfare even if Israel compensates Syria for its TWP freeze*. This result may not be achieved, however, without the intervention of a third party (a common result in non-cooperative games).

Note that the changes in the equilibrium due to the TWP freeze are rather small, particularly the compensation required to entice Syria to voluntarily abstain from acquiring new TWP (337 million US$ when compensation is made by the USA and 330 million US$ when compensation is made by Israel). This outcome is not surprising; current purchases of TWP by Syria are small (compared to its existing stock of TWP) and, thus, its concession of agreeing to abstain from purchasing new TWP is small too, and does not require large monetary compensation. More meaningfully, and possibly more difficult to achieve, an arms limitation agreement should require a gradual reduction in the existing stock of TWP. Thus, Tables 2 and 3 present equilibrium solutions similar to those in Table 1, but when the arms limitation agreement is extended to include a reduction of 7% or 20%, respectively, in the existing TWP stock, in addition to a freeze on purchases of new TWP.

Table 1

Equilibrium solutions with and without compensation:
TWP agreement – No new purchase of TWP

Variable	Initial solution without compensation or arms limitation	Solution without compensation and with $x_2 = 0$	Arms limitation: $x_2 = 0$ compensation by the USA	Arms limitation: $x_2 = 0$ compensation by Israel
x_1	0.69	0.19	0.25	0.25
x_2	0.63	0	0	0
C_x	24.05	25.61	25.85	25.85
U_x	2.84	2.82	2.84	2.84
y_1	2.52	3.07	3.10	3.02
y_2	1.18	0.85	0.84	0.82
C_y	75.25	75.25	75.25	75.08
U_y	12.04	12.41	12.39	12.36
Compensation (million US$)	-	-	337	330

<u>**Table 2**</u>

Equilibrium solutions with and without compensation:

TWP agreement – No new purchase + 7% reduction of existing TWP

Variable	Initial solution without compensation or arms limitation	Arms limitation: no new TWP and a 7% reduction of existing TWP – compensation by the USA	Arms limitation: no new TWP and a 7% reduction of existing TWP – compensation by Israel
x_1	0.69	0	0
x_2	0.63	0	0
C_x	24.05	26.96	26.86
U_x	2.84	2.84	2.84
y_1	2.52	3.37	3.17
y_2	1.18	0.67	0.63
C_y	75.25	75.25	74.79
U_y	12.04	12.59	12.52
Compensation (millions US$)	-	1127	907

The pattern of the results in Tables 2 and 3 is similar to that in Table 1, but the changes in the equilibrium outcomes are generally more pronounced. The required levels of compensation are much larger than those in Table 1 since Syria's concession is larger. Note that Syria opts to freeze the size of its conventional weapons since the security that it derives from them, following the decline in its TWP, is rather small. At the same time there is a noticeable increase in the Syrian government supply of civilian services to its citizens. Again, both Syria and Israel can benefit from a reduction in the stock of TWP, even when Israel is required to finance the compensation to Syria. Finally, note that the monetary compensation required to entice Syria to reduce its TWP stock by a significant amount (7% or 20% over a three-year period) is clearly within the reach of the USA and even of Israel.

<u>Table 3</u>

Equilibrium solutions with and without compensation:

TWP agreement – No new purchase + 20% reduction of existing TWP

Variable	Initial solution without compensation or arms limitation	Arms limitation: no new TWP and a 20% reduction of existing TWP – compensation by the USA	Arms limitation: no new TWP and a 20% reduction of existing TWP – compensation by Israel
x_1	0.69	0	0
x_2	0.63	0	0
C_x	24.05	29.01	28.37
U_x	2.84	2.84	2.84
y_1	2.52	4.29	3.74
y_2	1.18	0.14	0
C_y	75.25	75.25	74.00
U_y	12.04	12.88	12.66
Compensation (million US$)	-	2927	2472

Clearly, TWP limitation benefits both Syria and Israel, regardless of who compensates Syria for its TWP reduction. However, Israel's civilian government expenditure declines as a result of the TWP limitation agreement (since it raises its stock of conventional weapon systems), particularly when it finances the compensation to Syria (see Figures 4 and 5). Syrian civilian government expenditure always rises (see Figure 6) due to the TWP limitation agreement (since it lowers the acquisition of its, less potent, conventional weapon systems in response to the arms limitation agreement).[20] That is, Israel's main benefit from a TWP limitation agreement is in terms of an increase in its perception of national security, while Syria gains in terms of higher civilian expenditure (civilian services to its population).

Finally, the equilibrium outcomes in Tables 1-3 ensure that Syrian welfare does not decline due to the TWP limitation agreements. However, there is a whole range of equilibria for which both Israel and Syria may benefit from a TWP limitation agreement between them.[21]

Clearly, an agreement between these two countries is dependent on their bargaining power, which is not an integral part of our model. Furthermore, the model of this paper is not sufficiently detailed to compute the whole range of possible TWP limitation agreements since it is not a sufficiently good approximation of reality (it does not provide a good prediction of the actual data) when the arms limitation agreement calls for a reduction of more than 50% of the existing stock of Syrian TWP over a three-year period[22].

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[20] Note that the break points in Figures 5 and 6 mark the time period in which Syria stops purchasing conventional weapons.

[21] In principle, one could map the entire range of the division of the surplus between Syria and Israel from the extreme, in the text, in which Israel gets the entire surplus to the other extreme in which Syria gets the entire surplus. One could then find alternative solutions to that presented in the text, such as the Nash Bargaining solution. The qualitative conclusions would, of course, not change.

[22] Kagan (2005) provides synthetic examples in which the developed country is too poor and cannot compensate the less developed country without reducing its own welfare level. Hence, an arms limitation agreement without an international sponsor is not a viable option in this case. For an arms race taking place between two countries that are relatively poor and homogeneous, an international arms limitation agreement requires an international sponsor; otherwise the developed country prefers to deal with the TWP threat rather than pay compensation to the less developed country. However, if the

Figure 4

Civilian government expenditure in Israel as a function of the percentage reduction of existing Syrian stock of TWP

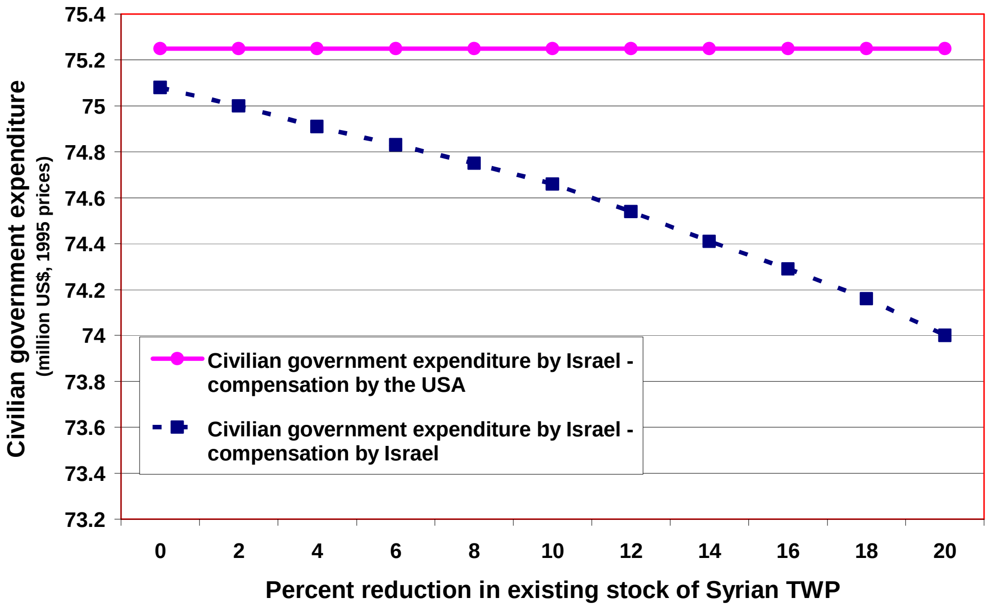
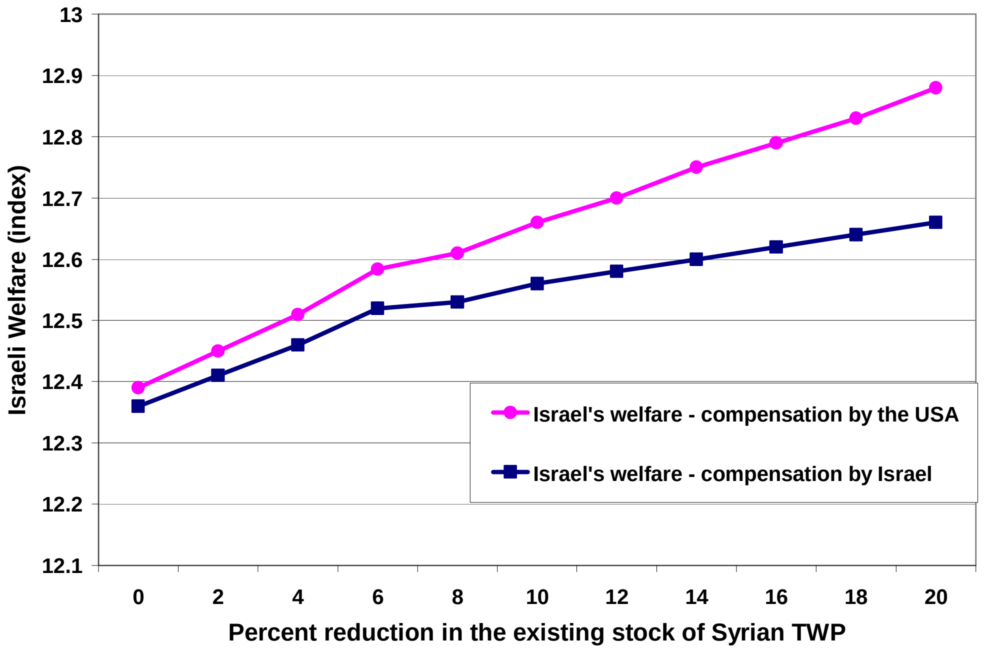


Figure 5

Israeli welfare as a function of the percentage reduction of existing Syrian stock of TWP



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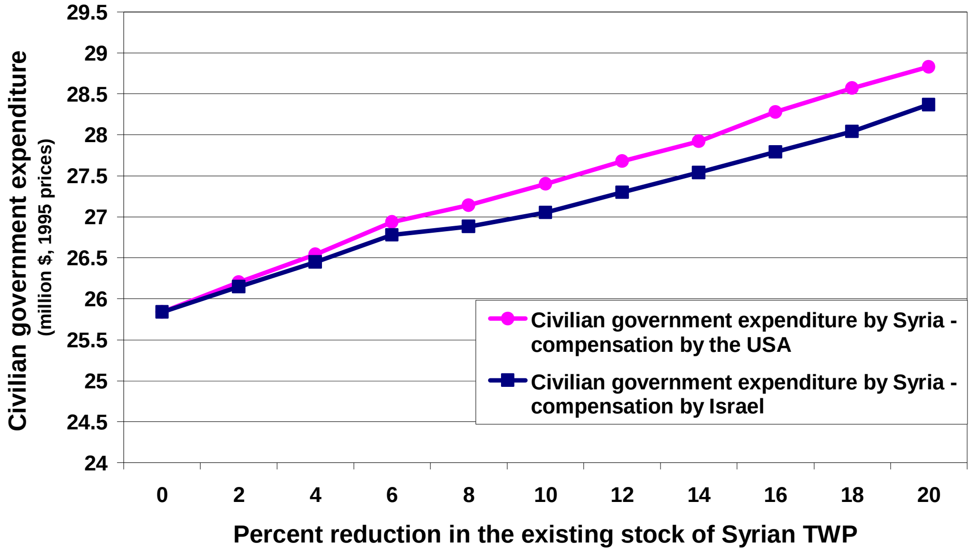
developed country is much richer than the less developed one, it is better off compensating the less developed country so that the latter will reduce its stock of TWP. The actual compensation depends on the bargaining power of the two countries.

Figure 6

Civilian government expenditure in Syria as a function of the percentage reduction of existing Syrian stock of TWP



6. Summary and Conclusion

This study extends the KTW model of an asymmetric arms race between a developed country and a less developed country. Each party in the arms race can use two types of weapon systems in order to maximize its welfare function. The less developed country can acquire conventional weapons and TWP while its developed rival acquires conventional and anti-TWP weapon systems. The model encompasses substitution between civilian consumption and security level, and solves for a Nash-Cournot equilibrium in which the less developed country may freeze the build-up of, or even reduce, its TWP in return for financial compensation that will benefit it more than continuing to build up its TWP. In reality, of course, TWP disarmament does not depend solely upon economic variables; however estimation of the magnitude of the financial settlement required to end the procurement of new TWP (or reduce the existing stock) and maintain a viable TWP limitation agreement provides an initial "measure" of the cost of relaxing current arms races.

A TWP limitation without compensation to the less developed country results in a decrease in that country's welfare level, and a large increase in the welfare of the developed country. This result explains the inclination of less developed countries to use TWP and the aggressive actions of the Western world to eliminate TWP. We show that when the developed country or an international power such as the USA compensates the less developed country, the result may be an agreement to limit the stock of TWP and an increase in the welfare of both rivals. We then show how to compute the necessary compensation.

The most interesting finding of this paper is the fact that it is worthwhile for Israel to financially compensate Syria for limiting its TWP stock. In practice, there is a range of possible compensation amounts in which both countries can increase their welfare levels by reaching a limitation agreement on TWP, while proceeding with the arms race in conventional weapons. Clearly, Israel should gain from a TWP limitation agreement with Syria because it is sufficiently rich (enjoys a sufficiently high GDP) to financially compensate Syria. It is possible that 20 or 30 years ago Israel was not in a position to compensate Syria for such an agreement.

Somewhat surprisingly, a TWP limitation agreement will have a spillover effect in that it will also lead to a lowering of conventional arms purchases by Syria and, through a slowdown of the arms race with Israel, might eventually help the sides reach a peaceful conclusion to the conflict between them.

Finally, while TWP limitation can benefit both Syria and Israel, regardless of who compensates Syria for its reduction of TWP, Israel’s civilian government expenditure declines as a result of the limitation agreement (since it raises its stock of conventional weapon systems), particularly when it finances the compensation to Syria. That is, it seems that Israel is more worried about Syria's conventional weapon systems than it is about Syria's TWP. Syria's civilian government expenditure always rises in response to the TWP limitation agreement (since it lowers the acquisition of its, less potent, conventional weapon systems in response to the arms limitation agreement). That is, Syria understands that Israel's conventional army is very powerful relative to its own and prefers to bolster its civilian government expenditure, rather than its conventional army, and lower its security in response to its agreement to reduce its holdings of TWP stocks.

In summary, Israel's main benefit from TWP limitation agreement is in terms of an increase in its perception of national security, while Syria gains in terms of higher civilian expenditure (civilian services to its population).

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Dr. Kobi Kagan is specializing in Defence Economics. He holds a Ph.D. degree in Economics from the Bar Ilan University (2005). In his research he developed models of optimal resource allocation in an arms race between a developed country and a less developed country, both engaged in an asymmetric arms race. The novelty in his studies is the analysis of the security aspect of state sponsored terror in isolation from other terrorist phenomena, such as nationalistic and religious fundamentalism. This setup is useful for a monetary evaluation of the applicability of international strategic TWP (terror weapons) limitation agreements. Dr. Kagan's studies have been presented in domestic and international economic conferences.

Prof. Asher Tishler received his B.A in Economics and Statistics from the Hebrew University in 1972 and his Ph.D. in Economics from the University of Pennsylvania in 1976. Since 1976 he is a faculty member of the faculty of Management at Tel - Aviv University.
Prof. Tishler serves as the director of both BRM Institute for Society and Technology and the Eli Horowitz Institute for Strategy in Tel Aviv University.
Prof. Tishler was a visiting professor at the Universities of South California, Iowa and the Pennsylvania. Prof. Tishler's fields of research are: Economics of Security, Economics of Energy, Research and Development and Research Methods. He has published more than ninety papers in professional periodicals. Prof. Tishler is an advisor to several companies in Israel and abroad.

Prof. Avi Weiss is currently the Chairman of the Department of Economics in Bar-Ilan University. He received his Ph.D. in Economics from the Universtiy of Chicago in 1987. He has served as chief economist and deputy general director of the Israel Antitrust Authority, a member of the antidumping committee of the Trade Ministry, and chairman of Bank Hapoalim's P.K.N. trust funds investment committee. His research interests are in Antitrust, Industrial Organization, Labor Economics, Migration, and Experimental Economics.

The ENS Program, established in late 2003, is an inter-mural program aiming to initiate, encourage, and facilitate high quality academic research and policy position papers on the interconnections between economics and defense. The close links between economic strength and development on one hand, and defense capabilities and security on the other are well recognized. Nevertheless, there is little theoretical and empirical research on these links by the academic community in Israel available to support policy making in these critically important matters. The Program holds periodic research meetings, organizes workshops on defense economics, and provides financial support on a competitive basis to proposals by researchers and graduate students submitted in response to widely circulated Calls for Proposals. Program participants include economists and researchers in other disciplines from various universities in Israel, research departments in the Bank of Israel and other government agencies, and some current and past officials in government and defense related organizations and industries. The Program Director is Prof. Dan Peled and the Coordinator is Col. (Res.) Moshe Elad.

Samuel Neaman Institute
for Advanced Studies in Science and Technology
Technion-Israel Institute of Technology
Technion City, Haifa 32000, Israel
Tel: 04-8292329, Fax: 04-8231889
www.neaman.org.il