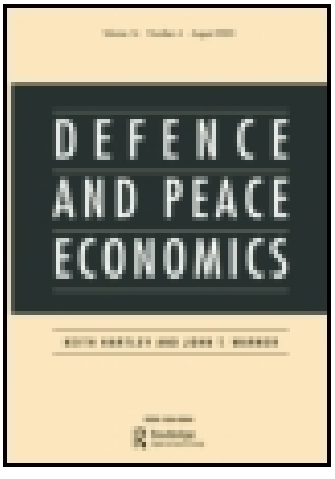

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AN ECONOMIC ANALYSIS OF MILITARY INTELLIGENCE

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AN ECONOMIC ANALYSIS OF MILITARY INTELLIGENCE

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The purpose of this paper is to provide an economic analysis of military intelligence by using the approach in contract theory to understand when a spy will be hired by a country, why a spy will defect, and how the enemy can use a double agent to fight back. Most importantly, we will provide four solutions to this defection problem in a spy contract using related discussions in the economic literature.

Keywords: Spies; Double agents; Defection; Military intelligence

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INTRODUCTION

Military intelligence plays an important role in both war and peace times. The information provided by spies can sometimes be determinative to ignite the fire of war. For example, the evidence provided by four Iraq defectors was cited by US Secretary of State Colin Powell in his speech to the United Nations Security Council as crucial evidence that Saddam Hussein had developed a system of mobile laboratories and factories to produce biological-warfare agents. However, according to later re-examination by the CIA, it is possible that some of the sources cited in US intelligence estimates about Saddam's weapons of mass destruction (WMD) turn out to have been double-agents planted by Saddam! There have been several theories explaining why Saddam's intelligence service might have used double agents to plant stories with US intelligence about WMD programs. One theory is that Saddam sent out bogus defectors with deliberately lurid WMD claims in the expectation that such claims would reach the United States and eventually be passed on to UN inspectors. Saddam had believed that when the investigators checked the claims out and found them to be bogus, the Bush administration and other parties who took the claims seriously would be shown to be crying wolf (Isikoff and Hosenball, 2004).

The above example teaches us two lessens. First, the information provided by spies is not always correct and sometimes could have been manipulated by the enemy. Second, the damage from incorrect military intelligence can be tragically enormous. The purpose of this

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paper is to provide an economic analysis of military intelligence by using the approach in the contract theory to understand when a spy will be hired by a country, why a spy will defect, and how the enemy can use a double agent to fight back. Most importantly, we will provide four solutions to this defection problem in a spy contract using related discussions in the economic literature.

We start by characterising the equilibrium for a War and Peace game between two countries with one-sided private information about the existence of a new weapon. The welfare difference in this equilibrium and in the equilibrium with complete information then provides the uninformed country with justification to hire a spy. We then follow the discussion in contract theory by addressing two major problems in the contracting process: *moral hazard* and *defection*. Moral hazard refers to the case where the spy can possibly shirk and hence cannot find any evidence of a weapon. In this case, the report will be exactly the same as when there is no weapon at all. Defection means that even if the spy has put effort into the investigation and hence is certain about the existence of a new weapon, the spy can possibly sell this piece of information back to the enemy for another deal. If the deal is done, the report will again be the same as if there were no weapon.

There has been an extensive literature addressing the moral hazard problem in the contracting process (see for example Hart and Holmstrom, 1987). The solution will be to design a contingent (on reports) contract where extra reward is paid to the spy with a positive report of the new weapon, so that the spy has enough motivation to put in effort. The defection problem has received little discussion[1] in the literature. Defection can be treated as sort of renegotiation, but it is with the enemy that the spy is negotiating. The enemy will outbid the reward from the contract and buy the spy's silence. The third section of this paper will provide four solutions for this defection problem.

The first solution is to encourage the patriotism of the spy. When this emotional factor is taken into account, the benefit of truthfully reporting will be extraordinarily large compared to any offer of a ransom. The second is the repeated game argument that in a trigger strategy equilibrium, if the spy cares enough about his future business, he will not sell the information for short term ransom and so lose future benefits. The third solution is to follow the renegotiation literature in finding a defection-free contract. However, since the competition between two countries in the renegotiation stage will push up the extra reward to keep the spy from defection, we will show that the extra reward can be so high that a defection-free contract might not exist at all. The forth solution is to increase competition on the spy side and use a relative rewarding scheme. We show in the third section that in one of the equilibria, the truth will be reported and the equilibrium reward is cheaper than in a defection-free contract.

The organization of the rest of the paper is as follows. The next section describes and characterises the equilibrium for the War and Peace game with one-sided private information. The section after addresses the moral hazard and defection problems in hiring a spy. We provide four solutions for the defection problem. The concluding remark is in the final section.

THE WAR AND PEACE GAME

This section describes a competitive game between two countries, one of which suspects that the other country has developed a new weapon, and would like to hire a spy to discover this

[1] In Solan and Yariv (2004) and Matsui (1989), espionage aims to obtain information on the rival's strategy. Whitney and Gaisford (1999) studied the welfare effects of economic espionage by showing that economic espionage can yield desirable strategic effects as well as cost savings for firms in a spying country.

secret. We will discuss the moral hazard and defection problems inherited in military intelligence of this sort.

The War and Peace Game

Let *A*, *B* denote the two countries, where country *A* suspects that *B* has developed a new weapon that changes the military balance of the two countries. Whether *B* has the new weapon or not is privately known by *B* herself. Let $\Theta := \{y,n\}$ denote the state of truth where *y* means there is a new weapon and *n* means there is not. Country *A*, on the other hand, has a prior belief ρ that the state is *y* and $(1 - \rho)$ that the state is *n*.

Under asymmetric information, each country needs to choose whether to stay in peace (*P*) and/or to prepare for a war (*W*). The war or peace decision, together with the true state of the secret, will affect each country's welfare. In notations, let $A_i := \{P,W\}$, $i = A,B$ denote country *i*'s action set. For each action profile $a \in A_A \times A_B$ and some state $\theta \in \Theta$, each country's welfare is defined by $\pi_i(a,\theta)$, where $\pi_i : A_A \times A_B \times \Theta \to R$. As an example, $\pi_i(WW,n)$ describes country *i*'s welfare when both countries get ready for war but *B* actually does not have the new weapon.

To illustrate the benefit of hiring a spy, we will apply the following assumptions throughout the paper. The first assumption will simplify country *B*'s decision, so that the information obtained by the spy will play a critical role in determining country *A*'s action. In particular, we assumed that for all $a_A \in A_A$, $\pi_B(a_AW,y) > \pi_B(a_AP,y)$ and $\pi_B(a_AP,n) > \pi_B(a_AW,n)$. With this assumption, for country *B*, *P* is strictly dominated if $\theta = y$ and *W* is strictly dominated if $\theta = n$. Notice that since two countries make decisions simultaneously, it is not possible for country *A* to update her belief by observing *B*'s decision. The second assumption ensures that country *A*'s complete information decision is to stay in peace if *B* has no new weapon, and to get ready for war if *B* has the weapon. That is, we assume that $\pi_A(PW,y) < \pi_A(WP,n) < \pi_A(WW,y) < \pi_A(PP,n)$. Finally, this above information structure is assumed common knowledge among players.

Equilibrium

The characterisation of Bayesian equilibrium is standard, and our focus is on country *A*'s welfare comparison in this equilibrium and in the equilibrium with complete information, in order to justify the necessity of hiring a spy. First, country *B*'s decision is simple: to choose *W* if $\theta = y$ and to choose *P* if $\theta = n$. Second, country *A* will adopt a cut-off strategy, that is, to choose *P* if $\rho \le \rho^*$ and to choose *W* if otherwise. The threshold[2] value of belief is

$$\rho^* = \left(1 + \frac{\pi_A(WW,y) - \pi_A(PW,y)}{\pi_A(PP,n) - \pi_A(WP,n)}\right)^{-1}.$$

Next, it can be verified that country *A*'s equilibrium welfare is less than that of a complete information case. Specifically, for $\rho > \rho^*$ country *A*'s welfare is $\rho\pi_A(WW,y) + (1 - \rho)\pi_A(WP,n)$, and this is smaller than if she were certain that country *B* owns the new weapon: $\pi_A(WW,y)$. On the other hand, for $\rho \le \rho^*$ country *A*'s welfare is $\rho\pi_A(PW,y) + (1 - \rho)\pi_A(PP,n)$ which is smaller than if she were certain that country *B* does not have a new weapon: $\pi_A(PP,n)$. This welfare difference provides a motivation for country *A* to hire a spy to discover the secret. In the next section, we discuss the moral hazard and defection problems encountered in the spy contract and then provide our solutions.

[2] To have a sensible discussion, it is assumed that $\pi_A(PP,n) - \pi_A(WP,n) \neq 0$.

CAN A SPY HELP?

Hiring a spy will encounter similar problems as in usual employment contracts: the spy will probably shirk in the investigation or hide the information that has been discovered. A new problem that emerges in a spy contract is that the spy can also sell the information to the enemy in a second deal. The Double Cross System of the UK in WWII provides a successful example that defection can be a useful tool to counter military intelligence (Aldrich, 1998). In this section, we first discuss the moral hazard and defection problems in a spy contract, and discuss solutions in a later subsection.

Moral Hazard and Defection

It is assumed that country *A* plans to hire a spy to check on country *B* and to collect evidence. Country *A* offers a contract *c* to a spy on a 'take it or leave it' basis. The contract consists of a report $\gamma \in \Theta$ about the state of the secret and a reward $\varpi(\gamma) \geq 0$. In short, $c := \{r, \varpi(\gamma)\}$.

If *c* is accepted by the spy, then the spy needs to make an effort to discover the truth. Let $e \in \{0, \bar{e}\}$ be the binary choice of effort. The output of this effort is the probability of discovering a new weapon, denoted by $p(e \mid \theta)$ for $\theta \in \Theta$, and the input of this effort is described by an effort cost function $\lambda(e)$. In particular, it is assumed that $p(0 \mid y) = 0$ and $p(\bar{e} \mid y) = 1$, and for all *e*, $p(e \mid n) = 0$. The interpretation is: if country *B* really owns the new weapon, the probability of discovering the evidence increases with effort level; however, if country *B* is innocent, it is impossible to fabricate any evidence. Moreover, the effort cost increases: $\lambda(0) < \lambda(e)$. Throughout the paper, it is assumed that this effort decision is neither observable nor contractible by any country.

To distinguish the difference between the spy's finding and the report, we denote $\delta \in \Theta$ as the finding and, as described, $\gamma \in \Theta$ as the report. We will consider the following two problems. First, restrict $\gamma = \delta$. Since the evidence of having new weapons can be found only when the spy has put in effort $\bar{e}$ and the true state is *y*, there is an incentive for the spy to shirk in the investigation, which will cause the probability of discovery to be zero (i.e. $p(0 \mid \theta) = 0$ for all θ), and to save the effort cost. Since finding $\delta = n$ (hence the report $\gamma = n$) is the same as the report for the state *n*, country *A* cannot distinguish between these two cases. This is the *moral hazard* problem in a spy contract.

Second, we consider the possibility that $\gamma \neq \delta$, given that $\bar{e}$ has been taken and the state is *y*. Note that now the spy is certain about the existence of new weapon. Instead of reporting to country *A* truthfully and receiving the reward $\varpi(y)$, the spy can sell this piece of information back to country *B* and ask country *B* to buy back. Country *B*, of course, will have doubt about the spy's blackmail. Let μ denote country *B*'s belief that the spy has really found the evidence. Since country *B* has now been informed (by the spy) about the contract, it is assumed that the structure of the contract is known by country *B* and hence $\mu = p(\bar{e} \mid y)$ in equilibrium. According to this belief, country *B* decides to accept or reject the spy's request. If country *B* accepts it and pays a ransom ϕ, the spy will change the report to $\gamma = n$ (which is different from δ), and receive two rewards: $\varpi(n)$ plus ϕ. The truth is never reported to country *A*, and this is the *defection* problem in a spy contract.

Solutions

Both moral hazard and defection problems will bring about fake reports and damage country *A*'s welfare. The existing literature (e.g. Myerson, 1979; Holmstrom & Milgrom, 1990) has provided a profound solution for the moral hazard problem, by restricting it to a contract that satisfies both individual rationality and incentive compatibility conditions. There is, however,

no literature addressing the defection problem of this sort, but we can still summarise four solutions[3] from those in similar circumstances. The first is to encourage the patriotism of the spy. When this emotional factor is taken into account, the benefit of truthfully reporting will be extraordinarily large compared with any offer of ransom. The second is the repeated game argument in which, in a trigger strategy equilibrium, if the spy cares enough about his future business, he will not sell the information for short term ransom and so lose future benefits (Abreu, 1988; Fudenberg and Maskin, 1986).

The third solution we will address in this subsection is from the literature of contract renegotiation. The idea is to treat defection as a kind of contract renegotiation, and the difference between the two concepts is that defection is a renegotiation with the enemy (country *B*). Since the offer is made by the enemy, there will be a price competition in the renegotiation stage. According to the renegotiation literature (e.g. Fudenberg and Tirole, 1990), we will focus on a defection proof contract where country *B* cannot buy back the information. The consequence of the price competition in the renegotiation stage is that the reward in the defection-free contract will become so high that if the maximum ransom that country *B* can afford is higher than country *A*'s expected benefit from investigation, a defection-free contract will not exist at all.

Defection-free Contract

We will now demonstrate how price competition in the renegotiation stage induces extra rewards to the spy, and when a defection-free contract does not exist.

According to the revelation principle (see Myerson, 1979), there is no loss of generality for country *A* to choose a contract *c* to implement an arbitrary effort of the spy. Then country *A*'s expected welfare in the contract will depend on the piece of information brought by the spy. There can be two kinds of information: $\gamma = y$ or *n*. Following Bayes' rule, country *A*'s posterior belief after hearing report *y* is $\frac{\rho\rho(e \mid y)}{\rho\rho(e \mid y)} = 1$; while after hearing report *n*, the posterior becomes $\hat{\rho}(e) := \frac{\rho(1 - p(e \mid y))}{\rho(1 - p(e \mid y)) + (1 - \rho)}$, which is smaller than ρ. According to the equilibrium in the War and Peace game, country *A* will choose *W* surely if *y* is reported by the spy; however, if *n* is reported, she will choose *W* or *P* according to whether $\hat{\rho}(e) > \rho^*$ or $\hat{\rho}(e) < \rho^*$, respectively.

Remember that the spy's effort is neither observable nor contractible. The only effort level for a successful spy contract is $e = \bar{e}$. If we focus on this case, the relative sizes of $\hat{\rho}(e)$ and ρ^* is clear: since we have $p(\bar{e} \mid y) = 1$, $\hat{\rho}(\bar{e}) = 0$. That is, *P* will be taken if *n* is reported. Let $\Pi_A(\bar{e}, c)$ denote the expected welfare for this contract, where:

$$\Pi_A(\bar{e}, c) = \rho[\pi_A(WW, y) - \varpi(y)] + (1 - \rho)[\pi_A(PP, n) - \varpi(n)].$$

The interpretation is: there is a prior belief $(\rho, 1 - \rho)$ about the states *y* and *n*. If the state is *y* and the spy has put in full effort $\bar{e}$, he will discover the new weapon certainly (i.e. $p(\bar{e} \mid y) = 1$), hence country *A* will take *W*. Country *B* will take *W* according to our assumptions. Hence country *A*'s welfare is $\pi_A(WW, y) - \varpi(y)$ where $\varpi(y)$ is the reward paid to the spy. On the other hand, if the state is *n*, the probability of discovering a new weapon is zero. Since $\hat{\rho}(\bar{e}) = 0$, country *A*'s welfare is $\pi_A(PP, n) - \varpi(n)$.

[3] The author is grateful to the referee for pointing out the first two solutions.

The spy's expected utility in this contract is denoted by $\Pi_0(\bar{e})$, defined by:

$$\prod_0(\bar{e}) = \rho\varpi(y) + (1-\rho)\varpi(n) - \lambda(\bar{e})$$

Note that since $p(\bar{e} \mid y) = 1$, the spy will discover the evidence surely if the state is y. To solve the moral hazard problem, we require:

$$\prod_0(\bar{e}) \geq \prod_0(0) = \varpi(n). \tag{1}$$

Since $\varpi(n)$ is non-negative, the individual rationality condition is satisfied.

Defection-free Conditions

The spy's utility must satisfy defection-free conditions as follows. First, to simplify the analysis, we assume that if the truth is uncovered, the spy will surely defect from country *A*. This assumption is fine with the risk neutrality of $\Pi_0(\bar{e})$ as, if the ransom from country *B* is high enough, then the expected utility becomes higher. Second, whether country *B* will accept the request depends on its belief μ on whether the spy has discovered the truth. As described earlier, since country *B* is now informed of the spy contract, the contract structure is known by country *B* and therefore, $\mu = p(\bar{e} \mid y)$ in equilibrium. In other words, if the spy makes a request for a second deal, country *B* will believe that the truth has been uncovered.

Third, in this renegotiation stage the spy knows the truth, so the reward[4] from the spy contract will be $\varpi(y)$. This means that *B*'s counter-offer ϕ must be at least greater than $\varpi(y$ and hence $\phi = \varpi(y) + \varepsilon$ with ε arbitrarily small. Hence, country *B*'s decision can be summarised as: if $\theta = n$, it is dominant for country *B* to reject the request; if $\theta = y$, then *B* will make an offer $\phi = \varpi(y) + \varepsilon$ if $\pi_B(PW,y) - \phi > \pi_B(WW,y)$. Here, the spy will change his report from *y* to *n*, so country *B*'s welfare will be $\pi_B(PW,y)$ which is higher than $\pi_B(WW,y)$.

Finally, in order to avoid defection, $\varpi(y)$ must be sufficiently high so that country *B* will find it not worthwhile to pay the ransom. That is, $\varpi(y)$ must satisfy the defection-free condition:

$$\varpi(y) \geq \pi_B(PW,y) - \pi_B(WW,y) \tag{2}$$

Together with the incentive condition in equation (1) where $\varpi(y) - \varpi(n) \geq \frac{\lambda(\bar{e})}{\rho}$, we can determine the least rewards: $\varpi(y) = \pi_B(PW,y) - \pi_B(WW,y)$ and $\varpi(n) = 0$. There is an extra reward $\pi_B(PW,y) - \pi_B(WW,y) - \frac{\lambda(\bar{e})}{\rho}$ paid for the royalty of the spy. Country *A*'s welfare in this contract is $\rho[\pi_A(WW,y) - (\pi_B(PW,y) - \pi_B(WW,y))] + (1-\rho)\pi_A(PP,n)$. The consequence of this extra reward is that, if country *B*'s benefit from hiding (i.e. $\pi_B(PW,y) - \pi_B(WW,y)$) is high enough, then it is not worthwhile[5] for *A* to hire a spy in the first place.

The reason for the extra reward is because the two countries are engaged in a sort of price competition: country *B* has the motive to outbid country *A*'s offer of a reward to buy the spy's silence, while country *A* has to offer a reward high enough so that country *B* cannot outbid. An economic solution for this is to create competition on the spy side too. Our fourth solution is to argue that when there is competition on the spy side, there can exist a successful investigation.

[4] Recall that the effort cost is sunk in the effort stage.

[5] If $\rho \leq \rho^*$, then *A*'s welfare is $\rho\pi_A(PW,y) + (1-\rho)\ \pi_A(PP,n)$ if $\rho > \rho^*$, then *A*'s welfare is $\rho\pi_A(WW,y) + (1-\rho)\pi_A(WP,n)$.

Competition among Spies

When there are at least two spies, each spy has motivation to do better for a higher reward in a relative rewarding scheme. Since country *B*'s benefit from hiding remains the same (i.e. $\pi_B(PW,y) - \pi_B(WW,y)$), the maximum ransom for each spy will be less than the single spy case, so country *A* has a better chance to get to the truth. We will discuss how competition among spies can solve the extra rewarding problem in the defection-free contract.

Assume that country *A* now hires two spies, 1 and 2, to work on the task. We will use the same effort set, type sets and probability of discovering as defined earlier, but add an index *k* to identify each spy. The difference here is that now country *A* adopts a relative rewarding scheme. Namely, if both spies discover the truth, both will be equally rewarded ϖ^M; if both find no evidence, both get $Z > 0$; if only one of them provides the evidence, he is to be paid $\varpi^H((>\varpi^M)$ and the other is paid some service fee, which is normalized to zero. The purpose for this relative scheme is to provide the spies' motivation to behave differently in the renegotiation stage.

Each spy can probably shirk or sell the information back to country B. There can be four kinds of effort combinations: 00, $0\bar{e}$, $\bar{e}0$, $\overline{ee}$. Under a relative rewarding scheme, not all spies will necessarily blackmail for a second deal. There will be three cases: if there are two requests, it must be both spies taking effort $\bar{e}$; if there is only request, it can be only one or two spies taking effort $\bar{e}$; if there is no request, then it can be no, only one or two spies taking $\bar{e}$. Consequently, country *B*'s decision in the renegotiation stage will be different for each case and will depend on the relative sizes of rewards.

To summarise the timing, after the spy contracts are accepted by two spies, these two spies make their effort choices independently and simultaneously. After the effort decisions, two spies again make defection decisions independently and simultaneously. Then country *B*, not knowing these decisions, has to decide whether to accept the requests or not. Our focus is on the existence of a spy contract where, if the state is *y*, there is at least one report that is *y* and the overall rewards are cheaper than in the previous subsection.

Country B's Decision

As described, there can be none, one or two requests. If the state is *n*, country *B* will decline all requests. However, in state *y* country *B* needs to trade-off the benefit and cost. If there are two requests, it is clear that both spies have paid full effort (i.e. the effort combination is $\overline{ee}$). If not paying both of them, country *A* will learn the truth. We assume that once country *B* is informed of the spy contract, it will know the structure of the contract. Hence, country *B* will pay both of them if:

$$2(Z+\varepsilon) \leq \pi_B(PW,y) - \pi_B(WW,y) \tag{3}$$

Next, if there is only one request, there can be one or two spies putting in full effort. Then, depending on country *B*'s beliefs in each of the two cases, the welfare for paying the ransom is different. Let ρ_1 denote *B*'s belief that two spies have put in full effort. Then the expected welfare for paying the ransom is $\rho_1\pi_B(WW,y) + (1-\rho_1)\pi_B(PW,y)$. Note that when both spies know the truth, paying only one spy cannot stop country *A* knowing the truth. The decision will be similar to the single spy case (i.e. to pay the ransom if $\rho_1\pi_B(WW,y) + (1-\rho_1)\pi_B(PW,y) - \Phi \geq \pi_B(WW,y)$). Moreover, since country *B* cannot observe effort decisions, paying $\Phi = \varpi^H + \varepsilon$ can buy the spies' silence for both possibilities of efforts. Hence, for $\rho_1 > 0$ the condition of accepting the request is weaker than the single case; that is, to pay the ransom if:

$$\varpi^H + \varepsilon \leq (1-\rho_1)[\pi_B(PW,y) - \pi_B(WW,y)] \quad (4)$$

Spies' Defection Decisions

Since blackmailing needs evidence, only those who have put in effort $\bar{e}$ need to worry about this decision. If the effort combinations are $0\bar{e}$ or $\bar{e}0$, the spy who has put in $\bar{e}$ will get a reward ϖ^H for telling the truth. However, if he sells it to country *B*, then according to our discussion above, the reward will be $Z + \varpi^H + \varepsilon$ if *B* pays the ransom, and only *Z* if *B* cannot afford to pay. *Z* is the reward for two negative reports, and $\varpi^H + \varepsilon$ is the ransom paid by *B*. It is hence obvious that spy will make a request.

If the effort combination is $\overline{ee}$, the decision of defection will be interdependent. Namely, if both spies make requests and country *B* can afford to pay $2(Z + \varepsilon)$, then both will have a total reward $Z + Z + \varepsilon$ where the first *Z* is the reward for two negative reports, and $Z + \varepsilon$ is the ransom paid by *B*. But if country *B* cannot afford to pay $2(Z + \varepsilon)$, then both spies will get only Z. If only one spy makes a request, the rewards will be ϖ^H and $\varpi^H + \varepsilon$ for telling the truth and defection, respectively. ϖ^H is the reward for a single positive report and $\varpi^H + \varepsilon$ is the ransom for a single request. Finally, if there is no request, both spies will get *Z*.

Spies' Effort Decisions

Whether to put in full effort $\bar{e}$ or to shirk will influence a spy's defection decision and then country *B*'s decision. We can summarise the above discussion as follows. If no spy puts in full effort, both get *Z*. If only one spy puts in $\bar{e}$, the payoff is $Z + \varpi^H + \varepsilon$ for the spy who has taken $\bar{e}$, and *Z* for the one not putting in effort. Finally, if both spies put in full effort, the payoffs will depend on the setting of the relative scheme. According to equations (3) and (4), if $2Z = \pi_B(PW,y) - \pi_B(WW,y)$ and $\varpi^H < (1 - \rho_1)[\pi_B(PW,y) - \pi_B(WW,y)]$ then country *B* will pay one defection request, but rejects two requests. Hence the outcome in this case will be only one spy to make a request.

Overall, if the relative scheme satisfies $2Z = \pi_B(PW,y) - \pi_B(WW,y)$ and for all $\varpi^H < (1 - \rho_1)[\pi_B(PW,y) - \pi_B(WW,y)]$, then there exists an equilibrium where both spies put in full effort, but only one will make a defection request. In this equilibrium, country *A* will pay less than in the defection free contract, as the equilibrium reward actually paid to the spy that provides the right report is ϖ^H.

CONCLUDING REMARKS

In this paper, we have addressed two very old issues in human society: *spying* and *defection*. Spying is considered one of the most direct and often used methods to grasp information from rivals, and it has become a well-organised profession, as there have been many private investigator schools – or even distance learning programmes[6] – in recent years.

Despite prevailing in various areas, spying has received few theoretical discussions in the literature (Matsui, 1989; Whitney and Gaisford, 1999; Solan and Yariv, 2004). This paper provides a contract approach discussion to understand how spying can raise another battle between two conflicting countries.

We have simplified the notions but without loss of generality. More complex assumptions, such as a risk averse principal or agent, a report contingent ransom, or a repeated framework can greatly enrich the discussion. The most arguable assumption would be the sizes of rewards

[6] For example, http://www.findprivatedetectives.co.uk/categories/eye/private_investigator_school.html

in the relative performance regimes. Although all rewards are to be determined in the model, these assumptions will be crucial for the equilibrium we will derive. However, it can be easily extended to a more general setting, where we need to duplicate the discussion here for different ranges of parameters.

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