A Real Option Approach to Military Service

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Abstract: This paper firstly demonstrates how real option approaches potentially improve a military system. We present a novel military system, a hybrid of conscription and voluntary military systems. Under this system, a drafted male would serve a predetermined period and then, if qualified, has the option of extending his military service and receiving a *strike price*. Our survey in Korea shows that the appropriate strike price is approximately $20,000 for a 10-month extension. This hybrid has the advantage of discharging unsatisfactory personnel from the military, reducing moral hazard and information asymmetry, and enhancing social welfare.

Keywords: conscription, voluntary army, option, military service, enlistment decision

INTRODUCTION

This paper suggests a hybrid military service and examines how people will respond to it. We collect the data from Korea because of its unique geopolitical status (e.g. South and North Koreas are technically at war) and ongoing debate on military system (e.g. accidents and corruptions in the military).

The debate on a voluntary versus a conscript system has a long history. To the Athenians at its apogee, serving their country as a warrior was a significant civic virtue and duty. Only the citizens who had completed their military duty (*ephebes*) could vote. However, the Athenians gradually relied on a professional standing army. In addition, more and more modern states have suspended conscription and instead adopted a voluntary system. In the United States only prior to 1973, the minimum service period was two years, with conscripts serving this minimum period and volunteers serving for periods of 3 years or more.

Many papers examine the debates. A voluntary system can lower turnover and implicit taxes levied on reluctant military participants (Oi 1967). The larger the required size of the army, the more the conscription can be efficient (Lee and McKenzie 1992; Ross 1994; Warner and Asch 1996). Therefore, it is important how much it costs to adopt a voluntary system. The estimated cost of a voluntary system varies - $4 billion (Oi 1967), $5.4 billion (Altman and Fechter, 1967) and $5-7.5 billion (Fisher 1979). Of course, the estimations depend on the macroeconomic and microeconomic factors affecting choice between military and civil jobs (Altman and Barro 1971; Kilburn and Klerman 1999; Asch, Hosek, and Warner 2007). Army and Navy educational programs can significantly reduce the cost (Warner, Simon and Payne, 2001). However, relatively little research exists on how ‘pay structure’ would influence the choice and cost in addition to ‘pay level’.

In this paper, we propose a hybrid structure and experiment the idea in Korea. We aim to improve the conscription system and to mitigate the weakness of the voluntary system. To understand our proposal, let us briefly introduce the Korean draft system. Every healthy Korean male should serve in the Korean military for 21 months. Since vacation is around one month, Korean men serve for 20 months. There are four ranks in this 20-month service. Each

lasts around five months. From lowest to highest, the ranks are private second class (*ibyeong* in Korean), private first class (*ilbyeong* in Korean), corporal (*sangbyeong* in Korean) and sergeant (*byeongjang* in Korean). In this Korean system, we want to introduce a novel hybrid of conscription and voluntary system as follows.

(1) Every healthy male should serve ten months as a private (second class and first class).

(2) At the end of 10th month (we call it "*option maturity*"), the government gives privates an option to choose from two alternatives. (A1) Leave the military immediately. (A2) Receive 20 million Korean won (KRW hereafter)[1] and serve in the military ten months more as corporal and sergeant if the military approves the extended service.

Insert Figure 1 about here

Figure 1 describes this novel hybrid military and option system. This choice given to privates is a European option because they can choose ('*exercise the option*') only at the end of the 10th month. It is a matter of interpretation whether this option is call or put (with human capital as its *underlying asset*). As a call option, a private will forsake the strike price (20 million KRW) if he believes his human capital outside of the military more valuable than the strike price. As a put option or insurance on human capital, the strike price is a downside protection for the latter ten months. A private will continue his military service if his human capital drops below the strike price. This can happen due to economic downturn or depreciation of his skills. In sum, from the soldiers' perspective, (A1: "discharge") is exercising a call option (discarding the put option); (A2: "continue") is exercising a put option (discarding the call option). The more likely the options are exercised, the higher the value of the options.

Specifically, let $V_{m,t}$ and $V_{d,t}$ indicate the value of *continue* and *discharge* respectively at time t. $V_{m,t}$ is the cash payoff (e.g. 20 million KRW). $V_{d,t}$ depends on the value of human capital outside of the military. Then at the expiration date T (i.e. 10^{th} month after initial enrollment), the payoff to a private is: $\max\{V_{m,t}, V_{d,t}\}$. We can express this position with both

[1] As of 2011, the average yearly wage of Korean men at their 20s is around 25 million KRW, or around 2 million KRW per month. We set the strike price based on this average monthly wage.

call and put options as:

$$\max\{V_{m,t}, V_{d,t}\} \text{ (Payoff at the Option Maturity)}$$
$$= V_{m,t} + \max\{0, V_{d,t} - V_{m,t}\} \text{ (Cash + } Call \text{ Option)}$$
$$= V_{d,t} + \max\{0, V_{m,t} - V_{d,t}\} \text{ (Underlying Human Capital + } Put \text{ Option).}$$

This hybrid has benefits. First, the military has the option to choose qualified people and to reject incapable ones. Keeping incapable ones as senior soldiers costs the military. Second, the hybrid can reduce moral hazard and information asymmetry salient in conscription and voluntary system respectively. Given the option, soldiers have the incentive to increase and to signal the value of their human capital during their mandatory service period. The military can observe a soldier and determine whether to bestow the option on him. After the option expiration date, the military can fire soldiers anytime and stop paying 'full' 20 million KRW. Under conscription, a reluctant participant has no incentive to work hard. Without any vision and interest in a military career, he just awaits his discharge while shirking his duty (moral hazard). Under a voluntary system, most candidates are without prior military experience. Those whom the military least wants are most likely to apply. The lower the military wage, the more serious such problems. This can create adverse selection (information asymmetry). Third, the government can flexibly supply the option to address social issues. This system can become an instrument for social insurance for the young unemployed.

The next section empirically analyzes how demographic characteristics and family economic status influence the choice on the options. The empirics will also clarify whether and how to implement the hybrid military system.

EMPIRICAL ANALYSIS

We examine the responses of 300 randomly selected Korean young educated males (21-31 years old). They are either college students or college graduates. We match the regional

distribution of the random sample with that of Korean population. Half of the 300 have not yet served in the military (pre-service group). The other half has already finished their military duty (post-service group).

Table 1 presents summary statistics. About 70% and 60% are willing to choose "continue" of those pre-service and post-service respondents respectively. Table 2 shows the probit estimation results for each group depending on military service completion.[2] First, we analyze only for those expecting military service (pre-service). Later, we do it again only for those who have finished their military service (post-service). We code "discharge" as 1 and "continue" as 0, which becomes a dependent variable. "Discharge" means that a respondent chooses alternative (A1), being discharged immediately. "Continue" indicates the choice of (A2), continuing the military service for ten months more and accepting 20 million KRW.

Insert Table 1 and Table 2 about here

As we expect, we have different results by group. For those who have not yet served in the military (expecting military service); the older a male, the more often he chooses to continue. If a respondent has a college degree, he is more likely to choose *discharge*. If he lives in Seoul, he is more likely to choose *continue*. The more the parents' wealth, the more he chooses to be discharged. College majors are insignificant.

Our interpretation of the results is as follows. First, the longer the working periods by getting a job ten months early, the higher his return from human capital investment. Thus, the longer the remaining working period, the higher the call option value or the incentive for discharge. Therefore, the younger he is, the more he prefers discharge. Second, since college graduates are ready to enter labor market, they tend to value the call option higher (or put option value lower due to put-call parity). Alternatively, college graduates may worry more about their human-capital depreciation after the extended ten-month service than college students do, because the former hardly have the opportunity to resume schooling and catch up with competitors after discharge. Third, Seoul residents are more likely to be pessimistic in getting a job due to high competition among labor supplies in the city. Hence, conditional on other characteristics, they value the call option less. Fourth, if the individual has rich parents,

[2] We drop 15 males exempted from military service. We drop two more whose parents passed away.

he is likely to be optimistic about his job market prospects because his family economic background works as an insurance, which increases the call option value (or decreases the put option value of the hybrid system).

For those who have finished military service; the more the parents' wealth, the more often he chooses discharge as well. If his major is business or economics, he is more likely to continue. Age, college degree, residing in Seoul and other college degree variables are insignificant. The discharged clearly have more information and knowledge about how military service affects their human capital. The discharged believe that their human capital (`how much their human capital change after discharge) is independent of age, college degree and residence. However, those expecting military service overestimate the effect of those variables. They believe that the military service might affect their human capital depending on age, college degree and residency.

Similar to the results for those expecting the military, the larger the parents' economic affluence, the higher the call option value. Thus, if those with rich parents can exercise the call option when they are in service, they are likely to do so. They consider rich parents as insurance or evaluate the time in the military very costly. Interestingly, the students with business or economics major are less likely to exercise the call option. Probably, they are conservative in self-evaluating their human capital expecting competitive labor market; they are optimistic about the depreciating speed of human capital; or they regard the military service as valuable or not-hugely-destructive to their human capital connected to business and economics majors.

Insert Table 3 about here

Next, we ask what a respondent thinks is a socially desirable *Strike Price*, the amount of staying in the military ("continue") per month. For example, if a respondent answers two million won, he believes that a soldier should receive 2 million KRW per month if the soldier chooses to serve for the military 10 months more as a corporal and sergeant. Thus, this question measures subjective and social valuation on the monthly strike price. It also assesses how much our hybrid system is socially implementable. The larger the number, the higher the society praises the sacrifice in military service, but the more costly to implement the hybrid.

Table 3 shows the results. The mean of socially accepted monthly option *Strike Price* is ₩2,049,047 or around ₩20 million for the latter 10 months. It is purely a coincidence that this 20 million KRW matches the number appearing in our first survey question. Our best guess is that Korean men in their 20's regard the time in the military as foregone labor income. Since this number is also consistent with the average wage of this young male group, our estimate can reflect the opportunity cost of the extended military service.

Interestingly, those who have finished military service tend to regard the desired strike price 618,400 KRW less. Similarly, Seoul residents, literature major and business-economics major tend to lower the strike price by 365,000 KRW, 655,200 KRW and 527,300 KRW less respectively. Other variables are insignificant.

Intuitively, those expecting military service require high strike price because they face higher uncertainty. The more the downside risks in human capital, the larger the required insurance payment (strike price). Equivalently by put-call parity, the more the upside potential in human capital, the larger the required strike price in order to keep the call option value constant. This result is consistent with the fact that call- or put option value increases with uncertainty.

The remaining results look consistent with those in Table 2. The only difference is the result for literature majors. This result reveals one aspect of the Korean labor market. These days, the college graduates with a literature major experience extreme hardship in job market. The value of the call option in hand tends to decrease if one has poor outside option, to which our results correspond.

DISCUSSION

Value Creation Mechanism and Enlistment Supply

This section presents a 'preference' mechanism on how our hybrid system is an improvement over a volunteer system (i.e., more efficient). There is much heterogeneity in youths' preferences for military service, and preference heterogeneity by itself makes the supply curve of new recruits relatively inelastic. However, the literature is silent on how

preferences are formed and how well informed youth are about their preferences prior to entering service. The relative efficiency of a hybrid system emerges depending on how well informed youth are.

Suppose there is much uncertainty in the youth population about their preferences for military service such that, prior to actual service, youth are likely to overstate the negative aspects of service and under-appreciate the positive aspects. As preference uncertainty exists and preferences are downward-biased, the supply curve of new recruits is to the left of where it would be if youth were fully informed their preferences. Hence, preference uncertainty raises the cost of a volunteer system because it increases the military wage necessary to meet a given demand for new accessions. See Asch et al (2007) for the detailed discussion about enlistment supply literature.

The hybrid system creates values as follows. Bring in a substantial number of draftees for a relatively short training period and expose them to military life. Then set the price to induce some desired fraction to continue service. Therefore, if (1) there is a lot of uncertainty in youths' preferences for service, (2) those preferences are downward-biased and (3) draftees discover their true preferences during the initial period, then a hybrid system has the potential to reduce costs relative to a volunteer system by reducing the wage rates needed to satisfy a given force strength requirement. Of course, other factors such as recruiting and training costs would count in the analysis in order to establish the relative efficiencies of the systems quantitatively.

Empirical Issues

Table 3 shows that post-service individuals have a lower strike price than the pre-service. In fact, the estimate (618,400 KRW) is strikingly large relative to the mean (2 million KRW). Some of this decline might be due to human capital or the learning about preferences by the post-service individuals. However, some might be due to self-selection of volunteers into service. Unless Korean military work force relies completely on random draft, some of those in the "completed service" sample will have been true volunteers. Then, we know that volunteers will have lower supply prices than the rest of the population that did not serve.

This group will report lower strike prices than individuals in the "never served" sample. Nevertheless, since almost all Korean males are drafted, such sample selection bias does not exist. Therefore, the difference in valuation between completed and expected military service group reflects how males change the valuation before and after their military service. This finding is the first in the literature.

Optimal Design

Our hybrid system allows anyone who prefers not to be in the military to leave, but the military may prefer keeping them. Of course, such problem would be more severe in voluntary system, less severe in our hybrid system and not present at least for 21 months under the current conscription system. High ability and highly educated individuals might prefer not to be in the military because of high opportunity costs, e.g., high earnings or good education opportunities outside the military, but the military might prefer to retain these individuals because of their capability. Thus, an optimal design for the hybrid system needs to balance moral hazard and the opportunity cost/benefit of keeping high ability personnel in the military instead of civil sector.

Signaling Game

The option is available only to the conscripts that the military wants to keep at the option maturity. Thus, to implement the hybrid system efficiently, the military must identify those it wants to keep. This can create a signaling game: A poor candidate can "play" a high performer and try to quality for the option. This paper does not formally analyze a separating equilibrium in which the types of conscripts truthfully reveal their ability[3]. However, if it is costly enough for a poor candidate to play a high performer, there will be a separating and intuitive equilibrium; i.e. the first 10 month can be a training and observation period, while the latter 10 month is a job market (Spence 1974; Cho and Kreps 1987).

[3] We do not present this formal model because it is straightforward.

Reserve Army and Skill

We interviewed several military officials. The officials expressed concerns on budgetary implications. In addition, they concerned that the system can weaken the reserve force. This subsection analyzes the latter issue.

Discharging a soldier is not the end of military service in Korea. In the current situation, the reserves (*yebigun*) are strategically important. Therefore, the military should ensure that a soldier is skilled enough at discharge. To this end, 10 months appear short to produce useful reserve forces. For example, a soldier may not even complete one ranger (*yugyeok*) and one extreme weather (*hokhangi*) training during his service. Some officials argue that it takes around 15 months for the infantry to be skilled, and longer for artillery and tank specialties. In addition, those soldiers in strategically important but difficult tasks can be less likely to stay in the military. Some argue that leadership skills materialize at the transition from private first class to corporal, around the option maturity. In order to address those budgetary concerns and skill acquisitions, we clearly need to implement the hybrid system flexible and varied depending on contexts. Next subsection discusses these issues.

Possible Variations

Given the aforementioned practical issues, we can introduce varied version of the hybrid system. First, we can delay the exercise date (e.g., 15-5, 16-4 split). For example, we can ask, “Do you want an early discharge or do you wish to stay on as a sergeant for 5 months at 10 million KRW?” Future study can undertake comprehensive surveys with more flexible exercise dates. Second, the options should take into account different specialties and strategic importance. For example, the option should be different for those stationed in frontline (DMZ) versus non-frontline or different branches.

CONCLUSION

This paper presents a novel hybrid military system that combines conscription and voluntary military system. This hybrid incorporates a real option. In the Korean context, we suggest the

strike price of the option as $20,000 on average in order for a Korean soldier to extend his military service 10 months more. A government can use this hybrid system in order to implement a social insurance again unemployment, to recruit experienced candidates, to prevent incapable soldiers from staying in the military and to reduce moral hazard and information asymmetry.

Future study can analyze our idea further to check whether it is implementable and how to implement it. They can examine the active soldiers, not just pre-service and post-service males. Nevertheless, we demonstrate how real-option researchers can identify research opportunities and contribute to the design of civic duty and to further community virtues. Future studies extend this line of research.

REFERENCE

Altman, S. H., & Barro, R. J. (1971). Officer supply: the impact of pay, the draft, and the Vietnam War. *The American Economic Review*, 649-664.

Altman, S. H., & Fechter, A. E. (1967). The supply of military personnel in the absence of a draft. *The American Economic Review*, 19-31.

Asch, B. J., Hosek, J. R., & Warner, J. T. (2007). New economics of manpower in the post-cold war era. *Handbook of Defense Economics*, *2*, 1075-1138.

Cho, I. K., & Kreps, D. M. (1987). Signaling games and stable equilibria. *The Quarterly Journal of Economics*, 179-221.

Fisher, A. C. (1969). The Cost of the Draft and the Cost of Ending the Draft. *The American Economic Review*, 239-254.

Kilburn, M. R., & Klerman, J. A. (1999). *Enlistment Decisions in the 1990s*. Rand Corporation.

Lee, D. R., & McKenzie, R. B. (1992). Reexamination of the relative efficiency of the draft and the all-volunteer army. *Southern Economic Journal*, 644-654.

Oi, W. Y. (1967). The economic cost of the draft. *The American Economic Review*, 39-62.

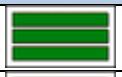
Ross, T. W. (1994). Raising an Army: A Positive Theory of Military Recruitment. *Journal of Law and Economics*, 37(1), 109-131.

Spence, A. M. (1974). Market signaling: Informational transfer in hiring and related screening processes (Vol. 143). Harvard Univ Pr.

Warner, J. T., & Asch, B. J. (1996). The economic theory of a military draft reconsidered*. *Defence and Peace Economics*, *7*(4), 297-312.

Warner, J. T., Simon, C. J., & Payne, D. M. (2001). *Enlistment Supply in the 1990's: A Study of the Navy College Fund and Other Enlistment Incentive Programs* (No. DMDC-2000-015). Defense Manpower Data Center Arlington VA.

Figure 1: Description of our Hybrid Military System

Army ranks from lowest	Insignia	Description
Private second class (*ibyeong*)		A healthy Korean male must serve ten months as a private
Private first class (*ilbyeong*),		
Option Maturity: A private should decide between *discharge* vs. *contiue*		Decide whether to be discharged immediately or to receive 20 million KRW and continue to the service ten months more
corporal (*sangbyeong*)		Serve only if a person chooses "continue" option and if the military approves him
Sergeant (*byeongjang*)		

The duration of each rank is five months.

Table 1: Summary Statistics
Option Exercise = 1 for "discharge" and 0 for "continue and receive ₩20 million." As for Subjective Socially Accepted Strike Price, we ask what a respondent thinks is a *socially desirable Strike Price*, the amount of staying in the military ("continue") per month. For example, if a respondent answers two million won, he believes that a soldier should receive 2 million KRW per month if the soldier chooses to serve for the military 10 months more as a corporal and sergeant.

	Military Service Expected (Pre-service)	Military Service Finished (Post-service)
Option Exercise	0.391	0.307
(choosing *discharge* over ₩20 million)	(0.490)	(0.463)
Age	20.09	26.33
	(1.357)	(2.703)
Subjective Socially Accepted *Strike Price* (unit: ₩10,000)	227.6	179.2
(choosing *discharge* over *Strike Price*)	(209.1)	(123.3)
College graduates	0.0301	0.533
	(0.171)	(0.501)
Parents' Net Asset (₩1,000,000)	13,647	18,517
	(12,775)	(15,946)
Seoul City Residents	0.248	0.293
	(0.434)	(0.457)
Literature Major in College	0.0752	0.0733
	(0.265)	(0.262)
Social Science Major	0.0827	0.107
	(0.276)	(0.310)
Business-Economics Major	0.105	0.180
	(0.308)	(0.385)
Natural Science Major	0.0902	0.0533
	(0.288)	(0.225)
Engineering Major	0.511	0.493
	(0.502)	(0.502)
Observations	133	150

Standard deviations in parentheses.

Table 2: Probit Estimation Results for Option Exercise (unit: 10,000 KRW)
We code "discharge" as 1 and "continue" as 0 to make a dependent variable.

	Military Service Expected (Pre-service)	Military Service Finished (Post-service)
Age	-0.291***	-0.0230
	(0.104)	(0.0461)
College graduates	1.544**	0.199
	(0.689)	(0.258)
Parents' Net Asset (₩1,000,000)	0.00188*	0.00153**
	(0.00102)	(0.000693)
Seoul City	-0.518*	0.0833
	(0.282)	(0.242)
Literature	-0.764	-0.915
	(0.569)	(0.580)
Social Science	0.252	-0.267
	(0.523)	(0.455)
Business-Economics	-0.700	-1.190**
	(0.511)	(0.470)
Natural Science	-0.0379	-0.473
	(0.511)	(0.561)
Engineering	-0.173	-0.578
	(0.340)	(0.370)
Constant	5.540***	0.269
	(2.058)	(1.261)
Observations	133	150
Log pseudolikelihood	-78.920813	-85.678038

Robust standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Subjective Socially Accepted Strike Price OLS Estimation Result
As for Subjective Socially Accepted Strike Price, we ask what a respondent thinks is a socially desirable Strike Price, the amount of staying in the military ("continue") per month. For example, if a respondent answers two million won, he believes that a soldier should receive 2 million KRW per month if the soldier chooses to serve for the military 10 months more as a corporal and sergeant.

Dependent Variable: Subjective Socially Accepted Strike Price per month	
Age	0.654
	(4.386)
Military Service Finished	-61.84**
	(29.54)
College graduates	18.40
	(31.57)
Parents' Net Asset (₩1,000,000)	0.130*
	(0.0707)
Seoul City	-36.50**
	(17.87)
Literature	-65.52**
	(31.86)
Social Science	41.18
	(39.26)
Business-Economics	-52.73**
	(25.83)
Natural Science	46.57
	(55.39)
Engineering	-19.04
	(23.30)
Constant	217.5**
	(94.47)
Observations	298
R-squared	0.081
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1	

Mean of Socially Accepted Monthly Option *Strike Price* = ₩2,049,047 per month.