Military Reserves and Social Welfare

by

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Abstract: We consider the contribution of reserves to the efficient mobilization of military manpower. Our analysis suggests that offering recruits an option to serve as reservists enhances social welfare if there is a sufficiently strong relationship between recruit performance in the military and their expected civilian income.

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Traditionally, the role of military reservists has been limited to the augmentation of regular forces during wartime. Increasingly, however, this is no longer the case: "Many powerful nations no longer manage their reserves as strictly strategic assets meant only to be used in the event of major war. Canada, Australia, Japan, Israel, and the nations of Western Europe now rely on their reserves as essential operational components within their total military forces."[1]

Motivating the growing reliance on reserve forces is the belief that offering reserve enlistment options makes it possible to recruit high quality personnel. But is the recruitment of high quality reservists – something that entails considerable financial cost – really worth the resultant social benefits?

In this paper, we consider the efficacy of offering reserve enlistment options in overcoming the asymmetric information problems widely believed to be the central inefficiency in the military recruitment process.[2] We argue that by allowing recruits to choose regular or reserve duty, the military can induce volunteers to reveal private information regarding their true ability – information that can be exploited in order to achieve a more efficient allocation of military manpower – since volunteers interested in maximizing income are likely to choose reserve service if their private expectations for civilian sector wages are high.

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[1] Nagl and Sharp (2010), p. 12

[2] For excellent reviews of the economics of military manpower, see Williams and Gilroy (2006) and Asch, Hosek, and Warner (2007).

This paper is divided into four sections. In Section 2, we lay out the model's basic architecture. In Section 3, we identify the socially optimal level of reserve recruitment under various conditions. In Section 4, we conclude the paper and offer some thoughts regarding the role of reserve forces.

Section 2: The Model

Following Berck and Lipow (2011), we assume that each potential recruit has a type *z*, which defines her marginal value product (wage) in a competitive private sector. The distribution of *z* is uniform on the unit interval. We assume that a recruit's type cannot be directly observed by the government, and constitutes private information known only to that person.

Recruits are offered three choices. They can (i) remain civilians and earn *z*; (ii) join the regular military and earn wage w_M; or (iii) join the reserves and earn an aggregate income of $pw_R + (1-p)z$, where *p* is the proportion of work time reservists devote to military activity. We assume that they choose the option that gives them the highest income. Potential volunteers will choose to join the regular military if $w_M > z$ and $w_M > pw_R + (1-p)z$. Potential volunteers will join the reserves if $W_R > z$ and $w_M < pw_R + (1-p)z$. The criteria for joining the reserves cannot be met unless $w_M < w_R$, hence that is a requirement for there to be reserve forces. Let *z** represent the type indifferent between regular and reserve service. Then, *z** is given by:

$$z^* = \frac{w_M - pw_R}{1-p} . \qquad (1)$$

Individuals of types [0,z^*] will volunteer to serve as regulars, individuals of types [z^*,w_R] will join the reserves, and individuals of types [w_R, 1] remain civilians. The number of regulars is given by z^*, and number of reserves by $w_R - z^*$. The aggregate size of the military is given by Q, the number of regulars, plus p times the number of reserves. If we take the derivative of Q with respect to w_R, we find that:

$$\frac{dQ}{dw_R} = \left(-\frac{p}{1-p}\right) + p\left(1+\frac{p}{1-p}\right) = 0\,. \qquad (2)$$

Q is not changed by raising the reserve wage. When $1/p$ reservists join the military, the regular military force declines by one.

Let F be the total amount of military capability fielded. The value of F depends both on Q as well as the productivity of each soldier in producing military capability. Let g(z) be the military productivity of a person of type z. For brevity, we assume that regulars and reserves are equally efficient at producing military capability.[3] We assume that F is simply the sum of the military productivities of those who serve, implying constant marginal returns:

$$F = \int_0^{z^*} g(z)dz + p\int_{z^*}^{w_R} g(z)dz\,. \qquad (3)$$

[3] Williams and Evans (2007) find no evidence that reservists perform worse than regulars. Ben-Ari and Lomsky-Feder (2001), however, report that it is widely believed amongst commanders that reserve forces are of inferior quality.

Section 3: Can Reserve Enlistments Enhance Social Welfare?

Now, let us identify the circumstances that may make it desirable to introduce reservists into the military's mix of forces. We start by defining *B*, the social welfare function as

$$B=\int_0^{z^*} g(z)\,dz+p\int_{z^*}^{w_R} g(z)\,dz-T\left(w_M z^*+pw_R\left(w_R-z^*\right)\right)+\int_0^{z^*}\left(w_M-z\right)dz+p\int_{z^*}^{w_R}\left(w_R-z\right)dz\,, \qquad (4)$$

where the first two terms sum up to *F*, *T* represents the total cost of taxation (including deadweight losses), and the last two terms represent the benefits to regulars and reservists stemming from their military service. We assume *T′* is constant and that *T′*>1.

First, consider the case where all soldiers contribute equally to defense capability regardless of their value in the civilian economy. Mathematically, this means that $g(z)$ is equal to some constant value. To determine the optimal reserve wage, we take the derivative with respect to w_R:

$$\frac{dB}{dw_R}=-\frac{dT\left(w_M z^*+pw_R\left(w_R-z^*\right)\right)}{dw_R}+\frac{d\left(\int_0^{z^*}\left(w_M-z\right)dz\right)}{dw_R}+\frac{d\left(p\int_{z^*}^{w_R}\left(w_R-z\right)dz\right)}{dw_R}\,. \qquad (5)$$

Combining terms and simplifying, the first derivative of *B* can then be expressed as:

$$\frac{dB}{dw_R} = \frac{p}{1-p}\left(w_R - w_M\right)\left(1-2T'\right). \tag{6}$$

Evaluated at the point where there are no reserves, w_R - w_M is equal to zero. Taking the second derivative, however, yields:

$$\frac{d^2B}{dw_R^2} = \frac{p}{1-p}\left(1-2T'\right). \tag{7}$$

Because T'>1, this term is always negative, and therefore any increase in w_R above w_M will reduce *B*. Thus, when military productivity does not depend on civilian type, it will be optimal to have no reserves.

Empirical analyses generally conclude, however, that military productivity actually does depend on civilian abilities. Warner and Asch (1996) succinctly summarize the literature: "Higher quality personnel have been demonstrated to be more productive." To reflect this, let us now consider the possibility that talented recruits are more productive in a military setting: $g'(z) > 0$. Taking the derivative of *B*, we get:

$$\frac{dB}{dw_R} = p\left[\left(g\left(w_R\right) - g\left(z^*\right)\right) - \left(2T'-1\right)\left(w_R - z^*\right)\right]. \tag{8}$$

This is always zero when evaluated at w_R=w_M , because z^* will then be equal to w_R. It is sufficient, however, that the 2nd derivative be positive at w_R=w_M for it to make sense to introduce at least some reserves into the force mix. The second derivative is given by:

$$\frac{d^2B}{dw_R^2} = p\left(g'\left(w_R\right) + \frac{p}{1-p}g'\left(z^*\right)\right) - \frac{p}{1-p}\left(2T'-1\right). \tag{9}$$

Evaluated at w_R=w_M, this will be positive if $g'(w_M) > 2T' - 1$.

The logic underpinning the result is that substituting reservists for regulars is financially costly but increases the quality of the force. If the gain to social welfare stemming from the recruitment of higher quality recruits more than offsets the damage to social welfare stemming from the resultant loss of civilian output and the deadweight losses resulting from the taxation required to finance the reservists' wages, then it makes sense to recruit at least some reservists.

Since we have assumed T' is constant, the optimal number reservists will be determined primarily by the behavior of g. If g is linear, then there are only two possible results: the optimal value of w_R will be either w_M or 1. If $g'<2T'–1$, then it will be optimal to set w_R equal to w_M and have no reserves. If $g'>2T'–1$, then it will be optimal to set w_R equal to one, assuring that every eligible individual is participating in the military.

A similar situation arises if g is convex. When g is convex, g' is increasing. Thus, if a small increase in w_R above w_M results in an increase in B, further increases will do so as well (at an increasing rate). Hence, the optimal value of w_R will be either w_M or 1. If $g'(w_M) > 2T' - 1$ then the optimal value will be 1. If, however, $g'(w_M) \leq 2T' – 1$, B has to be computed for both w_M and 1 and then compared.

Now, let us consider the situation when g is concave. In this case, the sufficient condition for a positive quantity of reserves will generally be a necessary condition as well. To be exact, $g'(w_M) > 2T' - 1$ will be a necessary condition if:

$$(1-p)g''(w_R)-\frac{p^2}{1-p}g''(z^*)\leq 0 \quad (10)$$

for all $w_R > w_M$. The reason for this is that, as reservists are added, the number of regular soldiers declines. Hence, in addition to the rate at which $g'(w_R)$ declines as w_R increases, identification of the optimum number of reservists also depends on the rate that $g'(z^*)$ increases as z^* declines.

Assuming a sufficiently small value of p, (10) will hold for all reasonable concave functional forms. When this is the case, and $g'(w_M) > 2T' - 1$, then the optimal value of w_R will straightforwardly be given by the first-order condition:

$$g(w_R)-g\left(\frac{w_M-pw_R}{1-p}\right)=(2T'-1)\left(w_R-\frac{w_M-pw_R}{1-p}\right). \quad (11)$$

The left side of (11) reflects the military benefit of adding an additional reservist, minus the military loss of converting a regular soldier into a reservist. The right side of (11) reflects the cost of paying the additional reservist, minus the savings from converting a regular soldier into a reservist.

Should (10) not hold, a positive number of reserves may still be desirable even if $g'(w_M) \leq 2T' - 1$. The only way to determine the optimal number of reservists is to compute B for all w_R that solve (11) and for $w_R = w_M$ and compare the resultant levels of social welfare.[4]

Section 4: Conclusion

[4] It may be necessary to compute the value of B for $w_R = 1$ as well.

In this paper, we considered the role that reserve forces could play in overcoming the asymmetric information problems that cause inefficiency in the military manpower market. Our analysis suggests that the introduction of reserve forces as an integral operational component of the peacetime military only makes sense if there is a sufficiently strong relationship between recruits' productivity as civilians and as soldiers. This relationship, of course, depends critically on the technology used to produce military capability. The efficacy of reserve forces is likely to evolve with changes in that technology.

Near term, it is likely that considerations of efficiency and social welfare will lead to greater reliance on reserve forces. For example, in China "the People's Liberation Army (PLA) increasingly recruits civilian reservists who lack prior military service but possess high-tech skills with military applicability."[5] Clearly, this can only make sense if highly skilled civilians are especially valuable when mobilized for military service. With advanced technological skills a growing component of defense technology, it seems reasonable to expect that this relationship will continue to strengthen. Reliance on reserve forces is likely to grow in the foreseeable future.

[5] Nagl and Sharp (2010), p. 12

References

Asch, B., Hosek, J., and Warner, J., 2007. New economics of manpower in the post-cold war era, in: Sandler, T. and Hartley, K. (Eds), Handbook of Defense Economics, Volume Two. North-Holland, Amsterdam and Boston, pp. 1075-1138.

Ben-Ari, E. and Lomsky-Feder, E., 2011. Epilogue: theoretical and comparative notes on reserve forces. Armed Forces and Society 37, 361-371.

Berck, P. and Lipow, J., 2011. Military conscription and the socially optimal number of boots on the ground. Southern Economic Journal 78, 95-106.

Nagl, J. and Sharp, T., 2010. An Indispensable Force: Investing in America's National Guard and Reserves. Center for New American Security, Washington D.C..

Warner, J. and Asch, B., 1996. The economic theory of the military draft reconsidered. Defense and Peace Economics 7, 297-312.

Williams, A.G. and Evans, P., 2007. Materials handling ability of regular and reserve british army soldiers. Military Medicine 172, 220-223.

Williams, C., and Gilroy, C., 2006. Service to Country: Personnel Policy and the Transformation of Western Militaries. MIT Press, Cambridge and London.