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Where Have All the Heroes Gone?
A Self-Interested, Economic Theory of Heroism

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Abstract: Heroism is a valued part of any society, yet its realization depends on the decisions of individual actors and a public reward to individuals who undertake heroic actions. Military combat related activities provide a useful starting point for thinking about the empirical nature of heroism. Interestingly, if we define heroism by those who have been awarded military honors such as the Congressional Medal of Honor, the number of heroes has actually fallen in the past 35 years. We develop a theory to explain heroism in a rational decision-making framework, and we model the case in which individuals respond to danger to themselves and others based on the costs and benefits associated with acts of courage. We also provide insight into how a government may wish to optimally subsidize heroic actions. We then use our model to understand why the observed decline in heroism could, in fact, be both an optimal individual and social response.

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Abstract

Heroism is a valued part of any society, yet its realization depends on the decisions of individual actors and a public reward to individuals who undertake heroic actions. Military combat related activities provide a useful starting point for thinking about the empirical nature of heroism. Interestingly, if we define heroism by those who have been awarded military honors such as the Congressional Medal of Honor, the number of heroes has actually fallen in the past 35 years. We develop a theory to explain heroism in a rational decision-making framework, and we model the case in which individuals respond to danger to themselves and others based on the costs and benefits associated with acts of courage. We also provide insight into how a government may wish to optimally subsidize heroic actions. We then use our model to understand why the observed decline in heroism could, in fact, be both an optimal individual and social response.

1. Introduction

Under what circumstances would you undertake a heroic action? Would you risk life or limb to save another? Lord Tennyson's *Charge of the Light Brigade* indicates that a soldier's heroic duty entails that "Their's not to reason why, Their's but to do or die", suggesting that the motivation for heroic actions comes from something beyond reason or rationality. In fact, most studies that address heroism focus on psychological or philosophical motivations for action in battle. For example Gat (1999), Horowitz (2001), and Stern (1995) describe how an attack, or even the threat of attack, can motivate individuals to overcome the instinct of flight versus fight. Others such as Johnson *et al* (2006) describe how overconfidence can lead some to overestimate their abilities and act in a heroic manner. Other authors, e.g. Smirnov*, et al* (2007), also avoid rational explanations for heroism, by investigating how ancestral war and evolution have "hard-wired" heroism into society.

Alternatively, there could be another explanation for heroic actions, an economic one, rooted in individual self-interest and public incentives. We construct a simple economic model to explain heroism. Our purpose is to use the model to understand the data — heroism during war — and compare the model's predictions to the empirical regularities associated with the Congressional Medal of Honor (CMH) distribution. We find that an economic, incentive based model of heroism can be useful for understanding and explaining the empirical regularities of heroism.

We measure heroism using military actions, because this is one of the most consistently observed individual measures of heroism. Using the Congressional Medal of Honor recipients' data for measured heroic actions, we find three major facts. First, the number of war heroes has declined over time. This empirical finding also holds when we control for the number of troops deployed, and the number of deaths in the battlefield. By implication, this suggests that the probability of being a hero declines with time. Second, the probability that a hero survives his/her heroic act has declined with time and since Vietnam War has become zero. Third, the likelihood of heroism is higher in smaller theatres.

Theoretically, we interpret heroic acts within the context of individual decision making, public rewards, and the coordination of individual decisions.[2] Conceptually, we consider the issue of a bomb that is tossed into the middle of a room, where each individual must decide whether he/she should dive on the bomb to protect others, or hope that someone else does. In equilibrium, we derive the individual likelihood of heroism and the expected number of heroes as a function of the private costs and benefits to action, and the public reward to heroism. We then derive the optimal public subsidy to ensure that, in expectation, society has the optimal number of heroes. Importantly, using our model we then consider how technological change in conflict – i.e. the efficacy of bombs, the extent of collateral damage and the labor intensity of heroism – and technological change in general – i.e. the rise in living standards which could lower heroism if heroism is an inferior good – have evolved and how this explains the observed equilibrium behavior of heroism. Finally, we use the model to provide an economic interpretation of the data on heroism.

We illustrate our theory of heroism in the analytics of aggregate supply and demand. We note that an increase in lifetime utility or income raises the opportunity cost of heroism which, *ceteris paribus*, should reduce the supply of heroes. Moreover, we note that an improvement in countermeasures for surviving combat will also cause the supply curve to shift toward reduced levels of heroism. Taken together, these effects lead to a reduction in the number of heroes, which helps explain the first empirical regularity. Second, we show that an increase in the technological efficacy of bomb-making raises the costliness of behaving heroically. This will lead to a higher likelihood of deaths for heroes and a reduction in the supply for heroes, again due to rising opportunity costs. These forces explain the second empirical regularity. Finally we note that the supply of heroes should fall as the size of the combat theatre expands because there is greater temptation to free-ride in the coordination game for heroism. This explains the remaining empirical regularity.

[2] Other papers also employ a rational framework when analyzing seemingly non-rational behavior. For example, there is a distinct literature that investigates crime (Becker (1968), Glaser et al (1996)), suicides (Hamermesh and Soss (1974), Becker and Posner (2005), and Cutler et al (2001)), martyrs and terrorism (Berman and Laitin (2005), Berman (2004), Iannaccone (2006), and Benmelech and Berrebi (2007)), hate (Glaeser (2005)) , love (Hess (2004)) and war (Hess and Orphanides (1995)).

Of course, there could be readers who wish to accept the empirical evidence that there is a decline in the number of heroes while simply dismissing our economic-based explanation for the following reason: namely, for whatever arbitrary reason, the government decided to reduce the number of recipients. While this possibility exists, one of the main contributions to this paper is that we establish a positive explanation for why the government should have changed its policy for rewarding heroism. Indeed, our theory describes why individuals may wish to behave heroically less often (supply) and why the government may wish there to be fewer heroes (demand) based on changing technologies and opportunity costs. Ultimately, we believe that economists prefer explanations of social phenomenon based on economic theory as compared to those based merely on caprice or whim.

The remainder of the paper is organized as follows. In Section 2 we report the empirical regularities of Congressional Medal of Honor recipients. To help provide an economic context to understand these stylized facts, in Section 3 we outline our baseline model that demonstrates the economic influences on equilibrium heroic behavior. In Section 4, we then use the theory to provide an illustration for observed heroism. The final section offers concluding remarks.

2. Three Empirical Regularities of Heroism

In this section we establish the simple empirical regularities of U.S. heroism. We define a hero as a recipient of the Congressional Medal of Honor (CMH). There are three main findings in the data. First, the number of heroes has declined over time. This finding holds even when we control for the number of troops deployed and the number of deaths associated with battle intensity. Second, the probability that a hero survives his/her heroic act has declined – namely, heroes are now very likely to die in action. Third, the likelihood of heroism is greater in smaller campaigns than in big ones. After establishing these data regularities, we demonstrate how our model can be used to explain the data.

Consider the first fact mentioned – the decline in the number of heroes. In all the major United States conflicts in the first three quarters of the 20th century, the fraction of heroes in war has been relatively constant at about 0.0025 percent per troops deployed. In World War I, the United States deployed 4.7 million troops in which 124 received the

Congressional Medal of Honor. In World War II, the United States deployed 16.1 million troops in which 464 received the Congressional Medal of Honor. In the Korean War, the United States deployed 5.7 million troops with 131 Congressional Medal of Honorees. In Vietnam, the United States deployed 8.7 million troops in which 245 received the Congressional Medal of Honor. The ratio of Silver Stars awarded has a similar trend. Over 14,000 were awarded the Silver Star in WWI, over 100,000 were awarded in WWII, over 10,000 were awarded in the Korea War, and over 20,000 were awarded in the Vietnam War.[3,4]

Since the Vietnam War, the United States has deployed over 2.6 million troops. If the average indicated above were to have continued, there would have been approximately 60-70 Congressional Medal of Honorees and over 5000 Silver Star recipients. Rather, there have been only 7 Congressional Medal of Honorees and around 400 silver stars, with two going to soldiers who served in Somalia, and with zero going to Persian Gulf veterans.[5]

The declining trend of medal of valor awards is not unique to the United States. The Victoria Cross is the highest military decoration awarded to members of the armed forces of some of the countries that previously belong to the British Empire. The medal has been awarded to 1,353 individual recipients since 1856. Only 14 medals have been awarded since the end of the Second World War. Also, the Medal of Valor is the highest Israeli Military decoration. To this day, 40 medals have been awarded: 12 during the Independence War (1948), 5 during the Sinai War (1956), 12 during the Six-Day War (1967), 8 during the Yom Kippur War (1973) and 3 others awarded on other occasions.[6]

Where have all the heroes gone? Tables 1A and 1B provide detailed summary statistics regarding the distribution of Congressional Medals of Honor. The first column

[3] http://www.homeofheroes.com/ .

[4] Incidentally in the other major conflicts before 1900, the ratio of heroes in war is even higher (when, once again human capital & technology would be the lowest). For Civil War, Spanish American War, & Philippines the Congressional Medal of Honoree ratio is 0.03 to 0.07 percent out of the troops deployed. Recently, Silver stars were given out during Kosovo (1 dead), Haiti (1dead), Somalia (24 dead but 16 silver stars and 2 CMH), Panama (24 dead 3 Silver stars), Grenada (19 dead 6 silver stars). Hence, for the smallest conflicts, the rate of award per fatalities is almost one to one. For the bigger conflicts in the post - Vietnam era, the percentage of heroes is much smaller. During the Persian Gulf War, the United States deployed 2.2 million and lost 147 but have fewer heroes (9 silver stars, 0 CMH) than in Somalia.

[5] http://www.homeofheroes.com/ .

[6] http://en.wikipedia.org/wiki/Medal_of_Valor .

in Table 1A describes the war/conflict in chronological order.[7] The second column reports the number of CMH recipients for each war. To provide a metric for the size of the conflict, column three reports the number of troops deployed during the war. Moreover, to gauge the carnage of each war, column's four and five report the number of battle deaths of U.S. military personnel (Column 4) and the number or awards given posthumously (Column 5). Table 1B repeats the same information for each war, but provides the probabilities associated with being a hero (Column 2), the fraction of heroes per battle death (Column 3), and the fraction of heroes who die while acting heroically (Column 4).

There are three main facts to be seen in Tables 1A and 1B. First there is a clear drop off in the number of CMH recipients since Vietnam. In every campaign before 1975, including the smallest excursions such as Korea in 1871, there were at least 15 CMH recipients. If we look only at major conflicts, in each there were always at least 100 recipients. However, since the Vietnam War, only five medals have been given even though several of the conflicts were significant as measured by the number of troops deployed. Figure 1 plots the Congressional Medal of Honor recipients over time.[8] The figure also includes a trend line for the first part of the sample up to and including Vietnam. There is a noticeable downward trend in CMH recipients until Vietnam (shown) and a precipitous decline thereafter.

Second, more troops do not necessarily mean more heroes. Small campaigns such as the Indian Campaigns led to nearly as many CMH recipients as the largest campaign, World War II. In the more recent period, there were nearly as many CMH recipients in Somalia as there were in the Persian Gulf War and the War on Terror. This tendency to have relatively more CMH recipients in smaller conflicts was also the case in the pre-Vietnam era. For example, there is a large percentage of CMH recipients in small unit-like theatres. In Korea (1871) only 3 soldiers died but there were 15 CMH recipients. In

[7] To aid in the exposition, for some conflicts, we grouped several conflicts into one. For example, we combined the campaigns in Nicaragua, Dominican Republican, Haiti, Samoa, and Vera Cruz into one – the so-called "Banana Wars." We did similar aggregation for the Indian Campaigns and the Philippine Insurrection.

[8] For expositional purposes, in Figures 1 and 3 we merge the data for conflicts after the Civil War and before World War I into the Inter-War period. We transformed the data for this sequence of smaller conflicts in order to emphasize the long run patterns in the data. We do not do so in Figure 2 as we explicitly distinguish conflicts by size.

Samoa (1899) only 4 died but there were 4 CMH recipients, while in the Boxer Rebellion 37 died, but there were 59 CMH recipients. During the Banana wars, we observed similar tendencies – Dominican Campaign (3 CMH recipients), Haiti (8 CMH recipients), Nicaragua (2 CMH recipients). Figure 2 provides a cross plot of the ratio of CMH recipients per battle deaths versus the number of battle deaths across U.S. conflicts. Clearly, the negatively sloped relationship indicates that larger conflicts, which typically involve more battle deaths, tend to have a lower ratio of heroes.

Third, during the more recent period, heroes are much more likely to die in battle. As Table 1B shows, in all wars before World War I, less than 10 percent of heroes died in battle. In World War I through Vietnam the probability increased from 26 percent to 60-70 percent. Since then, every hero has been killed in battle. Figure 3 plots the percent of CMH recipients that were awarded posthumously. There has been a noticeable increase in the percent awarded posthumously beginning during World War I. Since then, the rate has continued to increase until every winner of the CMH since 1991 has died heroically.[9]

3. Theoretical Considerations

The purpose of our model is two-fold. First, we characterize and establish an economic language for understanding heroism based on self-interest, rational decision making, incentives and coordination. Second, based on our model, we then interpret the empirical regularities.

3.1 The Simple Hero Model

The mechanics of our game are simple. It is a simultaneous one-shot game in which individuals choose whether or not to engage in heroism subject to their endowments and technologies. We demonstrate that initially, without government intervention, no one should behave heroically. The government plays a role of inducing heroism in our model in that it subsidizes heroic activity. We show that, due to the coordination problem, the government should neither under nor over-subsidize heroism.

[9] There were no recipients of the CMH during the 1991 Gulf War, and hence none were awarded posthumously.

We then extend the model to allow for risk tolerance and varying technologies. Qualitatively, the results are not affected by these extensions.

Consider the scenario in which there is a group of n identical people, each with expected lifetime utility V, whose lives are potentially in jeopardy. Each person prefers that the life threatening emergency situation be resolved, but also prefers that someone else put their life in harm's way in order to save everyone else. For illustrative purposes, consider the extreme scenario in which a grenade is rolled into a confined area.[10] Suppose that each person receives utility V, expected lifetime utility, if the situation is resolved and bears the cost of $\alpha_1 V$ if he takes the action (dives on the grenade). In the extreme case of death, an individual would receive no more lifetime utility, so that $\alpha_1 =$ 1. Assume also that if no one takes any action then everyone suffers a cost from collateral damage, $\alpha_2 V$, such that the expected utility attached to this event is $V\text{-}\alpha_2 V$. We assume that $1 \geq \alpha_1 \geq \alpha_2 \geq 0$.[11] The payoff matrix for any two arbitrary players, i and j, for all $j \neq i$, is given below in Table1.

Table 1: Payoff Matrix for Simple Hero Game with No Public Subsidy

Player i \ Player j	Act	Don't Act
Act	$V\text{-}\alpha_1 V$, $V\text{-}\alpha_1 V$	$V\text{-}\alpha_1 V$, V
Don't Act	V, $V\text{-}\alpha_1 V$	$V\text{-}\alpha_2 V$, $V\text{-}\alpha_2 V$

Notes: Each cell refers to two payoffs, separated by a comma. The first payoff listed is for player i, whose decision is labeled in the first column. The second payoff listed is for player j, for all $j \neq i$, whose decision is labeled in the top row.

Without government intervention, a unique Nash equilibrium exists in which no one takes any action. Simply put, not acting is a weakly dominant strategy. In this case, there

[10]According to Holmes (1985, p. 300), "Of the eight medals won by Marines on Peleliu in 1944, six were awarded to men who covered grenades with their bodies to save their comrades…." Also, in a history of the US Marine Corps by Robert Moskin, it is stated that "Five black Marines earned the Medal of Honor in Vietnam. All five were killed shielding their fellow Marines from exploding enemy grenades." Not all who did this were actually killed; Holmes reports that two winners of the Medal of Honor in Korea survived having thrown themselves on grenades. Yet the risk of death from such action is, clearly, very high.

[11] The situation in which $0 \leq \alpha_1 \leq \alpha_2$ describes a scenario in which one will suffer more if he is not acting than acting, condition on the fact that no one else is acting. This is not compatible with characterizing representing a heroism scenario, a situation in which people would prefer not to take such actions.

may be market failure if social welfare under the Nash equilibrium is less than it would be if a single person were to take action, which reduces to the restriction that $\alpha_1 < n\alpha_2$.[12]

In order to improve social welfare, the government needs to change the relative price of heroism in order to provide incentives to encourage action. One way the government may do this would be to recognize someone as a hero and give him status in society – a title, such as the Congressional Medal of Honor, and/or a stipend. Not every one that acts will get this reward; however, the expected utility gain from acting associated with these benefits is *g*. Please note that the perceived private benefit must be such that $\alpha_1 V - g \le \alpha_2 V$, as otherwise there will be no change in the behavior. This yields the following payoff matrix for any two players as shown in Table 2:

Table 2: Payoff Matrix for Simple Hero Game with a Public Subsidy

Player *i* \ Player *j*	Act	Don't Act
Act	V- $\alpha_1 V$ +g, V- $\alpha_1 V$ +g	V- $\alpha_1 V$ +g, V
Don't Act	V, V- $\alpha_1 V$ +g	V- $\alpha_2 V$, V- $\alpha_2 V$

Notes: Each cell refers to two payoffs, separated by a comma. The first payoff listed is for player *i*, whose decision is labeled in the first column. The second payoff listed is for player *j*, for all $j \neq i$, whose decision is labeled in the top row.

Since this is a symmetric simultaneous-play game, there are *n* pure Nash equilibria in which exactly one person takes action.[13] In contrast to the equilibrium without a public subsidy, if a person believes no one will act, he prefers to act heroically. Furthermore, if there is no mechanism to ensure coordination, every player uses the same mixed strategy. In this case, a player is indifferent between taking action and not taking action, if the following is satisfied:

(1) $$V - \alpha_1 V + g = (V - \alpha_2 V)\,\Pr(\text{No one acts}) + V\,\Pr(\text{At least one other acts}).$$

[12] If no one acts, the total welfare under the Nash equilibrium is $n(V - \alpha_2 V)$. On the other hand, if a single person will take action the total welfare will be $(n-1)V + V - \alpha_1 V$. Rearranging these terms yield the above criteria.

[13] If the members in the group differ in some respects, the symmetric equilibrium may be compelling as a steady state. For example, the social norm that the youngest or the high rank will take action is a stable equilibrium.

The left hand side is the expected payoff to individual *i* for acting, and the right hand side is the expected payoff to individual *i* for not acting.

Denote by p the probability that each person takes action. The probability that no one else takes action is the probability that every one of the other *n*-1 people does not take action, namely $(1-p)^{n-1}$. This implies that the equilibrium condition for *p, p*,* is:

$$(2) \qquad p^* = 1 - \left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{1}{n-1}}$$

where each person takes action with probability $p^* = 1 - \left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{1}{n-1}}$ and does nothing with probability $1\text{-}p^*$.[14]

<u>Proposition 1:</u> *Ceteris Paribus*, an increase in α_1 *or* V decreases *p*.

The proof of the proposition is obtained from straightforward differentiation.

Note that p^* is affected in the following way:

$$(3) \qquad p^* = p(\underset{-}{\alpha_1},\ \underset{+}{\alpha_2},\ \underset{-}{V},\ \underset{+}{g},\ \underset{-}{n}).$$

Increases in the value of α_1, the cost of action parameter, and *V,* the utility value of an unharmed life*,* decrease the probability that someone will be a hero. The former affect is straightforward, since an increase in the cost of an action typically leads to a decline in the probability that an individual will want to undertake that particular action. The latter affect is merely about opportunity cost: namely, a rise in the value of an unharmed life, *V*, reduces the net benefit of acting heroically.

Proposition 1 provides the prediction that as technology has rapidly progressed during the later part of the twentieth century, heroism should have fallen – i.e. the rise in living standards which could affect heroism if heroism is an inferior good (increases

[14] Solving $V - \alpha_1 V + g = (V - \alpha_2 V)(1\text{-}p)^{n-1} + V(1-(1-p)^{n-1})$ for *p* yields the above condition, which we label p^*.

in α_1 and V) should decrease the incentive to behave heroically. Proposition 1 is also noteworthy in that it requires a self-interested rationale to link rising standards of living to declines in heroism. Our approach is novel as other non-economic models do not link heroism and opportunity costs.

It is also worthwhile to note that, an increase in both α_2 and g increases the probability that someone will be a hero. This involves a straightforward argument about incentives. If the government raises the expected payoff to an individual to act heroically, or if the cost of not acting rises, then it would be in the best interest of a self-interested agent to increase the probability of acting heroically.

Finally, increases in the group size necessarily reduce the probability that any one individual will take heroic action. Namely, increases in *n* will reduce *p*. Given the linkage of this theoretical prediction to the empirical regularities pointed to above, we demonstrate this in the proposition below.

<u>Proposition 2:</u> *Ceteris Paribus*, an increase in n decreases *p*.

Derivation of (2) yields $\frac{\partial p}{\partial n} = \frac{(\frac{\alpha_1 V - g}{\alpha_2 V})^{\frac{1}{n-1}} \ln(\frac{\alpha_1 V - g}{\alpha_2 V})}{(n-1)^2} < 0$ because $\ln(\frac{\alpha_1 V - g}{\alpha_2 V}) < 0$.

The importance of Proposition 2 is that we are able to use our theory to fit another one of our three empirical regularities – namely, smaller campaigns, i.e. those with lower *n*, should have a higher fraction of heroes. Moreover, an increase in the group size reduces the probability that at least one person will take action. Recall that the probability that no one will take action is $\left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{n}{n-1}}$. Intuitively, as the group size rises, the coordination problem intensifies which reduces the likelihood of heroic action.

This latter point is not trivial and might be counter intuitive. When group size increases two opposite forces affect the expected number of heroes, *np**. On the one hand, the probability that each individual will take action is declining. On the other hand, there are more people and the expected number of heroes has a binomial distribution with expected value of np^*. Generally speaking, if p^* is small enough, then the expected number of heroes will decline as n rises.[15,16]

In summary, the subsection provides several implications from our model that are consistent with the three empirical regularities. First, we show that the probability of being a hero should decline with time (as α_1 and V have increased over time). Second, we show that the probability of behaving heroically should be greater in smaller theatres (as increases in n decrease the likelihood of behaving heroically). The model also provides implications for the third empirically regularity – that recent heroes die in battle. One way to explain this stylized fact is to consider how the cost of acting heroically may have changed in the most recent period. This argument is based on improvements in military technology (which should increase α_1). If we accept that such improvements have caused the parameter to approach its limiting value, $\alpha_1 = 1$, it follows that all heroes who do exhibit bravery will die.

3.2 The Optimal Reward for Heroism

Finally, to close the model, we consider the optimal size of g selected by the government. If g is too small no one will act. On the other hand, if g is too large, there will be too many heroes, in excess of what is socially optimal. Given our model assumptions, the expected number of people that take action is np^*, which is equal to:

(4) $$E(Heroes) = np^* = n\left(1-\left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{1}{n-1}}\right) = n - n\left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{1}{n-1}}.$$

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[15] Note that $\frac{\partial np^*}{\partial n} = 1-\left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{1}{n-1}} + \frac{\left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)^{\frac{1}{n-1}}\ln\left(\frac{\alpha_1 V - g}{\alpha_2 V}\right)}{(n-1)^2}$. The sign depends on the size of the parameters α_1, α_2 and V, that determine p^*. As long as p^* is not too high (as we expect) our numeric simulations demonstrate that the derivative sign is negative.

[16] There is an interesting implication we leave for future work. There are those who may believe that heroism is exogenous, in which case the number of heroes should rise monotonically with n. Alternatively, one may believe that heroism is affected by incentives and coordination issues, which would mean that the number of heroes would rise less than monotonically with group size and it may even fall with group size. Again, we leave this to future research as this goes beyond the scope of our current paper.

To recall, the socially optimal number of heroes is one.[17] Therefore, an optimizing government chooses g such that:

$$1 = n - n\left(\frac{\alpha_1 V - g^*}{\alpha_2 V}\right)^{\frac{1}{n-1}} \tag{5}$$

which is equivalent to:

$$\left(\frac{\alpha_1 V - g^*}{\alpha_2 V}\right) = \left(\frac{n-1}{n}\right)^{n-1}. \tag{6}$$

As n grows arbitrarily large, the right hand term of equation (6) approaches a constant term, $\left(\frac{n-1}{n}\right)^{n-1} \xrightarrow[n\to\infty]{} \frac{1}{e}$, and therefore we could approximate the optimal government subsidy such that:

$$e = \frac{\alpha_2 V}{\alpha_1 V - g^*}. \tag{7}$$

Solving for optimal g^* yields:

$$g^* = V(\alpha_1 - \alpha_2/e). \tag{8}$$

Note that for a large population, the optimal government welfare subsidy for heroism is a constant fraction of V. Note that as α_1 and V rise and α_2 declines, the optimal reward for heroism rises. In words, as the utility value of life or the individual cost to heroic action rises, the optimal government subsidy to heroism needs to rise. Moreover, as individual costs from inaction rise, the optimal public reward can fall as an individual needs fewer incentives to act heroically. We will discuss the implications for this in Section 4.

3.3 Model Extensions and Modifications

In this subsection, we relax some of the modeling assumptions to examine if the results are sensitive to our specifications. We consider the possibility of a different cost

[17] We define the social welfare as the sum off all individual utilities. In that case, the social welfare is $n(V - \alpha_2 V)$ where j=0 (the number of people that take action) and it is $j(V - \alpha_1 V + g) + (n - j)V$ for any $1 \le j \le n$. Clearly, total welfare is maximized when j=1.

structure, that individuals have varying risk tolerances, and that labor intensity shifts due to military technological progress. We demonstrate below that the predictions of our model continue to be consistent with a public goods argument for heroism without changing any of our qualitative predictions.

3.3.1 Additive Costs

We continue to assume a similar setup. We assume that each person attaches the utility of V if the situation is resolved but bears the cost of C_1 if he takes the heroic action. If no one takes action, everyone suffers a cost, C_2, such that the expected utility attached to this event is $V\text{-}C_2$. We assume that $V \geq C_1 \geq C_2 \geq 0$.[18] The payoff matrix with government intervention for any two arbitrary players, say *i* and *j*, is given below.

<u>Table 3: Payoff Matrix for Simple Hero Game with a Public Subsidy</u>

Player *i* \ Player *j*	Act	Don't Act
Act	$V\text{-}C_1$+g, $V\text{-}C_1$+g	$V\text{-}C_1$+g, V
Don't Act	V, $V\text{-}C_1$ +g	$V\text{-}C_2$, $V\text{-}C_2$

Notes: Each cell refers to two payoffs, separated by a comma. The first payoff listed is for player *i*, whose decision is labeled in the first column. The second payoff listed is for player *j*, for all $j \neq i$, whose decision is labeled in the top row.

In this case, we assume that $V \geq C_1 \geq C_2 \geq 0$ and $C_1 - C_2 \leq g$ (otherwise no one will act). Again, if we define p as the probability with which each person takes action, and use the fact that in mixed strategy equilibrium a player will be indifferent between acting and not acting, we could solve $V - C_1 + g = (V - C_2)(1\text{-}p)^{n-1} + V(1-(1-p)^{n-1})$ for p. Similar to the previous subsection, the probability of acting in the symmetric mixed strategy equilibrium is:

(9) $$p^* = 1 - \left(\frac{\alpha_1 - g}{\alpha_2}\right)^{\frac{1}{n-1}}.$$

[18] Note that if $C_2 > C_1$, then everyone will be a hero, which is not an interesting model to investigate.

All the results from the previous case are qualitatively similar. The only difference is that now the probability of acting does not depend on V. This is due to the additive property of costs such that V is part of each individual payoff. This is equivalent to adding a constant to the payoff which results in the vanishing of V from the equilibrium mixed strategy probabilities.

3.3.2 Risk Aversion

We now introduce risk aversion by assuming von Neumann Morgenstern utility preferences, the payoff matrix now represents the utility from payments, where V is expected lifetime income, and C_1 and C_2 are defined to be monetary costs. We will use the previous example's notation since the results are qualitatively the same for the baseline model. However, introducing von Neumann Morgenstern utility will keep V as a parameter in the mixed strategy equilibrium. To see this, we continue to assume that $V \geq C_1 \geq C_2 \geq 0$. The payoff matrix for any two arbitrary players, say i and j, in terms of the utility function U, is given below.

Table 4: Payoff Matrix for Hero Game with Risk Aversion

Player i \ Player j	Act	Don't Act
Act	$U(V\text{-}C_1\text{+g})$, $U(V\text{-}C_1\text{+g})$	$U(V\text{-}C_1\text{+g})$, $U(V)$
Don't Act	$U(V)$, $U(V\text{-}C_1\text{+g})$	$U(V\text{-}C_2)$, $U(V\text{-}C_2)$

Notes: Each cell refers to two utilities, separated by a comma. The first utility listed is for player i, whose decision is labeled in the first column. The second utility listed is for player j, for all $j \neq i$, whose decision is labeled in the top row.

Again, if we define p as the probability with which each person takes action, and use the fact that in a mixed strategy equilibrium a player will be indifferent between acting and not acting, we can solve $U(V-C_1+g)=U(V-C_2)(1\text{-}p^*)^{n-1}+U(V)(1-(1-p^*)^{n-1})$ for p^*. Similar to the previous case, the probability of acting in the symmetric mixed strategy equilibrium is:

$$p^* = 1-\left(\frac{U(V)-U(V-C_1+g)}{U(V)-U(V-C_2)}\right)^{\frac{1}{n-1}}. \tag{10}$$

In this case, we find that the relationship between the probability of acting and the model parameters continue to hold as demonstrated in expression (3).

3.3.3 The Labor Intensity of Heroic Action

Up to this point, our theory has focused on the case when only one hero is needed to efficiently and optimally resolve, from a social perspective, an incident. More generally, alternative scenarios could be considered where `*k*' individuals would be needed simultaneously to act heroically. Indeed, due to the historic nature and evolution of conflict technologies, it is likely that combat now places a greater reliance on physical capital and fewer contributions of labor for heroic acts. By contrast, in the past heroic actions may have been such that often more than one hero was needed for any given incident, $k>1$.

Consider the scenario where "*k* bombs" roll into a room and society needs at least *k* people to dive on the bombs. The idea is that technological progress has reduced *k* over time so that for the *k*-bombs case, $k>1$, we are considering represents military warfare in a previous era. In the past, fighting was a labor intensive task such that in order to solve a problem you needed many volunteers. With time, due to technology progress, the number of people required to act heroically to defuse a bomb situation has likely declined – indeed, even robots have now been developed for such task.

Again, each person attaches the utility of V if the situation is resolved and bears the cost of $\alpha_1 V$ if he takes the action. If the number of people that take action is less than k, the cost to everyone else is assumed to remain at $\alpha_2 V$, such that the expected utility attached to this event is $V\text{-}\alpha_2 V$.[19] Without government intervention, a unique Nash equilibrium exists in which no one takes any action. In this case, there may be a market failure if $k\alpha_1 < n\alpha_2$.[20]

[19] The assumption about payoffs in this version of the model is made to simplify the model. Other reasonable alternatives provide similar results, though with additional, more cumbersome notation.

[20] If this is the case the total welfare under the Nash equilibrium is $n(V - \alpha_2 V)$. On the other hand, if k persons will take action the total welfare will be $(n-k)V + k(V - \alpha_1 V)$. Rearranging these terms yield the above criteria.

The payoff matrix for player *i* with government subsidy *g* depends on the number of people that will act in the following way:

Table 5: Payoffs to Player i for Hero Game with k Bombs

Player *i*	At least *k* Act	Fewer than *k* Act
Act	$V\text{-}\,\alpha_1 V$ +g	$V\text{-}\,\alpha_1 V$ +g
Don't Act	V	$V\text{-}\,\alpha_2 V$

Notes: Each cell refers to the payoff to player *i*. The first column of payoffs presents the payoff to player *i* if at least *k* individuals take action, while the second column of payoffs presents the payoff to player *i* if fewer than *k* individuals act.

Since it is a symmetric, simultaneously played game, there are $\binom{n}{k}$ pure Nash equilibria in which exactly *k* persons take action. Again, if there is no mechanism to ensure coordination, in a symmetric equilibrium every player uses the same mixed strategy. In this case, a player is indifferent between taking action and not taking action, if the following is satisfied:

(11) $$V-\alpha_1 V+g=(V-\alpha_2 V)P(\text{Fewer than } k \text{ act})+VP(\text{At least } k \text{ others act}).$$

The left hand side is the expected benefit from acting. The right hand side is the benefit from not acting when too few others act, multiplied by the probability that too few act, plus the benefit from not acting when enough act, multiplied by the probability that enough people will act.. Again, if we denote by p^* the probability with which each person take action, it must satisfy the following equation:

(12) $$\sum_{i=0}^{k-1}\binom{n-1}{i}p^{*i}(1-p^*)^{n-i-1}=\frac{\alpha_1 V-g}{\alpha_2 V}.$$

Unfortunately, expression (12) does not have a closed form solution for p^*.[21] We would like to find, however, the effect of changing *k* on the expected demand and supply of heroes. We will demonstrate below that an increase in *k* leads to an increase in the probability that an individual will act heroically. Namely increasing the number of

[21] Even if we restrict ourselves only to the case where *k=2* we cannot solve this equation for p^* for an arbitrary *n*. We can, however, solve this equation analytically for p^* only when n is less than or equal to 5.

bombs will increase the probability that any individual will take action. The intuition for this result is that increasing the number of bombs reduces the coordination problem because more individuals are needed to act heroically.

Proposition 3: *Ceteris Paribus*, an increase in k increases p^*.

Proof: The proof follows in two pieces. In part A we show that the left hand side of expression (12) is decreasing in p^*. We then show in part B that an increase in k, increases p^* by directly calculating the derivative.

A. The left hand side of expression (12) is decreasing in p, namely:

$$\text{(13)} \qquad \frac{\partial \sum_{i=0}^{k-1} \binom{n-1}{i} p^{i} (1-p)^{n-i-1}}{\partial p} < 0 .$$

This follows from the fact that the binomial cumulative distribution function is monotonic and non-decreasing. Hence, increasing p leads to a binomial distribution that is stochastically dominates over the same support for any k.

B. Recall that the definition of the derivative of p with respect to k is the change in p when k increases by one unit. Denote by p_k the probability that satisfies the equilibrium condition (12) for the k bomb case, and similarly denote by p_{k+1} the probability that satisfies (12) for the $k+1$ bomb case. Hence, it follows that both conditions satisfy the same constant, namely:

$$\text{(14)} \qquad \sum_{i=0}^{k-1} \binom{n-1}{i} p_k^{i} (1-p_k)^{n-i-1} = \frac{\alpha_1 V - g}{\alpha_2 V} = \sum_{i=0}^{k} \binom{n-1}{i} p_{k+1}^{i} (1-p_{k+1})^{n-i-1} .$$

So that by expending the right hand side of expression (14) we get:

$$\text{(15)} \qquad \sum_{i=0}^{k-1} \binom{n-1}{i} p_k^{i} (1-p_k)^{n-i-1} = \sum_{i=0}^{k-1} \binom{n-1}{i} p_{k+1}^{i} (1-p_{k+1})^{n-i-1} + \binom{n-1}{k} p_{k+1}^{k} (1-p)_{k+1}^{n-k} .$$

It follows that $p_k \neq p_{k+1}$ since all the arguments in the summation are positive and the right hand side has an additional positive argument. Therefore:

$$\text{(16)} \qquad \sum_{i=0}^{k-1} \binom{n-1}{i} p_k^{i} (1-p_k)^{n-i-1} > \sum_{i=0}^{k-1} \binom{n-1}{i} p_{k+1}^{i} (1-p_{k+1})^{n-i-1}$$

And from **A**, it follows that $p_{k+1} > p_k$. Taken together, A and B imply that an increase in k increases p.

Note that the fact that p decreases as k decreases suggests that if conflict technologies change which lead k to fall, we should see a lower likelihood that any one individual soldier will be a hero, *ceteris paribus*. The implication is that as military technology has advanced, so that k has fallen, we would expect that each individual has a lower chance of becoming a hero.

4. Illustrating Our Results Using Supply and Demand

The usefulness of economic theory is to shape our understanding of important empirical phenomenon. As such, in the prior two sections we have outlined a list of empirical observations about heroism in combat and an economic theory of heroic action. In this section we use the language of our model to provide an economic interpretation to the data using the convention of supply and demand. Again, the empirical aspects of heroism point to three facts: observed heroism is down, the likelihood of dying during a heroic act has risen, and the size of a campaign negatively affects the likelihood that an individual soldier will be heroic.

4.1 Aggregate Supply and Socially Optimal Demand for Heroes

To clarify these matters we now reformulate the equilibrium relationships detailed in the above theory into the aggregate supply and demand for heroes. Figure 4 plots the the aggregate supply function. On the vertical axis we plot g, the expected utility benefit from behaving heroically,[22] and on the horizontal axis we plot the expected number of heroes. Expression (4) provides the equilibrium correspondence for the expected aggregate supply of heroes, np^*, as a function of the public reward for heroes. Clearly the relationship for the expected aggregate supply of heroes, EH^S, is upward sloping for

[22] More formally, recall that g is the expected utility from behaving heroically. It is the probability of being acknowledged as a hero when one has acted heroically, times the benefit received.

value of g that makes it incentive compatible for individuals to even consider acting heroically. Simply put, for higher values of g the expected number of heroes rises, i.e. the expected quantity of heroes supplies rises due to greater compensation for heroism. Note also that the intercept term is $\alpha_1 V - \alpha_2 V$ as is indicated in Figure 4. This means that if the government subsidy is not above this critical value, agents will be unwilling to risk their lives and the expected number of heroes will be zero. On the other hand, if $g \geq \alpha_1 V$ everyone in society behaves heroically. For any g_1 and g_2 such that $\alpha_1 V \geq g_2 > g_1 \geq \alpha_1 V - \alpha_2 V$ the expected numbers of heroes increase as we move up the expected supply of heroes' schedule, EH^S. We also note that the expected aggregate supply of heroes is affected by the parameters in our model -- α_1, α_2, V, n and k. The properties of EH^S, established in expression (3) and the proof of Proposition 1, suggest that the curve shifts to the left for increases in α_1 and V, and to the right for increases in α_2, and k. Note that, as stated above, $\partial p^*/\partial n$ is negative and $\partial np^*/\partial n$ is likely to be negative. In words, an increase in the utility from living and from the disutility of acting heroically will lower the expected supply of heroes for any given level of public subsidy, shifting the EH^S schedule to the left. Moreover, if the number of bombs increases, or the private disutility form insufficient public actions rises, the expected supply of heroes rises and the EH^S curve shifts to the right.

In addition, we can represent the optimal level of public reward, g^*, using this diagram. To accomplish this, we need to augment the graph to include the socially optimal number of heroes, or the socially optimal demand for heroes. This is straightforward as the optimal number of heroes is equal to k —the number of bombs – as seen from Proposition 3. Pictorially it is a vertical line such that the expected number of heroes equal to k, and it denoted by $E(H^*)$ in Figure 5. Note that the optimal public subsidy is the value of g where $E(H^S) = E(H^*)$, namely g^*.

4.2 Is the Decline in Heroes Due to Supply or Demand Shifts?

With these tools, we can now outline a set of explanations to the question of where have all the heroes gone? To make matters easier, presume for a moment that the technology of military combat is such that heroism is labor intensive in the sense that it takes a lot of individuals acting heroically in order to fully resolve a situation. This is the case of $k>1$ bombs. Further assume that the government has set the optimal subsidy such that $g = g^*$, which is represented in Figure 6 as point A. Below, we will outline how shifts in the supply of and demand for heroes can be used together to explain the empirical facts outlined above.

The key to understanding how heroism has changed is to recognize how the technologies, general and combat related, have changed, and how this affects the equilibrium level of heroism. For instance, the nature of combat technology defines the optimal number of heroes required to resolve a situation, which fully describes the optimal public demand for heroes, $E(H^*)$. In addition, technology also defines the utility benefit from living, V, the cost to the individual from heroic action, α_1, and the cost to the no acting individual if an insufficient number of heroes take action, α_2.

For example, as technology rises throughout the world, wages and living standards rise which makes V rise. Moreover, superior combat technology has improved the destructive capacity and reliability of bomb-making, which means that heroes will become less likely to survive as α_1 rises. Indeed, as $\alpha_1 \rightarrow 1$, heroes receive no benefit other than the public reward for heroism, suggesting that the private reward for being a hero approaches zero -- a payoff consistent with a hero's death. Everything else equal, these technological changes move the aggregate supply of heroes' schedule, EH^S to the left to EH^{S}'. For a given subsidy g^*, this would lead to a reduction in the number of heroes consistent with point B on Figure 6.

While the elevation of living standards and improved efficacy of bombs since the Civil War are clear from simple observation, what happens to α_2, the collateral damage to an individual who does not act when an insufficient number of others act, is less clear cut. One could easily make the argument that more efficient bombs will make the costs from insufficient heroic action also rise, though one could also argue that armor and counter-measures have made the collateral damage from bombs fall. All in all, if α_2 were to rise, this would shift the aggregate supply of heroes' schedule to the right which would lead to an increase in the number of heroes. By contrast, if it were to fall then this would move the schedule to the left, which would reinforce the declines in V and α_1. While we cannot resolve how technology affects the collateral damage from an insufficient number of heroes, it is clear that what is important is that even if α_2 rises, this can be consistent with a decline in the number of heroes as long as the increases in V and α_1 lead the EH^S schedule to shift to the left on net.

This explanation has been useful for two reasons. First, we showed that the decline in the number of heroes found in the data is consistent with the move from point A to point B due to shifts in the aggregate supply of heroes, which embody the equilibrium response by individuals to incentives based on a coordination problem. Moreover, one of the reasons for the shift is an increase in the private loss of being a hero (absent the public reward), which is consistent with heroes being more likely to die (i.e. no private enjoyment from life). As such, we have used the model to explain two empirical facts about heroism.

However, one element to this explanation, using just shifts in the aggregate supply of heroes to explain the decline in the number of heroes, is dissatisfying for the following reason: the decline in heroes is sub-optimal from a societal standpoint. In other words, has the government just allowed heroism to slip, with a corresponding loss in welfare to society? While the decline in the number of heroes has been demonstrated for a fixed public reward equal to g^*, an optimizing government would raise g^* to $g^{*\prime}$. We demonstrate this possibility in Figure 7. In this case, the optimal number of heroes was re-established at an equilibrium point such as C. Has the government myopically neglected heroism and arbitrarily let the rewards to heroism fall, thereby undermining public welfare?

The temptation to pursue this line of reasoning is strong, and one could point to evidence on barely modest compensation for CMH recipients to provide some support too. For instance, currently, surviving CMH recipients receive $1,000 a month. This support has been nominally increased over time, as initially CMH recipients received $10 per month starting in World War I. Monetary rewards for heroism are clearly not the same as the utility award embodied by g in the model, so we cannot follow this line of reasoning too far, though it suffices to say that the monetary rewards for heroism have likely fallen in real terms, especially with reference to changes in parameters V and $\alpha_{1.}$

However, the explanation that the government has neglected heroism or somehow arbitrarily changed the standards for heroism is ultimately not compelling. Given the seriousness and solemnity surrounding discussions of military heroism, the argument that the U.S. government and others have let heroism slip is not convincing to us.

Rather, the model provides a positive interpretation for the decline in heroism by pointing to the fact that the labor intensity of heroism has declined. In other words, the number of heroes required to resolve a situation, i.e. the optimal public demand for heroes, has fallen. As shown above, a reduction in k shifts both the aggregate demand of heroes to the left and the aggregate supply of heroes also to the left. This scenario is demonstrated in Figure 7, where the equilibrium expected number of heroes is now labeled by point D. The number of heroes has fallen as compared to point A, though the decline allows for both supply and demand factors, and the decline in heroes can be viewed as an optimal response by the government. Also note that the effect on the new optimal level of public reward is ambiguous and depends on the relative shifts of supply and demand.

Conclusions

The American Heritage Dictionary defines a hero as "a person noted for feats of courage or nobility of purpose, especially one who has risked or sacrificed his or her life." Are these feats of courage conditional to one's circumstances or not? If one believes that heroism is a constant hereditary trait, we should expect as difficult circumstances have arisen, then there should be a greater number of heroes simply by the increase in the size of the population. Interestingly, the number of heroes as measured by the number of valor devices (V-Devices) such as the number of Congressional Medal of Honorees and Silver Star recipients has actually fallen in the past 35 years.

We develop a model based on economic incentives and explain this empirical phenomenon as a response to changes in economic incentives and combat technology. Moreover, we demonstrate that while individual supply decisions are consistent with the observed decline in heroes, there is a case to be made that the government has accommodated this decline because combat technology has made combat situations less labor intensive. In other words, difficult situations can now be resolved with fewer heroes. As such, society may need fewer combat heroes.

Obviously, we are not claiming that arguments explaining heroism based on evolution, or arguments based on psychology or sociology are wrong or even misguided. Indeed, there is likely a great deal to learn from these other disciplines. However, we believe that there is part of the puzzle that can be learned by analyzing these issues in a rational choice framework. It may be difficult, for example, to ignore that as incomes have risen since World War II, that this may decrease the incentive for individuals to behave heroically. We also believe that future research that extends the analysis by allowing for dynamics and learning about one's and others' behavior would be beneficial. The purpose of our paper is merely to provide a starting point for such an investigation.

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Table 1A: Summary Statistics of Congressional Medal of Honor (CMH) Recipients

US War	Number of CMH Medals*	Number of Troops Deployed	US Battle Deaths	Posthumous Recipients of CMH
Civil War	1522	2,213,363	140,414	32
Indian Campaigns	426	106,000	919	13
Korea 1871	15	650	3	0
Spanish American War	110	306,760	385	1
Philippine Insurrection	90	126,468	1,020	4
Boxer Rebellion	59	3420	37	1
Banana Wars	69	9,644	146	0
World War I	124	4,734,991	53,402	33
World War II	464	16,112,566	291,557	266
Korean War	131	5,720,000	33,741	94
Vietnam War	245	8,744,000	47,424	154
Persian Gulf War	0	2,225,000	148	0
Somalia	2	25,000	29	2
War on Terror	5	1,600,000	4,300	5
TOTALS	3464	41,927,862	573,560	614

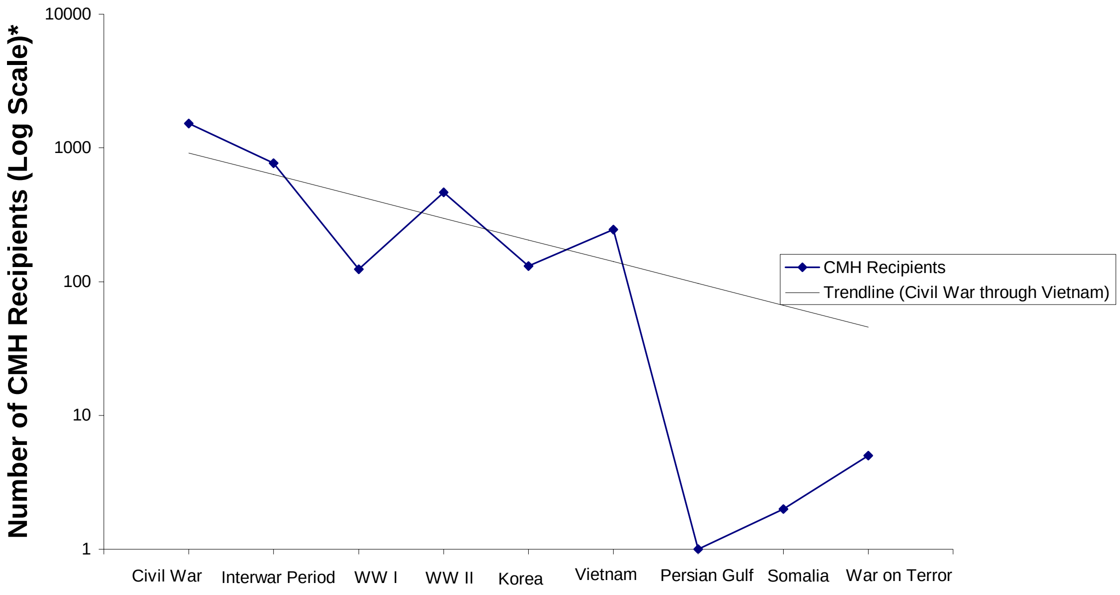
Notes: * denotes that the total number of medals is the sum of Congressional Medal of Honor medals received by U.S. Army, Navy, Marines, Air Force and Coast Guard personnel as of April 1 2008. The data are from publicly available resources that are provided at http://www.homeofheroes.com/

Table 1B: Probabilities Associated with Congressional Medal of Honor (CMH) Recipients

US War	Probability of Receiving the CMH Medal	Fraction of Heroes Per Death	Fraction of Heroes that Die Acting Heroically
Civil War	0.0688×10^{-2}	0.0108	0.0210
Indian Campaigns	0.4019×10^{-2}	0.4636	0.0305
Korea 1871	2.3077×10^{-2}	5.0000	0.0000
Spanish American War	0.0036×10^{-2}	0.2857	0.0091
Philippine Insurrection	0.0071×10^{-2}	0.0882	0.0444
Boxer Rebellion	1.7251×10^{-2}	1.5946	0.0169
Banana Wars	0.7155×10^{-2}	0.4726	0.0000
World War I	0.0026×10^{-2}	0.0023	0.2661
World War II	0.0029×10^{-2}	0.0016	0.5732
Korean War	0.0023×10^{-2}	0.0039	0.7176
Vietnam War	0.0028×10^{-2}	0.0052	0.6286
Persian Gulf War	0.0000×10^{-2}	0.0000	NA
Somalia	0.0080×10^{-2}	0.0690	1.0000
War on Terror	0.0003×10^{-2}	0.0012	1.0000

Notes: The Probability of a Receiving the CMH medal is measured as the number of medals divided by the number of troops. The Fraction of Heroes per Death is measured as the number of heroes divided by the number of battlefield deaths. The Fraction of Heroes that Die Acting Heroically is the number of heroes divided by the number of heroes who died during their heroic act. These numbers apply only to U.S. personnel.

Figure 1: Congressional Medal of Honor (CMH) Recipients



* The asterisk denotes that the log scale is augmented by one to account for the zero CMH recipients in the Persian Gulf War.

Figure 2: Number of CMH Recipients Per Battle Death vs. Number of Battle Deaths

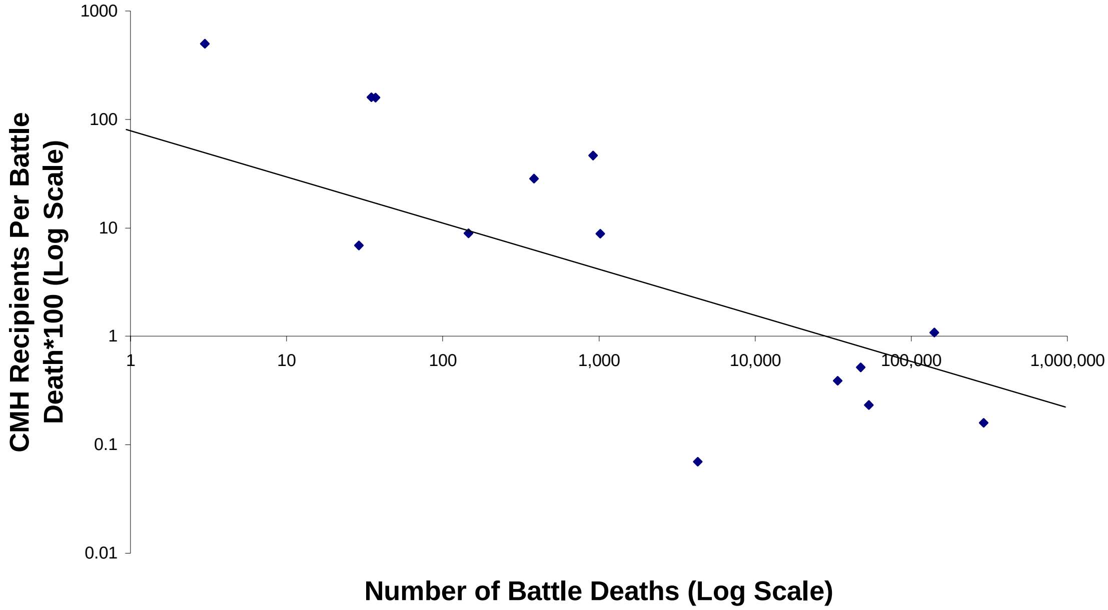


Figure 3: Percent of CMH Awarded Posthumously

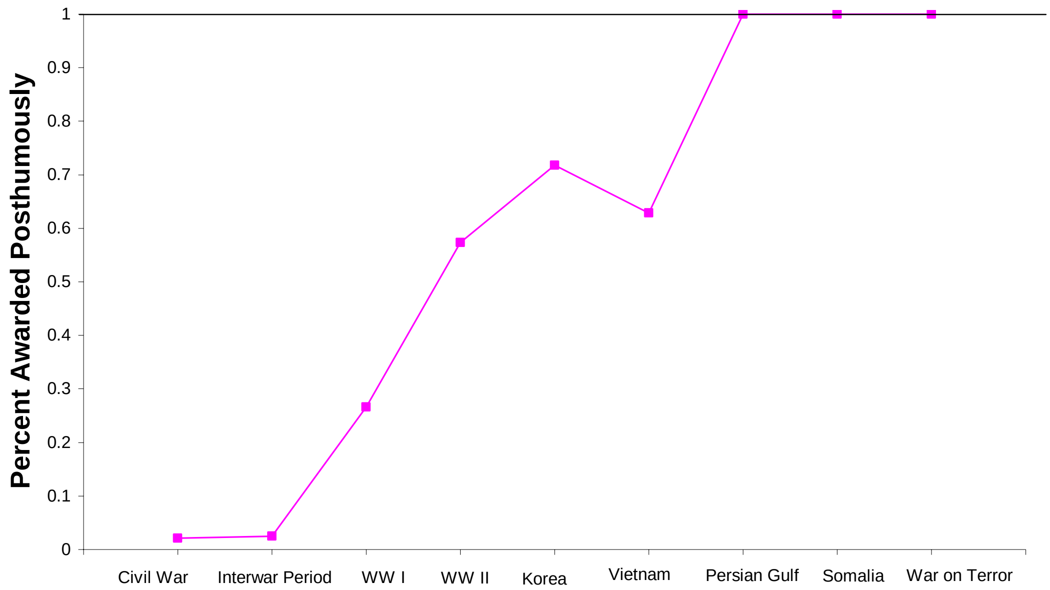


Figure 4: Aggregate Supply for Heroes

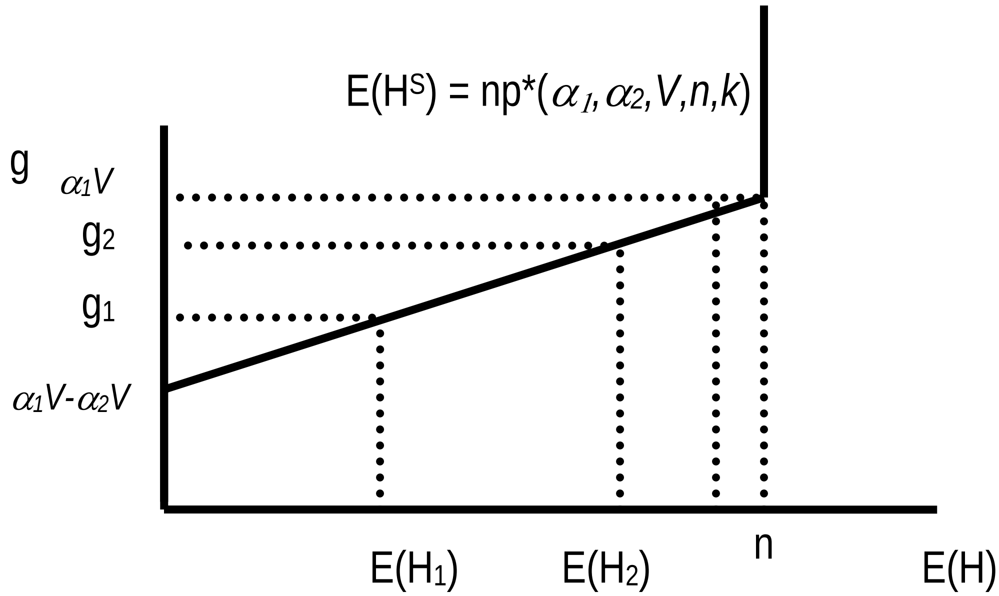


Figure 5: Aggregate Supply and Demand for Heroes

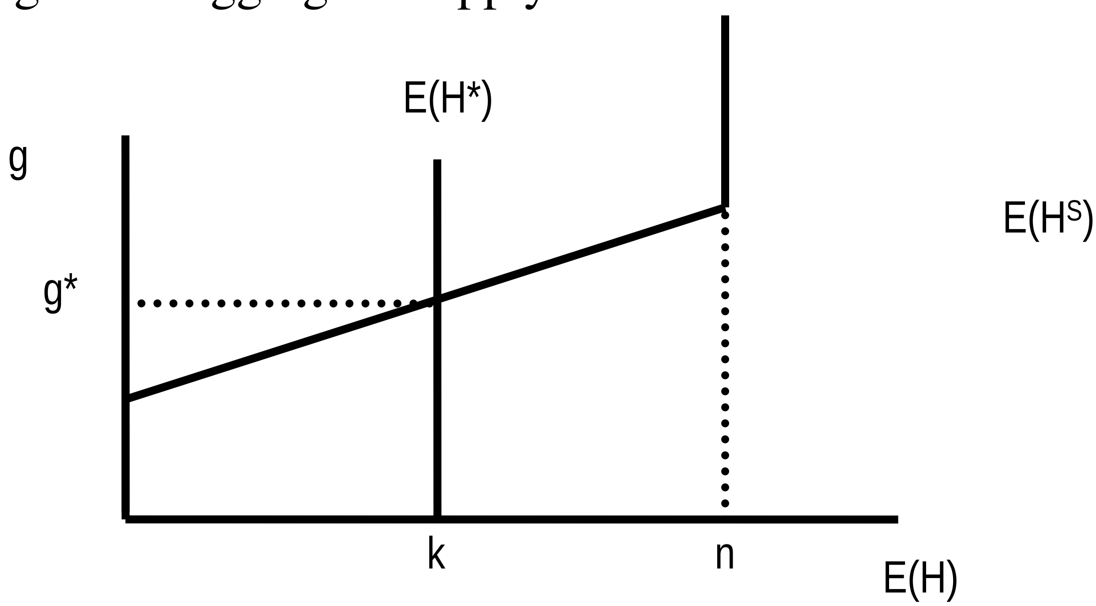


Figure 6: Supply Shifts and Heroism

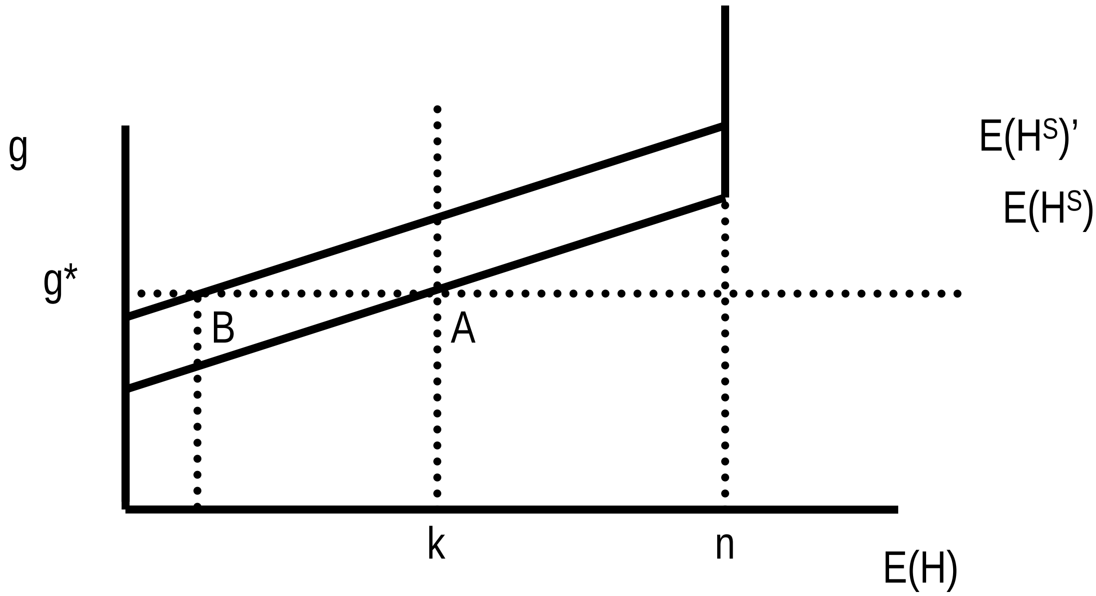


Figure 7: Supply and Demand Shifts vs Heroism