

THE U.S. ARMY AS A RATIONAL ECONOMIC AGENT: THE CHOICE OF DRAFT ANIMALS DURING THE CIVIL WAR

Kyle D. Kauffman
Wellesley College

INTRODUCTION

What factors lead firms to adopt one type of capital rather than another? Generally, economists assume that cost differences play the major role. It would then appear irrational for a firm, or any institution, to purchase a particular piece of capital that has a clearly cheaper alternative. But this is not necessarily the case. A firm faced with two substitutable types of capital, one of which is more abuse-resistant, might prefer to choose the more expensive, but more abuse-resistant alternative, particularly if there are principal-agent problems and the costs of abating the effects (such as monitoring workers) are high.

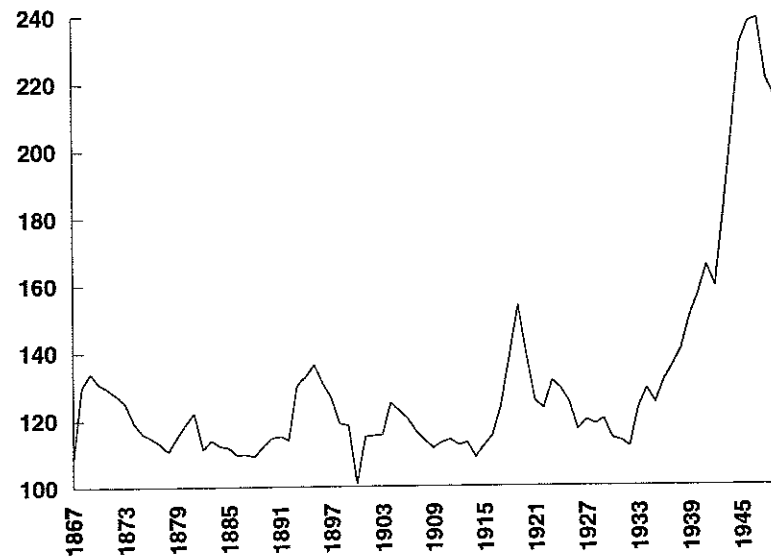
Certain firms, institutions, and government agencies have been known to "over pay" for equipment when there were clearly less costly alternatives. The U.S. Military is infamous for paying exorbitant prices for equipment when cheaper alternatives were available. Could it have been the case, however, that by purchasing the more expensive capital the Military was actually rational in its buying practices? This paper looks at just such a practice by the U.S. Army during the Civil War.¹

The primary motive power used by the U.S. Army during the Civil War was the draft animal, usually the horse or the mule. During the nineteenth century the Army purchased a large proportion of the draft animals available in the United States. In 1862, for example, the Union Army alone owned nearly four percent of all horses and mules enumerated in the U.S. census of 1860, which covered both the North *and* the South.

The Army issued both draft horses and draft mules to its enlisted men to pull wagons and move equipment. Reports of the Quartermaster General show that between 50 and 90 percent of draft animals purchased in the latter part of the nineteenth century were mules, although, census data shows that the purchase price of mules was always greater than that of horses.² Thus, the possibility that the Army was overspending comes quickly to mind (see Figure 1). Given that the horse is clearly a cheaper substitute, the high percentage of mules seems to suggest that the Army may have been irrational in its procurement of draft animals. This paper argues that, in fact, draft animal procurement by the Army was rational. As in similar decisions made by landlords and mine owners, the Army found it in its best interest to issue employees the more expensive but more resilient mule [Kauffman, 1992; 1993; 1996]³ to preserve its capital from excess depreciation brought on by abuse and neglect from enlisted men who had little incentive to care for the animals in their charge.

FIGURE 1

Ratio of Real Mule to Real Horse Price by Year



Source: U.S. Bureau of the Census [1975]. See Note 2 for details.

This principal-agent analysis of capital choice can also explain why the Army, as well as many other governmental and non-governmental organizations, utilize certain relatively expensive types of capital when individual owners seem to manage well with a cheaper substitute. The possibility that capital choice is driven in part by principal-agent problems opens a new and fruitful line of research for economists. This theory can be used to answer such modern questions as why taxicabs driven by non-owners must be more durable than seemingly identical model cars purchased by the general public, or why large construction companies must purchase more durable capital while smaller owner-operator firms can perform equally well with less expensive and less abuse-resistant substitutes.

DRAFT ANIMALS IN THE U.S. ARMY

From its inception the U.S. Army used a great number of animals, the type and number varying with its ever changing needs. All of the various breeds, however, can be categorized into two basic types: riding animals and draft animals. Nearly all of the riding animals used by the Army were horses, whereas the draft animals included horses, mules, and in a very few cases, oxen.

For the purpose of inventorying animals, the Army used the following categories: cavalry horses, artillery horses, private horses, horses, mules and oxen. Cavalry horses were owned by the Government and ridden by enlisted men and by some low-ranking officers.⁴ Artillery horses pulled the artillery, but many were also simultaneously

ridden by soldiers who guided them as they pulled.⁵ Private horses were ridden and owned by officers who had to provide their own mounts, a requirement unique to officers.⁶ These horses, however, were boarded and attended to at no cost to the officer. The simple classification of "horse" was an all-purpose draft horse used to pull wagons, move logs, haul material on its back, etc. The classification "mule" was also a generic title; these animals were also used to pull wagons, move logs, and haul materials, as with the "horse." Finally, a few oxen pulled wagons.⁷

The use of horses for cavalry purposes is not surprising. First, since the horse was the riding animal of choice in the U.S., using the horse reduced soldier training by taking advantage of pre-existing human capital.⁸ Second, enlisted cavalrymen rode and cared for the same horse throughout their enlistment. So, while the soldier riding the animal did not have a vested interest in preserving the capital value of his mount, his actions were observable, reducing the principal-agent problem.⁹ Abused horses would have suffered higher injury or death.

The Army required officers, on the other hand, to buy their own mounts, thus circumventing the principal-agent problem with respect to animals. An officer had a much greater incentive to keep his animal healthy since he was the residual claimant.¹⁰ Why, then, did the Army not ask the enlisted men to buy their own cavalry horses? This practice would seemingly have completely eliminated the agency problem for riding animals. The differential treatment may have had to do with the ease of monitoring enlisted men as opposed to officers. In the military the enlisted men act as agents and the officers act as monitors and, to some degree, as principals. Thus, while the officers can watch over the treatment and use of horses by the enlisted men, "who monitors the monitors?"¹¹ Each officer can be monitored by his superior, who may not do so consistently, whereas enlisted men could presumably be monitored more closely.

The use of horses to pull artillery can be explained with the same argument applied to the use of horses for cavalry duty. Again, because most soldiers were familiar with riding horses before joining the army, using horses in the Army reduced the cost of training soldiers. (Many of the animals used to pull artillery pieces were simultaneously ridden.) Nearly all forts and outposts used horses for cavalry duty and horses to pull artillery. Thus, for riding purposes, the horse enjoyed a comparative advantage over the mule.

For draft work the story is different. Certain installations tended to use the horse as the primary draft animal, whereas others used the mule. Still others used the two animals in nearly equal numbers. The focus of this paper is to explain this peculiar division of draft animals, given that horses were preferred for riding and mules were more expensive.

This topic of draft animal choice was very much on the mind of the Quartermasters. At the height of the Civil War, M. C. Meigs, the Quartermaster General of the U.S. Army, reported that "the consumption of horses has been very great. Mules bear the exposure and hardship of the campaign much better than horses, and they are used to a great extent in the trains" [Report of the Quartermaster General 1863, 72]. He went on to say that "ignorance and carelessness of raw soldiers waste our horses"

[*ibid.*, 72, emphasis added]. The abuse of army animals was still a problem by the end of the Civil War. According to the Quartermaster General, "the waste in active service [horses] is still too great; but as the cavalry has improved in discipline and knowledge, it is believed that the horses last longer" [Report of the Quartermaster General, 1865, 133].

In addition, other research has shown that horses required greater care than other draft animals. In discussing their use by the British, Singleton argues that "the dramatic improvement in the treatment of horses between the Boer and Great Wars could be explained on pragmatic grounds...the War Office accepted that horses were delicate and valuable military assets, which provided excellent service when properly maintained, but soon broke down when neglected" [1993, 200]. This evidence makes clear the agency problem in the use of horses by soldiers.

The physical and dispositional characteristics of horses and mules are important in deciding which to use. While both serve equally well in harness, for pulling various objects, they differ in how far they can be pushed to perform a job. The horse can be driven willingly into a state of over-exhaustion and even death, while the mule will stop to rest when tired.¹²

The innate self-monitoring capability of mules, has given them their reputation for stubbornness. The Army exploited this ordinarily undesirable trait by issuing mules to installations with more severe agency problems. The mules' stubbornness limited the abuse by its caretaker. In certain military instances, of course, the self-preservation trait of mules may have no value. For instance, when threatened, mules may stop and be difficult to move, making a quick retreat difficult. If the main goal were to effect a quick and safe retreat, the horse might be preferable even if it tolerated more abuse. Other concerns, such as skittishness of the animals under fire, do not seem to have been a deciding factor in the choice of one animal over the other, as both seemed equally able to acclimate themselves to the sounds of war [Glubb, 1977, 62].¹³

Besides the issue of self-monitoring in work pace, mules tend to watch out for themselves in other ways. For example, mules take care not to overeat or overdrink; horses readily indulge in both. Such behavior is dangerous because equines are susceptible to such afflictions as colic or laminitis when they eat or drink too much. Both conditions can lead to death or to severe debilitation. Interestingly, both of these afflictions, as well as others, can be caused by negligent feeding practice; thus, assignment of blame is difficult because they can result from natural causes as well as negligence.

What was the deciding factor for each of these installations in choosing which type of draft animal to use? With scarce resources with which to procure supplies, the Army wanted to minimize costs whenever possible. Thus, holding other things constant, we would expect that the mules that were purchased were issued to forts and outposts with the most severe agency problems. The more severe the agency problem, all else equal, the more likely it was that mules were used to abate the effects of abuse by enlisted men.

PRINCIPAL-AGENT PROBLEMS IN THE U.S. ARMY

To define the principal-agent problem in the use of draft animals by the U.S. Army, we must first identify the relevant parties in the relationship and then find some measure of the severity of the principal-agent problem. The agents were the enlisted men; those actually working the draft animals. The animals were not privately owned nor, as in the cavalry, exclusively used by any one soldier, making it difficult to assign blame when the animals were injured or became ill. The principal was the Army; its objective was to preserve the capital value of the animals, while keeping the cost of military spending as low as possible. Those charged with seeing that the principal's wishes were carried out were the officers, who therefore acted as the monitors. Their role in monitoring the use of publicly-owned animals was clearly laid out in an 1863 directive stating that, "it is the design of the War Department to correct such neglects [ill treatment of public animals], by dismissing from service officers whose inefficiency and inattention result in the deterioration or loss of the public animals under their charge" [General Orders No. 236, 1863].¹⁴ It was clearly in the interest of the officers to monitor draft animal use by enlisted men because promotions and demotions were tied to their effectiveness as monitors.

The severity of the agency problem varied across each fort, outpost, division and brigade, depending on the relative number of enlisted men to officers. In certain cases, the number of enlisted men equalled the number of officers; hence, the agency problem was very low. In other cases, as with the Army of the Potomac, enlisted men outnumbered officers 50 to 1. If the Army worked as a rational economic agent, we would expect it to use the less expensive horse in cases where the agency problem was less severe and the mule in cases where the agency problem was more severe, as was the case of mining and southern agriculture.

To test this hypothesis I use data collected from the "Report of the Means of Transportation, Number of Officers, Men, Animals, &c." This report, published monthly from 1840-1870, was sent to the Quartermaster General in Washington by the local Quartermaster of each army corps or outpost. Unfortunately, only 486 of the actual reports survive, covering only the years 1863-1866; the rest were destroyed. The remaining reports should represent an unbiased sample of the relative proportions of draft horses and draft mules in the U.S. Army.¹⁵

The report described above tallied the numbers of officers, enlisted men, and animals at each site. Table 1 contains descriptive statistics relating to this sample of the Means of Transportation Report. The numbers of enlisted men and officers varied considerably, with the mean number of enlisted men at 7026 and officers at 326. Thus, the average ratio of enlisted men to officers was nearly 22 to 1. The average number of draft mules was quite high at 1831, while the average number of horses was 410. These figures result in an average mule-to-horse ratio of over 4 to 1. While the relative level of enlisted men to officers seems high, so too is the average ratio of mules to horses.

The number of enlisted men at each installation is used as a measure of the size of the installations (see Table 2). This table shows that the smallest installations, those

TABLE 1
Animal and Human Statistics from
Sample of Means of Transportation Report

	Average Per Report	Total in Sample	Standard Dev.
Enlisted men	7026	3,414,502	11,873
Officers	326	158,671	581
Draft Mules	1831	889,973	3116
Draft Horses	410	199,084	791
Cavalry Horses	886	430,396	1992
Artillery Horses	196	95,182	563
Private Horses	185	89,800	406
Oxen	21	10,044	80

Source: Various "Reports of the Means of Transportation, Number of Officers, Men, Animals, &c." from 1863-1866.

with fewer than 100 enlisted men, had the highest ratio of officers to enlisted men. It is therefore not surprising that the ratio of horses to mules was highest in this category. In fact, only this category had a horse to mule ratio greater than one. The next two smallest categories had the next highest ratios of officers to enlisted men and the next two highest horse to mule ratios.

When the absolute number of enlisted men per installation becomes larger than 1500, the ratio of officers to enlisted men does not vary much. Presumably, however, as the sheer number of enlisted men grows the difficulty of monitoring increases. This is evident from the fact that the ratio of horses to mules never exceeds 27 horses for each 100 mules among installations with more than 3000 enlisted men.

To test the above-stated hypothesis, the severity of the agency problem in each case must be measured. I use the number of enlisted men as a percentage of all soldiers for all 486 reports as a proxy for the severity of the agency problem. The higher the number of enlisted men as a percentage of both enlisted men and officers, the greater the agency problem since a higher percentage of enlisted men at an installation necessarily meant that there was a smaller percentage of officers to monitor them. Therefore, the hypothesis predicts that the higher the percentage of enlisted men, the higher the percentage of mules used for draft work. The following Tobit regression was estimated with the percentage of mules as the dependent variable and percentage of enlisted men as the regressor. The t-statistics are listed below the coefficients:¹⁶

$$\text{PercentMule} = -0.534 + 1.347 \text{ PercentEnlisted.}$$

(6.96) (16.41) pseudo-R²=0.95

TABLE 2
Soldiers and Draft Animals by Number of Enlisted Men per Installation

Number Enlisted Men	# of Installations	Average # Enlisted Men	Average Number Officer	Average # Work horses	Average #Ratio of Work Mules Enlisted	Ratio of Officers to Horses to Mules
0-99	77	8	3	30	7	.42 4.32
100-499	40	297	22	59	146	.07 .40
500-999	30	730	88	79	163	.12 .49
1000-1499	32	1250	90	118	407	.07 .29
1500-1999	20	1739	95	216	948	.05 .23
2000-2499	22	2286	149	294	958	.06 .31
2500-2999	14	2657	118	398	1092	.04 .36
3000-3999	29	3524	164	552	2684	.05 .21
4000-4999	18	4374	196	587	2364	.04 .25
5000-5999	26	5482	254	327	1902	.05 .17
6000-6999	18	6418	281	407	1950	.04 .21
7000-7999	21	7477	290	376	2074	.04 .18
8000-8999	23	8413	368	410	1498	.04 .27
9000-9999	13	9453	360	770	3268	.04 .23
10K-14999	33	12,134	554	819	3235	.05 .25
15K-19999	38	17,138	801	656	3696	.05 .18
20K-49999	27	30,202	1309	1236	5968	.04 .21
50000+UP	5	87,670	4381	3337	15,310	.05 .22

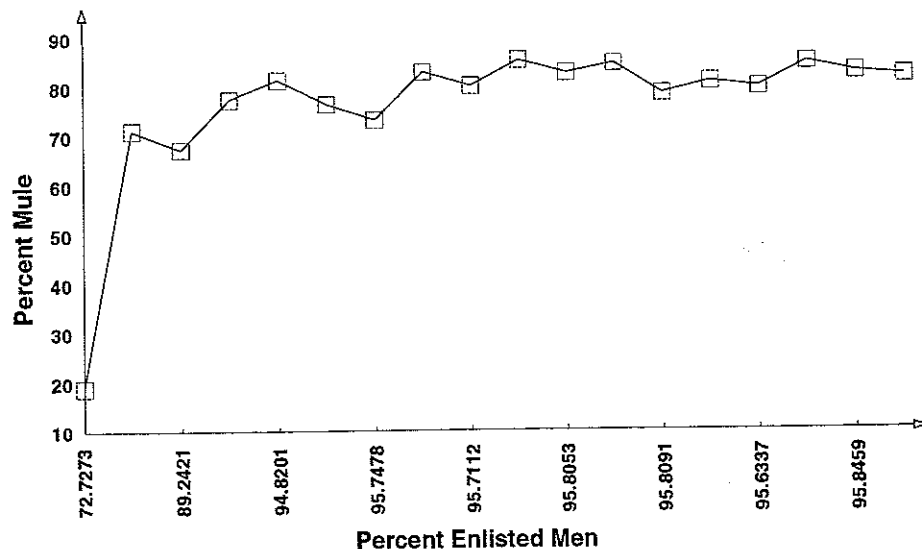
Source: Various "Reports of the Means of Transportation, Number of Officers, Men, Animals, &c." from 1863-1866.

The results of Tobit regressions cannot be interpreted in the standard fashion [McDonald and Moffitt, 1980]. Because the dependent variable vector contains several zeros (a number of posts used no mules), the coefficient on the independent variable must be transformed so that it can be interpreted as a partial derivative. Using methodology proposed by McDonald and Moffitt [1980], I have found the coefficient on *PercentEnlisted* to be 0.877. The results of this regression strongly suggest that mules were used to abate agency problems. A higher percentage of mules were used in locations where the percentage of enlisted men was high. For example, the corrected Tobit regression results suggest that a 10 percentage point increase in the percentage of enlisted men at a particular installation resulted in an 8.77 percentage point increase in the number of mules used. This single regressor is highly significant, both economically and statistically.

It could be argued, looking at Table 2, that much of what drives this result is the overwhelming use of horses by the smallest installations (those with under 100 enlisted men).¹⁷ Figure 2 illustrates graphically the overall positive relationship between the percentage of enlisted men and the percentage of mules at Army posts. The correlation is clearly strongest at the smallest installations, yet a strong positive relationship exists even among larger installations. In order to test the effect of agency problems on the larger installations, I dropped those with fewer than 100 enlisted

FIGURE 2

Relationship between the Percentage of Enlisted Men and the Percentage of Draft Mules during the Civil War



Source: Various Reports of the Means of Transportation, Number of Officers, Men, Animals &c from 1863-1866.

men because it could be argued that the work done at those locations might have been somewhat different from that at the larger camps. This resulted in the following OLS regression.¹⁸

$$\text{PercentMule} = -1.13 + 1.99 \text{PercentEnlisted.}$$

(5.31) (8.86)

adjusted-R²=0.16

The coefficient for the independent variable is positive and highly significant statistically, consistent with the previous regression. Note, however, that the magnitude of the coefficient is larger, as we would expect for larger installations with more severe agency problems. For these installations, a 10 percentage point increase in the percentage of enlisted men leads to a nearly 20 percentage point increase in the percentage of mules used. This delineation further makes the point that, as agency problems became more severe, the Army opted to issue an ever increasing number of mules to its enlisted men.

CONCLUSION

It has been generally accepted that army procurement was, and still is, somehow irrational. The exorbitant prices paid for some equipment cause many to believe that this institution does not use solid economic judgements in its purchasing decisions.

With respect to draft animals the procurement and distribution practices of the U.S. Army during the Civil War period do not appear irrational. Data from the Report of the Means of Transportation suggest that, at installations with relatively few officers compared to enlisted men, the draft animal of choice was the more expensive, and more abuse-resistant, mule. This choice was made to diminish the amount of capital depreciation of the overall draft animal stock of the U.S. Army. At smaller installations, where the proportion of officers to enlisted men was higher and monitoring was therefore easier, the Army could issue the less expensive horse.

This particular example of army procurement could potentially shed light on other such seemingly irrational procurements by large institutions with similar principal-agent problems, which may seem to be spending more on certain types of equipment that are more abuse-resistant than would individuals or small firms. When these principals are faced with the choice of issuing an agent highly abuse-resistant capital or a type that is less abuse-resistant yet less expensive, the principal may rationally choose the initially more expensive piece of capital.¹⁹

Many such cases of capital choice being driven by principal-agent problems can be found in the modern period. In Eastern Europe and the former Soviet Union, for example, where large-scale factories and farms still exist and where monitoring is difficult, issuing workers more abuse resistant-capital may be a wise decision even if the initial costs are high. These are potential areas for future research in which investigators may find results similar to the lessons of history discussed here. In particular, such research may provide further support for the idea that spending large amounts of money for capital that can withstand abuse, even if it is initially more costly than other alternatives, may not be irrational for entities such as the government or large firms.

NOTES

For helpful comments on an earlier version I thank Lee Alston, Francine Blau, Farley Grubb, Laurie Lawrence, Larry Neal, Susan Skeath, David Surdam, two helpful referees and the participants in the American Economic Association Meetings session on Understanding Collective Action and Outcomes, especially Richard Steckel. I, however, bear sole responsibility for any remaining error or inelegance. Shannon Graving provided invaluable research assistance. Financial assistance from Wellesley College is gratefully acknowledged.

1. I am in no way trying to defend all, or even most, military purchases, to illustrate a point. It may be possible, however, that some of the military's current "overpriced" procurements are indeed rational purchases of equipment that will abate the inherent principal-agent problem.
2. Average prices of mules and horses were compiled from U.S. Bureau of the Census, *Historical Statistics of the United States, Part I* (series K571 and K573) and deflated by the Warren and Pearson/BLS "Farm Products" Index (series E42 and E53). This series, unfortunately, begins in 1867; however, the qualitative evidence suggests that during the Civil War and before mules were also more expen-

- sive than horses. See for example Reports of the Quartermaster General [1863; 1865] and Sharpe [1899].
3. Additionally see Liebowitz [1992] for a discussion of the choice between horses and oxen in the U.S. and France.
 4. During the Civil War the North provided cavalry mounts for its enlisted men, whereas the South had the soldier provide his own mount [Ramsdell, 1930, 758].
 5. For a description of the artillery horse and its use see Hardy [1941, 2-6].
 6. The horses were purchased from the U.S. Army by the officers. When a new shipment of horses came to a post, the officers had first choice based on rank. Each paid one-third above the average price of the shipment for his mount.
 7. As oxen are also a very abuse-resistant type of animal it would seem that the Army would endeavor to issue them in a fashion similar to mules. However, their comparative advantage is in greater torque (that is, pulling strength, for things such as plows) and not in speed. Mules, being similar in self-monitoring ability, were preferred to oxen since they could pull wagons much more quickly than their slow bovine counterpart [Galassi and Kauffman, 1995].
 8. The gait of the horse and the mule are different. It was, however, not unheard of to have "cavalry mules." For example, Colonel Able Streight led a raiding force mounted on mules. It appears that his force consisted almost entirely of foot soldiers with little riding experience [Starr, 1981]. Also, mules were ridden by soldiers in the South as well. For example it was known that many of Longstreet's cavalymen rode mules [Ramsdell, 1930, 772].
 9. For a detailed discussion of the daily care requirements that the Army demanded be carried out on its horses, see Robbins [1910a, 90].
 10. As noted earlier, the Confederate Army did require their enlisted men to purchase, and even find, their own mounts. This practice, however, proved a tragic mistake. As soon as a soldier "lost" his horse he was furloughed until he could find a new mount. The incentives were such that, if a soldier wished to go home, he had only to kill his horse. On December 29, 1864 (obviously too late) the Confederacy adopted the North's method of procuring cavalry horses.
 11. This line comes from the well-known paper, by Alchian and Demsetz [1972].
 12. For a more expanded discussion see Kauffman [1993].
 13. As in this and virtually every other respect, horses and mules are near perfect substitutes when it comes to draft work. Pound for pound and input for input, horses and mules are equally productive. I thank Dr. Laurie Lawrence, Director of the Equine Nutrition and Physiology Center of the University of Kentucky for extended discussions on this topic. For some contemporary literature in this area see, Williams [1923], Anderson [1937], and Dinsmore [1945]. Unfortunately, no modern comparative study of the precise differences in capability or feed requirements between horses and mules exists. The only attempt to look at the differing input requirements suggest that pound for pound the differences are statistically insignificant, Lawrence, Klein, and Kauffman [1989].
 14. Coincidentally, the year this directive went into effect is the same year my data begin. For the time span under consideration the Army was strengthening the accountability of its officers to act as monitors.
 15. For reference, my Civil War data sample shows that there were 0.48 animals per person. According to Singleton [1993, 195], there were 0.26 animals per person in the British army during WW I when mechanization had reduced the demand for animals.
 16. A Tobit regression was estimated rather than an Ordinary Least Squares regression because 11 percent of the dependent variable was at the truncated lower limit value of zero. In addition, this regression was first run as a cross-section regression with dummy variables for each month, but none of these dummies were significant. The lack of a sufficient number of data points for the construction of a panel precluded running a panel regression, thus the use of dummy variables to pick up monthly variation. The problem of pooling the various months is greatly reduced due to the insignificance of the monthly dummies.
 17. This hypothesis is something that agency theory would predict, and the data in fact bear this out.
 18. In this case I estimated an OLS regression, corrected for heteroskedasticity, because only 6 of the 409 observations were at the limiting censored ends.
 19. The decision would obviously depend also on relative prices and costs of monitoring.

REFERENCES

- Alchian, A., and Demsetz, H. Production, Information Costs, and Economic Organization. *American Economic Review*, December 1972, 777-97.
- Anderson, W. S. *Workstock*. University of Kentucky Circular No. 306. Lexington, KY, 1937.
- Dinsmore, W. *Jacks, Jennets, and Mules*. Chicago: The Horse and Mule Association of America, 1945.
- Espanet, O. *Notes on the Supply of an Army During Active Operations*. Kansas City, MO: Hudson-Kimberly Publishing, 1899.
- Frazer, R. W. *Fort and Supplies: The Role of the Army in the Economy of the Southwest, 1846-1861*. Albuquerque, NM: University of New Mexico Press, 1983.
- Galassi, F. L. and Kauffman, K. D. The Economics of Draft Animal Choice in Italian Agriculture: A Principal-Agent Approach to the Adoption of an Early Form of Capital. mimeo. Department of Economics, Wellesley College, 1995.
- General Orders No. 236. War Department, Adjutant Generals Office. Washington, D.C.: Government Printing Office, 1863.
- Glubb, J. *Into Battle: A Soldier's Diary of the Great War*. London, 1977.
- Hardy, E. N. *Horses and Mules in Modern Warfare*. Chicago: Horse and Mule Assoc. of America, 1941.
- Kauffman, K. D. Why Was the Mining Mule Not a Horse?: The Control of Agency Problems in American Mines. *Research in Economic History*. 1996, 83-100.
- _____. Why Was the Mule Used in Southern Agriculture?: Empirical Evidence of Principal-Agent Solutions. *Explorations in Economic History*, July 1993, 336-351.
- _____. A Note on Technology Choice in a Principal-Agent Framework: The Use of Mules Over Horses in American Southern Agriculture. *Economics Letters*, February 1992, 233-235.
- Lawrence, L. M., Klein, K. H., and Kauffman, K. D. Survey of Draft Animal Feeding Practices. *Equine Practice*, March 1989, 10-15.
- Liebowitz, J. The Persistence of Draft Oxen in Western Agriculture. *Material History Review*, 1992, 29-36.
- McDonald, J. F. and Moffitt, R. A. The Uses of Tobit Analysis. *The Review of Economics and Statistics*, May 1980, 318-321.
- Report of the Quartermaster General. Washington D.C.: Government Printing Office, 1863.
- _____. Washington D.C.: Government Printing Office, 1865.
- Ramsdell, C. W. General Robert E. Lee's Horse Supply, 1862-1865. *The American Historical Review*, July 1930, 758-777.
- Robbins, E. T. With Uncle Sam's Horses and Mules. *The Breeder's Gazette*, March 1910a, 89-90.
- _____. United States Army Horses and Mules. *The Breeder's Gazette*, November 1910b, 445-6.
- Sharpe, H. G. The Art of Supplying Armies in the Field as Exemplified During the Civil War, in *Notes on the Supply of an Army During Active Operations*, edited by O. Espanet. Kansas City, MO: Hudson-Kimberly Publishing, 1899.
- Singleton, J. Britain's Military Use of Horses 1914-1918. *Past and Present*, 1993, 178-203.
- Starr, S. Z. *The Union Cavalry in the Civil War, Vol. III*. Baton Rouge, LA: Louisiana State University Press, 1981.
- U.S. Bureau of the Census. *Historical Statistics of the United States*. Washington, DC: Government Printing Office, 1975.
- Williams, J. O. *Mule Production*. USDA, Farmers Bulletin No. 1341, 1923.