2013

A comment on evaluating the cost-effectiveness of armored tactical wheeled vehicles

Rohlfs, Chris; Sullivan, Ryan

Taylor & Francis

Rohlfs, Chris, and Ryan Sullivan. "A comment on evaluating the cost-effectiveness of armored tactical wheeled vehicles." Defence and Peace Economics 24.5 (2013): 485-494.
http://hdl.handle.net/10945/65325

Defence and Peace Economics, 2013
Vol. 24, No. 5, 485–494, http://dx.doi.org/10.1080/10242694.2013.816093

A COMMENT ON EVALUATING THE COST-EFFECTIVENESS OF ARMORED TACTICAL WHEELED VEHICLES

CHRIS ROHLFS[a] AND RYAN SULLIVAN[b]*

[a]*Morgan Stanley, 750 Seventh Avenue, 33rd Floor. New York, NY, 10019, USA;* [b]*Naval Postgraduate School, 287 Halligan, Hall, Monterey, CA, 93943, USA*

(*Received 2 June 2013; in final form 7 June 2013*)

This comment discusses the pros and cons of the methodology and data used in our previous study on the cost-effectiveness of armor on Tactical Wheeled Vehicles (TWVs), and responds to recent critiques by Franz Gayl. In our previous article, we evaluated the large-scale Army policies to replace relatively light Type 1 Tactical Wheeled Vehicles (TWVs) with moderately protected Type 2 variants, and later to replace Type 2s with heavily protected Type 3s. We find that the switch from Type 2 to Type 3 TWVs did not appreciably reduce fatalities and were not cost-effective. Mr. Gayl contends that the data and choice of control variables used in our original study negatively bias our findings for Type 3 TWVs. We defend our previous conclusions and argue that Gayl's suggested approach of focusing on *deaths per insurgent attack* fails to account for effects of the vehicles on when, where, and how attacks occurred. Our methodology does not suffer from this bias and measures effects on total unit casualties rather those incurred *per attack*. We explain that our estimates are stable across many specifications and are not sensitive to the choice of controls as Gayl suggests.

Keywords: Cost-effectiveness; Tactical Wheeled Vehicles; U.S. military; Value of a statistical life

JEL Classifications: H56, J17, D24

1. INTRODUCTION

In our previous article (Rohlfs and Sullivan, 2013), 'The Cost-Effectiveness of Armored Tactical Wheeled Vehicles (TMVs) for Overseas U.S. Army Operations,' we evaluated two large-scale policies to replace relatively light Type 1 TWVs with more heavily protected Type 2 variants, and later to replace Type 2s with more heavily protected Type 3s. Our conclusions state that 'Type 2 TWVs reduced fatalities at $1.1 million to $24.6 million per life saved for infantry units, with our preferred cost estimates falling below the $7.5 million cost-effectiveness threshold, and did not reduce fatalities for administrative and support units. We find that replacing Type 2 with Type 3 TWVs did not appreciably reduce fatalities and was not cost-effective.'

This comment responds to the forthcoming article by Franz Gayl (2013) titled, 'Incomplete Rohlfs-Sullivan Analysis of the Cost-Effectiveness of Armored TMVs for Overseas U.S. Army Operations,' which is critical of our previous work in Rohlfs and Sullivan (2013). The purpose of this comment is to justify the continued use of the methodology

*Corresponding author. Email: rssulliv@nps.edu

provided in Rohlfs and Sullivan (2013) as an appropriate technique to evaluate the cost-effectiveness of TWVs and reply to the critiques in Gayl (2013) including, but not limited to, the following:

i. Contrary to the criticisms in Gayl (2013), we control for synchronized combat activities, increasing troop levels, and other types of vehicles in our regressions. Thus, our results are not biased due to these factors as suggested by Mr Gayl.
ii. Gayl (2013) maintains that his preferred method of sifting through detailed casualty reports on an 'attack-by-attack' basis is a superior identification strategy to our modeling technique for estimating the number of lives saved by heavily armored Type 3 TWVs. We discuss how this type of methodology ignores substitution effects in battle and incorrectly assumes that soldiers and insurgents behave in the same manner regardless of the types of vehicles used in combat. We make the case that this type of approach overestimates the lifesaving capabilities of Type 3 TWVs.
iii. Gayl (2013) asserts that the aggregate data we use in our original study biases our results. We clarify the limitations of the data provided to us by the Department of Defense (DoD) and show that these have little effect on our conclusions.

This paper proceeds as follows. Section two contrasts the methodology used in Rohlfs and Sullivan (2013) with what Gayl (2013) advocates. Section three discusses the data-sets utilized in Rohlfs and Sullivan (2013). Section four considers other critiques in Gayl (2013) and section five concludes the comment.

2. METHODOLOGY

2.1. Rohlfs and Sullivan (2013)

As discussed in Section IV in Rohlfs and Sullivan (2013), we use standard econometric methods, including regression analysis, to estimate changes in unit-level casualty rates as a function of each unit's complement of vehicle types while controlling for other factors. This modeling approach is shown below. From Rohlfs and Sullivan (2013):

'For a given unit i in month t, suppose that *fatalities* are determined according to the following linear equation:

$$\text{fatalities}_{it} = \sum_{j=1}^{3} \alpha_{cj}^{f} \times q_{jit} + \boldsymbol{\beta}_{\mathbf{c}}^{\mathbf{f}'} \mathbf{x_{it}} + \varepsilon_{it}^{f}, \qquad (1)$$

where q_{1it}, q_{2it}, and q_{3it} represent the quantities of each of the three types of vehicles possessed by unit i in month t, $\mathbf{x_{it}}$ is a vector of control variables that might include other vehicle quantities, troop characteristics, or fixed effects for month, province, month by province, or unit, ε_{it}^{f} is random error, and the coefficients are allowed to vary by the unit's classification c as infantry, armored or cavalry, administrative and support, or other. Let vehicle types one, two, and three be defined as Type 1, Type 2, and Type 3 TWVs.

Because the focus of this study is the effects of replacing one vehicle type with another, it is convenient to rearrange the terms in Equation (1) to obtain the following specification:

$$fatalities_{it} = (\alpha_{c2}^{f} - \alpha_{c1}^{f}) \times q_{2it} + (\alpha_{c3}^{f} - \alpha_{c1}^{f}) \times q_{3it} + \alpha_{c1}^{f} \times \sum_{j=1}^{3} q_{jit} + \boldsymbol{\beta}_{\mathbf{c}}^{\mathbf{f}'} \mathbf{x_{it}} + \varepsilon_{it}^{f}. \qquad (2)$$

Equation (2) serves as our main regression specification, with $\sum_{j=1}^{3} q_{jit}$, q_{2it}, q_{3it}, and varying formulations of $\mathbf{x_{it}}$ as the regressors. The differences $(\alpha_{c2}^{f} - \alpha_{c1}^{f})$ and $(\alpha_{c3}^{f} - \alpha_{c1}^{f})$ measure the effects of replacing Type 1 TWV with a Type 2 or Type 3 TWV.'

Like any armored wheeled vehicle, Type 3 TWVs have their positive (e.g. superior armor protection) and negative (e.g. weight, bulkiness, and lack of maneuverability) attributes. We use the aforementioned modeling approach to 'measure the full reduced-form effects of changing vehicle type, taking into account the intrinsic properties of the vehicles and any behavioral responses by the units.' Our emphasis on behavioral responses is a key difference from others in the literature (citations withheld due to security concerns), which show that the fraction of improvised explosive device (IED) attacks resulting in death is higher for Type 1 and 2 vehicles than for Type 3 vehicles. We discuss the limitations of these types of studies in detail below.

Gayl (2013) claims that we do not control for several factors that may have influenced casualties in our analysis. These assertions are as follows:

i. Mr Gayl maintains that we do not control for 'synchronized combat activities' such as, 'new armored vehicle employment policies, the accelerated fielding of complementary advanced weapons equipment, a new COIN [counterinsurgency] strategy and TTPs [tactics, techniques, and procedures], and related positive political changes.' Also, he states that we do not control for evolving 'enemy tactics and preferred weapons.'

- The monthly fixed effects allow us to control for any common shocks across units each month. For instance, if an Army-wide policy existed that affected all units in Theater A, then the monthly fixed effects would control for this. The monthly fixed effects also control for any nationwide political changes, which would impact all unit types. The province-by-month effects allow us to adjust for changes in the combat environment across units. In addition, the unit-level controls allow us to adjust for intrinsic differences between early and late receivers of the more protected vehicles. In short, all of the synchronized combat activities and the evolving combat environment that Mr Gayl claims we do not factor into our analysis are controlled for in our regressions.

ii. Mr Gayl claims that we do not control for the major increase in troop levels in the middle part of the conflict.

- We include monthly troop totals by unit as a control variable in our regressions. The troop totals are one of the troop characteristics described in Equation (1). Thus, the claim that we do not control for the increase in troop levels is incorrect.

iii. Mr Gayl asserts that we do not consider how a mixed fleet can have complementary benefits on the battlefield.

- Our modeling technique specifically includes various combinations of vehicle types. Our model, therefore, estimates the lifesaving effects of all three vehicle types, not just one in particular as Mr Gayl suggests.

We believe that our modeling technique provides the best estimates to date on the lifesaving capabilities of the vehicles. Ours is the only study to our knowledge that incorporates behavioral responses to the vehicles in its estimates. Other studies have focused on the casualty rate per IED attack by vehicle type which is similar to the identification strategy that Gayl (2013) advocates. It is our belief that this type of methodology overestimates the lifesaving capabilities of Type 3 TWVs by ignoring soldiers' and insurgents' behavioral responses to the vehicles.

2.2. Gayl (2013)

Gayl (2013) offers two identification strategies as alternatives for our modeling approach to estimate the number of lives saved by Type 3 TWVs. His main identification strategy advises researchers to sift through detailed casualty reports on an 'attack-by-attack' basis. Essentially, he is recommending, as others have done in the past, a comparison of the IED casualty rates from soldiers riding in Type 3 TWVs with Type 1 or 2 TWVs. In addition, he suggests examining other casualty types (for soldiers in vehicles) on an attack-by-attack basis that relate to small arms fire, indirect fire attacks, sniper attack, etc., as well as indirect events, such as drowning, roll-overs, crashes, and electrocutions. Gayl (2013) offers no estimates of his own for any of these casualty numbers. The only citations he provides as justification for this identification strategy relate to IED attacks. The studies he cites find that, given an IED attack, it is safer to be in a Type 3 TWV than a Type 1 or 2 TWV; we do not dispute this finding.

These types of studies assume, however, that soldiers in Type 3 vehicles are attacked by IEDs at the same rate as soldiers in other vehicles. They also implicitly assume that the extra protection on the Type 3 vehicles has no effect on the exposure of soldiers to attacks not involving IEDs or occurring outside of vehicles. We believe that these assumptions are not valid. For example, when soldiers adopted the heavily armored Type 3 vehicles, insurgents may have directed their efforts away from IED attacks on vehicles and toward attacks on less armored soldiers outside of vehicles. Providing troops with safer vehicles may have increased their willingness to take on risks. In the data, we saw strong evidence of a 'substitution effect' among armored and cavalry units. When their Type 1 and 2 vehicles were replaced with the heavier Type 3 vehicles, they made greater use of their TWVs and less use of vehicles with more firepower, such as tanks. We have also heard anecdotes of soldiers avoiding certain dirt roads and bridges when driving Type 3 TWVs due to their weight. If one believes that the behavioral responses that we describe could have occurred – and could have changed the rate at which units were exposed to different types of attacks – then the appropriate way to measure the vehicles' full effects is to use our approach of examining the impact of the vehicles on units' overall fatalities.

As a second identification strategy, Gayl (2013) argues that researchers should analyze graphically how casualties changed during the main rollout of the Type 3 TWVs and highlights the time period between months 37 and 52 appearing in Panels A and E in Rohlfs and Sullivan (2013). This time period witnessed an increase in the number of Army Type 3 TWVs and a decrease in overall Army casualty rates in Theater A. Of note, the large reductions in Army casualties began to take place *before* substantial numbers of Army Type 3 TWVs were present in Theater A. Gayl (2013) maintains that there were several factors that caused the marked change in casualty rates between months 37 and 52, one of which would have been the deployment of Type 3 TWVs. In addition, he states that other policies, such as restricting Type 1 and 2 TWVs from going outside the wire, an increase in the number of troops in theater, other equipment contributions, and other tactical operations, caused the change in casualty rates.

Many factors, of course, influenced the decline in casualty rates during this time period. Mr Gayl assumes that since theater-wide casualty reductions roughly coincided with increasing numbers of Type 3 TWVs, they must be related. We believe that, for the estimates to plausibly identify a causal relationship, they must take into account the changing combat environment and other policies that may have impacted casualties. We recommend incorporating a vector of control variables that include, 'other vehicle quantities, troop characteristics, or fixed effects for month, province, month by province' in the regressions as a way to disentangle the effects of these other policies from Type 3 TWVs. Mr Gayl offers no such solution to tease out these effects. Until such an estimation strategy is provided, this type of time-series analysis does not justify the cost-effectiveness of Type 3 TWVs.

3. DATA

One critique of our study in Gayl (2013) is that the Army introduced Type 3 TWVs earlier in the conflict than our aggregate data depict (as presented in Panel A, Figure I in Rohlfs and Sullivan 2013). Mr Gayl suggests that this shortcoming may reverse our conclusions. This section clarifies some of the limitations of the data that the Army Material Systems Analysis Activity (AMSAA) provided us and how they may or may not influence our conclusions.

3.1. AMSAA Sample Data Collection

The primary data-set that we use to obtain our estimates are the actual deployed field data from the SDC. Due to concerns with the quality and granularity of Army-reported Optempo and field-level logistics data,[1] AMSAA's SDC mission (as specified in United States 2007, AR 750-1) seeks to acquire more accurate and detailed information at the company level (which we aggregate to the battalion level) to be used for Army analysis. As discussed in Rohlfs and Sullivan (2013), 'The SDC tracks a range of tactical and non-tactical ground vehicle systems and includes each vehicle's serial number, mileage, and unit affiliation. The data measure a representative sample of roughly one-fifth of US Army units in Theater A and roughly one-third of a typical sampled unit's TWVs appear in the data.' Importantly, these data include information on the actual vehicles being used by Army units on the ground. This is in contrast to many of the references in Gayl (2013) which pertain to awarded contracts, requests from commanders, or other service types. To our knowledge, the SDC are the most accurate data available at the company level for Army units in Theatre A. The scrutiny from Mr Gayl does not pertain to the SDC data since they contain little measurement error. His critiques apply to how we weight the SDC data with the less-precise aggregate vehicle totals from the Army Material Command (AMC). While the SDC includes data from a sample of vehicles in theater, the data-set unfortunately does not include information on the rates at which different vehicles were sampled. For this reason, we constructed sample weights by using the AMC data; we discuss this process in detail below.

3.2. Army Material Command

In addition to the SDC data, the AMSAA provided us with aggregate vehicle totals that were tracked and reported by the AMC's Current Operations Update Briefing during the

[1]For instance, soldiers were not accurately writing down the numbers of vehicles they had or the mileage rates for the vehicles they were using.

course of Theater A's conflict. The AMC is one of the primary organizations in the Army that keeps records on the Status of Resources and Training Systems (SORTS) vehicle quantities and their usage rates. After our original article was accepted for publication, it came to our attention that certain organizations may have contributed limited numbers of vehicles to Army units that were not included as part of the main AMC tracking system. Had we been aware of this limitation of the AMC data prior to publication, we would have noted it. Readers should be aware of this AMC data limitation when reading our paper and Gayl (2013) is right to point out this shortcoming.

While Gayl (2013) is correct that a limited number of vehicles fell outside the AMC tracking system, clarifications for the numbers he presents are in order. His main critique against the data states, 'the Army had already long had hundreds of Type 3 TWVs, perhaps more than 350 by month 42.' It is unclear how Gayl (2013) obtained the specific figure of 350 from his text. To put this number into perspective, at the peak of our data, there were 8500 Army Type 3 TWVs and a total of 24,300 Army TWVs in Theater A. In contrast, the AMC data state that Army units had zero Type 3 TWVs in Theater A in month 42, with the numbers rapidly increasing shortly thereafter. Discussions with the DoD personnel lead us to believe that small numbers of Army Type 3 TWVs were in theater before month 42; however, exact numbers appear to be unavailable.

Figure I of Gayl (2013) displays some of his other critiques of the AMC data in graphical form. In that Figure, Gayl (2013) states that up to 53 Type 3 TWVs were present in Theater A by month eight and up to 500 by month 44. He cites his own work for the number 53 and the 500 value is from the website Olive-Drab.com.[2] Notably, the 53 and 500 amounts are for multiple service types, not just the Army. By comparison, the AMC numbers state that Army units had zero Type 3 TWVs in month eight and 423 Type 3 TWVs in month 45.[3] While some Army units may have received limited numbers of vehicles outside of the AMC tracking system, it does not appear that they were in large supply.

Unfortunately, we are unaware of any data-set that contains the exact Army vehicle quantities by month that were present in Theater A. To our knowledge, the AMC vehicle totals are the best aggregate data available, given the Army's tracking system. Our contacts at the AMSAA have told us that they believe the number of vehicles outside the AMC tracking system is limited and AMC's Army-reported totals closely mirror those systems deployed in theater (AMSAA 2010). Given the aforementioned limitations, however, the aggregate numbers displayed in Panel A, Figure I in Rohlfs and Sullivan (2013), may be slightly different than their actual totals.

3.3. Weighting the SDC data

As stated previously, the primary data that we use in our regressions are from the SDC. An important element, however, in obtaining accurate estimates relates to how we weight

[2]We are not permitted to disclose the actual titles of these references since they include the vehicle names in their titles. Readers will have to refer to Mr. Gayl's case study as referenced in Gayl (2013) for specifics on that citation.

[3]The numbers for month 44 were not directly available since this was one of the months that we linearly interpolated.

the SDC data, as discussed in footnote four in our original article and its appendix.[4] We believe that, given the available data, this re-weighting of the data provides the best possible estimates of the numbers of vehicles associated with different units in the SDC. While the AMC totals do enter into our computations, we believe that they represent the best available estimates of the total numbers of Army vehicles in theater over our study period. Moreover, if the theater-wide AMC totals under-count or over-count all vehicles by a fixed amount, then the month x year fixed effects in our regressions will correct for any bias generated by this under- or over-counting.

It is unclear how Mr Gayl would advise re-weighting the SDC data from his text. Our preferred method, unsupported by Gayl (2013), is to use the AMC data to weight the SDC vehicle totals. All of the weighting measures that we have tried point to the same conclusion – Type 3 TWVs are not cost-effective. Until more appropriate weighting methods emerge, we believe the data-sets and methods seen in Rohlfs and Sullivan (2013) provide the best estimates for the vehicle types used in Army units.

Most, if not all, empirical studies encounter data limitations, and this study is not immune to such issues. We agree with Mr Gayl that the AMC data does have some limitations; however, the weighting criteria we use would have to be wildly inaccurate to contradict our conclusions. Given our conversations with individuals at the AMSAA, we believe that our weights are reasonably accurate reflections of the actual sampling weights used and that it is highly unlikely that our weights are sufficiently imprecise as to change our main findings. Gayl (2013) criticizes us for using the best data available without offering use of an alternative, viable weighting criterion or data-set. The difference between our estimates and others is not due to minor disputes over data; this discrepancy exists because our study takes into account the behavioral aspects associated with use of the vehicles, while others focus primarily on their armor capabilities.

4. OTHER CRITIQUES IN GAYL (2013)

4.1. Not Citing the Literature on Armor Capabilities

Gayl (2013) is critical of our study for not citing other research showing that the armor protection of a Type 3 TWV is better equipped to withstand IED attacks in comparison to Type 1 or 2 TWVs. As stated previously, we readily agree with these findings and it would have been beneficial to discuss this research in our original article. The Office of Security Review (OSR), however, does not allow us to cite these types of studies. Thus,

---

[4]As we explain in the data appendix to our paper, the SDC data-set includes some fraction $1/w_v$ of each type of vehicle v that AMSAA tracks. Hence, each vehicle observed in the data represents w_v vehicles that appeared in the field. Unfortunately, these sampling weights do not appear in the data; in order to determine the approximate numbers of vehicles owned by each unit, we had to estimate these weights. Data from the Defense Manpower Data Center (DMDC) told us the total numbers of troops in each unit. To determine the fraction of troops who belonged to units appearing in the SDC, we added these troop totals across all of the units in the sample and divided them by the total number of troops in the theater. To estimate the sampling weights, we assumed that the units were randomly sampled from the theater, so that for each vehicle type the number of vehicles per troop was the same for units that appeared in the data as for units that did not. We then computed our sampling weights using the AMC data on the total numbers of vehicles of each type in the theater. Suppose that the AMC data showed that 10,000 vehicles of type v were in the theater in a given month. Suppose too that the troop data showed that 20% of troops from the theater appeared in SDC units. By our assumption that the vehicles per troop is the same for sampled and unsampled units, we conclude that this 20% of troops should have 2,000 type v vehicles. If we only observe 1,000 type v vehicles in the entire sample, then we assume that w_v is 2 – i.e. for each vehicle observed in the sample for a given unit, there is another vehicle possessed by that unit that did not make it into the sample. We construct these weights separately for each month of data included in the sample. The AMC vehicle totals are available for an irregular set of months, and we linearly interpolate these totals for in between months.

Gayl (2013) is criticizing us for not discussing information that OSR restricts due to security concerns.[5]

4.2. Causes for Type 3 TWV Delays

There are many reasons why the Army experienced delays in getting Type 3 TWVs into Theater A. Gayl (2013) criticizes our work for not going into more detail on this topic. Given that the purpose of our study was not to more thoroughly understand the reasons for the Type 3 TWV delays, this criticism is strange. The motive of our study was to determine the vehicles' cost-effectiveness in relation to the number of lives that they save.

4.3. Not Using Mission Accomplishment as Our Outcome Variable

The primary outcome variable in our original study was unit fatalities. We find that Type 3 TWVs are not cost-effective for their lifesaving capabilities. In other words, the money spent on Type 3 TWVs would be able to save more lives if spent on more cost-effective programs that are currently being cut. Gayl (2013) finds fault with the use of fatalities as our outcome variable in contrast to 'mission accomplishment.' He argues that, by focusing on fatalities, we ignore other tactical advantages provided by Type 3 TWVs.

He is correct that Type 3 TWVs may provide other tactical advantages (such as being able to more easily drive on IED ridden roads) and disadvantages (including greater noise, lost maneuverability, and difficulty interacting with locals) in a combat environment. A complete cost-benefit analysis would require the monetization of these non-traditional benefits and costs (as outlined in Office of Management and Budget [OMB] 1992). This is an inherently difficult task and would require collecting a massive amount of subjective data with many additional assumptions. We did not view this as practical. Until new estimates are provided to contradict our results, we believe that focusing on the principle aim (e.g. saving lives) of the vehicle procurement program is justified.

4.4. Using Data From One Service Type

Gayl (2013) argues that our study focuses too narrowly on one service type. We agree with Mr Gayl that it would be beneficial to analyze the cost-effectiveness of the various TWVs for other service types. It is possible that an extension of our study might find that Type 3 TWVs are cost-effective for other service types or in different combat environments. This point is important and readers should understand that our estimates only pertain to Army units in Theater A during the time period we study.

4.5. Favoring Data in an Urban Environment or from Particularly Active Units

Gayl (2013) criticizes the data we use for oversampling particularly active units and those in urban settings. In our study, we included separate estimates for urban and rural environments and for high- and low-intensity units. In none of these cases did we find the Type 3 vehicles to be effective at reducing units' fatalities. Therefore, the fact that some unit types

[5]Also, we are not permitted to disclose the actual names of the vehicles, the theater of operations, and specific dates from our original work due to our contractual obligations with the DoD. We would prefer to be able to disclose all of these, but unfortunately we are restricted from doing so by OSR regulations. The reason that Mr Gayl is allowed to discuss these topics is because he is not bound by the same agreement that we have with the DoD.

were oversampled in comparison to others does not affect our final conclusions for Type 3 TWVs.

4.6. Analyzing the Effects of the Vehicles for Different Types of Units

Gayl (2013) is critical of the way we present our estimates separately for four different unit types. All of the estimates appearing in Tables I and II of Rohlfs and Sullivan (2013) show that Type 3 TWVs are ineffective in saving lives. Pooling all of the unit types together into a single sample brings about the same conclusion; Type 3 TWVs are not cost-effective.

5. CONCLUSION

For years researchers have compared the casualty rate per IED attack by vehicle type as a means to estimate their lifesaving capabilities. This methodology is similar to the one advocated in Gayl (2013). Focusing solely on troop casualties in vehicles pays no attention to the possibility that insurgents may shift their attacks away from heavily armored vehicles toward less-armored troops outside of vehicles. It also implicitly assumes that soldiers behave in the same manner regardless of the vehicle type used. This type of approach overestimates the lifesaving capabilities of heavily armored Type 3 TWVs. To our knowledge, our study is the first to effectively incorporate the behavioral aspects of the vehicles in its estimates and finds that Type 3 TWVs did not appreciably reduce fatalities.

As discussed in this article, Mr Gayl's critiques about the AMC data have little impact on our final conclusions. Furthermore, the assertion that controlling for synchronized combat activities, increasing troop levels, and other types of vehicles might change our estimates is incorrect, since we already control for these in our regressions. We believe that our modeling technique provides the best estimates to date on the lifesaving capabilities of Army TWVs and stand by our conclusions that Type 3 TWVs do not meet any of the requirements necessary to be considered cost-effective for the number of lives they save.

ACKNOWLEDGMENTS

The views expressed herein are those of the authors and do not reflect the official policy or position of the Department of Defense or the US government. In addition, the results presented in this paper and in our previous work should not be interpreted as a criticism of past DoD procurement decisions. The decision to deploy these vehicle types in real time during war is very different from looking back in hindsight. In accordance with security regulations by the Office of Security Review (OSR), all vehicle systems in this comment are referred to with the generic titles of Types 1–3, the months of data are denoted as one through 71 and the theater of operations is mentioned as Theater A. We thank individuals at the AMSAA for providing us data and helpful comments. Thanks also for the editing assistance by Kathleen Bailey.

References

Gayl, F. (2013) Incomplete Rohlfs-Sullivan analysis of the cost-effectiveness of armored tactical wheeled vehicles for overseas U.S. army operations. In press. *Defence and Peace Economics*.

Office of Management and Budget. (1992) Circular No. A-94 Revised. *The White House*, http://www.whitehouse.gov/omb/circulars_a094 (accessed 29 October).

Rohlfs, C. and Sullivan, R. (2013). The cost-effectiveness of armored tactical wheeled vehicles for overseas U.S. army operations. In press. *Defence and Peace Economics.*

U.S. Army Materiel Systems Analysis Activity. (2010) *Theater A Sample Data Collection*. Contact: henry.simberg@us.army.mil.

United States. (2007) *Army material maintenance policy: Army regulation 750–1*. Washington, D.C: Headquarters, Department of the Army.