Killer Incentives: Relative Position, Performance and Risk-Taking among German Fighter Pilots, 1939-45

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Abstract. What motivates soldiers to fight energetically for their country? We shed new light on the intensive margin of conflict participation by focusing on a novel explanatory channel – concern over relative standing. Using newly-collected data on death rates and aerial victories of more than 5,000 German fighter pilots during World War II, we examine the effects of public recognition on performance and risk-taking. When a particular pilot received public recognition, both the victory rate and the death rate of his *former* peers increased. The strength of this spillover depends on the intensity of prior interactions and social distance. Our results suggest that an intrinsic concern about relative standing, beyond tangible benefits associated with public recognition, can be a prime motivating force.

Keywords: Conflict, non-financial rewards, status competition, World War II.

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I. INTRODUCTION

'Parochial altruism', the willingness to fight for one's own group, has long puzzled evolutionary anthropologists: Fighting imposes a substantial risk on each individual, but benefits a group that typically transcends the circle of family and friends (Bowles and Gintis 2004; Choi and Bowles 2007). Standard solutions to agency problems like promotions and incentive pay (Lazear 1979; Gibbons 1998) are difficult to implement in a setting where greater effort increases the risk of death (Costa and Kahn 2003). Why, then, do individuals go to war, and fight for their group, city, or country? The economic literature on conflict has largely focused on economic incentives and the extensive margin of conflict participation – how and when do people turn to violence? Who deserts and why? There is a rich body of evidence suggesting that when opportunity costs are low, people are more willing to fight (Miguel et al. 2004, Dube and Vargas 2013).[1]

What has received less attention are social status concerns as a motivating force, and *the intensive margin* of conflict participation – why many soldiers fight enthusiastically, with dedication and devotion. Soldiers' motivation became a key for success on the battlefield as a result of military developments after 1750 (Posen 1993; Van Creveld 1981). Western military doctrine increasingly relied on the concept of decisive battle (Hanson 2009) and soldiers' motivation is generally accepted as a key input. At the same time, creating such motivation, often for years, often under gruesome conditions, is challenging (Posen 1993).

In this paper, we argue that relative standing concerns can be a prime motivating force for highly skilled individuals, including those facing extreme risks. German fighter pilots during World War II serve as a case study. We examine their motivations despite the fact that they served one of the most immoral regimes in history – like numerous other German soldiers, many were well aware of the moral dilemma of fighting for their country while supporting an evil dictatorship. While successful social engineering (Van Creveld 1981) may have contributed to their motivation, our focus is on a novel dimension – concerns for relative standing. We assemble new data on casualties and aerial victories of German fighter pilots, and examine changes in performance and risk-taking as a result of peer recognition during World War II.[2]

We focus on the risk-taking and performance of individual pilots whose *former peer* (a pilot who flew in the same squadron[3] in the past) is recognized. This avoids the problem of correlated shocks for pilots in the same unit. We find large increases in both death and victory

[1] Dube and Vargas (2013) also show that higher income due to natural resource windfalls go hand in hand with more violence.

[2] When we refer to 'aerial victories' and the performance of fighter pilots, we in no way intend to glorify the pilots, or the cause they served. Every victory in our dataset means that an aircraft was destroyed, with the opposing pilot being killed in many cases.

[3] Squadrons are the primary fighting unit of every air force, consisting of 8-12 pilots.

rates during the month of a peer's public recognition – even for pilots who served thousands of miles apart. Figure 1 illustrates our main finding. It shows victory and survival rates for pilots who ever flew with a mentioned pilot. In normal times, these pilots scored 0.8 victories and died at a rate of 2.7% per month. When they were flying in the same squadron as a mentioned pilot, these rates jumped during the month of the mention to 1.2 victories per month, and an exit rate over 4%. Among *former* peers, the effects are of very similar magnitude as for current peers – they show large increases in performance, and a marked rise in death rates.

This effect holds even while controlling for the recognition of other (unconnected) pilots.[4] Controlling for these unconnected pilots' recognition is important because it eliminates potentially confounding effects from the instrumental benefits of relative standing (which would be derived from a pilot's relative standing in the air force as a whole). In contrast, recognition of a former peer does not change potential future benefits from extra victories; it only diminishes relative standing in a well-defined peer group of (former) comrades.[5] In combination, these results strongly suggest that intrinsic concern over relative standing was important – pilots were willing to make life-and-death decisions to enhance it.

The scale of these changes is greater the more closely former peers worked together, and the more similar the geographical origin of pilots. This suggests important spillovers in terms of risk-taking (and performance) through social networks. There is also suggestive evidence that pilots who are close to another type of major award (but have not yet obtained it) respond particularly strongly in terms of risk-taking and performance if a former peer is recognized. In particular, greater effort was more common if it was more likely to improve a pilot's relative standing vis-a-vis the recognized pilot.

Aerial combat is a useful setting for analyzing what motivates highly skilled individuals: The stakes are high, social status is closely tied to performance, and effort is difficult to observe, but both death and performance are fairly well-measured. Crucially, once an air battle begins, there is no effective control of individual planes by superior officers. In every 'dogfight', the pilot has to decide whether to continue trying to shoot down the enemy plane, or to break off contact. Motivating top pilots was key for aggregate performance; a carefully designed system of medals and other awards created incentives for pilots to keep scoring.[6] Top pilots mattered for aggregate outcomes: The best 1% (50) in our dataset accounted for 10% (5,500) of all

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[4] Public recognition of any pilot may impact a pilot's overall standing in the air force, and can hence increase motivation for higher performance through other channels.

[5] Future benefits – in expectations, if Germany had won the war – may well have been tied to absolute performance or relative standing among all German pilots. We control for performance changes in response to *any* pilot being mentioned, and focus on the additional effect of a former peer receiving recognition.

[6] In a bid to keep incentives sharp, the German air force repeatedly created new awards, effectively extending the "ladder" of medals that could be obtained.

victories, and the top 5% (250 pilots) for fully a third (18,000 enemy planes shot down). Overall, the 5,000 pilots in our dataset downed 54,000 enemy planes. At the same time, almost three quarters (3,600) of German pilots died, were captured, or invalided out.[7]

Anecdotally, there is ample evidence that status competition was a strong motivating force: During the Battle of Britain – arguably the decisive air battle of World War II – two highly-decorated German pilots, Adolf Galland and Werner Mölders, were neck and neck in terms of total victories (Galland 1993). When Mölders was ordered to confer with the head of the *Luftwaffe*, Hermann Göring, he went to Berlin for three days of meetings – but only on the condition that Galland be grounded for the same number of days. Remarkably, Göring (himself a high-scoring WWI fighter pilot) agreed to take one of his best pilots out of combat for no militarily justifiable reason, just to ensure 'fair' competition.

We focus on one type of public recognition – mentions in the German armed forces daily bulletin (*Wehrmachtbericht*). Armies have long used "mentions in dispatches" to recognize particular achievements. The German daily bulletin typically contained a summary of military developments. Occasionally, it would highlight an individual soldier's accomplishments, such as a high number of enemy ships sunk, of tanks destroyed, or a "round" number of cumulative victories, like 150 or 200.[8] Mentions constituted an exceptional form of recognition and were as rare as the most prestigious medals. The bulletin was distributed widely – it was broadcast on the radio, published in the press and on command posts throughout German-held territory. Mentions were largely unpredictable, since there was no simple rule that "entitled" a soldier to being mentioned. Moreover, unlike other settings in which individuals compete for an award or recognition (such as in sports competitions), there was no *fixed* number of mentions that pilots were competing for.[9]

Our work relates to a growing literature on social image concerns and behavior. Recent papers show that individuals care about how others view them and that this has important effects on an important range of behaviors, from charitable donations (DellaVigna et al. 2012), to campaign contributions (Perez-Truglia and Cruces 2017), voting (DellaVigna et al. 2017), protest participation (Enikolopov et al. 2017), credit card take-up (Bursztyn et al. 2018), and educational investments (Bursztyn and Jensen, 2015). Our paper evaluates the potential role of image concerns in a setting with extremely high stakes, and with a direct link to measurable output.

[7] Actual performance was even more concentrated at the top – to enter our dataset, a pilot had to have filed at least one victory claim. The majority of pilots never did.

[8] We draw on Wegmann (1982), an edited compendium of all *Wehrmachtbericht* issues.

[9] As a result, if the pilots were interested in (the relatively small) instrumental benefits associated with a public mention, responses to peer mentions were driven by relative concerns and not by changes in the perceived scarcity of future mentions.

Our work also speaks to the literature on tournaments. There are strong theoretical grounds for believing that – in a single-shot setting – tournaments can induce greater effort from participants (Lazear and Rosen 1981, Green and Stokey 1983, Nalebuff and Stiglitz 1983a, 1983b). However, many tournaments are dynamic in nature; the step-by-step release of information in such a setting has the potential to transform incentives in important ways (Lizzeri et al. 2002, Yildirim 2005, Ederer 2010, Goltsman and Mukherjee 2011). Empirically, Genakos and Pagliero (2012) show how risk-taking in professional weightlifting competitions follows an inverted-U curve as a function of relative standing. Fershtman and Gneezy (2011) similarly find that increasing the stakes of a tournament can lead to more effort, yet also to quitting by lower-ranked competitors. Examining golf tournaments, Brown (2011) shows that the presence of a superstar such as Tiger Woods is associated with lower performance. Our own results indicate that status concerns can indeed promote risk-taking, and we demonstrate this dynamic in a setting with high stakes (and no tangible upside, financially). Far from pilots "giving up", though, we find additional effort exerted and greater risks taken – with deadly consequences. Relatedly, the literature on status (Besley and Ghatak 2008, Moldovanu et al. 2007, Chan et al. 2014, Frey 2007) has shown how recognition can sharpen workplace incentives. The literature on incentives in the military has traditionally emphasized the importance of collaborative effort (Stouffer et al. 1949, McPherson 1997, Van Creveld 2007). In contrast, we highlight the importance of individual incentives and status competition as key determinants of military performance – at least in our setting.

Studies on peer effects examine how collaborating with others affects worker effort and performance (Falk and Ichino 2006, Bandiera et al. 2010). There is some well-identified evidence in modern settings that workers' effort increases when exposed to more productive peers (Mas and Moretti 2009), and that the strength of social ties mediates such peer effects (Bandiera, et al. 2005). Relative to that literature, we make three novel contributions. First, we provide insight on mechanisms: Peer effects can be driven by knowledge spillovers, task complementarities, or social pressure. Because we focus on information about *former* peers, the first two of these drivers can be ruled out, highlighting the importance of social pressure. Second, we show that peer effects – working through relative status concerns – can be important in high-skill occupations. This is important because there is so far only limited evidence of peer effects among the highly skilled (Jackson and Bruegmann 2009, Azoulay et al. 2010, Waldinger 2012). Third, we find very high performance under relative incentives. While we do not observe an alternative incentive structure overall (such as piece rates), we do find that the stronger relative status concerns, the higher performance was. This contrasts sharply with Bandiera et al. (2005), who find markedly lower performance under relative incentives.

Our results are of general interest: Military spending remains one of the largest items in national budgets around the globe, and national security concerns are acute in many regions. In this context, insight into the factors that help to extract greater effort in military settings is important – precisely because the standard tools of personnel economics are likely to be blunt (Acemoglu et al. 2016; Costa and Kahn 2003). While our findings refer to a specific setting and group of individuals, every army – and many non-military organizations – use non-financial incentives to create status competition amongst employees (Frey 2007, Ghatak and Moldovanu 2008). Military data on pilots allows us to use individual-level outcome data and to measure risk-taking – a rare combination in modern firms. Second, we contribute to the literature on status concerns and relative standing: We show how the effects of symbolic rewards depend on social context. Status competition can lead to a crowding-in of effort. At the same time, high-powered incentives – in the form of public recognition – may backfire precisely because concerns about relative standing can induce too much risk-taking.[10] Finally, we contribute to the peer effects literature by showing that relative standing concerns can be a key mechanism for spillovers amongst peers, and that these apply in high-skill settings.

The paper proceeds as follows. Section II provides background on the German air force during World War II and on the data we use. In Section III we present the main findings, and Section IV discusses alternative interpretations and presents additional robustness checks. We conclude in Section V.

II. Historical Background and Data

In this section we describe the setting of our study: The organization of the German air force in World War II and its rise and fall as a fighting force. We also discuss the sources and limitations of our data.

A. The German air force during World War II

In 1939, the German air force had 4,000 planes, including 1,200 fighters, and 880,000 men (Kroener et al. 1988). In the opening phase of World War II, the German air force achieved air supremacy. The only exception before 1943 was the defeat during the Battle of Britain. The planned invasion of the British Isles had to be called off because of the Luftwaffe's failure to dominate the skies.

By 1943, both personnel and the number of planes had approximately doubled (Kroener et al. 1988). As the Allied bomber offensive against German cities gathered pace, ever more fighter units were called back to defend the Reich. Having started the war with modern planes

[10] One clear analogy is bonuses in financial institutions, where, the desire to be the "best" trader or loan officer can lead to catastrophic losses. Brown et al. (1996) argue that relative performance incentives can lead to excessive risk-taking in asset management.

and a large air fleet, Germany first lost its quantitative edge. Once the Wehrmacht invaded Russia, and the United States joined the war, the Luftwaffe was heavily outnumbered in all theaters of war. It eventually fell behind also in terms of equipment quality. New planes with advanced technology, such as the ME-262 jet, arrived too late to make a difference. Pilot training also suffered: by 1944, a typical German pilot accumulated less than half the flying hours of UK and U.S. pilots before being sent into combat (Murray 1996).

Loss rates increased over the course of the war, reaching staggering levels. By January 1942, the German air force lost 1.8% of its fighter pilots; by May 1944, it was losing 25% of them every month (Evans 2009). The destruction of planes was even more rapid: The Luftwaffe lost 785 planes in combat (and another 300 in accidents, etc.) during the six months between June and November 1940; between January and June 1944, it lost 2,855 aircraft in combat (plus another 1,345 in accidents, Murray 1996). Nonetheless, due to high production rates, the actual number of fighters in combat units continued to rise until the end of 1944. Nonetheless, by 1944, the Luftwaffe was a much-diminished force – despite the introduction of the world's first operational jet fighter. German air force pilots were by then trained less well than Allied pilots, fuel for aircraft was often in short supply, and it was numerically outnumbered in the East and in the West.

B. *Rank and public recognition*

Aerial victories are the key determinant of social standing among fighter pilots. To attain "ace" status is an important concern highlighted in many memoirs of surviving pilots from all major wars with aerial combat, from WWI to Yom Kippur. James Salter, a U.S. fighter pilot during the Korean War, described his experiences in an autobiographical novel:

> "[The aces] stood out like men moving forward through a forest of stumps. Their names were gilded. They had shot down at least five [enemy planes]. […] There were no other values […] That was the final judgement. [Victories] were everything. If you had [victories] you were a standard of excellence. The sun shone upon you. The crew chiefs were happy to have you fly their ships. The touring actresses wanted to meet you. You were the center of everything—the praise, the excitement, the enviers […] If you did not have [victories], you were nothing." (Salter 1956).

Wider recognition for aerial victories took two forms – medals and mentions. The German armed forces operated an elaborate system of medals. The principal awards for valor were the Iron

Crosses and the Knight's Cross, with higher awards requiring increasingly higher tallies of downed enemy fighters.[11]

In addition, soldiers could receive a mention in the daily bulletin. This was one of the highest forms of recognition available in the German armed forces. A typical daily report would describe battles on the different fronts. Mentions were rare: During the entire war, fewer than 1,200 men were recognized in this way (Wegmann 1982), out of the 18 million German men who served.[12] A typical example for fighter pilots is Hans-Joachim Marseille's second mention on June 18, 1942: "First Lieutenant Marseille shot down ten enemy planes in a 24 hour period in North Africa, raising his total score of aerial victories to 101" (Wegmann 1982).

The propaganda department within the operations staff of the German armed forces, under the direction of General Hasso von Wedel, produced the *Wehrmachtbericht* . Like all propaganda by the Third Reich, the reports mixed truth and distortions to create support for the war and the regime (Scherzer 2005). Highlighting the alleged "superiority" of German fighting men was an integral part of this strategy. However, we find no evidence of the *Wehrmachtbericht* distorting the accomplishments of pilots. Mentions only occur for an exclusive group of outstanding pilots. In our data, we have information on 60 fighter pilots mentioned in the bulletin; of these, 43 are mentioned for the number of aerial victories they achieved, either cumulatively or in a single period (one day, one month, etc). Mentioned pilots ended the war with an average of 90 victories, and scored an average of 2.4 victories a month (compared to an average of 0.62 victories per pilot-month in our sample).

C. Data

Our database of German fighter pilots during World War II draws on two principal sources: Jim Perry and Tony Wood's *Oberkommando der Luftwaffe* (OKL) combat claims list, and the Kracker Luftwaffe Archive.[13] The OKL fighter claims list was extracted from microfilms of the handwritten records of the Luftwaffe Personalamt stored at the German Federal Archives (Bundesarchiv) in Freiburg. Because some OKL fighter claims records did not survive the war, Tony Wood augmented the list with claims from other published sources – such as Donald Caldwell's (1996) JG26 war dairy – to obtain a comprehensive list of German fighter claims for the years 1939–1945.

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[11] During World War II, about 3.3 million Iron Crosses 2nd class were awarded but only 7,300 Knight's Crosses, 890 Knight's Crosses with Oak Leaves, 160 with Swords, 27 with Diamonds, and one with Golden Oak Leaves.
[12] There are 1,182 individual surnames in the *Wehrmachtbericht.* Because first names are not always recorded, there could be as many as 1,739 soldiers mentioned (if each mention with an identical last name is of a different subject).
[13] For more information about Tony Wood's combat claims list and the Kracker Luftwaffe Archive, see https://web.archive.org/web/20130928070316/http://lesbutler.co.uk/claims/tonywood.htm and http://www.aircrewremembered.com/KrackerDatabase/.

We clean the Perry-Wood fighter claims records by correcting typos (e.g., misspelled names, incorrect rank or unit) and then construct a monthly panel by aggregating the information for every pilot by month and year. This panel contains the number of monthly victories per pilot together with pilots' first and last name, rank, wing, group, and squadron. We then match the panel data with additional information from the Kracker Luftwaffe Archive. Kracker's archive contains detailed personal data on German fighter pilots, collected from several sources, such as their war status (e.g., killed in action, prisoner of war, World War II survivor), and for some pilots also the starting date of his Luftwaffe career. Thus, for every pilot in the sample, we have information on their monthly victories, whether he received an award, his war status, how long he was active during World War II, and whether he was killed or wounded. Our database does not include pilots who never shot down an enemy plane during aerial combat.

We only analyze daytime fighter pilots. This is because the tasks and skills of day and night fighter pilots differ substantially. Whereas day fighters mainly battled against other fighter pilots, night fighters were mainly used to intercept bombers (Murray 1996). Our sample is unbalanced and consists of more than 5,000 fighter pilots of the German Luftwaffe that made at least one combat claim during World War II. Pilots are observed for 19 months on average, yielding a total of 88,845 observations. In our data, we find that of the 5,081 pilots, 3,633 (or 71.5%) exit the sample – meaning they are not in the next month's data set (provided the war has not yet ended). Next, we compare these exits with additional data on the death dates of pilots taken from the pilot biographies (Mathews and Foreman 2015). These biographies are based on primary sources, principally microfilms from the Bundesarchiv in Germany and unit war diaries.[14] This allows us to confirm 2,494 of the 3,633 exits in our data. The Kracker archive also refers to some of the other exiting pilots as being killed in action, missing in action, or being severely wounded. This suggests that the vast majority of cases indeed refer to pilots who were either killed or permanently incapacitated.

The high command of the German air force (*Oberkommando der Luftwaffe*, OKL) received fighter claims throughout the war. A special staff for recognition and discipline was in charge of collecting and validating claimed aerial victories. Pilots were required to file extensive documentation before a claim was recognized. The OKL records contain information on every reported aerial victory of German fighter pilots during World War II by wing (*Geschwader*), unit

[14] While Mathews and Foreman (2015) only publish biographies of pilots with at least five claims, we are grateful to Johannes Mathews for sharing with us his 7,730 biographies of pilots with at least one claim. When merging the biography data into our data set based on pilot names, we get 2,920 exact matches. Additionally, we manually went through 1,422 possible matches proposed by probabilistic matching and confirmed 943 of them as correct. We had to discard a small number of matches (44) in which the names of pilots coincided, but clearly referred to different pilots, because we record victory claims after their alleged deaths. In almost all cases this happens because of very common German names such as Heinz Schmidt or Hans Fischer. We end up with detailed biographical data for 3,819 of our 5,018 pilots.

(*Gruppe*), squadron (*Staffel*), and pilot's name and rank as well as by the day, location (grid reference), type of damage, witnesses, and type of the claimed aircraft. German rules for counting a claim as an aerial victory were demanding (Caldwell 2012). Each claim had to be accompanied by a witness report confirming either the destruction of the enemy plane (impact or explosion in the air) or that the enemy pilot was seen bailing out. Many claims were not accepted, and often rightly so.[15]

The German air force in World War II counted among its ranks the highest-scoring pilots of all time. During the war, 409 pilots from all nations scored 40 or more victories: 379 were from Germany, 10 from the Soviet Union, 7 from Japan, 6 from Finland, one from the United States, and one from the British Commonwealth. The highest-scoring fighter pilot in history was Erich Hartmann, with 352 confirmed aerial victories. The highest-scoring non-German pilot was Ilmari Juutilainen from Finland, with 94 victories; the best Soviet, Commonwealth, and American pilots were credited with 66, 40, and 38 enemy planes shot down. Figure A.1 in the Appendix plots the distribution and nationality of all World War II aces.[16]

Altogether, German air force records document 53,008 confirmed destructions of enemy aircraft. In an average month, the average German pilot scored 0.62 victories and faced a 4.1% risk of exiting the sample permanently (which was practically synonymous with death). In the East (West), the victory rate was 1.02 (0.37) and the exit rate 0.032 (0.046). In other words, the exchange ratio (the number of enemy planes shot down before a pilot was lost) was 32 in the East and 8 in the West.[17]

The distribution of scores was extremely uneven. The top-scoring 350 pilots achieved almost as many aerial victories as the 4,700 lowest-scoring pilots combined. In an average month, the vast majority (almost 80%) of pilots failed to score even a single victory. At the same time, some pilots quickly notched up large numbers of victories: Emil Lang shot down 68 enemy planes in October 1943, and Hans-Joachim Marseille scored 17 victories in a single day (September 1, 1942). Figure 2 graphs the number of monthly victories per pilot by the quantiles of the distribution.

There was a large seasonal component to air combat. The summer season – when ground operations were common and hours of daylight were long – also saw substantial spikes in aerial activity; the winter months brought a lull in fighting. Figure 3 plots the mean victory and exit

[15] This is because of a tendency to "over-claim" by both the Western and German air forces (Caldwell 2012). This has probably less to do with systematic dishonesty and more with the highly volatile conditions of air combat itself (Galland 1993).

[16] The top 100 pilots during World War II are all German. This high concentration of aces in the German air force mainly reflects the "fly till you die" rule – German pilots did not have a pre-specified "tour" after which they could rotate out of active service.

[17] This is *not* the standard definition of the exchange ratio, which normally measures either planes for planes or pilots for pilots. Here we calculate the number of enemy planes shot down in exchange for every pilot lost.

(death) rates over time. The time-series peaks mostly coincide, except for the end of the war when the victory rate plummeted and the exit rate spiked.

D. Organization and training

The German air force was divided into air fleets (*Luftflotten*), each of which was responsible for a particular geographical area. The number of fleets rose from four to seven during World War II. Air corps within each air fleet controlled the planes and men; air "districts" were responsible for infrastructure. The air corps consisted of wings (*Geschwader*) of 100-150 planes each. The wings were organized by function, with different *Geschwader* for fighter planes, long-range bombers, dive bombers, reconnaissance, and so forth. Each wing typically comprised three groups (*Gruppe)* each consisting, in turn, of three or four squadrons (*Staffel*). Every squadron had an authorized strength of twelve aircraft, but the actual number could be as high as sixteen or as few as four or five aircraft (Stedman and Chappell 2002).

In contrast to army divisions, there was no region-based recruitment of airforce units. There is also no evidence that the better graduates from the air combat schools were sent to elite squadrons. The allocation of new pilots to units was largely random, driven by operational needs, recent losses, and – sometimes – personal connections as well as the use of transfers for disciplinary reasons (Caldwell 1996). The transfer of Hans-Joachim Marseille from the Channel Front to North Africa is a case in point – after spending another night on the town, he showed up hung over and overtired for duty, and was sent to the desert (Kurowski 1994).

III. MAIN EMPIRICAL RESULTS

In this section, we examine the determinants of death rates and aerial victory rates among fighter pilots. Former peers of a pilot receiving public recognition perform better, but also take higher risks, being killed more often. Pilot skill modifies these patterns –"top" pilots mostly reacted to a peer's recognition by improving their scores, whereas average pilots were more likely to die. We then show that pilots are more likely to react strongly to the mention of a former peer if they were born in close geographical proximity. Also, pilots who are close to the informal quota for another major award take more risks and achieve more victories if a former peer is mentioned – but those who already have the award do not change their behavior.

A. Performance and risk-taking of former peers

We are interested in whether pilots whose former peers are mentioned die at a higher rate in the same month, while scoring more victories. Over time, pilot performance and exit rates are strongly correlated within squadrons. Pilots in the same unit are subject to similar shocks (weather, enemy activity, etc.). To sidestep the reflection problem, we focus on the effect of *former* peers being mentioned in the Wehrmacht bulletin.

Figure 4 illustrates our identification strategy, using the case of two pilots: Günther Rall, one of the highest-scoring pilots of World War II, and Karl Gratz. From the autumn of 1941 until March 1943 they served together in Squadron 8 of Fighter Wing 52 (except for a few months when Rall was wounded). Rall remained with the squadron when Gratz was transferred to 2/JG2 (squadron 2, Fighter Wing 2). Eventually, Rall was moved to the "Stab" of Group III, Fighter Wing 52. In August 1943, Rall was mentioned in the *Wehrmachtbericht*. We classify Gratz as a "past squadron peer" after he moved to Group II, Fighter Wing 2. We then compare his performance in August 1943, the month of Rall's mention, with other months of his service record.[18]

A quarter of our pilots are former peers of pilots who are mentioned eventually. Some 1% of our observations refer to pilot-months when a former peer of a pilot is mentioned. Pilots who are former peers of mentioned pilots are clearly different from the rest as our balancedness table shows (Appendix Table A.1), which is why we control for "ever peer" status separately.

Figure A.2 in the Appendix plots survival curves for both mention periods and peers of mentioned pilots. Death rates are higher during mention periods in general, and former peers of mentioned pilots tend to die at an even faster rate.

To examine the effect of past peers getting honored on a pilot's death rate, we estimate a Cox proportional hazard model:[19]

$$D_{it} = D_0(t)\exp(\alpha_D E_i + \beta_D P_{it} + X_{it}\gamma_D) + \varepsilon_{D,it}$$

Note that $D_0(t)$ stands for the baseline hazard function evaluated at month *t* (i.e. the baseline risk of death for any pilot *t* months after entering the war), α_D is a constant risk factor of having any one of your peers mentioned ($E_i = 1$), P_{it} is a dummy for a former peer *of pilot i* being mentioned in month *t*, and X_{it} is a vector of controls. Controls include dummies for the Eastern front, aircraft type, the pilot's squadron, each month *t* of the war, and a measure of pilot quality, calculated as a pilot's cumulative victories up to period *t-1* divided by the number of months in combat.[20] It also contains a dummy for months with any pilot mention – which will absorb the effect from mentions changing an individual pilot's relative standing in the air force as a whole.

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[18] Note that from March 1944, the two flew together again; had one of them been mentioned during this period, we would have disregarded the other's victories in our calculations.

[19] Our estimates are virtually unchanged when we instead estimate a parametric survival-time model fitting a Weibull regression model using maximum likelihood. Results are available upon request.

[20] Since death only happens once, estimating with pilot fixed effects for the risk of death is nonsensical (and the Cox estimator does not converge). Instead, we control for ever peer status (E_i) when estimating the hazard model. We also do not control for a pilot's experience since the model already controls for time at risk.

We are particularly interested in the coefficient β_D, the extent to which a pilot's death is more likely in a month when his former peer is publicly recognized.

To examine statistically the effect on performance of pilot *i* in month *t,* we estimate the following least squares model:

$$V_{it} = \alpha_{V,i} + \beta_V P_{it} + X_{it}\gamma_V + \varepsilon_{V,it}$$

Compared to the proportional hazard model, this equation includes also fixed effects for each individual pilot ($\alpha_{V,i}$), which implies that the control for ever peer status (E_i) is being absorbed. The remaining covariates X_{it} are the same, except that we also include a control for experience (the number of months a pilot has already been tracked in our data).

Table 1 presents our main results. Panel A shows results for death rates. Months with (any) mention show somewhat higher death rates, and pilots whose peers are mentioned at any one point in time die at lower rates (columns 1 and 2). During the month of a former fellow pilot's mention, pilots see their hazard rates rise by more than 50%, on top of the general 23-28% rise in death rates during mention periods (column 3). This effect becomes somewhat larger the more controls are added. In columns 6 and 7, we first include squadron fixed effects and then time fixed effects to our estimation. Even in the most demanding specification (column 7), when we control for pilot quality, front, aircraft type, and squadron and time fixed effects, we find significantly higher risks of exit of the same order of magnitude (40%) for former peers of the mentioned pilot. The relative magnitudes for mention periods and past squadron peer mentions suggest that intrinsic concerns about relative standing (captured by the effect on past peers) are at least as powerful as other channels operating through a public mention (as reflected in the mention period coefficient), with the coefficient on past peers being mentioned being at least twice as large as the general mention effect.

A similar pattern is visible for victory claims (Table 1, Panel B). Mention periods see more aerial victories in general. In months when a former peer is mentioned, the victory rate jumps by an additional half of a victory on average (column 2). After adding – in addition to individual fixed effects – controls for pilot quality (column 3) as well as experience, front, aircraft type, squadron and time fixed effects (column 6), having a former peer mentioned still adds more than a third of a victory in the same month. Again, we find that past peer effects are stronger than mention period effects, suggesting that intrinsic concerns over relative standing are at least as important as extrinsic factors.

B. Results by pilot ability

On average, former peers of mentioned pilots score more in the same month, but also die more frequently. We now subdivide the sample by performance groups and investigate whether responses are different according to a pilot's ability.

Table 2 gives the results. Average pilots (up to the 80th percentile of pilot quality) see a sharp increase in death rates, by a factor of 1.67; those above the 80th percentile see a small and insignificant decrease, by a factor of 0.83. For the top 10%, at 1.06 this factor is larger, but not significantly greater than unity.[21] These results suggest that for the outstanding pilots, there is at most a "small price" to pay when they try to score more during the mention periods of former squadron peers. And try they do, as Panel B makes clear – the top 20 pilots score an extra 1.1 victories, and those in the top 10% go up by 1.5 victories – while there is no effect for the bottom 80% of pilots.[22] This suggests that pilots at different points in the skill distribution react differently: While all of them aim to score more, some – the average pilots – get themselves killed, and the very best pilots mainly react by increasing their scores.

C. Results by intensity of past interaction

So far, we have defined (former) peers exclusively as those who served together in the same squadron. This makes sense since bonds between squadron peers were particularly close. At the same time, other forms of interaction may also have acquainted pilots with each other, possibly leading to bonding and status competition.

How are comparison groups formed? We perform the same analysis as before, but for two other definitions of peers – pilots who previously served in the same group and those who flew from the same airbase. Groups consisted of 3-4 squadrons. They often flew together and would participate in joint training and recreational activities – but they would not necessarily fly from the same airfields (even if they often did so). Pilots from other groups would often use the same airbase, too, giving us another form of peer interaction. These were less likely to join in the same operation, but social interaction over a meal or a drink were more likely.

Figure 5 repeats the analysis in Table 1, plotting the coefficient of interest for group peers and base peers, for both death rates and victory rates. Victory rate increases are lower amongst base and group peers, but greater than zero. This is in line with our expectations – pilots who

[21] However, differences between the main coefficients in columns 1 to 4 of Table 2, Panel A, are not significant. We assume for all comparisons that the covariance of our estimates is equal to zero.

[22] Testing for the significance of these differences in coefficients, we find that that the effect on victories for the bottom 80% of pilots (col.2) is significantly lower ($p < 1\%$) than the effect for the entire sample (col. 1). The difference between the full sample effect (col.1) and the effect for top 20% pilots (col.3) is marginally significant ($p < 10\%$). We get similar results when comparing the full sample with the top 10% of pilots. We assume for all comparisons that the covariance of our estimates is equal to zero.

flew from the same base will have had many chances to interact, from drinking in the mess to joint outings; and group peers may or may not have interacted frequently in training and in briefings, for example. For death rates, we find no clear pattern of significant additional effects.

D. Birthplace proximity

We use regional origin as a proxy for social proximity. While not every high-performing pilot knew every other top pilot, many of them would have been familiar with each other's careers and background. In addition, last names often contain information about regional origins. We have information on the birthplaces of 352 high-performing pilots (and their tallies are higher than average).

How much greater is the increase in the number of victories when a pilot from the same region is mentioned? Figure A.3 in the Appendix shows that for pilots born close to each other, the effect of a mention in dispatches is especially large.[23] At a distance of less than 100 miles, there is a peer-induced boost during mention months of almost 2 extra victories. Yet at a distance of (say) 300 miles, the performance increase becomes insignificant and amounts to only one additional victory. The effect of having a past peer mentioned is also decreasing with distance in the case of exits. But, as documented in Table 2, high-performing pilots rarely react by exiting the sample. In our data set with birthplace data, only two top pilots exit when their peer gets mentioned, which does not allow us to quantify effects with any precision.

This result is compatible with social image concerns – pilots from the same region share a social setting in which their reputation counts. After a fellow pilot's recognition, the relative standing of other pilots from the same area will have diminished, heightening the incentive to perform.[24] Our finding is similar to Bandiera et al. (2010), who show that in settings without production externalities, social ties between co-workers can strengthen peer effects.

E. Responses to former peer recognition and pilots' chances of an award

To examine spillovers from public recognition further, we look at another award – the Knight's Cross (KCR). In contrast to the mention in the *Wehrmachtbericht*, this medal was awarded through informal "quotas" (which changed in response to combat conditions). Quotas were not a hard criterion – many pilots would receive the award while still 10 victories short of the quota, and others had to wait until they exceeded it by 5. Nonetheless, chances of receiving an award increased the closer a pilot got to the KCR quota – meaning that some victories were much more useful for receiving public recognition than others. KCRs were worn on the recipient's uniform,

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[23] We use the simple specification from Table 1, Panel B, column 3 because our sample is small.
[24] We cannot rule out self-image concerns entirely – pilots may simply know more and care more about fellow pilots who are closer to them socially, even without reacting to changes in their standing in the eyes of others.

and often added to the tail rudder decoration of a plane; they were considered so important that officers had to salute privates who had received them. Out of the 13 million men who served in the German armed forces in World War II, only 7,000 received a KCR.

In our data, 414 pilots are KCR recipients. We examine whether pilots close to the quota for the KCR responded more to a former peer being recognized in the *Wehrmachtbericht.* Figure 6 shows graphically the results for both hazard and victory rates. In each case, the bars represent the coefficient on past peers of the mentioned pilot. In the first case, we look at pilots who do not yet have a KCR, and are far from the quota (i.e. they are at least 20 victories below the quota, which had an average value of 45 during the war but reached a high of 100 for the Eastern front in 1943). Their probability of exit remains virtually unchanged when a former peer is recognized. In contrast, for pilots who also do not have the KCR, but are close to the quota, the risk of death is more than twice as high when a former peer is mentioned – and the effect is significant at the 5% level. For pilots who already have the KCR and are far from the quota, we also find no significant effects.[25] Pilots still close to the quota who already have the KCR – arguably the best comparison group for pilots close to the quota, but without the medal – show reductions in the risk of exit. While standard errors are large and effects are not always different from each other, the broad pattern appears to suggest that pilots who can hope to gain a major award through extra effort take much greater risks when a peer is recognized. Once a pilot has received a major award (and while still far away from the next one), the public recognition of a fellow pilot does not lead to increased risk-taking.

The same pattern is visible for victories. Pilots without a KCR and far from the quota show small, although insignificant, improvements in scoring rates; those without the medal but closer to the quota increase their scoring tempo by 0.74 victories per month. This is around double of the spillover effect that we measure in Table 1. The coefficient is significant at 10% ($p = 0.056$). Pilots who are still close to the quota but already received a KCR show no noticeable change in victory rates. Pilots who have the KCR but are no longer close perform better when a former peer is mentioned in the *Wehrmachtbericht*, but the effect is not significant.

Pilots' responses to the public recognition of others could reflect social or self image concerns. If self-image concerns are key, pilots should want to "even the score" by taking greater risks and scoring more victories in response to a former peer being recognized. In contrast, if social image concerns are the main driving force, then those pilots who have a chance of receiving additional public recognition themselves should react more strongly to the mention of a former peer. We looked at a highly prestigious medal that pilots could receive – the KCR.

[25] For pilots who have the award and are far from the quota, we exclude those who are getting close to the next higher award, the Oak Leaves to the Knight's Cross.

While error bands are large, the evidence is at least suggestive of relative status concerns, with former peers taking greater risks and trying harder if they can boost their social status by obtaining an important medal.

F. Discussion

We find strong evidence of pilots reacting to the public recognition of a former peer. These reactions are stronger if the pilots served in the same, small unit, and if they come from the same geographical area in Germany. We also find that pilots who have a good chance of winning a major award react more strongly to the mention of a former peer. All of these patterns suggest that pilots care about relative standing, and that this concern is important for their (risky) choices.

IV. Additional Results and Alternative Interpretations

We next attempt to rule out potential confounding mechanisms. In addition, we examine the robustness of our findings.

A. Correlated shocks

A natural confounding factor is the possibility of unobserved and correlated shocks simultaneously affecting the outcomes of different peer groups. While we exclude pilots serving in the same squadron when looking at past peers, this may not be enough to rule out the effect of aggregate changes in the combat environment.

One direct way of addressing the risk of correlated shocks is to see if our findings hold when pilots from nearby units are excluded. For this purpose, we impose a minimum distance requirement for the airfields from which pilots' squadrons operated. During World War II, German forces were fighting from the Arctic Circle to the deserts of North Africa and from Stalingrad to the Pyrenees. The minimum distance between air fields in our data is 9 miles, and the maximum is 2,600 miles (see Figure A.4).

Figure 7 shows the coefficients on the former peer interaction variable as a function of minimum distance requirements between the airfields of two (former) peers. Even a distance of 100 miles usually corresponded to a marked change in combat conditions. At a distance of 500 miles, units would be operating with different army groups (North, Center, or South) on the Eastern front. Units flying bomber intercept missions over Germany were separated by up to 1,000 miles from their counterparts on the Eastern front. The effects for exits shown in Figure 7 Panel A are similar across distance groups (and not statistically different from each other). Panel B, demonstrates that the coefficient for outperformance becomes larger as we impose more and more demanding distance requirements.[26] These results strongly suggest that our results are not driven by correlated shocks.

The upgrading of aircraft could also confound our results. Since aerial combat performance partly depends on equipment quality, changes in performance could reflect improvements in technology. Thus, a sudden increase in the number of aerial victories could reflect good pilots receiving simultaneous upgrades in their planes. However, as discussed next, this mechanism is unlikely to explain our results.

We have information on the aircraft type for 77,000 of our total 88,000 monthly observations (see Figure A.5 for the distribution of aircraft types used). Most missions were flown in one of just four aircraft types – the BF-109E, F, and G and the FW-190. Did correlated changes of equipment across former peers contribute to the increase in performance during mention months? This is unlikely: The Luftwaffe typically upgraded entire squadrons to facilitate maintenance and training. Squadrons were typically recalled to Germany, re-equipped, and then sent back to the front. There is no anecdotal evidence of top performing pilots being given special treatment. To the contrary, at least one leading pilot (Hans-Joachim Marseille) was, despite his protests, forced to pilot a new BF-109G because his entire squadron was being re-equipped. Marseille died shortly thereafter when the new plane's engine failed. In addition, we control for aircraft type. Our main results are from regressions that include dummy variables for the different types of aircraft. Any systematic increase in performance as a result of aircraft upgrades should be captured in our data. Finally, we test whether the probability of flying a similar type of aircraft is systematically higher in months during which a pilot is mentioned in the *Wehrmachtbericht*. This is not the case.[27]

B. Social learning

One potential concern is a general co-movement of scores among pilots who belonged to the same squadron in the past. Suppose that pilots had previously learned some specific skills from other pilots or in special circumstances in their area of operation while flying together, and those skills became especially useful in some later period. If outstanding pilots do so well that they are mentioned in the daily bulletin, then other pilots with whom they trained – or who developed similar skills in the same environment – might likewise do better. In this case, we would find higher performance by past peers in periods when top pilots are mentioned in the daily bulletin; yet the reason would be correlated on-the-job learning rather than motivation effects.

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[26] We use the basic specification from Table 1, column 4 for Panel A (column 4 for Panel B). Results are almost identical when using the more stringent specifications.

[27] Results available upon request.

We do not believe that this mechanism, either, is likely to drive our findings. First, our results in Table 1 already control for whether pilots ever served together with a mentioned peer in the past. This allows for general spillovers from the mentioned pilot to his former peer in all quiet periods (i.e. those without a mention). Second, note that the fixed effects of having flown with a top pilot are not uniformly positive (see Figure A.6): Some 44% of the mentioned-pilot fixed effects are negative with respect to performance. There is no evidence that those who flew with later-mentioned pilots are themselves noticeably better pilots.

One remaining possibility is that by flying together, pilots picked up skills that became useful in particular situations. A pilot with a good enough month to be mentioned in dispatches may have had former peers who could similarly exploit the skills jointly acquired in the past. Instead of estimating a level difference for pilots who are former peers, we allow for co-movement of victory scores of pilots in different squadrons if they flew together in the past, and ask whether this co-movement strengthens during months when a former peer is mentioned. In this way, we allow the payoff from joint experience to be time-varying, as it should be, if different combat conditions reward particular skills differentially.

To examine this question empirically, we first restrict the sample to former peers – that is, all pilots who flew at some earlier time with a pilot who is mentioned in the Wehrmacht bulletin. We then regress the log of victories V'_{it} on the log of victories of the mentioned peer $V'_{m_i t}$ (where $V' = \log(V + 0.01)$) to allow for a direct estimation of the performance elasticities as follows:

$$V'_{it} = \alpha_{V',i} + \beta_{v'} M_{m_i t}\, V'_{m_i t} + \mu_{v'} V'_{m_i t} + \eta_{v'} M_{m_i t} + X_{it}\gamma_{V'} + \varepsilon_{V',it}$$

In this expression $\alpha_{V',i}$ is a pilot fixed effect, $\mu_{v'}$ measures the correlation of victory scores between pilot i and his dispatch-mentioned former peer, m_i; $\eta_{v'}$ is the average change in (log) victories for pilot i in a mention month (captured by the dummy variable $M_{m_i t}$) for pilot m_i; and $\beta_{v'}$ is the coefficient of interest for the change in the co-movement between pilot i's victory score and that of his mentioned former peer. We hypothesize that there is an increase in the correlation between a pilot's victories and those of his former peer during the mention period. Any pilot cited in the *Wehrmachtbericht* must by definition have had an exceptionally good month. For his former peer to show an even greater victory score correlation during mention periods requires a large improvement in performance

Table 3 reports the results. In non-mention periods, there is already co-movement between the victory scores of former squadron peers. The correlation is 0.112; in mention periods it is 0.157, almost 50% higher (column 1). This effect holds also when we control for front, experience, quality, and aircraft type (column 2) as well as for squadron and time fixed effects (column 3). The results in column 3 indicate that the correlation during mention periods is stronger, by a factor of more than 2, than the correlation during quiet periods. After excluding pilots from the same group (because they might be subject to correlated shocks), we find a strong co-movement during mention periods but only a small and insignificant baseline correlation (column 4).[28]

C. Learning about one's own ability versus status competition

Pilots who knew that their former peer had just been recognized may have updated their beliefs about their own skills and potential – and all the more so if they viewed the mentioned pilot as someone similar to themselves. These pilots might then exert more effort and/or take more risks, which would result in time-varying correlation in victory scores but *not* because of status concerns.

To tackle the problem of learning about one's own ability empirically, we divide pilots into two groups: Treated pilots with a lower overall score than their former peer during the mention period, and treated pilots with at least as many victories. For instance, when Rall is mentioned with a monthly score that far exceeds Gratz's, the latter may be learning about his own type. However, if in August 1943 (the month of Rall's *Wehrmachtbericht* mention) Gratz had already scored as much as Rall had, then it is unlikely that he was learning about his own potential – and instead, status competition is a more likely interpretation.

The results are reported in Table 4. In Panel A, we analyze survival rates. Here, the spillover effect is strongest in the group of pilots who have never performed at the same level – the risk of death increases by more than 50% during the mention month. Amongst pilots who had performed at the same level before, death rates are actually lower, but not significantly so. For victories, we find the opposite ordering of relative effect sizes (Panel B). Pilots who had never performed at the same level do increase their score, and significantly so – but not nearly as much as pilots who have already scored at the same level. These findings suggest that learning about one's own type is probably not the main mechanism behind our findings – because then we would expect the pilots with a less distinguished previous record to score more, and die as much as before, inspired by the example of their former peer. Instead, death rates surge for those who may *mistakenly* think that they are as great as the mentioned top pilot; but when it comes to increasing aerial victories, the pilots who react the most (and accomplish more) are the ones who have already scored at the same level and who may have the ability to up their score.

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[28] Note that we drop the squadron fixed effects in column 4 with our reduced sample. If we control for pilots' current squadron, our estimated coefficient remains similar (0.051 instead of 0.064) but is less precisely estimated and no longer significantly different from zero.

D. Permutation tests

The statistical properties of our estimators merit further attention. Both squadron membership and victory scores are observed with error, and our coding of the former affects the explanatory variable because we form peer groups based on who previously flew with whom.

To address this potential issue, we randomly assign past peer status to pilots in our data set, and then repeat the estimation of Table 1 for both exits (column 4, Panel A) and victories (column 3 Panel B). Figure A.7 in the Appendix presents the results. Reassuringly, for both death and victory rates the simulated coefficients are much lower than the one we actually observe in the data.

E. Lags and leads

It is crucial for our analysis that pilots do not react to their peers' performance *before* it actually occurs. Using lags and leads is a simple way to test the assumption of identical counterfactual trends for treatment and control pilots (Angrist and Pischke 2009). To test for pre-event trends and effects we align observations so that $t = 0$ is the time of peer mention, and drop all observations of pilots who were never the peer of a mentioned pilot.

Figure 8 plots average performance and exits relative to the time of a mention. We distinguish between pilots above the 80th percentile and all other pilots. As clearly shown in the left graph in Panel A of Figure 8, there is no positive trend among pilots *prior* to the mention of a peer. The same is true in periods *after* the mention of a peer. Thus, for victories, the only period that stands out is the one in which the mention occurs, where we see outperformance to the tune of 1.8 more victories per month by the best pilots. Not surprisingly, given the lack of effects for the lower quality pilots, for pilots below the 80th percentile we do not find a substantial jump in performance during the mention month relative to other months.

For exits, we cannot perform an identical exercise, as peer status is defined by being alive at the time of a former peer's mention.[29] Panel B, Figure 8, plots the exit rates in our sample for the month when a former peer is mentioned and the following six months. While coefficients are positive after the event month and decline slowly in size. For the top 20%, the month of treatment and the first lag are significant; for the bottom 80%, we find a significant contemporaneous effect, with lags of 1 and 2 months, and at 4 months.

[29] The only alternative is to calculate exit rates for "ghost pilots", i.e., former peers of a pilot who will be mentioned in the future, but who already died before. This is also highly artificial, since the vast majority died a long time before the mention of their future (mentioned) peer. The fact that they do not exit immediately before a mention is also not informative.

V. Conclusion

How to motivate individuals to fight and die for their group or country is a problem as old as mankind. The higher the level of skill required for an effective fighting force, the more important individual motivation tends to be (Van Creveld 1981). Standard economic mechanisms are not effective in a setting when death is a real possibility (Costa and Kahn 2003). Armies have long used medals and other symbolic rewards to overcome incentive problems. By creating an artificial scarcity, awards are meant to spur effort and increase output (Besley and Ghatak 2008; Moldovanu et al. 2007; Frey 2007; Bénabou and Tirole 2003, 2006). On average, the prospect of symbolic awards for potential recipients appears to increase effort.[30]

At the same time, as Winston Churchill famously observed, "every medal casts a shadow." Every award or medal awarded affects many others who do not receive it, too. The likely effect is ambiguous: It may spur greater efforts – or encourage people to give up.[31] To examine the effects of status competition, we evaluate the performance of fighter pilots during World War II. Using data on aerial victories and losses for German pilots, we find that they responded strongly to the public recognition of others. When a pilot is mentioned in the daily bulletin of the German armed forces for their success in aerial combat, both current and former colleagues, on average, score more victories. At the same time, their risk of death increases. These effects vary by skill group: Performance gains are concentrated among highly skilled pilots; and while average pilots also score more, their gains are relatively small. Risk increases significantly for the low-skilled pilots. Unlike outstanding pilots, they die at a much higher rate following the official recognition of a (former) comrade. This implies that high-powered incentives, while encouraging greater effort, can also backfire, possibly reducing efficiency in contexts where risk matters.[32] Results are unlikely to be driven by social learning or learning about one's own type.

We argue that these effects reflect status competition. When a pilot is publicly recognized, the *relative* standing of all other pilots declines. Our data suggests that pilots on average appear to react to the recognition of a pilot – but the effect is at least twice as strong if a former squadron mate's accomplishments are highlighted. Tangible benefits linked to relative standing are generally not a function of whether a recognized pilot is personally known to others.

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[30] Empirical evidence from the field and from experimental settings suggests that non-pecuniary rewards on the whole lead to lower absenteeism, greater effort, and higher accuracy (Markham et al. 2002; Chan et al. 2014; Kosfeld and Neckermann 2011; Ashraf, et al. 2014).

[31] One prominent example of this would be the "Tiger Woods" effect documented in professional golf tournaments (Brown 2011).

[32] A full accounting of the overall efficiency effect would have to take into account the cost of training replacement pilots, their (time-varying) quality, and the aggregate impact of engineering a culture where status was closely tied to aerial victories. Neither parameter can be pinned down by our analysis.

Our empirical strategy therefore underlines the importance of *intrinsic* status concerns – pilots try much harder to restore their relative standing vis-à-vis others who they personally know, compared with anonymous competitors. The greater the similarity in background, the greater the increase in risk-taking: Pilots react more the closer their birthplace is to that of the mentioned pilot. These findings suggest that status concerns can be an important motivating factor, especially for highly skilled individuals.[33]

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[33] Such behavior is – inter alia – compatible with an interpretation of social image and relative standing as an 'identity asset', in the spirit of Bénabou and Tirole (2011).

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TABLES

Table 1: Death and Victory Rates, Past Peers

Panel A: Death rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mention period	1.243***	1.241***	1.234***	1.230***	1.275***	1.277***	
	(5.74)	(5.72)	(5.52)	(5.42)	(6.30)	(6.39)	
Past squadron peer			1.595**	1.544**	1.631**	1.650**	1.400*
			(2.45)	(2.25)	(2.45)	(2.57)	(1.84)
Ever peer of mentioned pilots		0.563***	0.555***	0.542***	0.631***	0.492***	0.549***
		(-10.88)	(-11.07)	(-11.73)	(-8.82)	(-11.14)	(-8.83)
N	88761	88761	88761	88761	88761	88761	88761
Aircraft type	N	N	N	N	Y	Y	Y
Pilot quality	N	N	N	Y	Y	Y	Y
Eastern front	N	N	N	N	Y	Y	Y
Pilot FE	N	N	N	N	N	N	N
Squadron FE	N	N	N	N	N	Y	Y
Time FE	N	N	N	N	N	N	Y

Panel B: Victory rates

	(1)	(2)	(3)	(4)	(5)	(6)
Mention period	0.254***	0.246***	0.246***	0.249***	0.248***	
	(0.022)	(0.022)	(0.022)	(0.023)	(0.023)	
Past squadron peer		0.436***	0.430***	0.395***	0.366***	0.346***
		(0.134)	(0.135)	(0.136)	(0.137)	(0.125)
N	88353	88353	88353	88353	88327	88327
R^2	0.210	0.211	0.211	0.223	0.239	0.263
Aircraft type	N	N	N	Y	Y	Y
Pilot quality	N	N	Y	Y	Y	Y
Eastern front	N	N	N	Y	Y	Y
Experience	N	N	N	Y	Y	Y
Pilot FE	Y	Y	Y	Y	Y	Y
Squadron FE	N	N	N	N	Y	Y
Time FE	N	N	N	N	N	Y

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). Panel A displays hazard ratios from Cox regressions as exponentiated coefficients with z-statistics in parentheses. Panel B is based on fixed effect models and displays standard errors instead. Our fixed effect model drops singleton observations. Standard errors are virtually unchanged if singletons are kept. Past squadron peer is a dummy for pilots who, in the past (but not at the moment of the mention), served with the mentioned pilot in the same squadron (*Staffel*. Starting with column 4 in Panel A (and column 3 in Panel B) controls for pilot quality are included. Pilot quality is calculated as a pilot's cumulative victories before period *t* divided by his experience. Experience is the number of months of wartime service since the start of World War II, beginning with the first victory claim in our records (except for veterans of the Spanish Civil War, for whom we add months of service there after the first victory claim). Eastern front is a dummy for pilots serving on the Russian front.

Table 2: Death and Victory Rates, Past Peers, By Previous Performance

Panel A: Death rates

	(1)	(2)	(3)	(4)
	Full sample	<80	80+	90+
Past squadron peer of mentioned	1.400*	1.671**	0.831	1.060
	(1.84)	(2.39)	(-0.50)	(0.12)
Ever peer of mentioned pilots	0.549***	0.497***	0.552***	0.438***
	(-8.83)	(-9.86)	(-5.19)	(-4.44)
N	88761	71038	17723	9017
Aircraft type	Y	Y	Y	Y
Pilot quality	Y	Y	Y	Y
Eastern front	Y	Y	Y	Y
Pilot FE	N	N	N	N
Squadron FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y

Panel B: Victory rates

	(1)	(2)	(3)	(4)
	Full sample	<80	80+	90+
Past squadron peer of mentioned	0.346***	0.008	1.054***	1.486***
	(0.125)	(0.059)	(0.358)	(0.572)
N	88327	70174	17108	8682
R^2	0.263	0.252	0.292	0.313
Aircraft type	Y	Y	Y	Y
Pilot quality	Y	Y	Y	Y
Eastern front	Y	Y	Y	Y
Experience	Y	Y	Y	Y
Pilot FE	Y	Y	Y	Y
Squadron FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). Panel A displays hazard ratios from Cox regressions as exponentiated coefficients with z-statistics in parentheses. Panel B is based on fixed effect models and displays standard errors instead. Our fixed effect model drops singleton observations. Standard errors are virtually unaffected. The table repeats the analysis of Table 1, column 7 in Panel A (column 6 in Panel B) but stratifies by performance subgroup (results reported in columns 2-4). See notes of Tables 1 for variable descriptions.

Table 3: Correlation of Pilot Performance, Past Peers and Mentioned Pilot

(Dependent variable: $\mathbf{log}(\boldsymbol{Victory\ rate} + \mathbf{0.01})$)

	(1)	(2)	(3)	(4)
Mentioned peer victories: $\log(V_{m_i} + 0.01)$	0.112^{***}	0.101^{***}	0.045^{***}	0.004
	(0.0090)	(0.009)	(0.008)	(0.007)
Mention period	-0.157^{*}	-0.177^{*}	-0.199^{**}	-0.166^{*}
	(0.089)	(0.088)	(0.084)	(0.099)
Mention period × $\log(V_{m_i} + 0.01)$	0.055^{*}	0.065^{*}	0.067^{**}	0.064^{*}
	(0.032)	(0.031)	(0.031)	(0.034)
N	39131	39131	39111	20813
R^2	0.242	0.351	0.334	0.309
Aircraft type	N	Y	Y	Y
Pilot quality	N	Y	Y	Y
Eastern Front	N	Y	Y	Y
Experience	N	Y	N	N
Pilot FE	Y	Y	Y	Y
Squadron FE	N	N	Y	N
Time FE	N	N	Y	Y

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). $\log(V_{m_i} + 0.01)$ is the natural logarithm of pilot *m*'s victory score (+.01), when *m* is a former peer of pilot *i*. In column 4, we only keep those observations for which pilots and their eventually mentioned squadron peer are not in the same group. See notes of Tables 1 for variable descriptions.

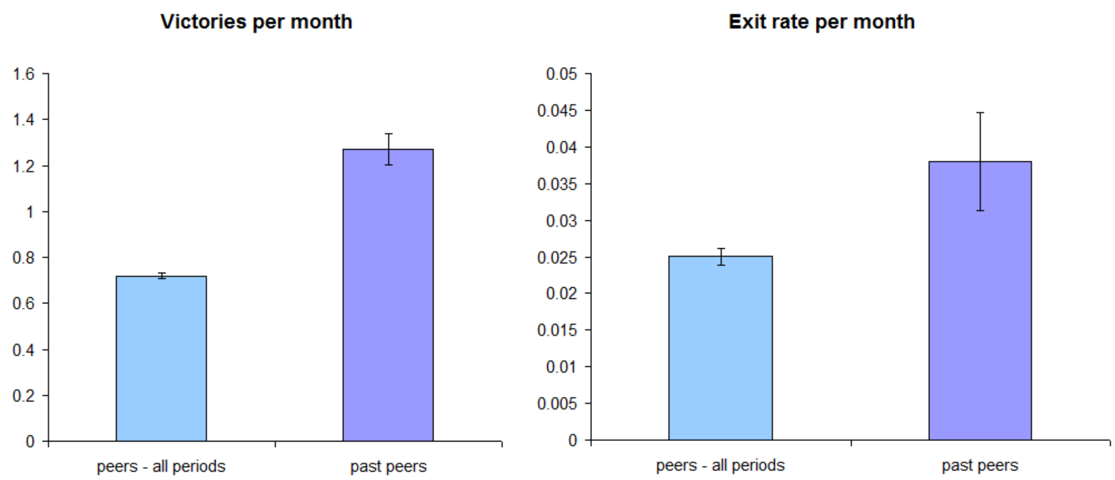
Table 4: Death and Victory Rates, Past Peers, by Previous Cumulative Score

	Panel A: Death rates		Panel B: Victory rates	
	(1)	(2)	(3)	(4)
	< score	>= score	< score	>= score
Past squadron peer of mentioned	1.579**	0.830	0.213**	0.711**
	(0.287)	(0.377)	(0.107)	(0.325)
Ever peer of mentioned pilots	0.550***	0.548***		
	(0.037)	(0.037)		
Pilot quality	1.222***	1.223***	0.019	0.015
	(0.025)	(0.025)	(0.052)	(0.050)
N	88525	88077	88091	87639
Aircraft type	Y	Y	Y	Y
Pilot quality	Y	Y	Y	Y
Eastern front	Y	Y	Y	Y
Pilot FE	N	N	Y	Y
Squadron FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). Panel A displays hazard ratios from Cox regressions as exponentiated coefficients with z-statistics in parentheses. Panel B is based on fixed effect models and displays standard errors instead. Our fixed effect model drops singleton observations. Standard errors are virtually unaffected. The table repeats the analysis of Table 1, column 7 in Panel A (column 6 in Panel B), but column 1 (column 2) only keeps treated observations where past squadron peers never (already) scored as high as the mentioned pilot's cumulative score in that month. See notes of Table 1 for variable descriptions.

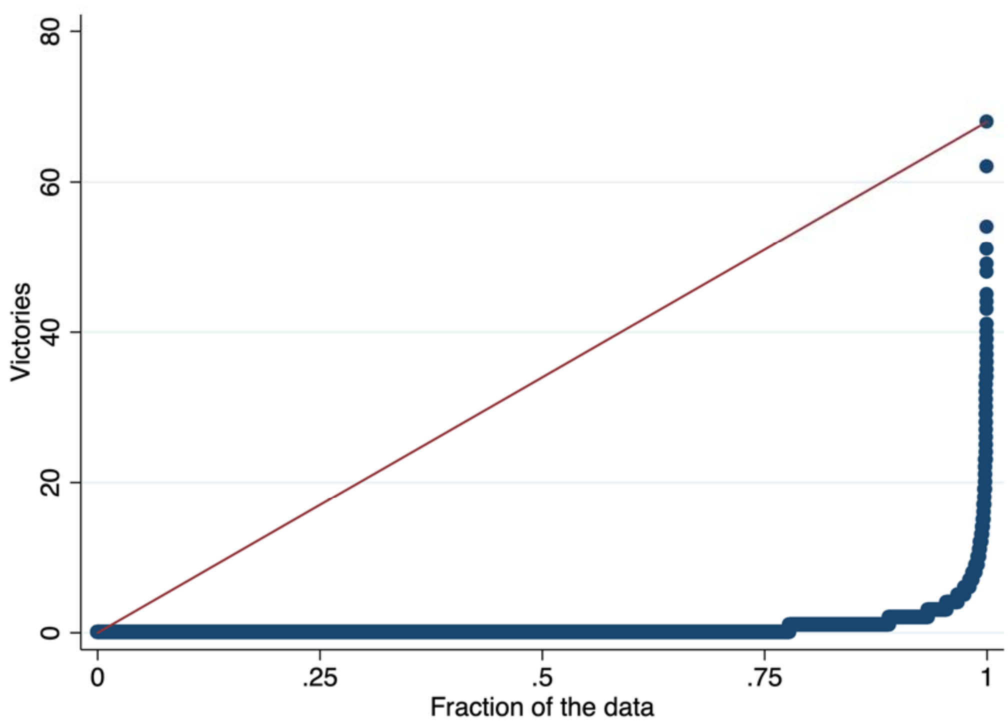
FIGURES

Figure 1: Victory and Death Rates per Month during Mention Periods



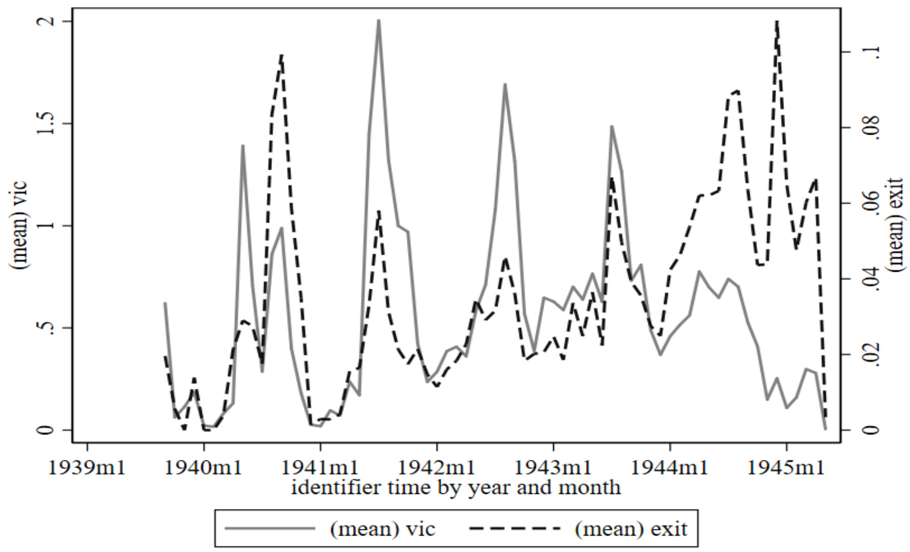
Note: The figure shows mean monthly victory and exit rates for pilots who ever flew with a mentioned pilot, those who currently fly with a mentioned pilot, and those who flew with one in the past. Mentions are from the German armed forces daily bulletin (*Wehrmachtbericht*).

Figure 2: Cumulative Distribution of Victory Rates per Month and Pilot from September 1939 Through April 1945



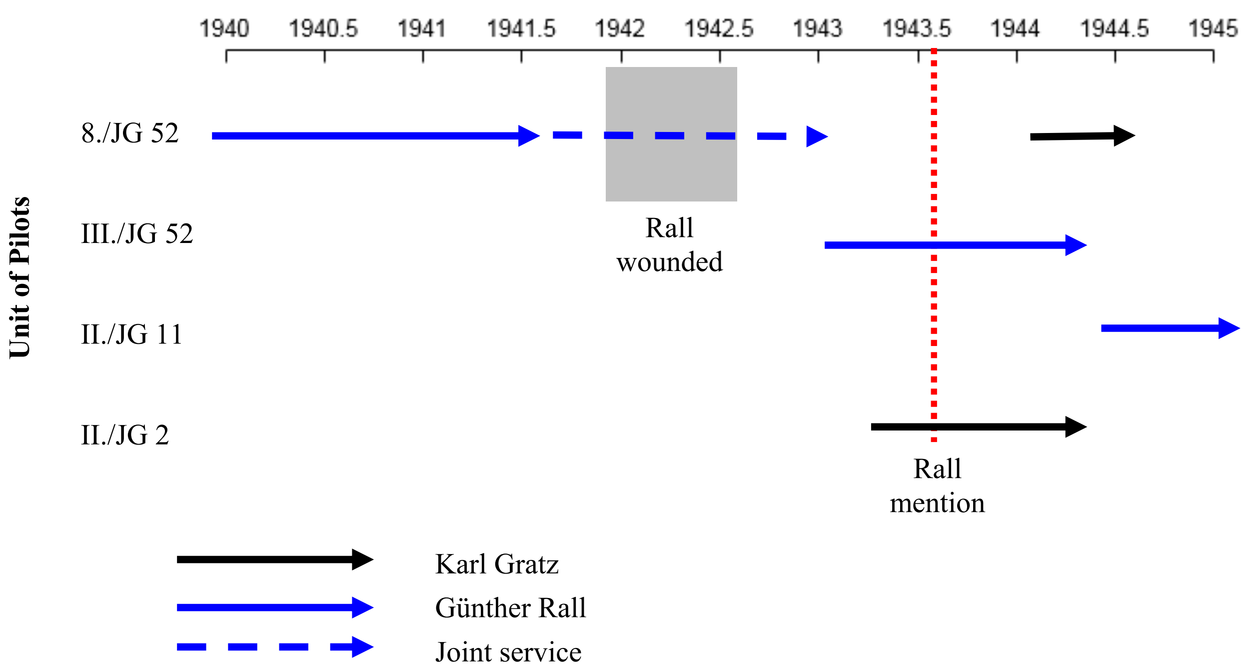
Note: The figure shows the cumulative distribution of monthly victory scores per month (dots). While 80% of German pilots did not score in an average month, one pilot scored 68 victories in a single month.

Figure 3: Mean Victory and Exit Rate per Pilot and Month from September 1939 Through April 1945



Note: The figure plots the per-pilot average monthly victory score (left-hand *y*-axis) and the exit rate per month (right-hand *y*-axis) over time (*x*-axis).

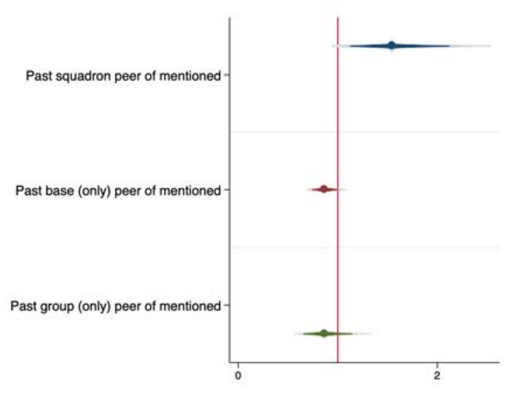
Figure 4: Identification Strategy

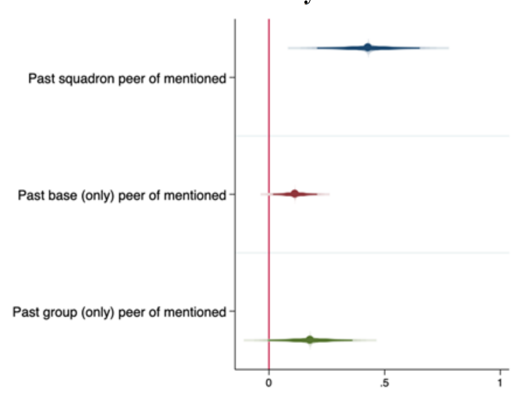


Note: The red dashed line indicates mention in the *Wehrmachtbericht* for Günther Rall. The blue dashed line indicates joint service. Rall and Gratz served together in 8/JG 52 from May 1941 to November 1941, when Rall was shot down and wounded. Rall returned to JG52 in August 1942, where he served until April 1944; from February 1943, he commanded III/JG52. Gratz transferred to II/JG 2 in March 1943, and returned to JG52 in March 1944.

Figure 5: Coefficient sizes, alternative peer groups

A: Death rate **B: Victory rate**

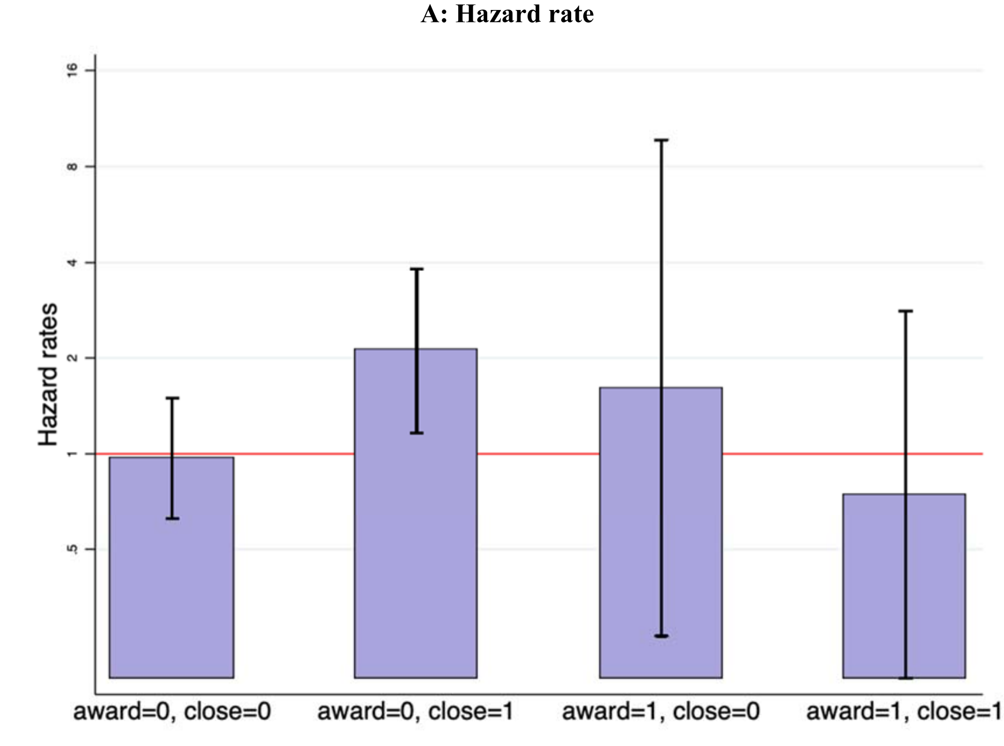




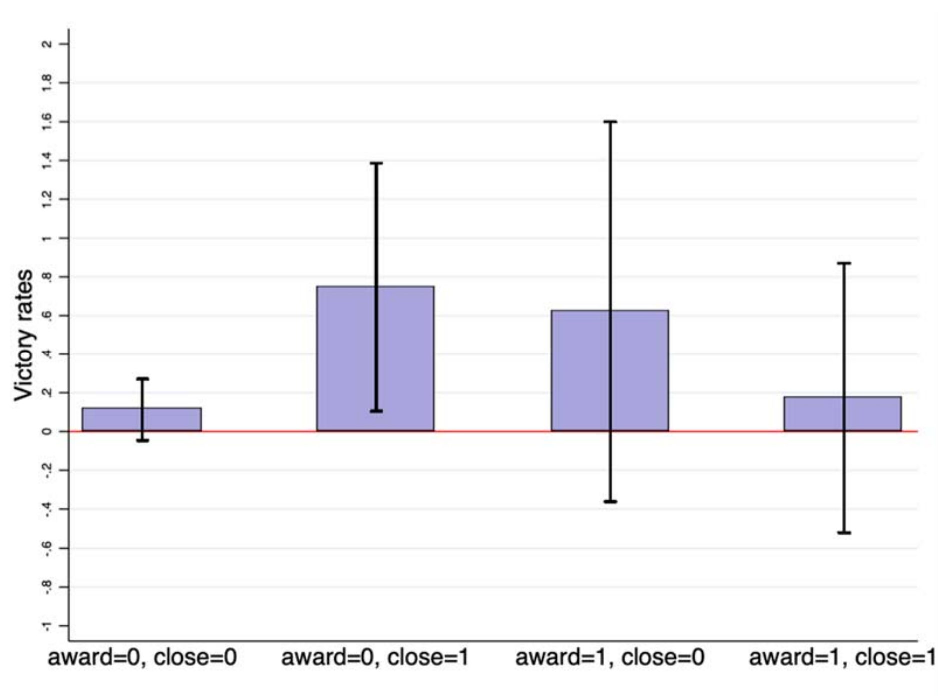
Note: Based on the specification in Table 1, column 4 in Panel A (column 3 in Panel B).

Figure 6: Exit and Victory Rates, Close to Knight's Cross

A: Hazard rate



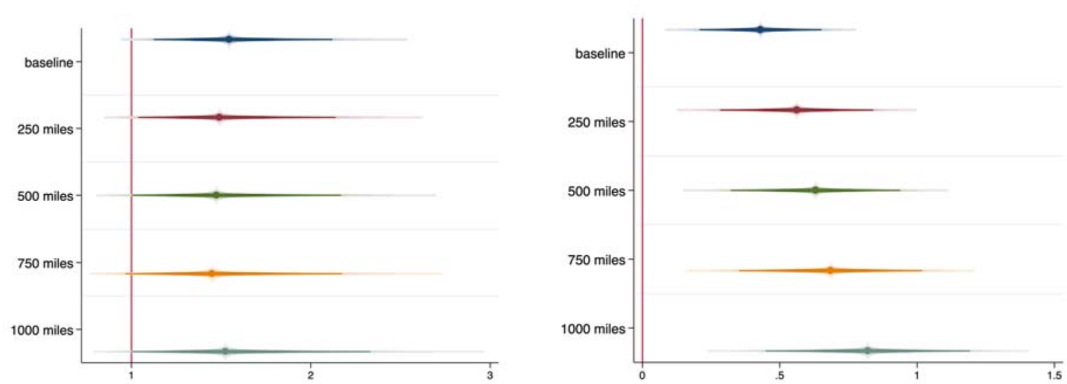
B: Victory rate



Note: The figure shows the coefficient on the variable past peer of mentioned in regressions based on Table 1, column 4 of Panel A (column 3 of Panel B). Note that the y-axis in the top panel is scaled logarithmically. We use a more parsimonious specification since the samples of pilots with awards is relative small (1,426 and 2,972 observations, respectively, for columns 3 and 4 of this figure). Award = 1 (or 0) indicates that either only pilots who do (not) yet have the Knight's Cross are included; close=1 indicates whether a pilot is within +/- 20 victories of the quota for the Knight's Cross. Column 4 additionally drops all pilots that are within 20 victories of the next higher award (the Knight's Cross with Oak Leaves) or have scored even higher.

Figure 7: Exit and Victory Rates, by distance to the mentioned pilot

Panel A: Death rate **Panel B: Victory rate**

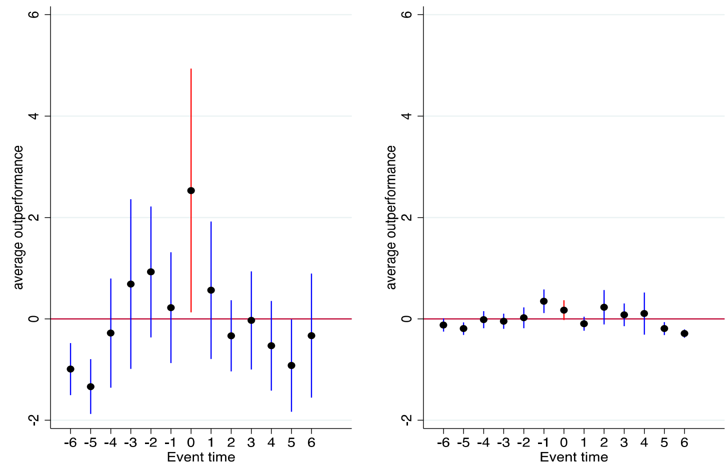


Note: The figure plots the coefficient (x-axes) for exits (Panel A) and outperformance (Panel B) during mention months of the peers of mentioned pilots as a function of minimum distance (y-axes) for squadron peers. It uses the same specification as Table 1, column 4 in Panel A (column 3 in Panel B).

Figure 8: Pilot Outperformance in Event Time by Quality Group

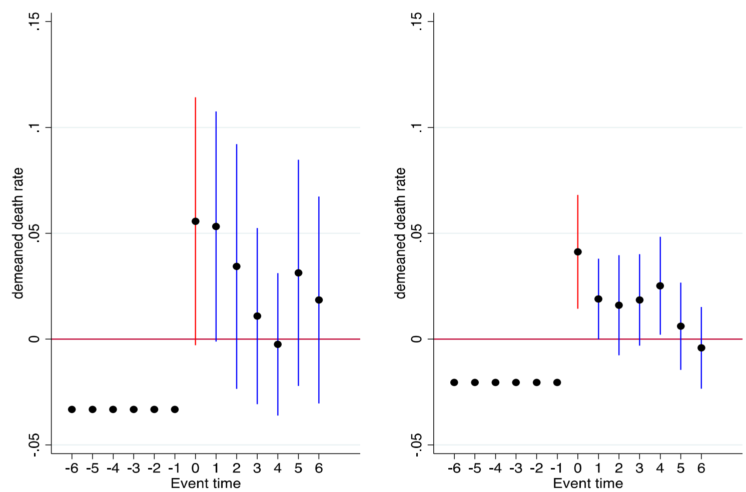
Panel A: Victory rate

Top 20% Bottom 80%



Panel B: Death rate

Top 20% Bottom 80%



Note: Each panel plots the coefficient for outperformance/exit rate of past peers of a mentioned pilot in event time (the pilot's mention in the *Wehrmachtbericht* corresponds to $t = 0$). The left (right) panel shows results for past peers in the top 20% (bottom 80%) of performance as defined by our pilot quality variable. Period of mention highlighted in red.

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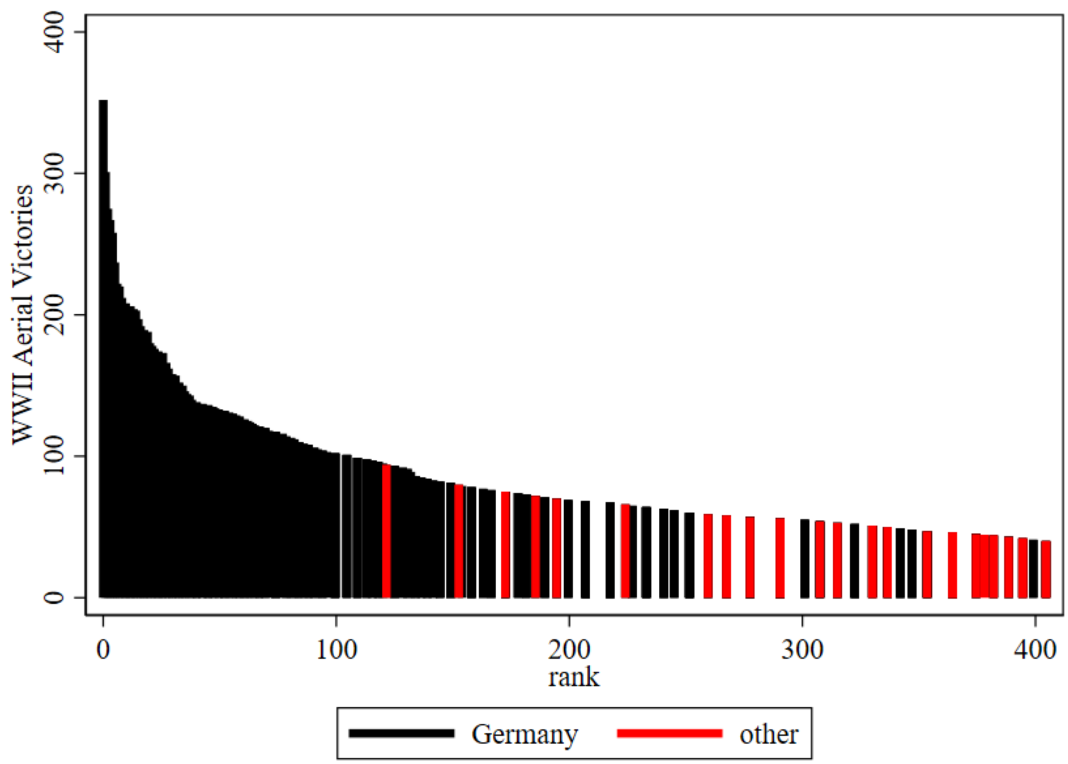
APPENDIX

Table A.1: Balancedness Test, Peers of Mentioned Pilots

	everpeer		
	0	1	t-test
victories	0.55	0.72	-11.4***
experience	15.4	21.1	-56.9***
exit	0.05	0.025	19.1***
front	0.35	0.42	-22.9***

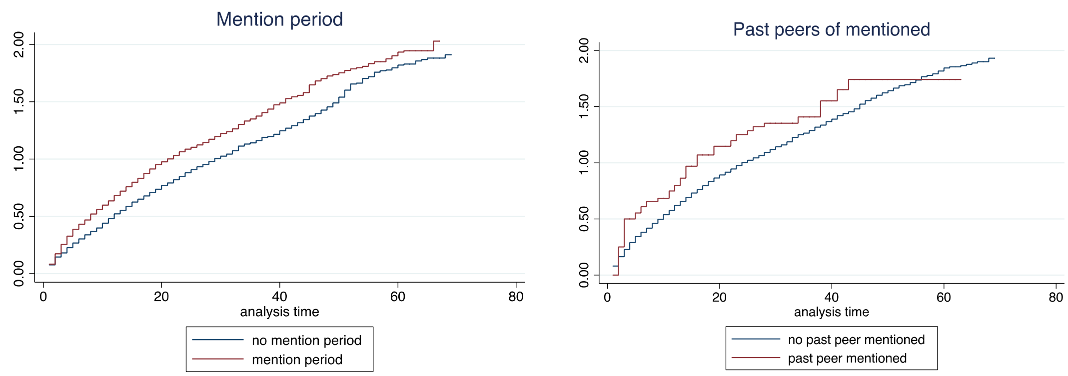
Note: All rates are calculated per month. Everpeers are defined as pilots who have ever been the peer of a mentioned pilot.

Figure A.1: Aerial Victories – Total for World War II by Rank and Nationality



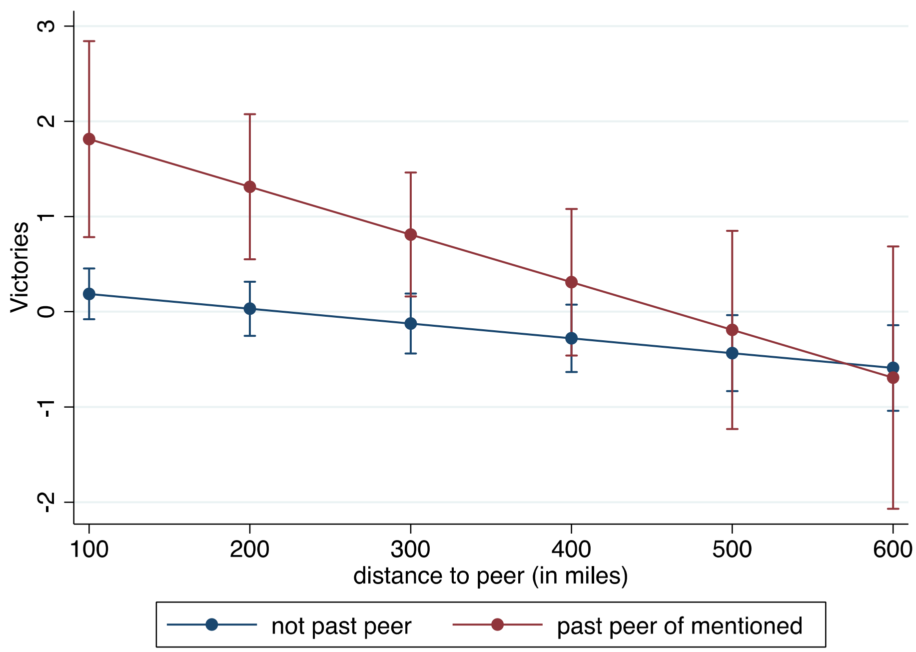
Note: The figure shows the overall score, by pilot, for pilots ranked 1 through 400 during World War II. The gaps signify ties.

Figure A.2: Hazard curves



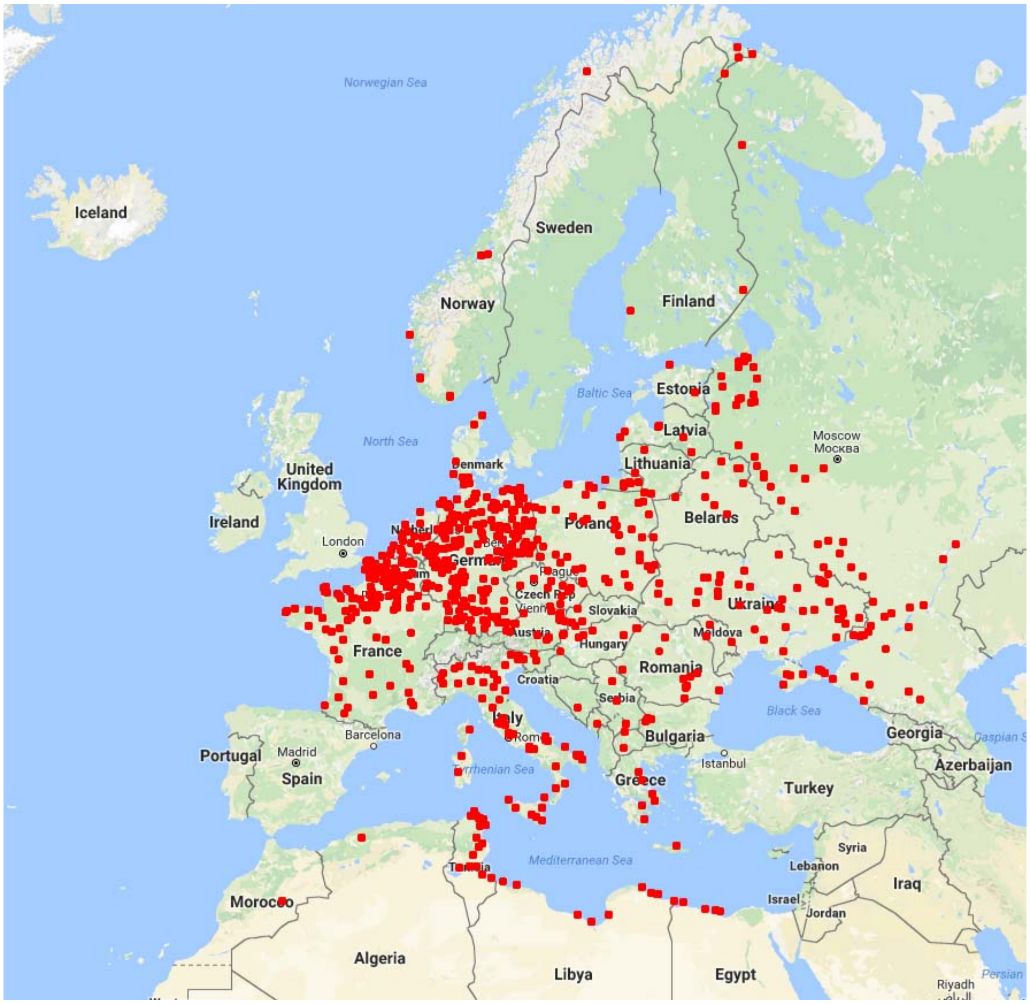
Note: The curves show the hazard rates (Nelson-Aalen) of pilots either conditional on being in a mention periods (left panel) or conditional on being the past peer of a mentioned pilot (right panel) during a mention period. Both figures are based on the specification from Table 1, Panel A, column 4.

Figure A.3: Marginal Peer Effects by Birthplace Distance



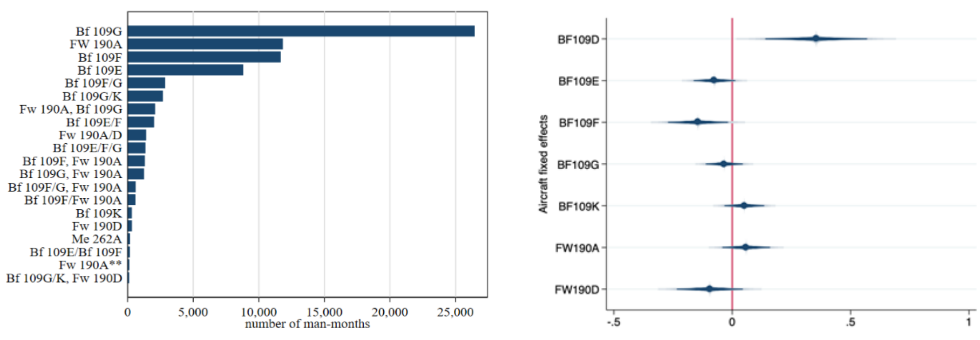
Note: The figure shows a margin-plot for the interaction effect of birthplace distance (in miles) and our treatment on the number of victories of peers of a mentioned past peer. Past peers are former squadron peers who are no longer serving in the same unit. The analysis is based on data from 352 aces for whom birthplace location is available, and we use the specification of Table 1, Panel B, column 3.

Figure A.4: Airfield Locations of Luftwaffe Squadrons, 1939–1945



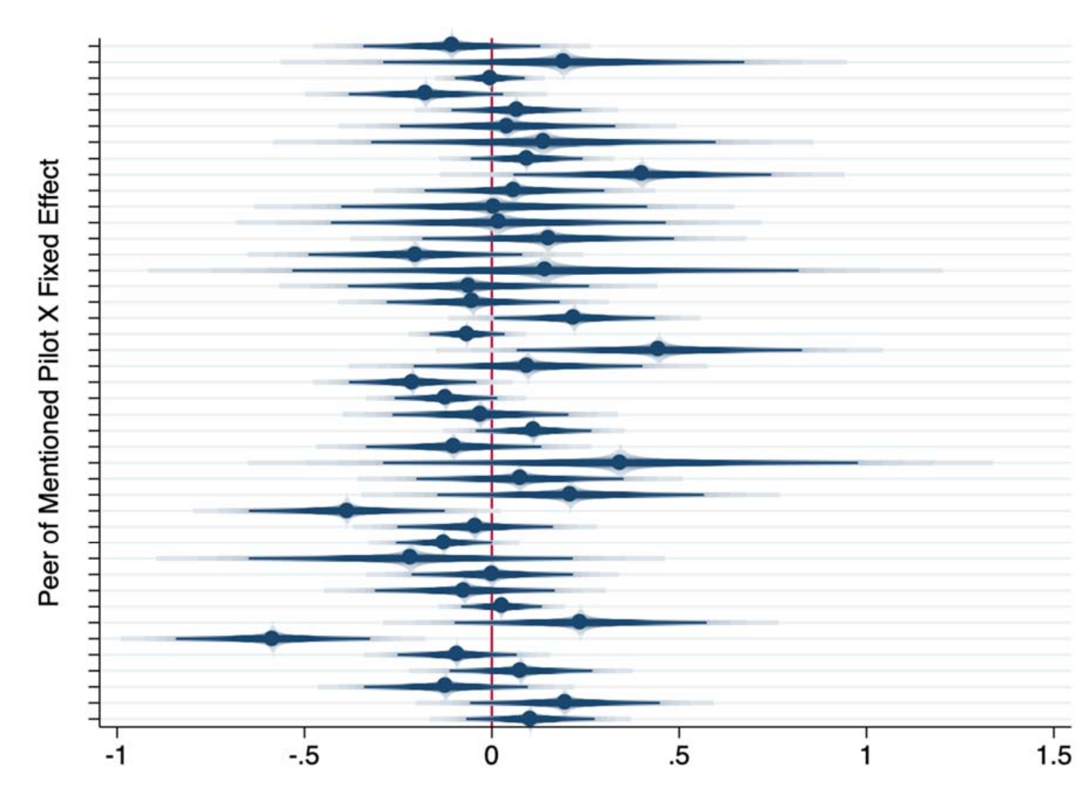
Note: This map plots the location of every airfield from which pilots in our data set flew at least once during the period September 1939 to May 1945.

Figure A.5: Aircraft Type – Usage and Fixed Effect (95% and 99% CIs) on Victory Scores



Note: The left panel of Figure A.5 plots the number of man-months in our data set of different aircraft types (or combinations) flown by squadrons. The right panel plots the fixed effects for the main aircraft types in a regression using the specification of Table 1, Panel B, column 6.

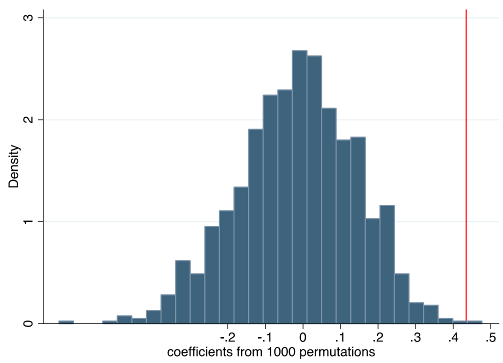
Figure A.6: Fixed Effects of Pilots Who Are or Become Peers of Mentioned Pilots



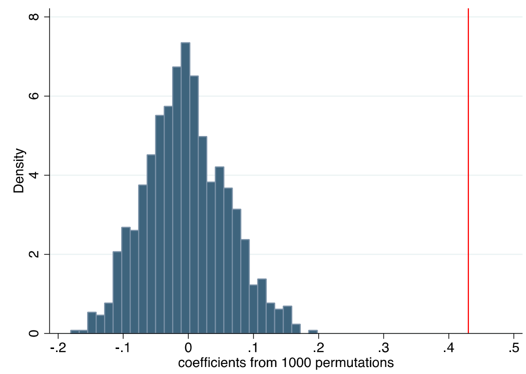
Note: Each point represents the estimated fixed effects for pilots who become peers of a pilot who is eventually mentioned in the *Wehrmachtbericht*. The figure is based on the specification of Table 1, Panel B, column 6. But instead of pilot FEs, we include dummies for ever being peer of a particular mentioned pilot.

Figure A.7: Permutations of Past Peer Status – Distribution of Coefficients

Panel A: Exits



Panel B: Victories



Note: The figure shows the distribution of coefficients for our past squadron peer variable based on the specification in column 4 (column 3) of Table 1, Panel A (Panel B). As described in the text, we run our regressions with 1,000 random permutations of our main variable. For comparison, we report the non-exponentiated coefficients of the Cox model in Panel A. The red horizontal line marks the estimated coefficient when we instead use our actually observed past peer variable (as reported in Table 1).