

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

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**Abstract.** What motivates soldiers to fight with dedication and devotion for their country? While the economic literature has focused on the extensive margin of conflict participation, we examine the motivation of soldiers facing extreme risks. The leading German fighter pilots in World War II scored many more aerial victories than those of other countries. While ideology may have played a role, we focus on a new explanatory channel – concern over relative standing. Using newly-collected data on death rates and victory claims of more than 5,000 German pilots during World War II, we examine the effects of public recognition on the performance and risk-taking among fighter pilots. When a particular fighter 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 instrumental consequences associated with public recognition, can be a prime motivating force on the battlefield.

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

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## I. INTRODUCTION

Humans are the only species to cooperate in large groups of genetically unrelated individuals (De Quervain et al. 2004; Boyd et al. 2003). To survive and thrive, these groups have to defend themselves against outsiders wanting to enslave them, kill them, or to take over territory and riches. ‘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). Why, then, do individuals go to war, and fight for their group, city, or country?

The economic literature on conflict has largely focused on 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 ready to fight (Miguel et al. 2004, Dube and Vargas 2013).<sup>1</sup> Also, desertion is less frequent in socially cohesive groups of fighting men (Costa and Kahn 2003). What has received less attention is *the intensive margin* of conflict participation – why many soldiers fight enthusiastically, with dedication and devotion. Soldiers’ motivation became key for success on the battlefield as a result of military developments after 1750 (Posen 1993; van Creveld 1981) – Western military doctrine became increasingly centered on the concept of decisive battle, carried out by highly-motivated mass armies (Hanson 2001; 1989). As a result, the fighting power of modern armies differs greatly – the Israeli army repeatedly defeated much larger Arab formations after 1948, and the German army in World War I and II inflicted much higher casualties on its Russian, British, French and US foes than the other way around (Ferguson 2001; van Creveld 1981). Despite the power of nationalist sentiment (Posen 1993), motivating soldiers for years under gruesome conditions is challenging. 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).<sup>2</sup>

In this paper, we examine the motivation of soldiers facing extreme risks, using German fighter pilots during World War II as a case study. While serving one of the most evil regimes in history, these pilots include the highest-scoring aces of all time, and account for 100% of the 100 highest-scoring pilots in the history of aerial combat. Many military historians have noted the exceptionally high morale of German soldiers in World War II (Bevor 2009, Hastings

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

<sup>2</sup> Acemoglu et al. (2016) document in the case of Colombia how giving high-powered incentives to the military backfired.

1999).<sup>3</sup> While normally attributed to a mixture of successful social engineering (van Creveld 1981) and the effects of Nazi indoctrination (Beevor 2009), we focus on a novel dimension – relative standing concerns. To do so, we examine changes in performance and risk-taking as a result of peer recognition during World War II. Using newly assembled data on the death rates and aerial victory scores of German fighter pilots, we show that when peers are publicly recognized, there is a sharp rise in death rates amongst fellow pilots, as well as a large increase in aerial victories in the same month. Death rates and victory rates are typically correlated over time within each squadron.<sup>4</sup>

To identify effects, we focus on the risk-taking and performance of individual pilots whose *former peer* (a pilot who used to fly in the same squadron in the past) is recognized. We find large increases in both death and victory rates during the month of a peer's public recognition. This effect holds true even while controlling for the recognition of other, unconnected pilots.<sup>5</sup> Importantly, this eliminates potentially confounding effects from the instrumental benefits of relative standing (which apply to the rank in the air force as a whole): Recognition of a former peer does not change a pilot's potential future benefits from scoring extra victories; it only diminishes his relative standing in a well-defined peer group of (former) comrades.<sup>6</sup> Effects only last for one month, making it unlikely that pilots learn about their own type as a result of peer recognition. In combination, these results strongly suggest that intrinsic concerns over relative standing were an important motivating factor for pilots. These concerns were sufficiently strong to change important behavior – pilots were willing to make life-and-death decisions in order to improve their relative standing.

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 major award (but have not yet obtained it) respond particularly strongly if a former peer is recognized – if a pilot has a good chance of receiving an award, he is more likely to score more and take greater risks when a former peer's accomplishments have just been highlighted. We interpret these results as evidence for relative standing concerns leading to greater effort and increased risk-taking.

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<sup>3</sup> We in no way want to imply that the accomplishments of German soldiers compensate for the immorality of their nation's cause.

<sup>4</sup> Squadrons are the primary fighting unit of every air force, consisting of 8-12 pilots. Simultaneous shocks to the combat environment lead to correlated outcomes.

<sup>5</sup> 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.

<sup>6</sup> Future benefits – in expectations, if Germany had won the war – may well have been tied to absolute performance or relative standing among all German aces. We control for performance changes in response to *any* pilot being mentioned, and focus on the additional effect of a former peer receiving recognition.

Aerial combat is a useful setting for analyzing what motivates soldiers to exert effort: 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 battle is joined, there is no effective control of individual planes by superior officers. In every dogfight, each pilot had to decide whether to pursue victory or break off contact. Motivating top performers was key for aggregate performance. A carefully designed system of medals and other awards created incentives for aces to keep scoring.<sup>7</sup> Top performers mattered for aggregate outcomes: The best 1% (50) of pilots in our dataset accounted for 10% (5,500) of all 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, for the loss of 3,600 German pilots.<sup>8</sup>

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 German aces, 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 WWI fighter ace) 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” as a form of recognizing 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 tank “kills”, or a “round” number of cumulative aerial victories, like 150 or 200.<sup>9</sup> 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 posted at command posts throughout German-held territory. Mentions were also difficult to predict, since there was no simple rule that “entitled” a soldier to being mentioned. Moreover, unlike

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<sup>7</sup> 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.

<sup>8</sup> 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.

<sup>9</sup> We draw on Wegmann (1982), an edited compendium of all *Wehrmachtbericht* issues.

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.<sup>10</sup>

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 score 0.8 victories per month and die at a rate of 2.7%. When they are flying in the same squadron as a mentioned pilot, these rates jump 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 and statistically indistinguishable from the effects for current peers – they show large increases in performance, and a marked rise in death rates.

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 individual incentives and status competition as key determinants of military performance. 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. 2017, forthcoming), 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.

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

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<sup>10</sup> 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.

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. Work on peer effects studies how collaborating with others affects worker effort and performance (Falk and Ichino 2006, Mas and Moretti 2009, Bandiera et al. 2010).<sup>11</sup> We examine a case where social interactions amplify the effects of non-financial rewards and create greater incentives to perform among highly skilled (and motivated) individuals.

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 instruments (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). In contrast to most environments in modern firms, using military data on pilots allows us to use individual-level performance and risk measures. 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.<sup>12</sup>

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 likely mechanisms behind our main findings, and Section V examines alternative interpretations and additional evidence. We conclude in Section VI.

## **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.

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<sup>11</sup> Peer effects are typically driven by knowledge spillovers, task complementarities, or social pressure. In our setting, the first two of these drivers can essentially be ruled out. Evidence for peer pressure is typically stronger for low-skilled individuals but is distinctly mixed among the highly skilled (Jackson and Bruegmann 2009, Azoulay et al. 2010, Waldinger 2012).

<sup>12</sup> 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.

### *A. The German air force during World War II*

Aerial combat began during World War I. Initially, planes were unarmed. They quickly evolved into specialized types, ranging from single-seat fighters to bombers. During that war, the highest-scoring ace – the “Red Baron”, Manfred von Richthofen – notched up 80 victories (Castan 2007). By the time World War II began, both fighters and bombers had become faster and more powerful. The German air force had sent planes and men to participate in the Spanish Civil War, gaining experience while supporting the fascist rebels. There, the Luftwaffe carried out atrocities like the first mass bombing of a civilian target at Guernica in 1936. German air support was crucial for the ultimate victory of the Spanish fascist rebels (Westwell 2004).

In 1939, the German air force had 4,000 planes, including 1,200 fighters, and 880,000 men (Kroener et al. 1988). During the early Blitzkrieg campaigns, it mainly operated as close air support for the army. The wars against Poland, France, and Russia opened with successful attacks on enemy air forces, destroying many planes on the ground – achieving air superiority for the Luftwaffe. The only exception before 1943 was the Luftwaffe’s defeat during the Battle of Britain. The planned invasion of the British Isles had to be called off because of Germany’s failure to dominate the skies.

By 1943, both personnel and the number of planes had approximately doubled (since 1939) to 2,000,000 men and some 7,000 planes (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. In particular, air attacks on hydrogenation plants and on airframe and aero-engine factories threatened the Luftwaffe. Despite these efforts, many German cities were quickly reduced to rubble.

Having started the war with modern planes and a large air fleet, Germany first lost its quantitative edge. Once it 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; the outdated BF-109 remained Germany’s main fighter plane until the end of the war. New planes with advanced technology, such as the ME-262 jet, arrived too late to make a difference. Pilot training also suffered. Until 1942, German pilots received at least as much training as their Allied counterparts, but 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, eventually rising to staggering levels. During January 1942, the 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). Actual planes available relative to authorized strength fell from 95% in January 1942 to 45% in September 1944 (Murray 1996). Nonetheless, due to the prolific output of German armament factories, the actual number of fighters in combat units continued to rise until the end of 1944.

Air attacks against German cities may not have dented morale as much as British planners had hoped, and “precision” daylight bombing by the U.S. air force destroyed much less industrial capacity than anticipated. Even so, the Anglo-American air offensive degraded the German airforce’s capabilities – to the extent that the Normandy landings in the summer of 1944 were largely unopposed from the air (Neillands 2001). While the Luftwaffe lost air superiority in the West from 1942–43 onward, it continued to be a match for the Red Air Force almost until the end of the war. Better training and better equipment gave German units an edge against Russian planes and pilots; when it made an effort, the Luftwaffe could establish temporary air supremacy at specific points over the Eastern front. Not until late 1944 did it begin to lose that ability as more and more units were transferred to the Reich.

### *B. Rank and public recognition*

Aerial victories are the key determinant of social standing among fighter status. 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).

During World War II, a pilot’s victory score was prominently displayed on his fighter’s tail rudder. In this way, a fighter pilot’s prowess was easily visible to comrades and foes alike. Wider recognition for aerial victories took two forms – medals, and mentions. The German armed forces operated an elaborate system of medals. Some were widely distributed, such as “campaign medals” handed out to every soldier who participated in a particular operation. Some awards recognized particular skills or feats of arms, such as the close-combat badge and

tank destruction badge. 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.<sup>13</sup>

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.<sup>14</sup> Mentions by name were introduced in April 1940. One of the first soldiers receiving this recognition was General Erwin Rommel for his role in leading the German attack into France. 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 *Wehrmachtbericht* was produced by the propaganda department within the operations staff of the German armed forces, under the direction of General Hasso von Wedel. Like all propaganda by the Third Reich, it skillfully 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. 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.<sup>15</sup> 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 diary – to obtain a comprehensive list of German fighter claims

<sup>13</sup> During World War II, about 3.3 million Iron Crosses 2<sup>nd</sup> 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.

<sup>14</sup> 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).

<sup>15</sup> 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/>.

for the years 1939–1945.

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 scored a victory 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 often 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.<sup>16</sup> 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.

We also use the victory claims data compiled by Perry-Wood and Kracker. 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

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<sup>16</sup> 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.

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 (*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 relatively 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 rightly so.<sup>17</sup>

The German air force in World War II counted among its ranks the highest-scoring aces 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 ace was Ilmari Juutilainen from Finland, with 94 victories; the best Soviet, Commonwealth, and American pilots were credited with 66, 40, and 38 kills. Figure A.1 in the Appendix plots the distribution and nationality of World War II aces.

The top 100 pilots during World War II are all German. This high concentration of aces in the German air force reflects three main factors. The first was its “fly till you die” rule. While Western air forces rotated pilots out of active duty after a fixed number of sorties, as famously described in the novel *Catch 22*, German pilots continued to fly until they died or were incapacitated.<sup>18</sup> Second, the poor quality of planes and training in the USSR at the start of World War II gave German pilots great opportunities to rack up victory claims. Third, as a result of their participation in the Spanish Civil War, German pilots had much greater experience vis-à-vis enemy air forces during the early stages of the conflict (Bungay 2001).

Altogether, German air force records document 53,008 aerial victories. These are credited “kills”, not simply claims. 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.<sup>19</sup>

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<sup>17</sup> There is some evidence of “over-claiming” 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).

<sup>18</sup> The number of total sorties is a key factor in skewing the distribution of victory scores (Neillands 2001).

<sup>19</sup> 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.

The distribution of scores was extremely uneven. The top-scoring 350 pilots achieved almost as many aerial victories as the more than 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 (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).

Pilots were trained to fly before they received training in more specialized skills such as aerial combat. They would first attend “boot camp”, which revolved around physical fitness and military discipline. After some basic training in aeronautics, they would then move on to an elementary flying school. Once they had their pilot’s wings (after 100–150 hours), prospective fighter pilots were sent to air combat schools. Upon completing that course, the pilot would be attached to a squadron or group in an operational training unit at the front. The plan was for them to learn from experienced pilots before transferring to actual combat. Yet often – and especially as Germany’s war situation worsened – training units were quickly sent into battle. By 1943, newly trained German airmen received markedly fewer training hours than their Western counterparts (Murray 1996).

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, where he became one of the highest-scores aces of the war (Kurowski 1994).

### III. MAIN EMPIRICAL RESULTS

In this section, we examine the determinants of death rates and victory rates amongst fighter pilots.

#### A. Baseline correlations within squadrons and with contemporary peers

Pilot performance and exit rates are strongly correlated within squadrons. To illustrate the extent of co-movement, we calculate leave-out means of the death rate  $D$  (victory rate  $V$ ) in squadron  $i$  at time  $t$ , and then estimate an individual  $j$ 's death rate  $D_{ijt}$  (success  $V_{ijt}$ ) as

$$D_{ijt} = \alpha_{d_1} + \beta_{d_1,i} + \gamma_{d_1,t} + \delta_{d_1} \overline{D_{ijt}} + X_{1,ijt} \phi_{d_1} + \epsilon_{d_1,ijt}$$

$$V_{ijt} = \alpha_{v_1} + \beta_{v_1,i} + \gamma_{v_1,t} + \delta_{v_1} \overline{V_{ijt}} + X_{1,ijt} \phi_{v_1} + \epsilon_{v_1,ijt}$$

where  $\alpha_1$  is a constant,  $\beta_1$  and  $\gamma_1$  are squadron- and time-fixed effects respectively, and  $\overline{D_{ijt}}$  and  $\overline{V_{ijt}}$  are leave-out means, and  $X_{1,ijt}$  is a vector of controls. The controls include dummies for the Eastern front, and experience (the number of months a pilots has already been tracked in our data), as well as a measure of pilot quality, calculated as a pilot's prior cumulative victories divided by his experience. We are particularly interested in the coefficient  $\delta_1$ .

As Table 1 shows, within each squadron, both victory rates and death rates are strongly correlated. If a pilot's squadron scores one more victory on average (abstracting from his own performance), his individual victory claims increase by almost 0.6; for every increase in the squadron-wide rate of death by 5 percentage points, individual risk went up by 1.14 percentage points per month, or 36% of the baseline rate of risk. In column 3 we also add squadron fixed effects, and in addition, in column 4, time fixed effects. In every specification, the leave-out mean of both death rates and of victory rates predicts a pilot's risk of death and his chances of a victory.

Next, we focus on periods when pilots' accomplishments were highlighted in the Wehrmacht bulletin ("mention periods"). Here, we are not simply interested in squadron-level co-movement in general – which will reflect the similarity of combat conditions, etc. – but the extent to which (current) peers of a mentioned pilot perform better. To this end, we estimate the following fixed effect model for the victory rate  $V_{ijt}$

$$V_{ijt} = \alpha_{v_2,j} + \beta_{v_2,i} + \gamma_{v_2,t} + \delta_{v_2}P_{it} + X_{v_2,ijt}\phi_{v_2} + \epsilon_{v_2,ijt}$$

where  $\alpha_2$  is the pilot fixed effect, and  $\beta_2$  and  $\gamma_2$  are squadron- and time-fixed effects respectively.  $P_{it}$  is an indicator variable showing whether squadron  $i$  contains a mentioned pilot, and the associated coefficient  $\delta_2$  is our effect of interest. The vector of controls,  $X_{ijt}$ , includes the same variables as our regressions from Table 1, plus a dummy for any month with a pilot mention, for both connected and unconnected pilots. The coefficient  $\delta$  therefore measures the additional effect of having a current peer recognized publicly, over and above the effect of any mention for a *Luftwaffe* pilot. The latter, we argue, can reflect extrinsic motivation resulting from rank changes; the former, peer-based effect plausibly captures intrinsic responses to changes in relative standing in the relevant comparison group.

For the death rate  $D_{ijt}$ , we estimate a Cox proportional hazard model:

$$D_{ijt} = D_{2,t}e^{(\alpha_{D_2}E_j + \beta_{D_2,i} + \gamma_{D_2,t} + \delta_{D_2}P_{it} + X_{D_2,ijt}\phi_{D_2})} + \epsilon_{D_2,ijt}$$

Note that  $D_{2,t}$  stands for the baseline hazard function after  $t$  months (i.e. the baseline risk of death for any pilot  $t$  months after entering the war). The remaining covariates are the same, except for  $E_j$  a time-invariant dummy variable for pilots that ever flew with a mentioned pilot, instead of pilot fixed effects.<sup>20</sup> Table 2 presents the results from these regressions for both victory and death rates. Pilots with (currently) mentioned peers in the *Wehrmacht* bulletin perform better in the same month, by 0.3 to 0.4 victories. They also die faster, with the hazard rate going up by a factor of 1.5 to 1.8. These effects are in addition to the fact that mention periods in general see more active combat and higher risk.

One obvious concern is that the results in Tables 1 and 2 might suffer from correlated shocks – pilots in a squadron not only experience changes in the performance and risk-taking of their peers, but also share the same general environment: They typically fly the same planes, fight the same enemy formations, receive service from the same mechanics, are commanded by the same officers, and are tasked with similar objectives. Although suggestive, the evidence in Tables 1 and 2 cannot be considered as evidence of spillovers and status competition among squadron peers.

### *B. Spillovers amongst past peers*

To sidestep the reflection problem, from now on we estimate regressions that only examine the effect of *former* peers having been mentioned in the *Wehrmacht* bulletin.

We illustrate our identification strategy in Figure 4, using the case of two pilots: Günther Rall, one of the highest-scoring aces of World War II, and Karl Gratz. From the

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<sup>20</sup> Since death only happens once, estimating with pilot fixed effects for the risk of death is nonsensical (and the Cox estimator does not converge). We also drop the experience variable from the Cox specifications since they already control for time at risk.

autumn of 1941 until March 1943 they served together in Squadron 8 of Fighter Wing 52. Rall remained with the squadron when Gratz was transferred to another squadron, the “Stab” in Group II, 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.

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).

We are interested in whether pilots whose former peers are mentioned die at a higher rate in the same month, while scoring more victories. Figure A.2 in the Appendix plots survival curves for both mention periods and peers of mentioned pilots; while death rates are higher during mention periods in general, former peers of mentioned pilots tend to die at an even faster rate.

To examine statistically the effect of former peers being mentioned, we estimate:

$$V_{ijt} = \alpha_{v_3,j} + \beta_{v_3,i} + \gamma_{v_3,t} + \delta_{v_3} P_{ijt} + X_{v_3,ijt} \phi_{v_3} + \epsilon_{v_3,ijt}$$

$$D_{ijt} = D_{3,t} e^{(\alpha_{D_3} E_j + \beta_{D_3,i} + \gamma_{D_3,t} + \delta_{D_3} P_{ijt} + X_{D_3,ijt} \phi_{D_3})} + \epsilon_{D_3,ijt}$$

where coefficient  $\delta_3$  on the past peer of mentioned dummy  $P_{ijt}$  now additionally exploits variation across pilots within squadrons. Panel A in Table 3 presents results from survival regressions. Again,  $X_{ijt}$  includes a dummy variable for months with any pilot mention. It will absorb any effect from mentions changing an individual pilot’s relative standing in the air force as a whole;  $\delta_3$  captures the additional, specific spillover from *a former peer* being mentioned. We find that during the general mention periods, death rates go up, in line with earlier results. Pilots whose peers are eventually mentioned also survive longer in general (column 3, Panel A), but this partly reflects the fact that pilots who live longer acquire more peers. During the month of the mention, past squadron peers see their hazard rates additionally rise by more than 50%, on top of the general 23-28% rise in death rates during mention periods. 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, when we control for quality, front, experience, ever having been the peer of a mentioned pilot, and squadron and time fixed effects, we find significantly higher risks of exit (40%) for former peers of the mentioned pilot – but only at that moment in time. 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 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 (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 3). After adding controls for experience, front, pilot quality as well as squadron and time fixed effects, 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.

### *C. Results by social distance*

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 3, plotting the coefficient of interest for group peers and base peers, for both death rates and victory rates. Victory rates are lower amongst base and group peers, but greater than zero. This is in line with our expectations – pilots who 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 significant effects overall.

### *D. Results by pilot quality*

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 4 gives the results. Average pilots (up to the 80<sup>th</sup> percentile of pilot quality) see a sharp increase in death rates, by a factor of 1.67; those above the 80<sup>th</sup> 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.<sup>21</sup> 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.<sup>22</sup> This suggests that pilots at different points in the skill distribution react differently: While all of them aim to score more, some – the more average pilots – get themselves killed, and the very best pilots mainly react by increasing their scores.

### *E. Discussion*

During months when an individual pilot was mentioned in the Wehrmacht bulletin, both his current and past peers show marked improvements in performance – as well as greater risk-taking, as reflected in higher death rates. These two effects are of approximately similar size. This suggests that positive shocks to the status of a fellow pilot spurred more aggressive behavior amongst peers, and that tightly-knit, former peer groups are almost as powerful a reference group as the current unit. The fact that pilot reactions differ by overall performance suggests that both outstanding and average pilots care about relative standing, and that the recognition of their peer is a spur to greater efforts and risk-taking. At the same time, margins of adjustment are clearly different – great pilots mainly score more when a former peer is mentioned, while average pilots only die more.

## **IV. SOCIAL VERSUS SELF-IMAGE CONCERNS**

The results so far suggest that pilot effort and risk-taking increase when a former peer is mentioned; however they do not allow us to distinguish between self-image and social image concerns.

While we cannot rule out self-image concerns completely, we use evidence from two empirical exercises to argue that they are less likely to be responsible for our results. We first examine data on the birthplace of aces, and show that those born close to each other are more likely to react strongly to the mention of a former peer. Second, we stratify our sample by the likelihood of a pilot receiving another important award associated with considerable public recognition. If social image concerns are key and pilots feel diminished by a former peer being

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<sup>21</sup> These differences between the main coefficients in columns 1 to 4 of Table 4, Panel A, are however not significant. We assume for all comparisons that the covariance of our estimates is equal to zero.

<sup>22</sup> Testing for the significance of these differences in coefficients, we find 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.

mentioned, they are likely to try harder and take more risks, especially when they have some chance to be similarly recognized. While error bands are large, the evidence suggests that pilots who have a good chance of winning a medal (and do not yet have it) react more strongly to the mention of a former peer.

#### *A. Birthplace proximity*

We are able to determine the birthplaces of 352 aces. We already know that among aces the average score and the incremental effect of a peer mention is relatively large. But how much greater is the increase in the number of victories when a pilot from the same region is mentioned? While not every ace knew every other ace, many of them would have been familiar with each other's careers and background. In addition, last names often contain information about regional origins.

Figure A.6 in the Appendix shows that for pilots born close to each other the effect of a mention in dispatches is especially large.<sup>23</sup> 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 4, aces rarely react by exiting the sample. In our data set with birthplace data, only two aces exit when their peer gets mentioned. This result is therefore of limited value.

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 aces from the same area will have diminished, heightening the incentive to perform.<sup>24</sup>

#### *B. 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*, it has the advantage of being awarded via informal "quotas" (which changed in response to combat conditions). Quotas were not a hard criterion – many pilots would get the award while still 10 victories short of the quota, or have to wait until they exceeded it by 20. Nonetheless, chances of an award increased more 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

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<sup>23</sup> We use the simple specification from Table 3, column 4 for Panel A (column 3 for Panel B) because our sample is small.

<sup>24</sup> 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.

uniform, and often added to the tail rudder decoration of a plane; they were considered so important that they entitled even privates to be saluted by officers. Out of the 13 million soldiers in the German armed forces in World War II, only 7,000 received a KCR.

In our data set, 414 pilots received the KCR. We now examine whether pilots who were close to the quota for this award *responded more to a former peer being recognized in the Wehrmachtbericht*. Figure 6 shows graphically the results for both hazard rates 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, but are far from the quota (i.e. they are 20 victories below the quota, which had an average value of 45 during the war but was as high as 100 on the Eastern front in 1943). Their probability of exit remains virtually unchanged. 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 5%. For pilots who already have the KCR and are far from the quota, we find no significant effects.<sup>25</sup> 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, this appears to suggest that once a pilot has received a major award (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 more than 50% higher than the spillover effect that we measure in Table 3. 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 reaction. Pilots who have the KCR but are no longer close also perform better when a former peer is mentioned in the *Wehrmachtbericht*, but the effect is not significant.

If pilots' responses to the public recognition of others reflect social image concerns, then those pilots who have a chance of receiving additional public recognition themselves should react more strongly to the mention of a former peer. To examine if the data bears out this prediction, we look at the first major award that pilots could receive – the KCR. While error bands are large, we think that this evidence is at least suggestive of relative status concerns overall, with former peers taking greater risks and trying harder if they can “even the score” by obtaining an important medal themselves.

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<sup>25</sup> 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.

### *C. Discussion*

To determine whether self-image or social image concerns are responsible for increased performance and risk-taking when a former peer is being mentioned, we examine evidence from two additional settings – the geographical origin of pilots and the likelihood of receiving an additional award. Pilots who yet have to earn their first major medal react more when a former peer is mentioned in the *Wehrmachtbericht*, and pilots change their behavior more at a time of a fellow pilot’s public recognition when they hail from the same part of the country.

## **V. 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.3).

Having imposed minimum distance requirements on our data, we present in Figure 7 the coefficients on the former peer interaction variable as those requirements become increasingly stringent. Even a distance of 100 miles usually corresponded to a marked change in combat conditions (for example, the northern and southern sectors in the battle of Kursk and Orel were approximately 100 miles apart). 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. Figure 7, Panel B, demonstrates that the coefficient for outperformance becomes greater as we impose more and more demanding distance requirements.<sup>26</sup> The effects for exits (Panel A) are similar across distance groups (and not statistically different from each other). These results strongly suggest that our results are not driven by correlated shocks.

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<sup>26</sup> We use the basic specification from Table 3, column 4 for Panel A (column 3 for Panel B). Results are almost identical when using the more stringent specifications.

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, this mechanism is unlikely to explain our results.

We have information on the type of aircraft used for a little more than 77,000 of our total 88,000 observations (see Figure A.4 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 – which together accounted for the vast majority of aircraft types used. Did correlated upgrades 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. Its usual procedure involved squadrons being recalled to Germany, re-equipped, and then sent back to the front. There is no anecdotal evidence of aces being given special treatment. To the contrary, at least one ace (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 more powerful but unreliable new engine failed on one of its first missions. Furthermore, we directly control for the effect of aircraft type. The results reported in Tables 1–3 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 an ace is mentioned in the *Wehrmachtbericht*. This is not the case.<sup>27</sup>

### *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 assume that 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 aces are mentioned in the daily bulletin; yet the reason would be correlated on-the-job learning rather than motivation effects.

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<sup>27</sup> Results available upon request.

We do not believe that this mechanism, either, is likely to drive our findings. First, our results in Table 3 already control for whether pilots ever served together 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 an ace are not uniformly positive (see Figure A.5): Some 44% of 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, novel situations. A pilot with a good enough month to be mentioned in dispatches may have had many 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  $V'_{ijt}$  on the log of victories of the mentioned peer  $V'_{im_jt}$  (where  $V' = \log(V + 0.01)$ ) to allow for a direct estimation of the performance elasticities as follows:

$$V'_{ijt} = \alpha_5 + \beta_{5,i} + \gamma_{5,t} + \delta_5 M_{im_jt} \cdot V'_{im_jt} + \mu_5 \cdot V'_{im_jt} + \eta_5 M_{im_jt} + X_{5,ijt} \phi_5 + \epsilon_{5,ijt}$$

In this expression  $\alpha_5$  is a constant;  $\beta_5$  and  $\gamma_5$  are squadron- and time-fixed effects, respectively,  $\mu_5$  measures the correlation of victory scores between pilot  $j$  and his dispatch-mentioned peer,  $m_j$ ,  $\eta_5$  is the average change in (log) victories for pilot  $j$  in a mention month (captured by the dummy variable  $M_{im_jt}$ ) for pilot  $m_j$ , and  $\delta_5$  is the coefficient of interest for the change in the co-movement between pilot  $j$ 's victory score and that of his mentioned former peer. There is a high bar for validating this hypothesis: There must be an increase in the correlation during the mention period. Any pilot cited in the *Wehrmachtbericht* must by definition have had an exceptionally good month. So for his former peer to exhibit an even greater victory score correlation during mention periods would require a dramatic change in the fortunes of the latter.

Table 5 reports the results. In non-mention periods, there is already co-movement between the victory scores of former squadron peers. The correlation is 0.119; in mention

periods it is 0.184, or more than 50% higher (column 1). This effect holds also when we control for front, experience, 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).

### *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.

This is unlikely. Figure 8 plots effects over time, for both lags and leads. There is no upward shift in victory or death rates beyond the month of the mention for former peers. This alone strongly speaks against (permanent) learning about one's own type as an explanation. The brief nature of the spillover also suggests that we are capturing relatively short-term, and possibly emotional effects, rather than permanent shifts in attitude. 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 of this comparison are reported in Table 6. 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 ace; 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.

#### *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.

As a first step, we randomly assign past peer status to pilots in our data set, and then repeat the estimation of Table 3 for both exits (column 4, Panel A) and victories (column 3 Panel B). Figure A.7 in the Appendix gives the results. The results show that for both death rates and victories 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 80<sup>th</sup> 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 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 80<sup>th</sup> 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.<sup>28</sup> 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

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<sup>28</sup> 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.

coefficients vary in size, none is statistically significant – only during the month of treatment do we find a sizeable increase in exit rates.

Overall, these findings suggest that the spillover effects of public mentions were temporary. In a setting where many important things – including one’s own death – could happen in a given month, it is possible that the salience of a peer’s recognition was short-lived.

## VI. 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 has become (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.<sup>29</sup> At the same time, as Winston Churchill famously observed, “every medal casts a shadow.” In other words, for every award or medal handed out, there are many others – within range of the award or not – who may be affected. Do their reactions affect the efficacy of rewards? To examine the effect that competing for status through symbolic recognition can have in social networks, we examine the performance of high-scoring fighter aces during World War II, and focus on one motivating factor – status competition. Using German data on aerial victories and losses, we find that pilots responded strongly to public recognition of others. When a pilot is mentioned in the daily bulletin of the German armed forces for outstanding accomplishments, both current and former colleagues, on average, score more victories. At the same time, their risk of death increases considerably. 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 increased significantly for the low-skilled pilots. Unlike outstanding pilots, they die at a much higher rate following the official recognition of a peer. This implies that high-powered incentives can also backfire, possibly reducing efficiency in contexts where risk matters.<sup>30</sup> We also show that results are unlikely to be driven by social learning or learning about one’s own type.

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<sup>29</sup> 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).

<sup>30</sup> 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.

We argue that these effects reflect status competition. When a pilot is publicly recognized, the relative standing of all other pilots declines (slightly). 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 the accomplishments of a former squadron mate are highlighted. Since any tangible benefits linked to relative standing are not a function of whether the recognized pilot is personally known, our empirical strategy underlines the importance of *intrinsic* status concerns. While we cannot rule out self-image concerns, evidence from two additional settings makes this less likely: We first show that pilots react more the closer their birthplace is to that of the mentioned pilot. Second, pilots who yet have to earn a major award (but are close to the necessary quota) react the most when a former peer is mentioned. These findings suggest that status competition can be an important motivating factor in military organizations, even in extreme settings: To preserve and enhance their relative standing, some individuals are willing to go all the way to the grave.<sup>31</sup>

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<sup>31</sup> 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, Co-movement Within Squadrons

Panel A: Death rates				
	(1)	(2)	(3)	(4)
Death rate of current peers	0.228 <sup>***</sup> (0.016)	0.205 <sup>***</sup> (0.015)	0.128 <sup>***</sup> (0.017)	0.077 <sup>***</sup> (0.017)
Eastern front		-0.017 <sup>***</sup> (0.002)	-0.015 <sup>***</sup> (0.002)	-0.014 <sup>***</sup> (0.002)
Experience		-0.001 <sup>***</sup> (0.000)	-0.001 <sup>***</sup> (0.000)	-0.001 <sup>***</sup> (0.000)
Pilot quality		0.009 <sup>***</sup> (0.001)	0.009 <sup>***</sup> (0.001)	0.009 <sup>***</sup> (0.001)
Constant	0.032 <sup>***</sup> (0.001)	0.062 <sup>***</sup> (0.003)	0.066 <sup>***</sup> (0.003)	0.094 <sup>***</sup> (0.004)
<i>N</i>	84369	84369	84369	84369
<i>R</i> <sup>2</sup>	0.011	0.022	0.034	0.043
<i>Aircraft type</i>	N	Y	Y	Y
<i>Pilot FE</i>	N	N	N	N
<i>Squadron FE</i>	N	N	Y	Y
<i>Time FE</i>	N	N	N	Y
Panel B: Victory rates				
	(1)	(2)	(3)	(4)
Mean victories of current peers	0.582 <sup>***</sup> (0.026)	0.520 <sup>***</sup> (0.027)	0.520 <sup>***</sup> (0.029)	0.435 <sup>***</sup> (0.030)
Eastern front		0.077 <sup>***</sup> (0.021)	0.183 <sup>***</sup> (0.032)	0.183 <sup>***</sup> (0.033)
Experience		-0.002 <sup>***</sup> (0.001)	-0.001 <sup>*</sup> (0.001)	-0.000 (0.001)
Pilot quality		0.793 <sup>***</sup> (0.037)	0.822 <sup>***</sup> (0.037)	0.831 <sup>***</sup> (0.037)
Constant	0.266 <sup>***</sup> (0.020)	-0.114 <sup>***</sup> (0.023)	-0.188 <sup>***</sup> (0.034)	-0.160 <sup>***</sup> (0.038)
<i>N</i>	84369	84369	84369	84369
<i>R</i> <sup>2</sup>	0.088	0.182	0.186	0.196
<i>Aircraft type</i>	N	Y	Y	Y
<i>Pilot FE</i>	N	N	N	N
<i>Squadron FE</i>	N	N	Y	Y
<i>Time FE</i>	N	N	N	Y

**Note:** \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ . Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). Starting with column 2, dummy variables for aircraft type are included. Mean victories (death rate) of peers is calculated as the leave-out mean of victories (deaths) in a pilot's squadron in a given month. Eastern front is a dummy for pilots serving on the Russian front. 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). Pilot quality is calculated as a pilot's cumulative victories before period  $t$  divided by his experience.

**Table 2: Death and Victory Rates, Co-movement for Current Peers**

<b>Panel A: Death rates</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mention period	1.243 <sup>***</sup> (5.74)	1.241 <sup>***</sup> (5.72)	1.229 <sup>***</sup> (5.44)	1.225 <sup>***</sup> (5.34)	1.269 <sup>***</sup> (6.18)	1.271 <sup>***</sup> (6.26)	
Ever peer of mentioned		0.563 <sup>***</sup> (-10.88)	0.549 <sup>***</sup> (-11.05)	0.536 <sup>***</sup> (-11.63)	0.623 <sup>***</sup> (-8.83)	0.487 <sup>***</sup> (-11.2)	0.544 <sup>***</sup> (-8.91)
Current squadron peer			1.619 <sup>***</sup> (3.10)	1.577 <sup>***</sup> (2.95)	1.760 <sup>***</sup> (3.60)	1.808 <sup>***</sup> (3.77)	1.537 <sup>***</sup> (2.71)
<i>N</i>	88761	88761	88761	88761	88761	88761	88761
<i>Aircraft type</i>	N	N	N	N	Y	Y	Y
<i>Pilot quality</i>	N	N	N	Y	Y	Y	Y
<i>Eastern front</i>	N	N	N	N	Y	Y	Y
<i>Pilot FE</i>	N	N	N	N	N	N	N
<i>Squadron FE</i>	N	N	N	N	N	Y	Y
<i>Time FE</i>	N	N	N	N	N	N	Y
<b>Panel B: Victory rates</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	
Mention period	0.254 <sup>***</sup> (0.022)	0.243 <sup>***</sup> (0.022)	0.243 <sup>***</sup> (0.021)	0.247 <sup>***</sup> (0.023)	0.246 <sup>***</sup> (0.023)		
Current squadron peer		0.396 <sup>***</sup> (0.098)	0.392 <sup>***</sup> (0.098)	0.349 <sup>***</sup> (0.100)	0.318 <sup>***</sup> (0.101)	0.290 <sup>***</sup> (0.091)	
<i>N</i>	88353	88353	88353	88353	88327	88327	
<i>R</i> <sup>2</sup>	0.210	0.211	0.211	0.223	0.239	0.263	
<i>Aircraft type</i>	N	N	N	Y	Y	Y	
<i>Pilot quality</i>	N	N	Y	Y	Y	Y	
<i>Eastern front</i>	N	N	Y	Y	Y	Y	
<i>Experience</i>	N	N	Y	Y	Y	Y	
<i>Pilot FE</i>	Y	Y	Y	Y	Y	Y	
<i>Squadron FE</i>	N	N	N	N	Y	Y	
<i>Time FE</i>	N	N	N	N	N	Y	

**Note:** \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ . Standard errors clustered at the squadron level. 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. *Mention period* is a dummy variable that takes the value zero if no Luftwaffe fighter pilot is mentioned in the *Wehrmachtbericht* during a month, and 1 otherwise. Current squadron peer is a dummy for pilots who serve with the mentioned pilot in the same squadron (*Staffel*). Ever peer of mentioned pilots is a time-invariant dummy that indicates whether a pilot served with a mentioned pilot at any time during the war. Experience is the number of months of 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). We do not control for experience in Panel A because survival analysis already controls for time at risk. Pilot quality is calculated as a pilot's cumulative victories before period  $t$  divided by his experience.

**Table 3: Death and Victory Rates, Past Peers**

<b>Panel A: Death rates</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mention period	1.243 <sup>***</sup> (5.74)	1.241 <sup>***</sup> (5.72)	1.234 <sup>***</sup> (5.52)	1.230 <sup>***</sup> (5.42)	1.275 <sup>***</sup> (6.30)	1.277 <sup>***</sup> (6.39)	
Past squadron peer			1.595 <sup>**</sup> (2.45)	1.544 <sup>**</sup> (2.25)	1.631 <sup>**</sup> (2.45)	1.650 <sup>**</sup> (2.57)	1.400 <sup>*</sup> (1.84)
Ever peer of mentioned pilots		0.563 <sup>***</sup> (-10.88)	0.555 <sup>***</sup> (-11.07)	0.542 <sup>***</sup> (-11.73)	0.631 <sup>***</sup> (-8.82)	0.492 <sup>***</sup> (-11.14)	0.549 <sup>***</sup> (-8.83)
<i>N</i>	88761	88761	88761	88761	88761	88761	88761
<i>Aircraft type</i>	N	N	N	N	Y	Y	Y
<i>Pilot quality</i>	N	N	N	Y	Y	Y	Y
<i>Eastern front</i>	N	N	N	N	Y	Y	Y
<i>Pilot FE</i>	N	N	N	N	N	N	N
<i>Squadron FE</i>	N	N	N	N	N	Y	Y
<i>Time FE</i>	N	N	N	N	N	N	Y
<b>Panel B: Victory rates</b>							
	(1)	(2)	(3)	(4)	(5)	(6)	
Mention period	0.254 <sup>***</sup> (0.022)	0.246 <sup>***</sup> (0.022)	0.246 <sup>***</sup> (0.022)	0.249 <sup>***</sup> (0.023)	0.248 <sup>***</sup> (0.023)		
Past squadron peer		0.436 <sup>***</sup> (0.134)	0.430 <sup>***</sup> (0.135)	0.395 <sup>***</sup> (0.136)	0.366 <sup>***</sup> (0.137)	0.346 <sup>***</sup> (0.125)	
<i>N</i>	88353	88353	88353	88353	88327	88327	
<i>R</i> <sup>2</sup>	0.210	0.211	0.211	0.223	0.239	0.263	
<i>Aircraft type</i>	N	N	N	Y	Y	Y	
<i>Pilot quality</i>	N	N	Y	Y	Y	Y	
<i>Eastern front</i>	N	N	N	Y	Y	Y	
<i>Experience</i>	N	N	N	Y	Y	Y	
<i>Pilot FE</i>	Y	Y	Y	Y	Y	Y	
<i>Squadron FE</i>	N	N	N	N	Y	Y	
<i>Time FE</i>	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*). For Panel B, our fixed effect model drops singleton observations. Standard errors are virtually unaffected. See the note of Table 2 for additional variable descriptions.

**Table 4: Death and Victory Rates, Past Peers, By Previous Performance**

<b>Panel A: Death rates</b>				
	(1)	(2)	(3)	(4)
	Full sample	<80	80+	90+
Past squadron peer of mentioned	1.400 <sup>*</sup> (1.84)	1.671 <sup>**</sup> (2.39)	0.831 (-0.50)	1.060 (0.12)
Ever peer of mentioned pilots	0.549 <sup>***</sup> (-8.83)	0.497 <sup>***</sup> (-9.86)	0.552 <sup>***</sup> (-5.19)	0.438 <sup>***</sup> (-4.44)
<i>N</i>	88761	71038	17723	9017
<i>Aircraft type</i>	Y	Y	Y	Y
<i>Pilot quality</i>	Y	Y	Y	Y
<i>Eastern front</i>	Y	Y	Y	Y
<i>Pilot FE</i>	N	N	N	N
<i>Squadron FE</i>	Y	Y	Y	Y
<i>Time FE</i>	Y	Y	Y	Y
<b>Panel B: Victory rates</b>				
	(1)	(2)	(3)	(4)
	Full sample	<80	80+	90+
Past squadron peer of mentioned	0.346 <sup>***</sup> (0.125)	0.008 (0.059)	1.054 <sup>***</sup> (0.358)	1.486 <sup>***</sup> (0.572)
<i>N</i>	88327	70174	17108	8682
<i>R</i> <sup>2</sup>	0.263	0.252	0.292	0.313
<i>Aircraft type</i>	Y	Y	Y	Y
<i>Pilot quality</i>	Y	Y	Y	Y
<i>Eastern front</i>	Y	Y	Y	Y
<i>Experience</i>	Y	Y	Y	Y
<i>Pilot FE</i>	Y	Y	Y	Y
<i>Squadron FE</i>	Y	Y	Y	Y
<i>Time FE</i>	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 3, 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 2 and 3 for variable descriptions.

**Table 5: Correlation of Pilot Performance, Past Peers and Mentioned Pilot** (dependent variable:  $\log(\text{victory rate}+0.01)$ )

	(1)	(2)	(3)	(4)
$\text{Log}(\text{vic}_{mi} + 0.01)$	0.119 <sup>***</sup> (0.010)	0.097 <sup>***</sup> (0.009)	0.046 <sup>***</sup> (0.008)	0.001 (0.007)
Mention period	-0.156 <sup>*</sup> (0.092)	-0.160 <sup>*</sup> (0.096)	-0.213 <sup>**</sup> (0.089)	-0.191 <sup>**</sup> (0.093)
Mention period * $\log(\text{vic}_{mi} + 0.01)$	0.065 <sup>*</sup> (0.033)	0.062 <sup>*</sup> (0.033)	0.068 <sup>**</sup> (0.033)	0.070 <sup>*</sup> (0.038)
Eastern front		0.262 <sup>***</sup> (0.070)	0.349 <sup>**</sup> (0.136)	0.300 <sup>*</sup> (0.163)
Experience		-0.016 <sup>***</sup> (0.002)	-0.016 <sup>***</sup> (0.002)	-0.011 <sup>***</sup> (0.003)
Pilot quality		0.653 <sup>***</sup> (0.042)	0.628 <sup>***</sup> (0.040)	0.663 <sup>***</sup> (0.044)
Constant	-3.044 <sup>***</sup> (0.048)	-3.281 <sup>***</sup> (0.086)	-2.067 <sup>***</sup> (0.648)	-2.991 <sup>***</sup> (0.724)
<i>N</i>	39183	39183	39183	20858
<i>R</i> <sup>2</sup>	0.024	0.118	0.207	0.242
<i>Aircraft type</i>	N	Y	Y	Y
<i>Pilot quality</i>	N	Y	Y	Y
<i>Experience</i>	N	Y	Y	Y
<i>Pilot FE</i>	N	N	N	N
<i>Squadron FE</i>	N	N	Y	Y
<i>Time FE</i>	N	N	Y	Y

**Note:** \*  $p < .1$ , \*\*  $p < .05$ , \*\*\*  $p < .01$ . Standard errors in parentheses are clustered at the level of the squadron (*Staffel*).  $\text{Log}(\text{vic}_{mi}+0.01)$  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 note of Table 2 for variable descriptions.

**Table 6: Death and Victory Rates, Past Peers, by Previous Cumulative Score**

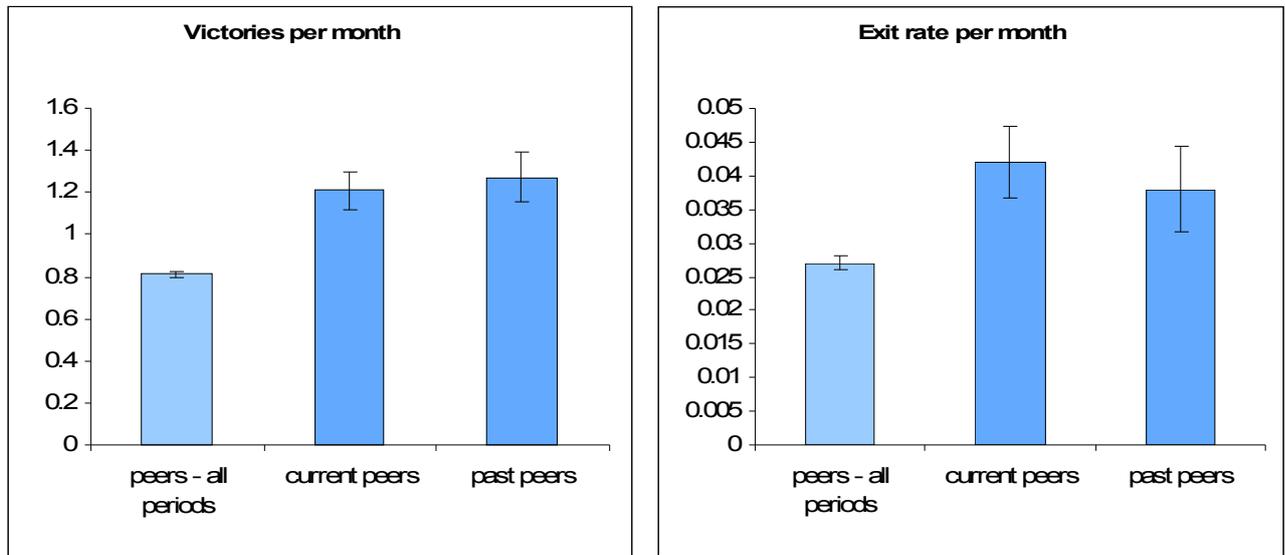
	Panel A: Death rates		Panel B: Victory rates	
	(1) < score	(2) ≥ score	(3) < score	(4) ≥ score
Past squadron peer of mentioned	1.579 <sup>**</sup> (0.287)	0.830 (0.377)	0.213 <sup>**</sup> (0.107)	0.711 <sup>**</sup> (0.325)
Ever peer of mentioned pilots	0.550 <sup>***</sup> (0.037)	0.548 <sup>***</sup>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

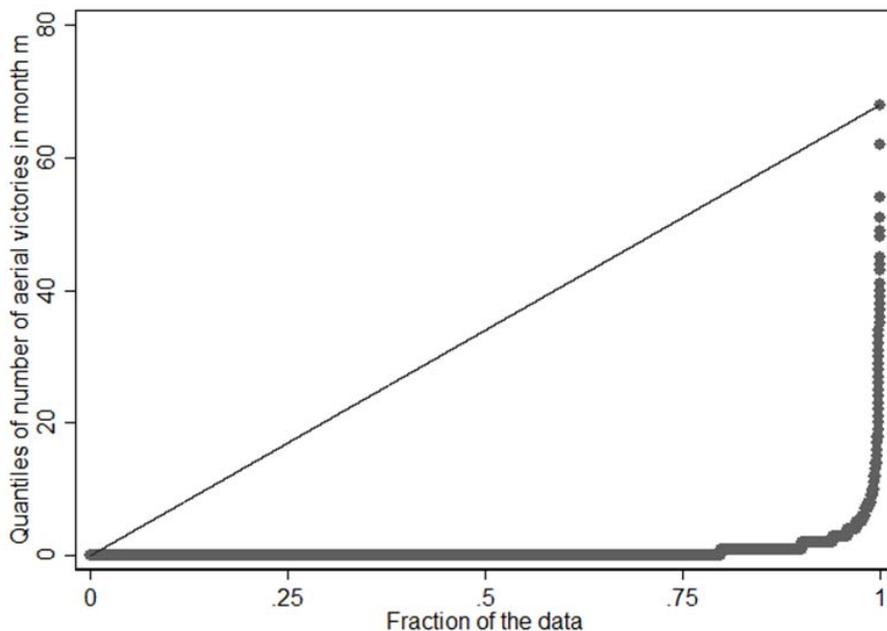
## FIGURES

**Figure 1: Victory and Death Rates per Month During Mention Periods**



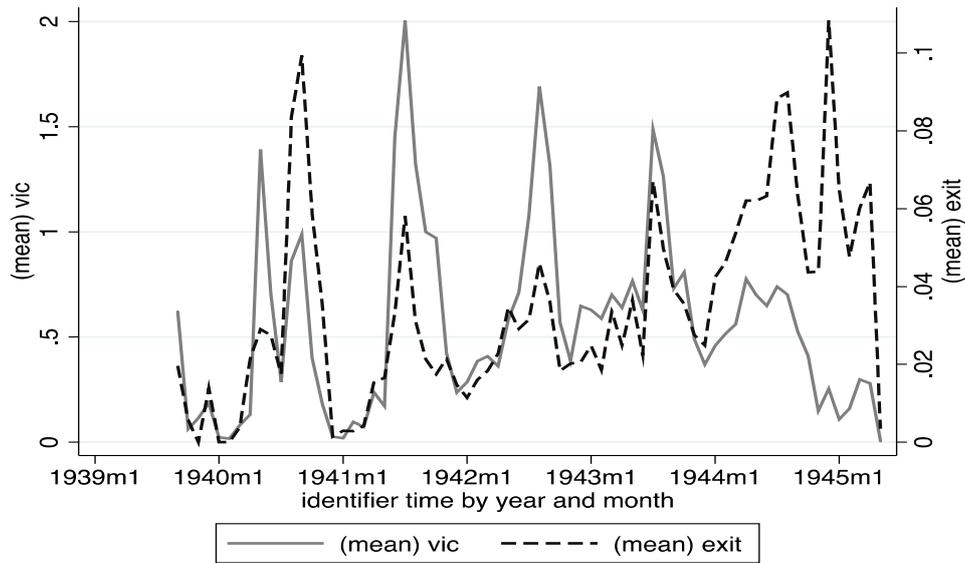
**Note:** The figure shows mean monthly victory and exit rates for pilots who ever flew with a mentioned pilot, those who currently fly with a mentioned pilot, and those who flew with one in the past. Mentions are from the German armed forces daily bulletin (*Wehrmachtbericht*).

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



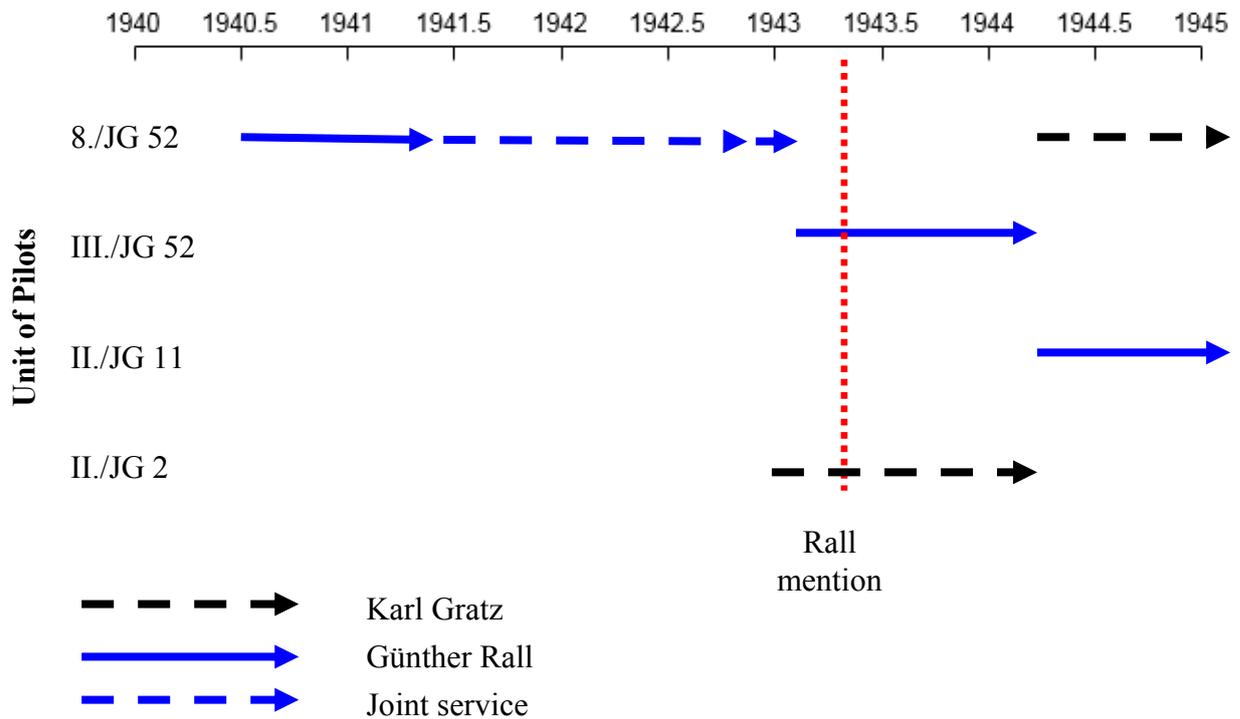
**Note:** The figure shows the cumulative distribution of monthly victory scores per month (dots). While 80% of German pilots did not score in an average month, one pilot scored 68 victories in a single month.

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



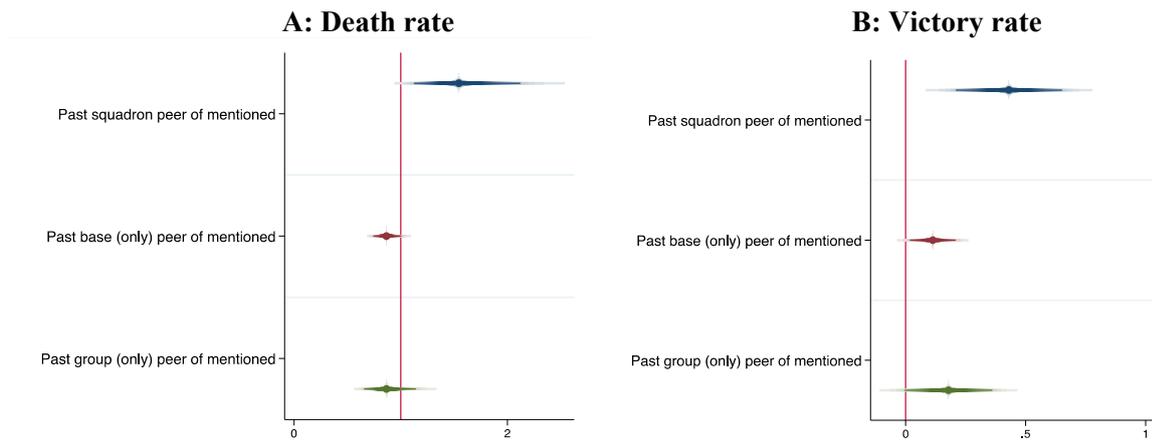
**Note:** The figure plots the per-pilot average monthly victory score (left-hand y-axis) and the exit rate per month (right-hand y-axis) over time (x-axis).

**Figure 4: Identification Strategy**



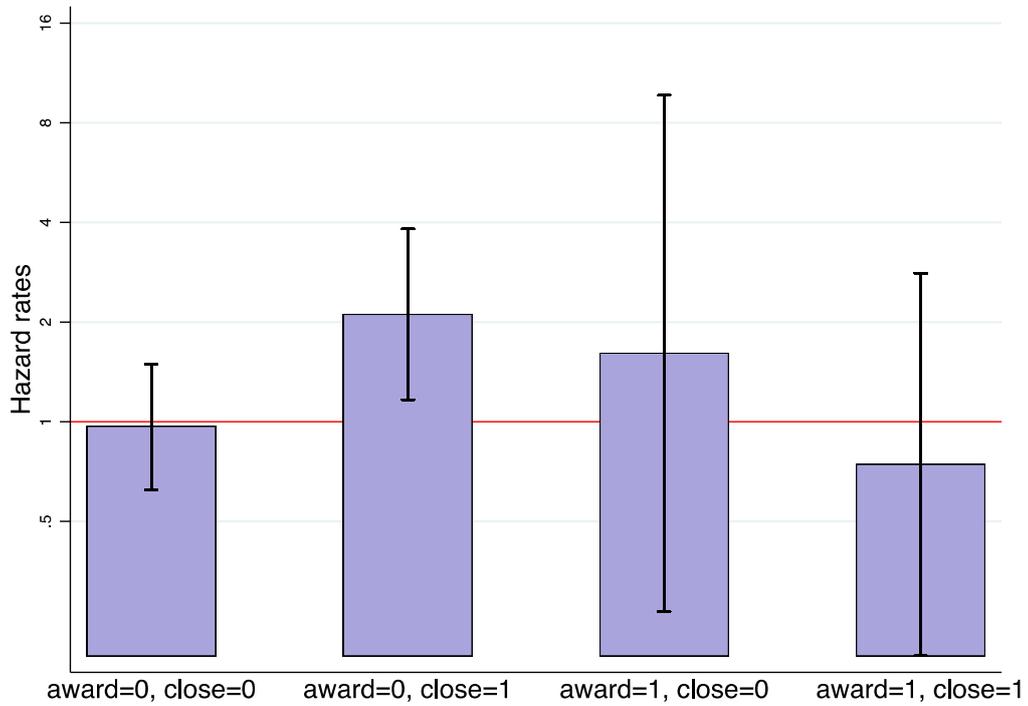
**Note:** The red dashed line indicates mention in the *Wehrmachtbericht* for Günther Rall.

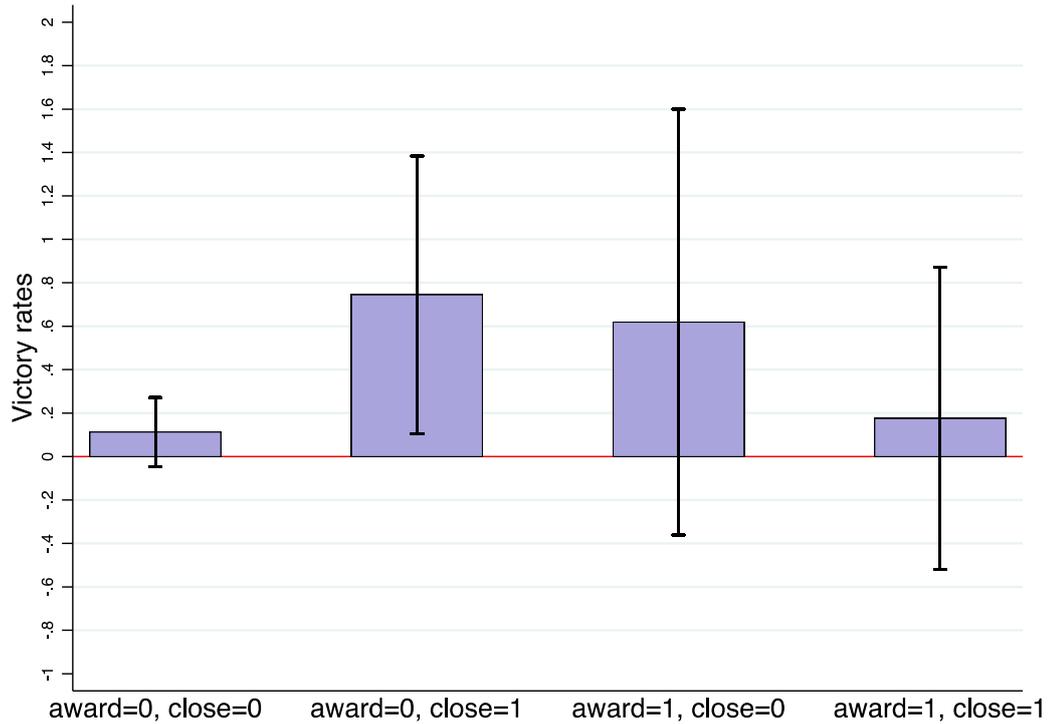
**Figure 5: Coefficient sizes, alternative peer groups**



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

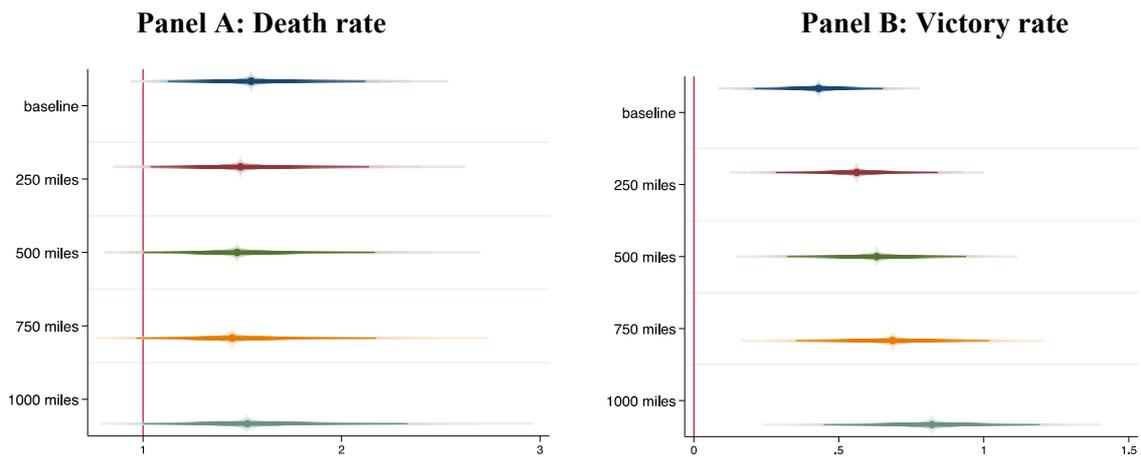
**Figure 6: Exit and Victory Rates, Close to Knight's Cross**





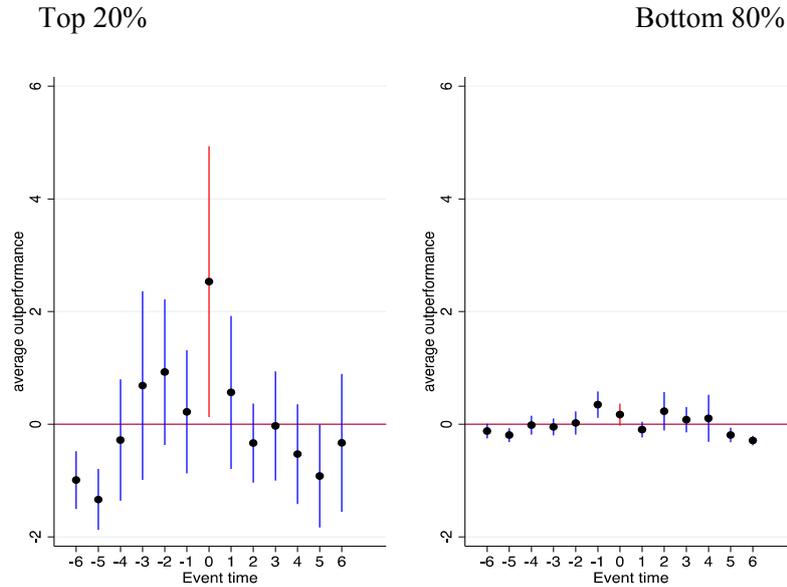
**Note:** The figure shows the coefficient on the variable past peer of mentioned in regressions based on Table 3, column 4 of Panel A (column 3 of Panel B). Note that the y-axis in the top panel is scaled logarithmically. We use the simpler specification since the samples of pilots with awards is relative small (1,426 and 2,972 observations, respectively, for columns 3 and 4 of this figure). Results from regressions based on more demanding specifications of Table 3 are very similar. 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**

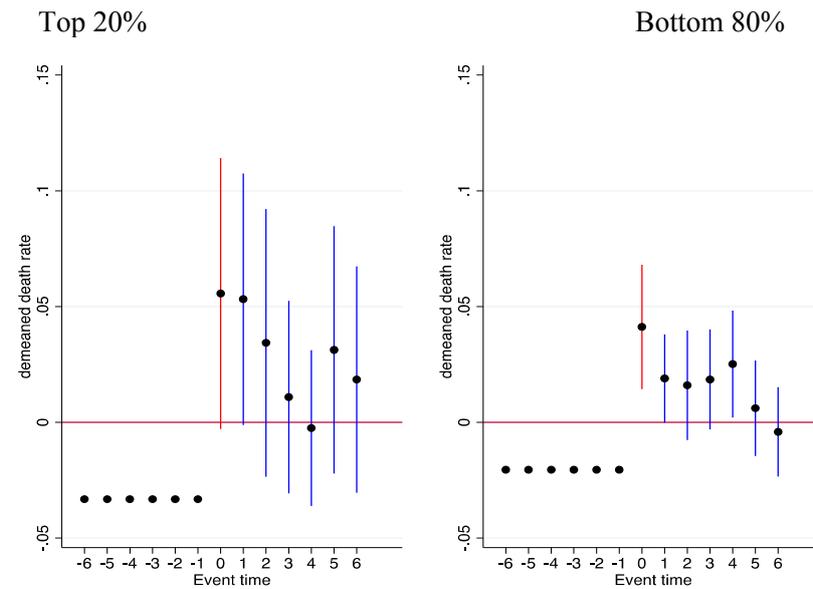


**Note:** The figure plots the coefficient (x-axes) for exits (Panel A) and outperformance (Panel B) during mention months of the peers of mentioned pilots as a function of minimum distance (y-axes) for squadron peers. It uses the same specification as Table 3, column 4 in Panel A (column 3 in Panel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

**Figure 8: Pilot Outperformance in Event Time by Quality Group**  
**Panel A: Victory rate**



**Panel B: Death rate**



**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.

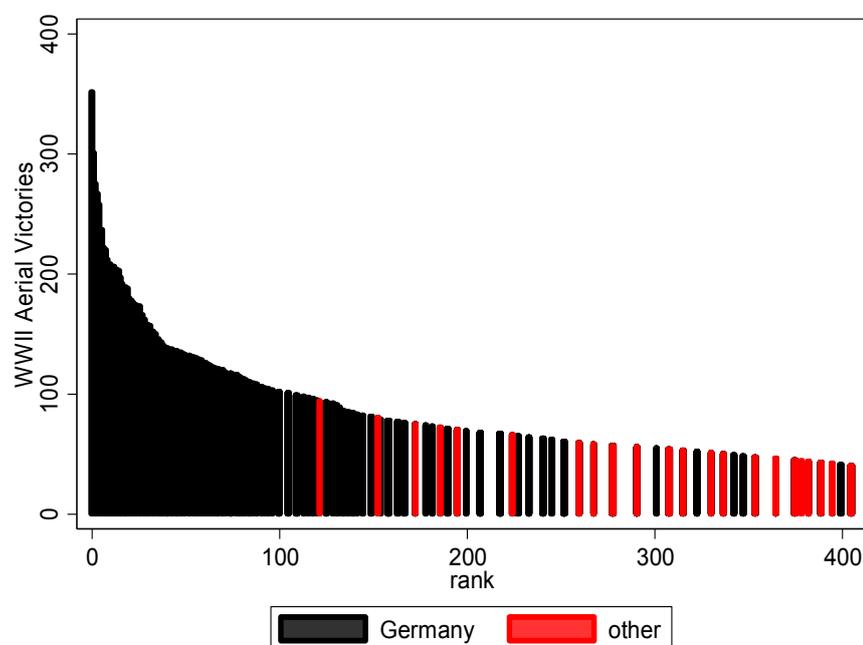
## For Online Publication

## APPENDIX

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

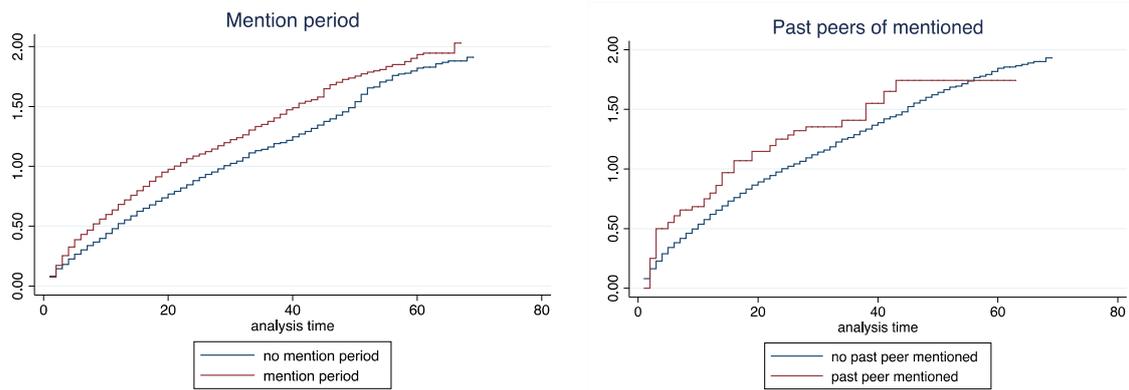
	everpeer		t-test
	0	1	
victories	0.55	0.72	-11.4***
experience	15.4	21.1	-56.9***
exit	0.05	0.025	19.1***
front	0.35	0.42	-22.9***

**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**

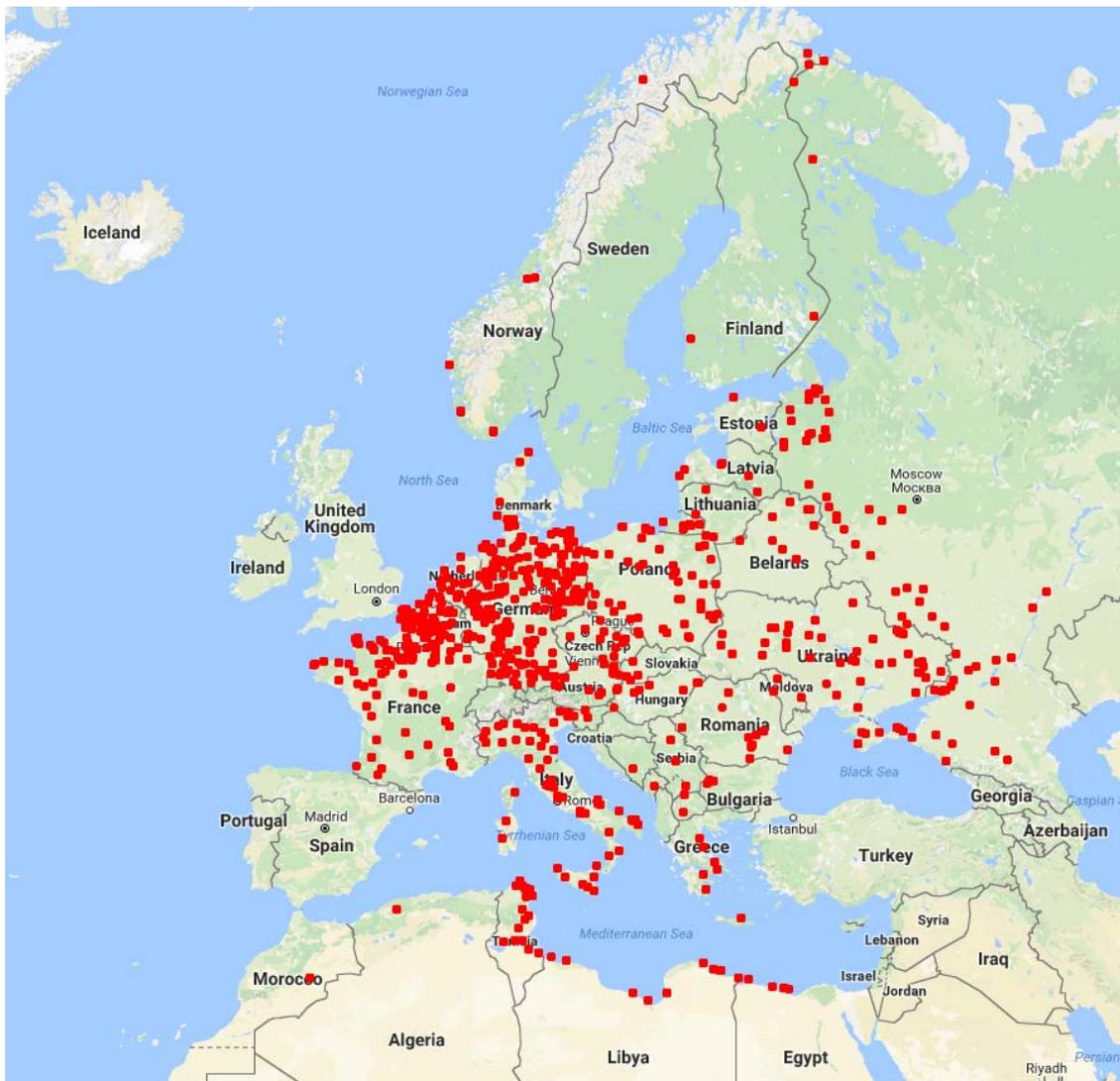
**Note:** The figure shows the overall score, by pilot, for pilots ranked 1 through 400 during World War II. The gaps signify ties.

**Figure A.2: Hazard curves**



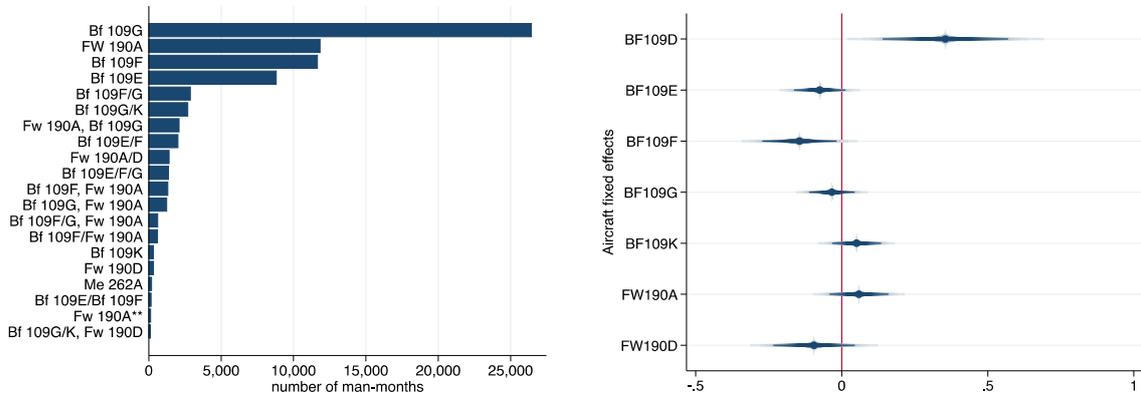
**Note:** The curves show the hazard rates (Nelson-Aalen) of pilots either conditional on being in a mention periods (left panel) or conditional on being the past peer of a mentioned pilot (right panel) during a mention period. Both figures are based on the specification from Table 3, Panel A, column 4.

**Figure A.3: Airfield Locations of Luftwaffe Squadrons, 1939–1945**



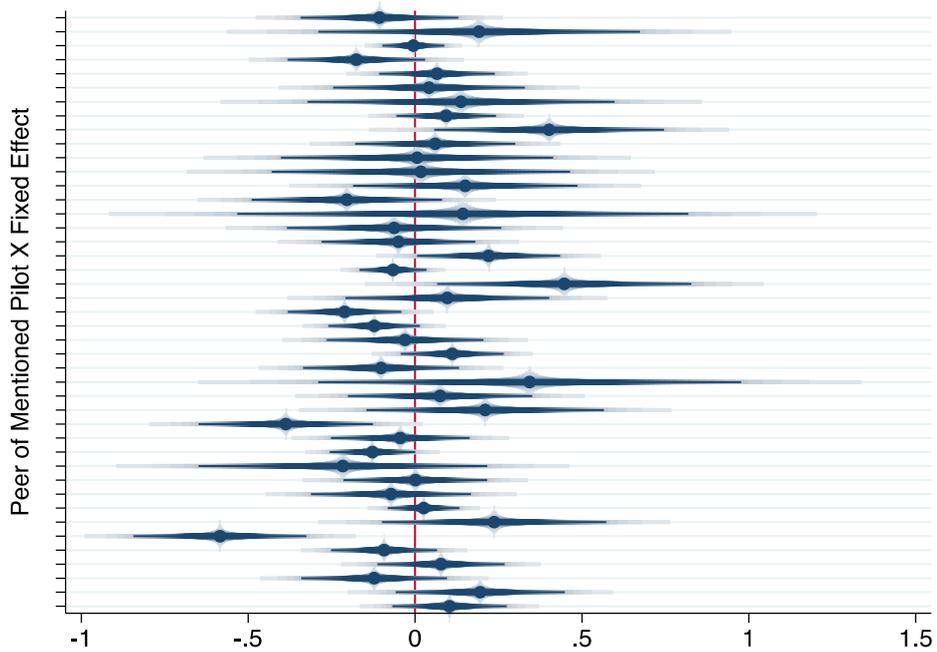
**Note:** This map plots the location of every airfield from which pilots in our data set flew at least once during the period September 1939 to May 1945.

**Figure A.4: Aircraft Type – Usage and Fixed Effect (95% and 99% CIs) on Victory Scores**



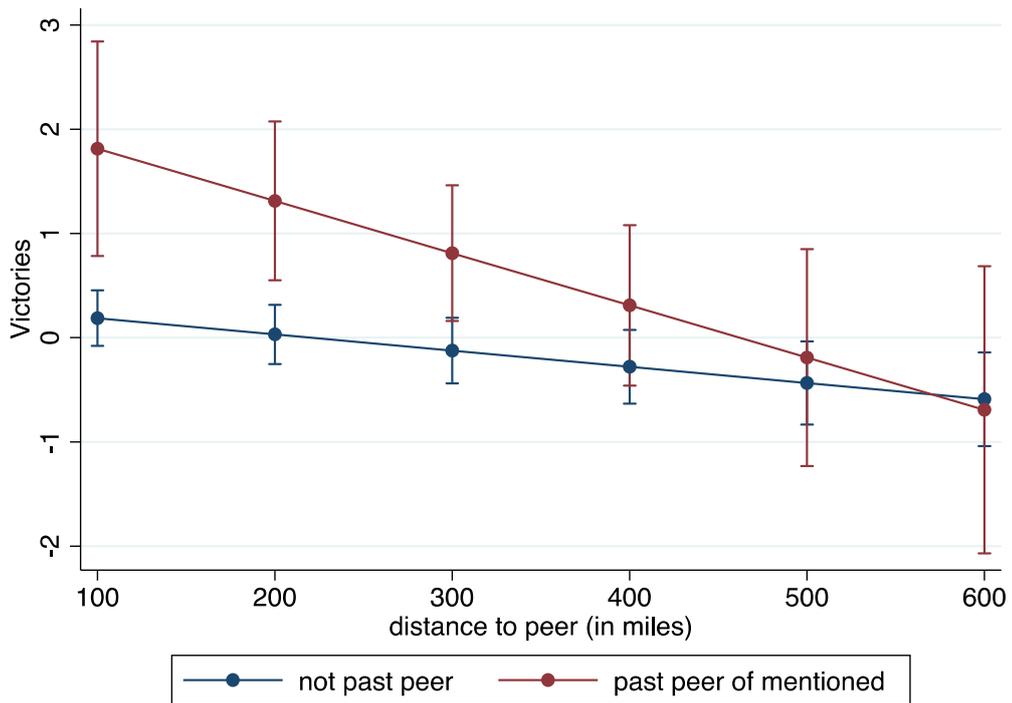
**Note:** The left panel of Figure A.4 plots the number of man-months in our data set of different aircraft types (or combinations) flown by squadrons. The right panel plots the fixed effects for the main aircraft types in a regression using the specification of Table 3, Panel B, column 6.

**Figure A.5: 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 3, Panel B, column 6. But instead of pilot FEs, we include dummies for ever being peer of a particular mentioned pilot.

**Figure A.6: Marginal Peer Effects by Birthplace Distance**

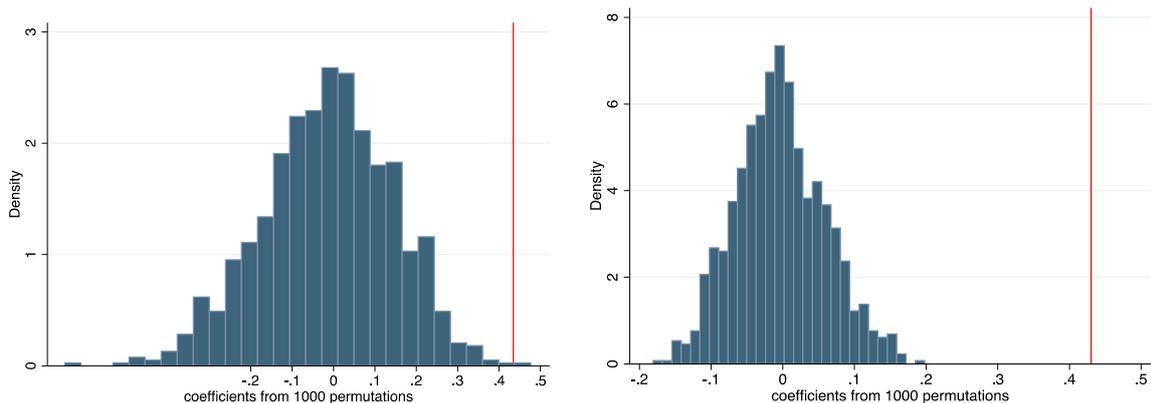


**Note:** The figure shows a marginplot for the interaction effect of birthplace distance (in miles) and our treatment on the number of victories of peers of a mentioned past peer. Past peers are former squadron peers who are no longer serving in the same unit. The analysis is based on data from 352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

**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 3, 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 3).