Ego Trips to the Grave: Relative Position and Risk Taking among German Fighter Pilots, 1939-45

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Abstract. How far are people willing to go to improve their relative position – their status? And what determines the reference groups that they care about? In this paper, we focus on the effects of rank and public recognition on the risk taking and performance of pilots. Using newly collected data on monthly death rates and victory claims of more than 5,000 German pilots during World War II, we find that concerns about relative position can have important effects: After the German armed forces bulletin mentioned the accomplishments of a particular fighter pilot, his peers performed better, but died at much greater rates. This is true of both current and former peers, i.e. pilots serving concurrently in the same unit as well as those serving in different units and at different fronts. The strength of this spillover, in turn, depends on the intensity of prior interactions and social distance: Pilots from the same squadron show much larger effects than pilots who merely flew from the same airfield, and pilots born in the same region as a mentioned pilot react more to public recognition.

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I. INTRODUCTION

Humans are social animals; it is part of human nature to compare ourselves with others. Many institutions and firms tap into the primal nature of relative status concerns. Prizes are regularly awarded to the best teacher, artist, or athlete, with lower awards reserved for the runners-up. Many firms from GE to Microsoft reward workers for relative performance, and professors assign grades based on class rank. Economists from Adam Smith to John Stuart Mill and James Duesenberry already emphasized the importance of concerns about relative position. The desire to outrank others may even have conferred a selective advantage in earlier periods (Cole et al. 1992); it is also common in other primates (Raleigh et al. 1984).

Concerns about rank extend beyond the workplace, and may have detrimental effects: Conspicuous consumption can decrease well-being in society as a whole (Veblen 1899, Frank 1985). Subjective well-being often goes down with (perceived) increases in the mean income of a reference group (Luttmer 2005 and Perez-Truglia 2016).[1] At the same time, a rich theoretical literature on tournaments has argued that competing for relative standing can align employee incentives and lead to greater effort (Lazear and Rosen 1981; Nalebuff and Stiglitz 1983). Individuals typically care not only about their rank in as such. Generally, they do so relative to a specific peer group. What the relevant social groups are, how they are created, and under what conditions they matter are open questions.

In this paper, we examine how much sharper concerns about relative standing become as a result of previous teamwork, current workplace assignment, and similar geographical origin. We also analyze how much risk people are willing to take to improve their relative standing. To examine these questions, we turn to a high-stakes setting – aerial combat during World War II. Using newly assembled data on the death rates and aerial victory scores of German fighter pilots, we show that relative status concerns can systematically lead to greater risk-taking. Death rates and victory rates are typically correlated over time, and especially so within squadrons – the primary fighting unit of every air force, consisting of 8-12 pilots. Joint combat not only welds units together. Simultaneous shocks to the combat environment, such as a major offensive or changes in weather, will lead to correlated outcomes. We therefore focus on the performance of individual pilots when a *former* peer is publicly recognized in a highly visible way. Such recognition is also associated with a sharp increase in death rates amongst fellow pilots with whom he flew in the same squadron in the past ("squadron peers"), as well as a sharp increase in aerial victories. This effect suggests that there are important spillovers in terms of risk-taking (and performance) through social networks formed in the workplace. Similar effects are visible for individuals who come from the same geographical area.

Aerial combat is a useful setting for analyzing the effects of status concerns on risk taking and performance: the stakes are high, social status is closely tied to relative

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[1] Kuziemko et al. (2014) show evidence that individuals go to great lengths to avoid being ranked last in a group.

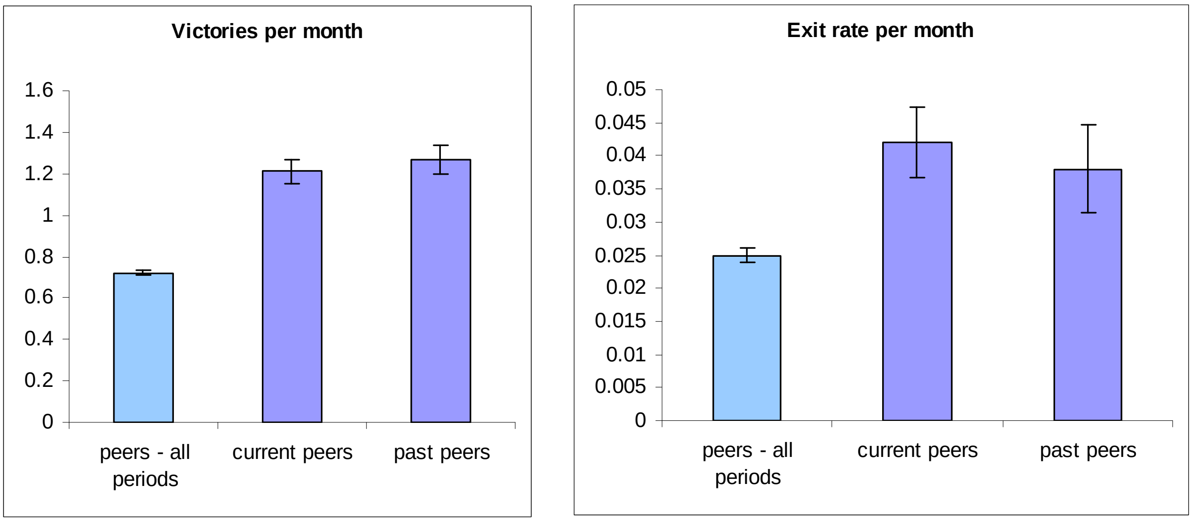
performance, effort is extremely difficult to observe but both death and victories are fairly well-measured. Crucially, once a battle is joined, there is no effective control of individual planes by superior officers. In every dogfight, each pilot had to decide whether to pursue victory or break off contact: Pilots could try to boost their score by flying more days a week, performing additional sorties per day, and taking extra risks during missions. Finally, victories were also highly visible to squadron peers: pilots would typically paint the number of aerial victories on their own aircraft's tail rudder, with special markings for "round" numbers such as 50 or 100.

Anecdotally, there is ample evidence that status competition was a strong motivating force: During the Battle of Britain – arguably the decisive air battle of WW 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 ground one of his best pilots 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)*. It typically only contained a news summary of military developments on each front. Occasionally, it would highlight the accomplishments of an individual soldier, such as a high number of tank 'kills' or enemy ships sunk.[2] Mentions constituted an exceptional form of recognition, and were as rare as the most prestigious medals. News from the bulletin would also be broadcast on the radio, published in the press, and distributed at command posts throughout German-held territory. They were also largely unexpected, since there was simple rule that "entitled" a soldier to being mentioned. We exploit these mentions to examine how pilots react to public recognition of fellow pilots.

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

Figure 1: Victory and Exit Rates per Month for Fighter Pilots (Aces and Non-Aces) during Periods of Fighter Pilot Mentions



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 (*Wehrmachtsbericht*).

Figure 1 illustrates our main finding. It shows victory and survival rates for pilots who ever flew with a mentioned pilots. In normal times, these pilots score 0.7 victories per moth, and die at a rate of 2.5%. When they currently fly with a mentioned pilot, these rates jump – to 1.2 victories per month, and an exit rate over 4%. To avoid the effect of correlated shocks, we look at *former* peers. The effects for these pilots are very similar in magnitude (and statistically indistinguishable) from the effects for current peers – they show large increases in performance, and a marked rise in death rates.

The effect from mentions of past squadron peers can potentially shed light on the formation of reference groups. As we show below, pilots seem to care about their standing relative to their current peers; shocks making their *past* peers' performance more salient appear to reactivate relative concerns with respect to these peers. Moreover, the effect sizes for current and past peers are of similar magnitudes, suggesting that relative concerns with respect to former peers are intense and can easily be reactivated. We show that these results are largest for pilots who served in the same squadron, and smaller for pilots who served in the same group ("Gruppe"), or flew from the same airfield. Effects are largest for privates and NCOs, and smaller for officers. They do not depend on using pilots from nearby airfields – even pilots as far away as 1,000 km show evidence of spillovers. We also find that for peers born close to each other, the effects of a mention on risk taking and performance in dispatches are especially large.

Our work relates to a growing literature on image concerns and social behavior. Recent papers have shown that individuals care about how they are viewed by others, and that this has important effects on a important range of behaviors, from charitable donations (DellaVigna et al., 2012), to campaign contributions (Perez-Truglia and Cruces, forthcoming), to voting (DellaVigna et al., 2017), to protest participation (Enikolopov et al., 2017) and educational investments (Bursztyn and Jensen, 2015). Our paper evaluates the potential role of image concerns in a setting with extremely high stakes, and it allows us to examine how the reference groups that are crucial for (self- and social) image concerns are shaped by an individual's history.

Our work also relates to the literatures on tournaments and peer effects. 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; Aoyagi 2007; 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.[3] Our own results indicate that status concerns can indeed promote risk taking, and we demonstrate this dynamic in a setting with high stakes (and no tangible upside, financially). Far from pilots "giving up", though, we find additional effort exerted and greater risks taken – with deadly consequences.

The rich literature 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). 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. It is worth pointing out that evidence for peer pressure is relatively strong for low-skilled individuals but is distinctly mixed among the highly skilled (Jackson and Bruegmann 2009; Azoulay et al. 2010; Waldinger 2012). In this paper, we offer an example of social interactions creating greater incentives to perform among highly skilled (and motivated) individuals.

Finally, we contribute to the literature on the determinants of military performance. Classic studies in military history have emphasized the importance of collaborative efforts (Stouffer et al. 1949; McPherson 1997; Van Creveld 2007). Along these lines, unit cohesion has been shown to be higher when soldiers are from similar backgrounds. For instance, Costa and Kahn (2003) document lower rates of desertion from units with low occupational and birthplace fragmentation; these authors also find that survival rates in a prisoner-of-war camp were much higher for POWs embedded in richer social networks (Costa and Kahn 2007). In contrast to the

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[3] For example, Brown (2011) shows that golf players underperform when competing against Tiger Woods.

literature emphasizing the importance of joint production and unit cohesion in military units, we underline the importance of individual incentives and of competition.

Our results are of wider interest despite the highly specific setting of our study. We present novel evidence that 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 status can induce too much risk taking. One clear analogy is the performance incentive in the compensation that a financial institution pays to its traders; in that case, the desire to be the "best" trader can lead to catastrophic losses.[4]

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

II. Historical Background and Data

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

A. The German air force during World War II

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 (on Franco's side), gaining valuable experience. There, the Luftwaffe carried out 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).

The German air force was organized into air fleets composed of several flying corps. Flying corps contained several wings (*Geschwader*), most of which comprised three groups (*Gruppe)* each consisting, in turn, of three or four squadrons (*Staffel*). Each squadron had an authorized strength of twelve aircraft, but actual strength could be as many as sixteen or as few as four or five aircraft (Stedman and Chappell 2002).

The German air force began the war in 1939 with 4,000 planes, including 1,200 fighters, and 880,000 men (Kroener et al. 1988). It had initially been designed for joint

[4] The closest paper to ours in spirit is the one by Brown et al. (1996), who show that relative performance incentives can lead to excessive risk taking in asset management.

arms operations; during the early Blitzkrieg campaigns, it mostly 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. This tactic ensured that the Luftwaffe achieved air superiority. The only exception before 1943 was the Luftwaffe's defeat during the Battle of Britain. There, Germany's failure to dominate the skies ultimately led to the planned invasion of the British Isles being called off.

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. Air attacks on hydrogenation plants and on airframe and aero-engine factories threatened the Luftwaffe especially, and from 1943 onward its efforts were devoted mainly to fending off the growing tide of bomber attacks. Despite these efforts, German cities were quickly reduced to rubble as the strength of British and American air forces grew.

Having started the war with modern planes and a large air fleet, Germany first lost its quantitative edge. Once it invaded Russia and US forces joined the fight, the Luftwaffe was heavily outnumbered in all theatres 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 US pilots before being sent into combat (Murray 1996).

Loss rates increased over the course of the war, eventually rising to staggering heights. 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). 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 May and December 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 US air force destroyed much less industrial capacity than anticipated. Even so, the Anglo-American air offensive was clearly able to degrade substantially the German air force'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 1942–1943 onward, it continued to be a match for the Red Air Force almost until the war's end. 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 WW I to Yom Kippur. James Salter, a US fighter pilot during the Korean War, described his experiences in an autobiographical novel:

> "There were no other values… [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… no matter how capable and courageous, [you had] failed…" (Salter 1956).

On German fighter aircraft during WW II, a pilot's victory score was prominently displayed on the tail rudder. In this way, a figher 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.[5]

In addition, soldier could receive a mention in the daily bulletin. This was considered one of the highest forms of recognition available in the German armed forces. A typical daily report would describe major 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.[6] 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

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[5] During World War II, about 3.3 million Iron Crosses 2nd class were awarded but only 7,300 Knight's Crosses, 890 Knight's Crosses with Oak Leaves, 160 with Swords, 27 with Diamonds, and one with Golden Oak Leaves.

[6] 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).

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 skilfully 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 highly-performing pilots. In our data, we have information on 52 fighter pilots mentioned in the bulletin; of these, 39 mentions are about the numbero of aerial victories achieved, either cumulatively or in a single period (one day, one month, etc.). Mentioned pilots ended the war with an average of 108 victories, and scored an average of 2.3 victories a month (compared to an average in our sample of 0.6).

C. Data

Our database of German fighter pilots during WWII draws on two principal sources: Jim Perry's and Tony Wood's *Oberkommando der Luftwaffe* combat claims list, and the Kracker Luftwaffe Archive.[7] The OKL fighter claims list was extracted from microfilms of the handwritten records of the Luftwaffe Personalamt stored at the German Federal Archives (Bundesarchiv) in Freiburg. Because some OKL fighter claims records did not survive the war, Tony Wood augmented the list with claims from other published sources – such as Donald Caldwell's (1996) JG26 war dairy – to obtain a comprehensive list of German fighter claims for the years 1939–1945.

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, WWII survivor) and for some pilots also the starting date of their 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 WWII, 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 night fighter pilots differ substantially. Whereas day fighters often battled against other

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[7] 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/.

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 WWII. 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 71.50%) 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 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.[9] This allows us to confirm that 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 severely wounded. This suggests that the vast majority of cases so identified do indeed reference pilots who were either killed or permanently incapacitated.

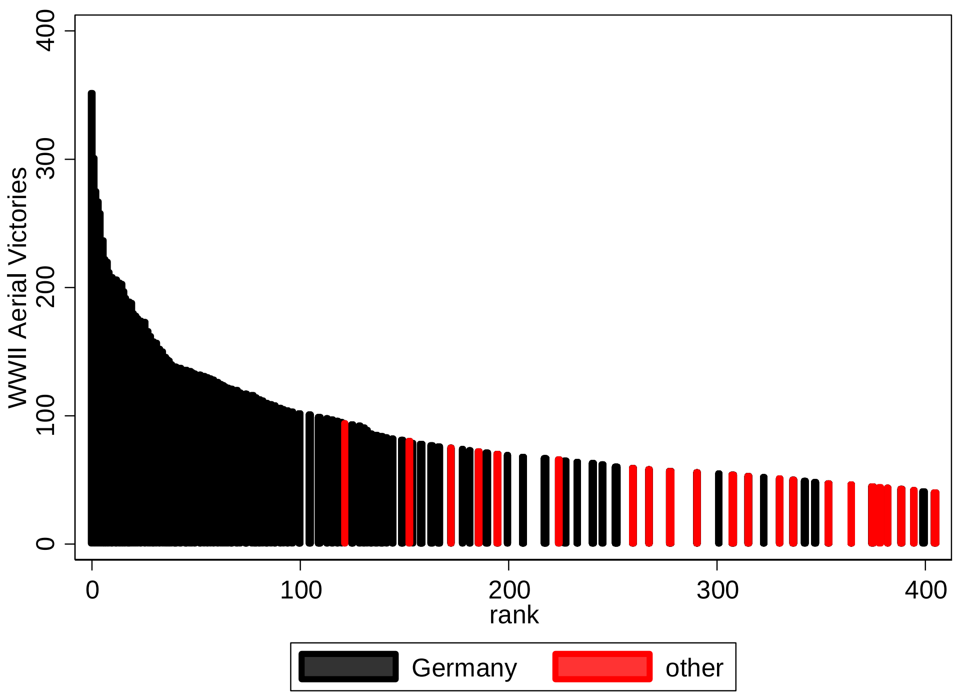
We also use the victory claims data compiled by Perry-Wood and Kracker. The high command of the German air force (*Oberkommando der Luftwaffe*, OKL) received fighter claims throughout the war. A special staff for recognition and discipline was in charge of collecting and validating claimed aerial victories. 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 WWII 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

[9] 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 dataset 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 biographical data for 3819 of our 5018 pilots.

explosion in the air) or that the enemy pilot was seen bailing out. Many claims were not accepted, and rightly so.[10]

The German air force in WWII 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-performing Soviet, Commonwealth, and American pilots were credited with (respectively) 66, 40, and 38 kills. Figure 2 plots the distribution and nationality of WWII aces.

Figure 2: Aerial Victories – Total for WWII 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.

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 were shot down.[11] Second, the poor quality of planes and training in the USSR at the start of WWII gave German pilots great opportunities to

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[10] 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).

[11] The number of total sorties is a key factor in skewing the distribution of victory scores (Neillands 2001).

rack up victory claims. Third, a result of their participation in the Spanish Civil War, German pilots had much greater experience vis-à-vis enemy air forces during the conflict's early stages, (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 (resp., 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.[12]

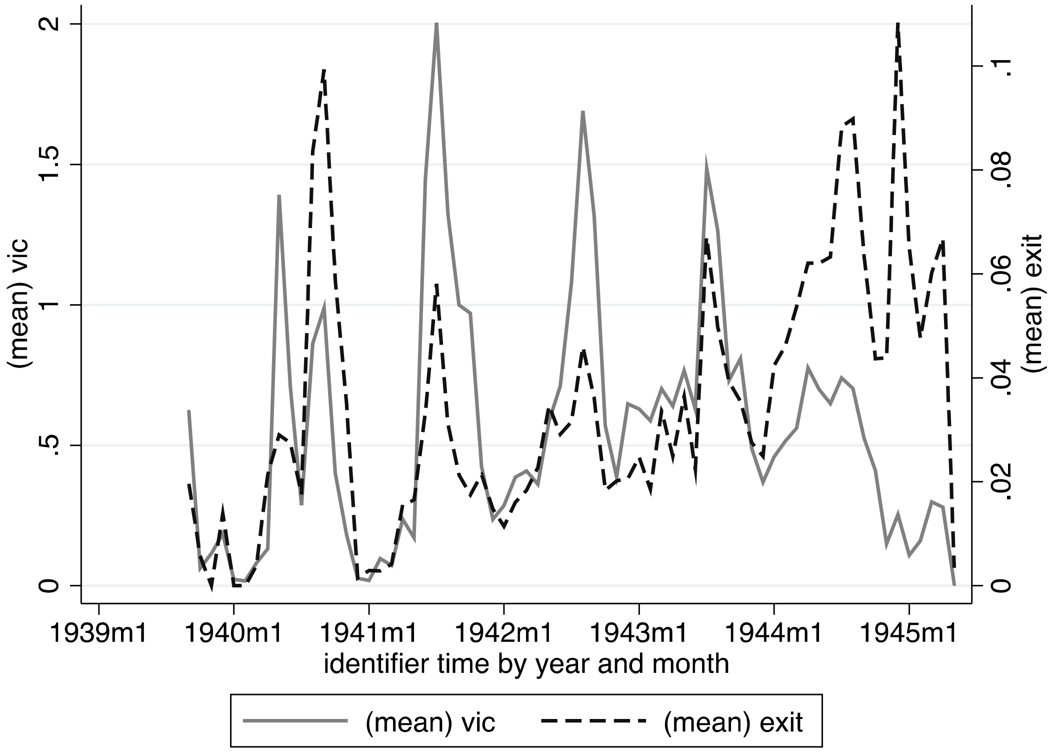
The distribution of scores was extremely uneven. The top-scoring 110 pilots achieved as many aerial victories as the bottom 4,900 pilots combined. In an average month, the vast majority (more than 80%) of pilots failed to score even a single victory. At the same time, some pilots quickly notched up large 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 4 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 4 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.

[12] 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.

Figure 4: 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).

E. 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 contained several groups, all dedicated to the same specialized function.

Pilots were trained to fly before they received training in more specialized skills such as aerial combat. They would first attend "boot camp", which emphasized 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). There is no evidence that better graduates of the air combat schools were sent to elite squadrons. Allocation of new pilots to units was largely random, driven by operational needs, recent losses, and – sometimes – personal connections (Caldwell 1996).

III. MAIN RESULTS

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

A. Correlation within squadrons and with contemporary peers

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

$$V_{j,i,t} = C + \alpha * V^*_{i,t} + \beta * X' + \epsilon$$

$$E_{j,i,t} = C + \alpha * E^*_{i,t} + \beta * X' + \epsilon$$

where C is a constant, V(E)* is a leave-out mean, and X' is a vector of controls. As principal controls we use a dummy for the Eastern front, experience (the number of months a pilots has already been tracked in our data), and a measure of pilot quality, based on the Mas-Moretti (2009) indicator of individual performance.

Table 1: Death and victory rates, co-movement within squadrons

Panel A: Death rates

	(1) OLS	(2) controls	(3) +SqFE	(4) +timeFE
Death rate of current peers	0.228***	0.205***	0.128***	0.077***
	(0.016)	(0.015)	(0.017)	(0.017)
Eastern front		-0.017***	-0.015***	-0.014***
		(0.002)	(0.002)	(0.002)
Experience		-0.001***	-0.001***	-0.001***
		(0.000)	(0.000)	(0.000)
Pilot quality		0.009***	0.009***	0.009***
		(0.001)	(0.001)	(0.001)
Constant	0.032***	0.062***	0.066***	0.094***
	(0.001)	(0.003)	(0.003)	(0.004)
N	84369	84369	84369	84369
R^2	0.011	0.022	0.034	0.043

Panel B: Victory rates

	(1) OLS	(2) controls	(3) +SqFE	(4) +timeFE
Mean victories of current peers	0.582***	0.520***	0.520***	0.435***
	(0.026)	(0.027)	(0.029)	(0.030)
Eastern front		0.077***	0.183***	0.183***
		(0.021)	(0.032)	(0.033)
Experience		-0.002***	-0.001*	-0.000
		(0.001)	(0.001)	(0.001)
Pilot quality		0.793***	0.822***	0.831***
		(0.037)	(0.037)	(0.037)
Constant	0.266***	-0.114***	-0.188***	-0.160***
	(0.020)	(0.023)	(0.034)	(0.038)
N	84369	84369	84369	84369
R^2	0.088	0.182	0.186	0.196

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. 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.

Within each squadron, both victory rates and death rates are strongly correlated. If a pilot's squadron scores on average one more victory (abstracting from his own performance), his individual victory claims increases 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 percent per month, or 36% of the baseline rate of risk.

Similar results obtain when we focus on mention periods – those months when the Wehrmacht bulletin highlighted the success of individual fighter pilots. Here, we are not simply interested in squadron-level co-movement, but the extent to which (contemporary) peers of a mentioned pilot perform better. To this end, we estimate

$$V_{j,i,t} = C + \alpha * P_{i,t} + \beta * M_t + \gamma * X' + \epsilon$$

Where V is the victory rate, P is an indicator variable showing whether squadron i contains a mentioned pilot, M is a dummy for a month with a pilot mention, and X' is a vector of controls. Table 2 presents the results from these regressions for both victories and exits.

Table 2: Death and victory rates, co-movement within squadrons

Panel A: Death rates

	(1) Cox	(2) Cox	(3) Cox	(4) controls	(5) +quality
Mention period	1.243***	1.241***	1.229***	1.279***	1.269***
	(5.74)	(5.72)	(5.44)	(6.39)	(6.18)
Current squadron peer of mentioned			1.619***	1.806***	1.760***
			(3.10)	(3.74)	(3.60)
Ever peer of mentioned pilots		0.563***	0.549***	0.639***	0.623***
		(-10.88)	(-11.05)	(-8.13)	(-8.83)
Eastern front				0.760***	0.686***
				(-5.46)	(-7.33)
Pilot quality					1.243***
					(12.18)
N	88761	88761	88761	88761	88761

Panel B: Victory rates

	(1) OLS	(2) OLS	(3) OLS	(4) controls	(5) +quality
Mention period	0.241***	0.242***	0.231***	0.224***	0.217***
	(0.021)	(0.022)	(0.021)	(0.021)	(0.020)
Current squadron peer of mentioned			0.448***	0.344***	0.299***
			(0.109)	(0.109)	(0.106)
Ever peer of mentioned pilots		0.149***	0.131***	0.119***	0.038
		(0.045)	(0.045)	(0.040)	(0.026)
Eastern front				0.621***	0.350***
				(0.048)	(0.031)
Experience				-0.006***	-0.005***
				(0.001)	(0.001)
Pilot quality					0.759***
					(0.033)
N	88761	88761	88761	88761	88761
R2	0.003	0.005	0.005	0.032	0.118

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 t-statistics in parentheses. Starting with column 4, dummy variables for aircraft type are included. Mentionperiod is a dummy variable that takes the value zero if no Luftwaffe fighter pilot is mentioned in the *Wehrmachtsbericht* 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 serves with a mentioned pilot at any time during the war. 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). We do not control additionally 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.

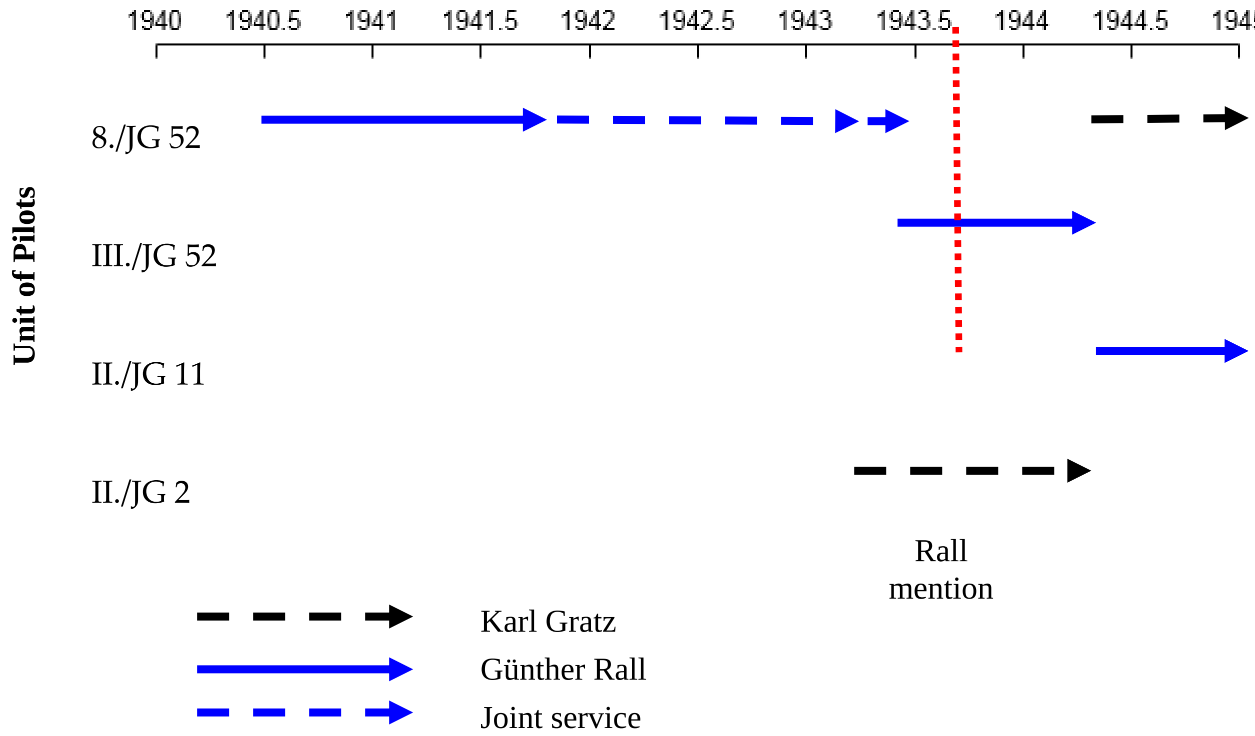
Pilots whose current peers are mentioned by the Wehrmacht bulletin both perform better in the same month, by 0.3 to 0.4 victories. They also die at a significantly higher rate, with the hazard rate going up by a factor of 1.6 to 1.8. These effects are in addition to the effect coming from mention periods that, in general, see more active combat and higher risk.

The results in Tables 1 and 2 of course suffer from the reflection problem – pilots in a squadron are not only subject to changes in their peers' performance and risk-taking, but also share the same general environment. For example, they typically fly the same planes, fight at the same front, receive service from the same mechanics, 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 side-step the reflection problem, from now on we estimate regressions that only examine the effect of *former* peers having been mentioned in the Wehrmacht bulletin. To illustrate our empirical strategy, consider Fig. 5.

Figure 5: Identification strategy.



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

Figure 5 illustrates our identification strategy. We focus on pilots who flew with the mentioned pilot in the past but who have since been posted to another unit. Figure 5 presents the example of two pilots: Günther Rall, one of the highest-scoring aces of World War II; and Karl Gratz. From Autumn 1941 until March 1943, they served together in Squadron 8 of Fighter Wing 52. Rall remained with the squadron when Gratz was transferred to the another squadron ("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 therefore classify Gratz as a "past squadron peer" and compare his performance in the month of Rall's citation with other months.

Overall, a quarter of our pilots are former peers of pilots who are mentioned eventually. Some 8% of our observations identify pilot-months of a former peer of a pilot mentioned in the same month. Pilots who are former peers of mentioned pilots are clearly different from the rest, as our balancedness table shows:

Table 3: Balancedness Test, Peers of Mentioned Pilots

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

Note: all rates per month

We are now interested in whether pilots whose former peers are mentioned die at a higher rate in the same month, while scoring more victories. Figure A1 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 die at an even faster rate.

Table 4, Panel A presents results from survival regressions. We find that during the mention periods, death rates go up, in line with earlier results. Pilots whose peers are eventually mentioned also survive longer (col 2, Panel A). Past squadron peers see their hazard rates rise by more than 50%, and the effect becomes larger the more controls are added – except for specification (7), when we use time fixed effects, too.

A similar pattern is visible for victory claims (Panel B). Mention periods see more claims, and pilots who eventually have peers score more on average. In months when a former peers is mentioned, the victory rate jumps by almost half a victory on average (col 3). After adding controls for experience, front, pilot quality, as well as squadron and time fixed effects, we still estimate an effect of having a former peer mentioned of more than ¼ of a victory in the same month.

Table 4: Death and victory rates, past peers

Panel A: Death rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cox	Cox	Cox	controls	+quality	+SqFE	+timeFE
Mention period	1.243***	1.241***	1.234***	1.286***	1.275***	1.277***	
	(5.74)	(5.72)	(5.52)	(6.51)	(6.30)	(6.39)	
Past squadron peer of mentioned			1.595**	1.692***	1.631**	1.650**	1.400*
			(2.45)	(2.68)	(2.45)	(2.57)	(1.84)
Ever peer of mentioned pilots		0.563***	0.555***	0.647***	0.631***	0.492***	0.549***
		(-10.88)	(-11.07)	(-8.04)	(-8.82)	(-11.14)	(-8.83)
Eastern front				0.762***	0.687***	0.684***	0.731***
				(-5.42)	(-7.29)	(-5.59)	(-4.91)
Pilot quality					1.243***	1.218***	1.221***
					(12.28)	(10.12)	(9.82)
N	88761	88761	88761	88761	88761	88761	88761

Panel B: Victory rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	controls	+quality	+SqFE	+timeFE
Mention period	0.241***	0.242***	0.234***	0.225***	0.218***	0.221***	
	(0.021)	(0.022)	(0.021)	(0.021)	(0.020)	(0.021)	
Past squadron peer of mentioned			0.498***	0.429***	0.348**	0.310**	0.272**
			(0.150)	(0.152)	(0.144)	(0.150)	(0.136)
Ever peer of mentioned pilots		0.149***	0.136***	0.121***	0.041	0.051	0.012
		(0.045)	(0.045)	(0.040)	(0.025)	(0.034)	(0.033)
Eastern front				0.622***	0.351***	0.401***	0.315***
				(0.048)	(0.031)	(0.040)	(0.038)
Pilot quality					0.759***	0.751***	0.767***
					(0.033)	(0.034)	(0.035)
N	88761	88761	88761	88761	88761	88761	88761
R^2	0.003	0.005	0.005	0.033	0.118	0.128	0.159

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 t-statistics in parentheses. Starting with column 4, dummy variables for aircraft type are included. Mentionperiod is a dummy variable that takes the value zero 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"). Ever peer of mentioned pilots is a time-invariant dummy that indicates whether a pilot serves with a mentioned pilot at any time during the war. 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). We do not control additionally 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.

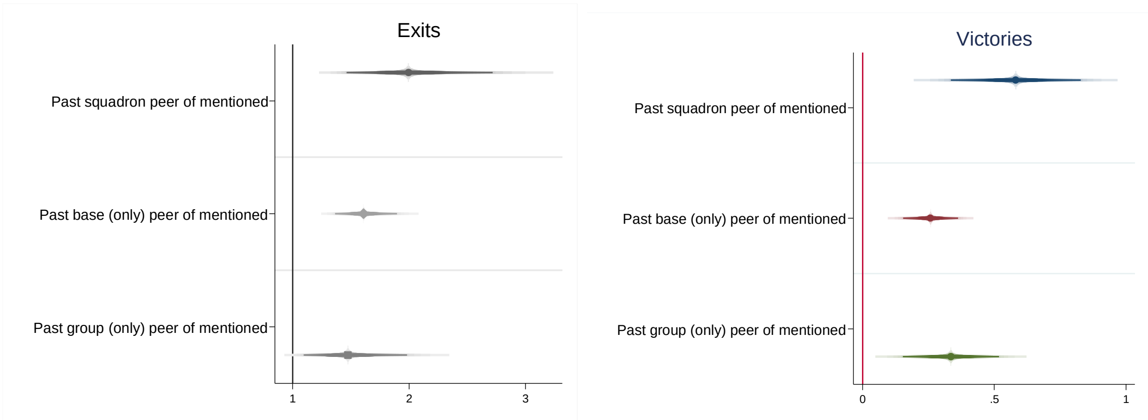
C. Results by social distance

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.

To examine the effect of other factors leading to comparison group formation, 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.

Figure 6 repeats the analysis in Table 4, plotting the coefficient of interest for group peers and base peers, for both exit rates and victory rates

Figure 6: Coefficient sizes, alternative peer groups



Both base and group peers show the same pattern of spillovers as former squadron peers – but in a less striking fashion. Base peers show a smaller increase in the death rate, but results are still large (hazard rate 1.6) and significant; the same is true of group peers (factor 1.47). Victory rates are similarly higher amongst base and group peers, but the effects are, again, somewhat smaller than for squadron peers. 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.

C. Birthplace proximity

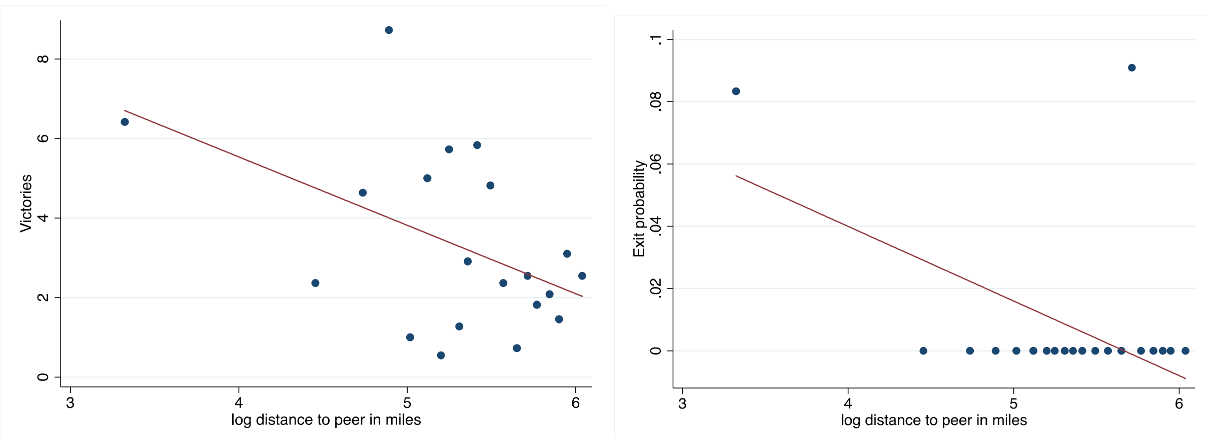
We interpret the effects of peer recognition as being driven by a desire to "keep up" with one's peers. In other words, the increase in the number of victories is compatible with an interpretation that emphasizes status competition. To examine further whether such status competition could reasonably explain our findings, we test whether those born in nearby towns react more strongly to a mention in the dispatches.

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 high-performing 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 7 shows that, for pilots born close to each other, the effect of a mention in dispatches is especially large.[13] At a distance of less than 100 miles, the peer-induced boost during mention months amounts to almost 4 extra victories. Yet at a distance of (say) 400 miles, the performance bump amounts to only two additional victories.

Figure 7: Peer effects as a Function of Birthplace Distance

Panel A: Victories Panel B: Exit probability



Note: The figure shows a binscatter of the number of additional victories of peers of a mentioned past peer, during mention periods of that particular pilot, as a function of log birthplace distance (mentioned pilot *minus* pilot in question). Past peers are former squadron peers who are no longer serving in the same unit. The underlying specification is identical to the one used in Table 3, column 3. The analysis is based on data from 352 aces for whom birthplace location is available.

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[13] We use the simple specification from Table 3, column 3 because our sample is small.

[15] We use the basic specification from Table 3, column 3. Results are almost identical when using the more stringent specifications.

A similar pattern is visible for exits – but by their nature, they are much less common. In both cases, there is a statistically significant effect of log distance to a peer's birthplace on performance and risk-taking (p<0.02).

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^{th} percentile of pilot quality) see a sharp increase in their death rates, by a factor of 1.86; those above the 80^{th} percentile only see a small and insignificant rise, by a factor of 1.1. For the top 10%, this factor is larger, but not significantly greater than unity. These results suggests that for great pilots, there is mostly a small price to pay when they try to score more during mention periods of former squadron peers. And try they do, as Panel B makes clear – top 20 pilots score an extra of 0.8 victories, those in the top 10%, of 1.2 victories – while there is no effect for the bottom 80% of pilots. 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, while the very best pilots mainly react by increasing their scores.

Table 4: Death and victory rates, past peers, by previous performance

Panel A: Death rates

	(1) Full sample	(2) <80	(3) 80+	(4) 90+
Past squadron peer of mentioned	1.400*	1.599**	1.093	1.532
	(1.84)	(2.25)	(0.31)	(1.16)
Ever peer of mentioned pilots	0.549***	0.518***	0.602***	0.527***
	(-8.83)	(-9.35)	(-4.42)	(-3.30)
Eastern front	0.731***	0.682***	0.600***	0.419***
	(-4.91)	(-5.13)	(-3.12)	(-3.71)
Pilot quality	1.221***	4.125***	1.090***	1.114***
	(9.82)	(14.04)	(2.89)	(3.23)
N	88761	1038	17723	9017

Panel B: Victory rates

	(1) Full sample	(2) <80	(3) 80+	(4) 90+
Past squadron peer of mentioned	0.272**	-0.023	0.820**	1.181**
	(0.136)	(0.062)	(0.384)	(0.593)
Ever peer of mentioned pilots	0.012	-0.023	0.065	0.014
	(0.033)	(0.026)	(0.089)	(0.160)
Eastern front	0.315***	0.245***	0.423***	0.489**
	(0.038)	(0.027)	(0.146)	(0.235)
Experience	-0.002***	-0.005***	0.016***	0.018**
	(0.001)	(0.001)	(0.003)	(0.007)
Pilot quality	0.767***	0.310***	0.696***	0.624***
	(0.035)	(0.040)	(0.051)	(0.070)
N	88761	71038	17723	9017
R^2	0.159	0.108	0.159	0.158

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 t-statistics in parentheses. The table repeats the analysis of Table 3, column 7, but stratifies by performance subgroup (results reported in columns 2-4). Mention period is a dummy variable that takes the value zero 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"). Ever peer of mentioned pilots is a time-invariant dummy that indicates whether a pilot serves with a mentioned pilot at any time during the war. 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). We do not control additionally 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.

F. Discussion

During months when an individual pilot was mentioned in the armed forces 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 great and average pilots care about relative standing, and that their peer's recognition 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. 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

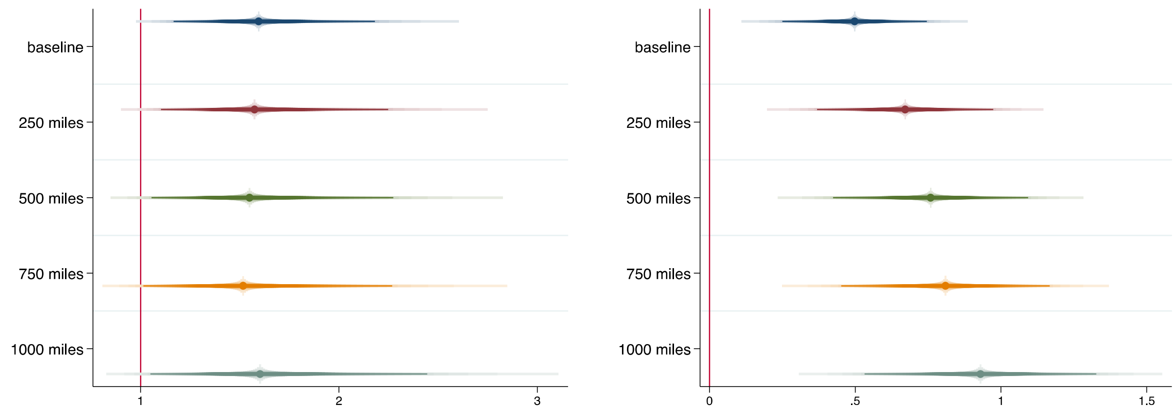
A natural confounding factor is the possibility of unobserved and correlated shocks simultaneously affecting the outcomes of different peer groups. While we exclude pilots serving in the same squadron when we look at past peers, this may not be enough rule out the effect of aggregate changes in combat 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 Spanish frontier with France. The minimum distance between air fields in our data is 9 miles; the maximum, 2,600 miles (see Figure A2).

Having imposed minimum distance requirements on our data, Figure 8 gives the coefficients on the former peer interaction variable as those requirements become increasingly stringent. A distance of even 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 8: Exit and Victory Rates, by distance to the mentioned pilot

Panel A: Exits **Panel B: Victories**



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 3.

Figure 8, Panel B, demonstrates that the coefficient for outperformance becomes greater as we impose increasingly stringent distance requirements.[15] Effects for exit (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.

Another issue is possible confounding by differential but correlated upgrades in aircraft equipment. Since aerial combat performance depends not only on pilot ability but also on equipment quality, it follows that changes in performance could reflect changes in planes. Thus a sudden increase in the number of aerial victories could be driven by aces receiving nearly simultaneous upgrades in the planes they piloted.

However, that mechanism does a poor job of explaining 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 A3 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 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 forced to pilot an "upgraded" BF-109G – despite his protests – 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 check to ensure that the probability of flying a similar type of aircraft is not systematically higher in months during which an ace is mentioned in the *Wehrmachtbericht*. This is not the case.[16]

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 learned some specific skills from other pilots or in special circumstances in their area of operation while previously flying together, and assume that skill became especially useful in some later period. If outstanding pilots do so well that they are mentioned in the daily bulletin, then also other pilots with whom they trained – or who developed similar skills in the same environment – might likewise do better. In that event we would find higher performance by past peers in periods when aces are mentioned in the

[16] Results available upon request.

daily bulletin; yet the reason would be correlated on-the-job learning rather than motivation effects.

We do not believe that this mechanism, either, is likely to drive our findings. In the first place, 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. Also, note that fixed effects of having flown with an ace are not uniformly positive (see Figure A4): Some 42% 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 become 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 a WWII daily bulletin. We then regress the log of victories by pilot *i* (+.01) on the log of victories of the mentioned pilot m (+.01), to allow for a direct estimation of the performance elasticities as follows:

$$\log(vic_i + .01) = C + \alpha \cdot \log(vic_{mi} + .01) + \beta \cdot M_{mi} + \gamma \cdot M_{mi} \cdot \log(vic_{mi} + .01) + \delta \cdot X' + \varepsilon. \quad (3)$$

In this expression, C is a constant, α measures the correlation of victory scores between pilot *i* and his dispatch-mentioned peer *m*, β is the average change in (log) victories in a mention month for pilot *m*, and γ is the coefficient of interest – for the change in the co-movement between pilot *i*'s victory score and that of his mentioned former peer. 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 latter's fortunes.

In non-mention periods, there is already co-movement between the victory scores of former squadron peers. The correlation is 0.114; in mention periods it is 0.18, 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 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 negative baseline correlation (column 4).

Table 5: Correlation of Pilot Performance, Past Peers and Mentioned Pilot (Mention vs Other Periods)

	(1) Baseline	(2) Controls	(3) +TimeFE+SqFE	(4) Samegroup=0	(5) Placebo
$\text{Log}(\text{vic}_{\text{mi}} + 0.01)$	0.114***	0.090***	0.041***	-0.005	0.008
	(0.009)	(0.008)	(0.007)	(0.008)	(0.008)
Mention period	-0.128	-0.137	-0.178**	-0.154*	0.314
	(0.087)	(0.088)	(0.086)	(0.090)	(0.957)
Mention period * $\text{Log}(\text{vic}_{\text{mi}} + 0.01)$	0.062**	0.072**	0.071**	0.075**	-0.045
	(0.031)	(0.030)	(0.032)	(0.035)	(0.340)
Eastern Front		0.476***	0.600***	0.461**	0.310*
		(0.082)	(0.154)	(0.184)	(0.162)
Experience		-0.015***	-0.018***	-0.011***	-0.021***
		(0.003)	(0.003)	(0.003)	(0.004)
Constant	-3.129***	-3.023***	-2.135***	-3.055***	-1.514
	(0.043)	(0.105)	(0.678)	(0.765)	(1.395)
N	41737	41737	41737	22115	19339
R^2	0.023	0.049	0.152	0.183	0.178

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron ("Staffel"). Dummy variables for aircraft type are included from col (2) onwards. $\text{Log}(\text{vic}_{\text{mi}}+0.01)$ is the natural logarithm of pilot m's victory score (+.01), when m is a former peer of pilot i. Mention period is a dummy variable that takes the value one when a former peer is mentioned in the *Wehrmachtbericht.* In col (4), we only keep those observations for which pilots and their eventually mentioned squadron peer are not in the same group. Col (5) uses the same specification as the preceding column but is based on placebo mentions (cf. Appendix for details). 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).

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 skill 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 risk, which would result in time-varying correlation in victory scores but *not* because of status concerns.

We consider this to be an unlikely account. We tackle the problem empirically by separating our data into two categories: mentions of a former peer whose monthly victory score exceeds the treated pilot's own past performance, and those that had already scored so much in a single month. 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 more likely that status competition motivated Gratz to do better.

Table 6: Death and victory rates, past peers, by previous performance

Panel A: Exit

	(1) < score	(2) >= score
Past squadron peer of mentioned	1.579**	0.830
	(0.287)	(0.377)
Ever peer of mentioned pilots	0.550***	0.548***
	(0.037)	(0.037)
Pilot quality	1.222***	1.223***
	(0.025)	(0.025)
N	88525	88077

Panel B: Victories

	(1) < score	(2) >= score
Past squadron peer of mentioned	0.117	0.711**
	(0.116)	(0.337)
Ever peer of mentioned pilots	0.011	0.010
	(0.033)	(0.032)
Pilot quality	0.763***	0.760***
	(0.035)	(0.035)
N	88525	88077

The results of this comparison are reported in Table 6. In col. 1 and 2, we analyze survival rates. For death rates, the spillover effect is strongest in the group of pilots who have never performed at the same level, the risk of death more than doubles in the month in question. 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. 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 go out, 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 are the ones who have already scored at the same level, and who may have margins of adjustment to up their score.

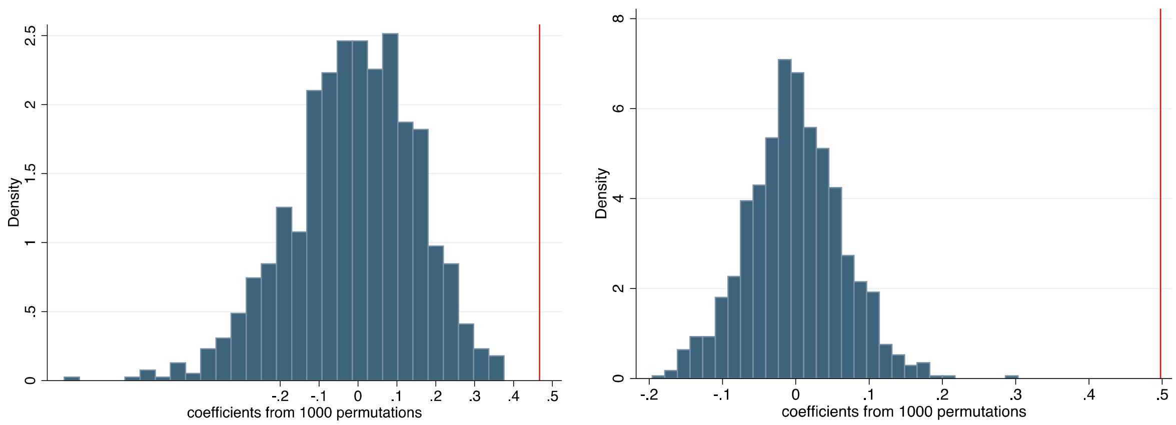
D. Placebo tests and Monte Carlo simulations

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 dataset, and then repeat the estimation in col (3) of Table 3 for both exits and victories. Figure # gives the results.

Figure 9: Permutations of Past Peer Status – Distribution of Coefficients

Panel A: Exits **Panel B: Victories**

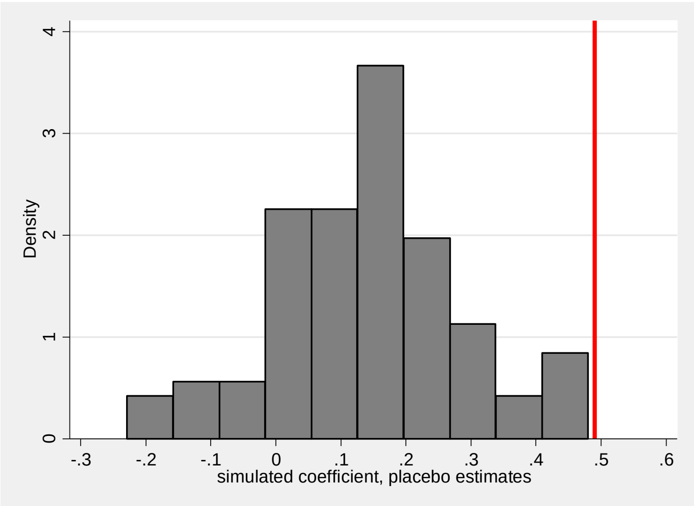


Note: The figure shows the distribution of coefficients for our past squadron peer variable based on the specification in column 3 of Table 3. As described in the text, we run our regressions with 1,000 random permutations of our main variable. Panel A takes exits as the dependent variable, and Panel B does the same for victories. The red horizontal line marks the estimated coefficient when we instead use our actually observed past peer variable (as reported in column 3 of Table 3).

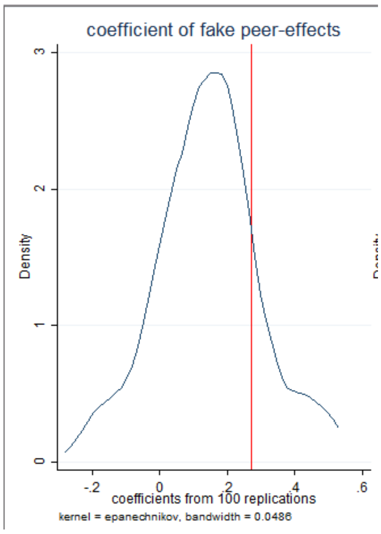
Next, we create placebo mentions in our dataset, and then track the response of placebo peers. We draw 0.01% of the observations randomly and designate them as placebo mentions. This procedure generates 89 instances, which is close to the actual number (84) of mentions. We use these faux mentions to code new peer variables and then run regressions of pilot performance against them (as in Table 4, column 3). This simulation is repeated 100 times, and the results are plotted in Figure 9.

Figure 10: Permutations of Past Peer Status – Distribution of Coefficients

Survival



Victories



Results suggest that our results are not driven by chance or the pecularities of the data. Placebo mentions are slightly biased towards positive values, but they are never as big as the actual estimated coefficient for survival. The same is not true for victories, where we find simulated values that are bigger than the estimated coefficient in 16% of all cases.

F. Results by front

Next we see whether results are similar for the Eastern Front and the Western Front. In Table 7, columns 4 and 5 report coefficients for the various categories of peer *by front*. There are positive coefficients in both theatres of combat operations for former peers, but those for the Western Front are somewhat lower when it comes to exit. Both coefficients are significant and not different from each other. In terms of victory reactions, effect sizes are smaller in the West than in the East. This is in line with generally lower scores, given the tougher combat environment; for the Western front, the coefficient is marginally below statistical significance.

Table 7: Coefficients on past peer of mentioned,

by subsample

	Private	NCO	Officer	East	West
Exit	2.47***	2.388*	1.52	1.7**	1.9**
	(3.75)	(1.7)	(1.48)	(1.99)	(2.36)
Victory	0.22*	0.38	0.45**	0.47*	0.13
	(1.71)	(0.86)	(2.3)	(1.7)	(1.5)
N	43,341	6,880	38,624	33,560	55,285

Note: The table reports coefficients on the dummy variable for past peer of mentioned pilot, according to the specification in Table 4, col. 7

G. Officers' versus other pilots' reaction

Status is a multifaceted concept. It is not clear ex ante if higher-status pilots should react more or less (than other pilots) to a former peer being recognized. In col 1-3 of Table 7, we report results when our main analysis is replicated while grouping the sample into privates, NCOs, and officers.[17] We find that officers react less than privates and NCOs in terms of taking risks. At the same time, they increase their score more than any other group. Compared to their baseline rate of victory, privates see the biggest increases (doubling their victory rate), while increases for NCOs are smallest (less than a 20% increase).

Officer status mainly of course reflected a difference in social background, education, and career choice. One possible interpretation is that concerns about relative status were smaller for officers because they had other sources of status (Galland 1993).[18]

I. 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 in event time, so $t = 0$ is the time of peer mention, and we drop all observations of pilots who were never the peer of a mentioned pilot.

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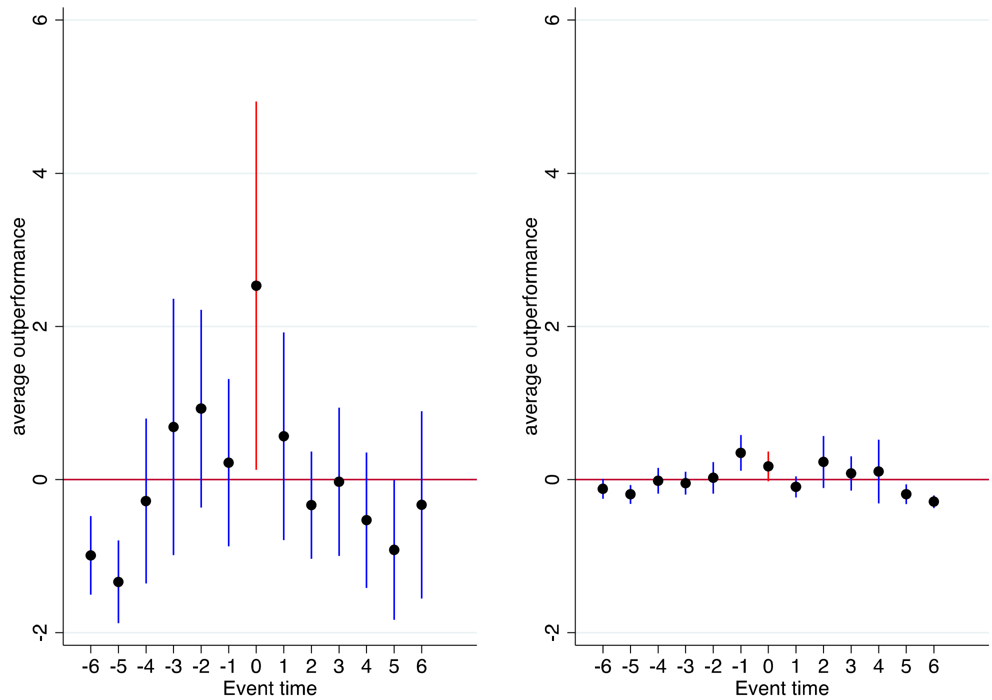
[17] Contrary to the practice in the USAAF, German pilots were not all officers.

[18] The lack of differences in the effects for the two groups might mask other, potentially counterbalancing, sources of heterogeneity, such as individual concerns about relative status or differences in average skill by rank.

Figure 10: Pilot Outperformance in Event Time by Quality Group

Panel A: Top 20% **Panel B: Bottom 80%**



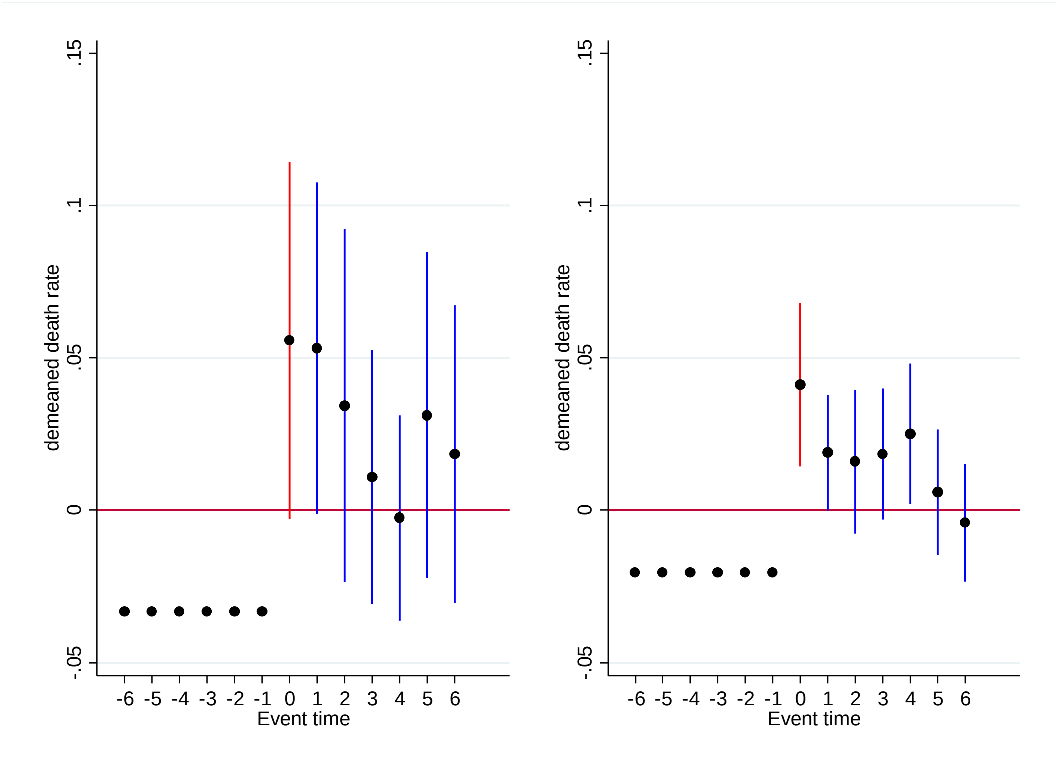
Note: Each panel plots the coefficient for outperformance of past peers of a mentioned pilot in event time (the pilot's mention in the *Wehrmachtbericht* corresponds to $t = 0$). The left (right) panel shows results for past peers in the top 20% (bottom 80%) of performance as defined by our pilot quality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

Figure 10 plots average performance in event time. We distinguish between pilots above the 80th percentile and all other pilots. As clearly shown in the left panel of Figure 10, there is no positive trend among pilots *prior* to the mention of a peer. The same is true in periods *after* the peer's mention. 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. For pilots below the 80th percentile, as expected given the results in Table 4, we do not find a substantial jump in performance during the mention month relative to other months.

A crucial assumption for the validity of our exercise is that pilots *react* to the mention of a former peer, and that there are no differential pre-trends (Angrist and Pischke 2009). In this spirit, we examine exit rates *prior* to a peer being mentioned, to see if correlated skills as a result of joint training, for example, may have doomed pilots in a similar way. Figure 11 plots the exit rates in our sample, for the month when a former peer is mentioned and the preceding six months. While coefficients vary in size, none is statistically significant – only during the month of treatment do we find a sizeable increase in exit rates.

Figure 11: Exit Rates in Event Time by Quality Group

Panel A: Top 20% **Panel B: Bottom 80%**



V. Conclusion

Using data from the German air force during World War II, we find that pilots respond strongly to public recognition received of their peers. When one of these pilots is mentioned in the daily bulletin of the German armed forces for his outstanding accomplishments, both current and former colleagues on average exert more effort and score more victories.

The effect varies 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 high-skilled pilots, they die at a much higher rate following the official recognition of a peer. Our findings suggest that relative concerns through competition for status can be a key motivator for individuals in a high-risk setting with severe principal–agent problems.

Yet these high-powered incentives can backfire, possibly reducing efficiency in contexts where risk matters.[19]

Our results suggest that periods of joint service create exceptionally strong bonds. Pilots react as much to the mention of a former peer as of a current peer. Social distance is a key determinant of the strength of spillovers – pilots born further away from the mentioned ace, or those serving in other units but with some personal contact (such as the ones flying from the same air base) show markedly smaller reactions.

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[19] 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.

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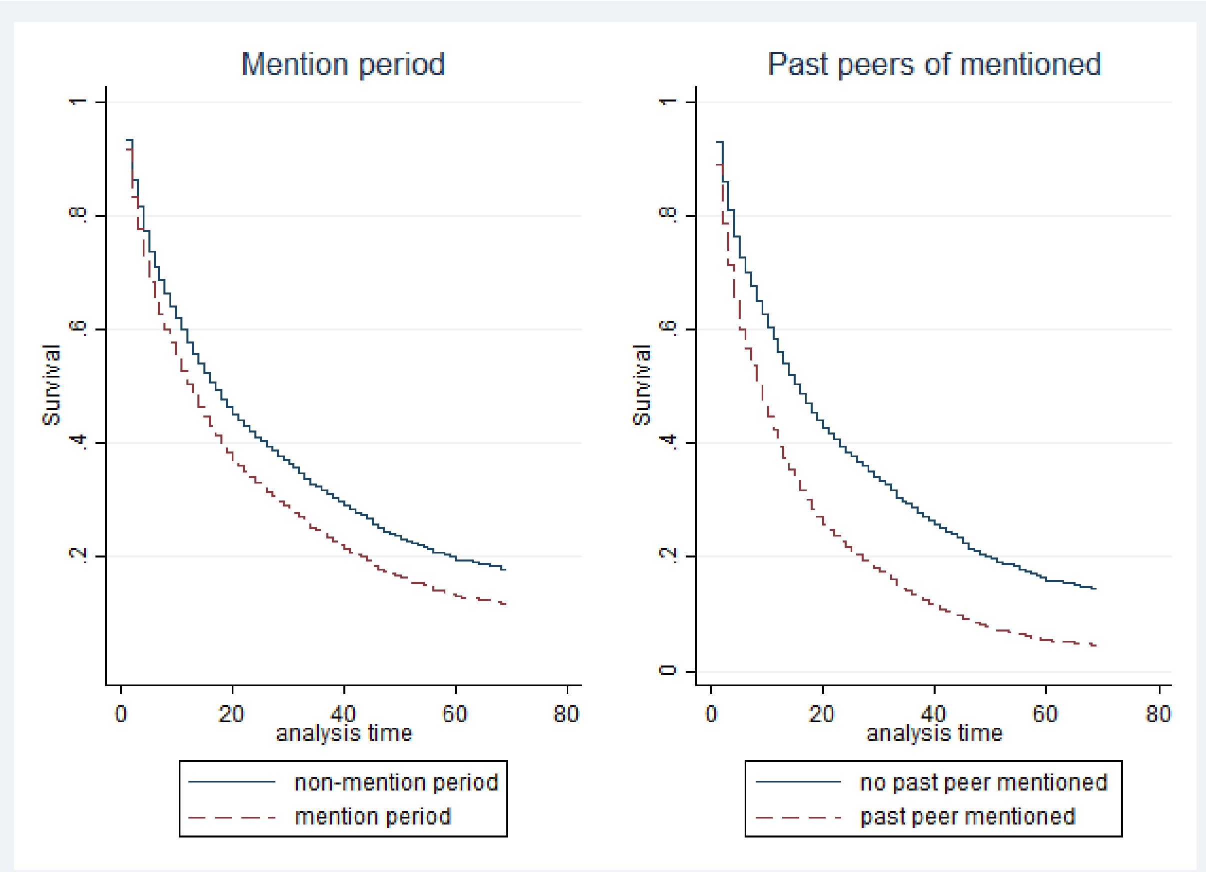
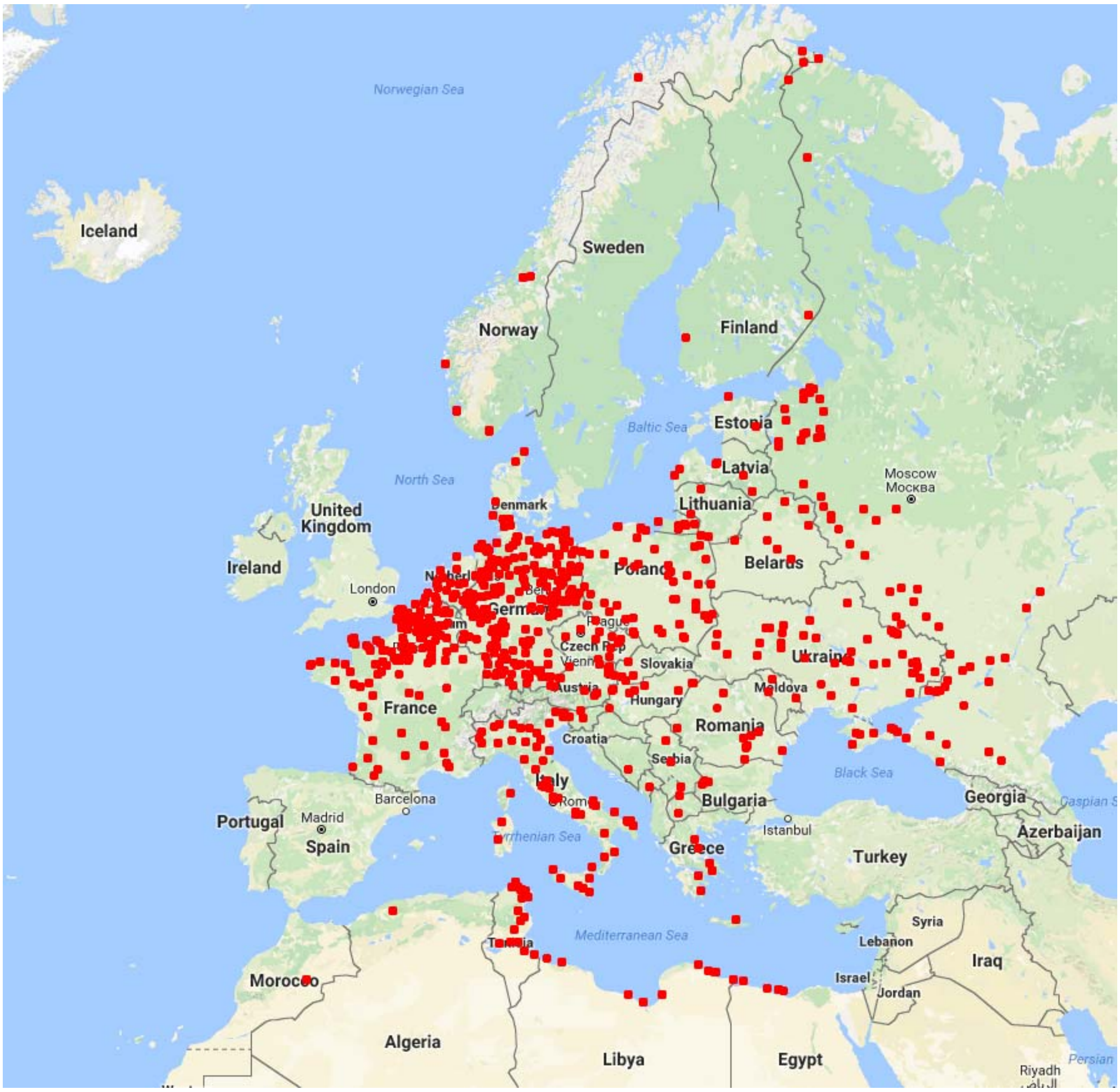
APPENDIX

Figure A.1: Cumulative survival curves



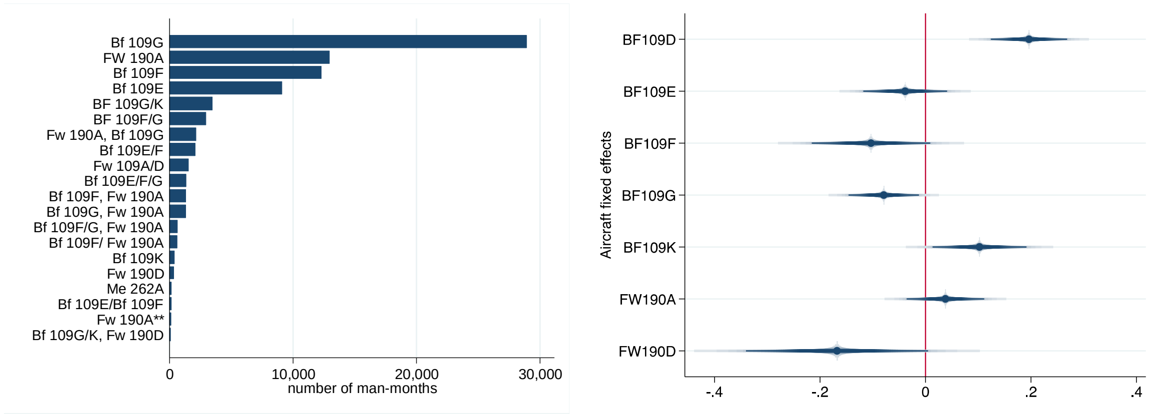
Note: The curves show the hypothetical cumulative effect of pilots being either in mention periods (left panel) or the past peer of a mentioned pilot (right panel) over the entire duration of the war. See columns 1 and 3 of Table 3, Panel A, for point estimates.

Figure A2: Airfield Locations of Luftwaffe Squadrons, 1939–1945



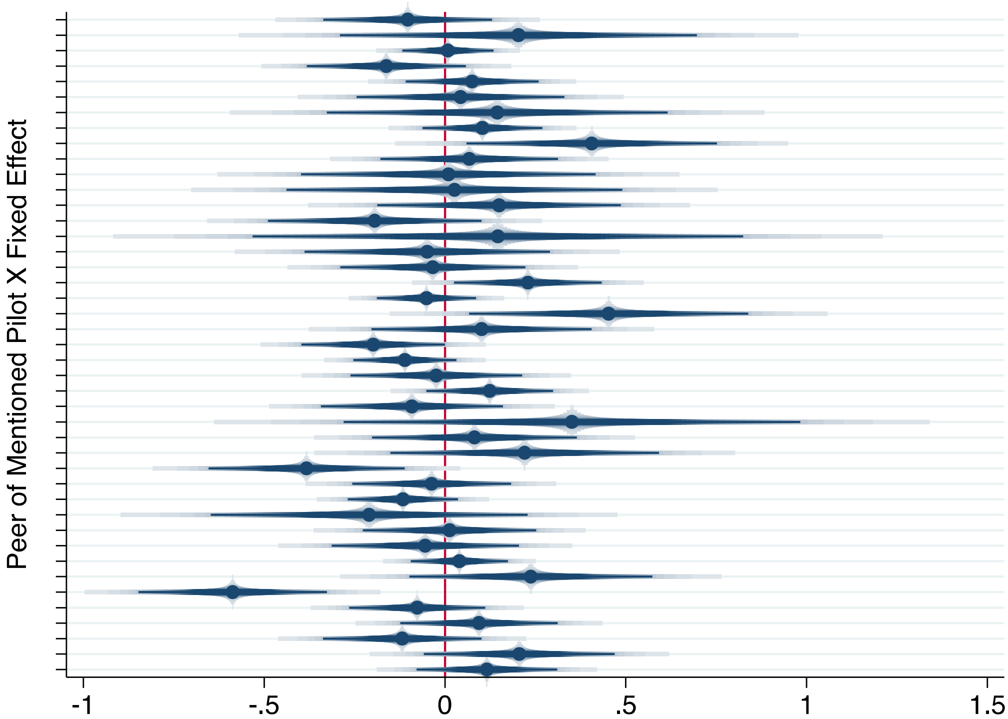
Note: This map plots the location of every airfield from which pilots in our dataset flew at least once during the period September 1939 to May 1945.

Figure A3: Aircraft Type – Usage and Fixed Effect (95% and 99% CIs) on Victory Scores



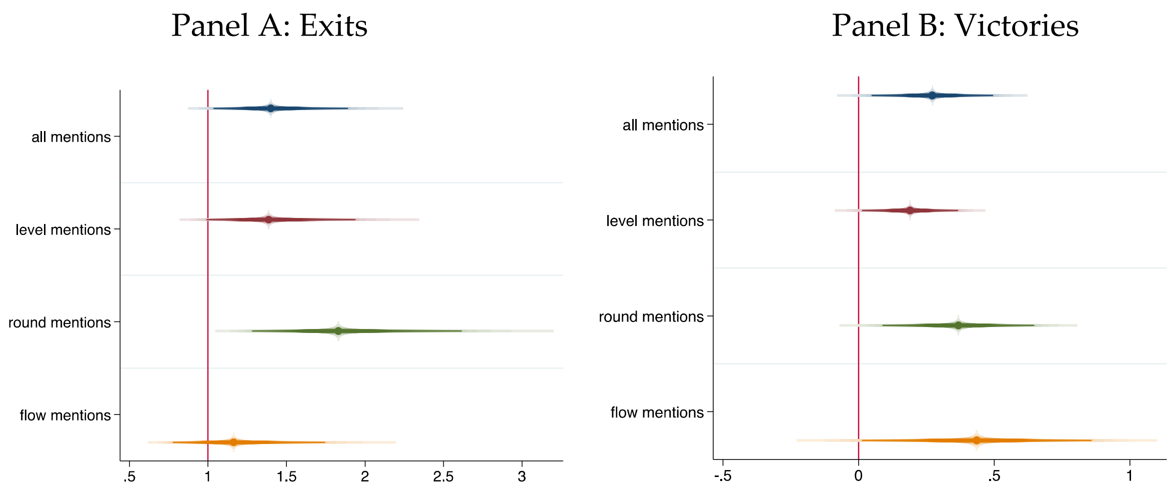
Note: The left panel of Figure A3 plots the number of man-months in our data set of different aircraft types (or combinations) flown by squadrons. The right panel plots the fixed effects for the main aircraft types in a regression using the specification of Table 3, Panel B, col. 7.

Figure A4: 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 *Wehrmachtsbericht* (estimated for the sample as a whole). The figure is based on the specification of Table 3, Panel B, col. 7.

Figure A5: Spillovers by Type of Mention



Note: The first row of the figure is based on the specification of Table 3, col. 7, and exploits the variation from all victory mentions. Row 2 only uses mentions that were awarded because of high cumulative victory scores (i.e. *level mentions*), while row 3 only uses the subset of those level mentions that honor round victory scores. Row 4 focuses on the spillover effects from victory mentions because of high monthly victory scores.