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

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Concerns about Relative Position

- Economists have long hypothesized that individuals care about their *relative* position within reference group
- Consistent evidence:
  - higher earnings of neighbors correlate with lower levels of self-reported happiness (Luttmer 2005)
  - knowledge of relative salary or income matters for job satisfaction (Card et al. 2012), choice of city of residence (Bottan and Perez-Truglia 2017) or subjective well-being (Perez-Truglia 2016)

Intrinsic Concerns?

- But do individuals *intrinsically* care about their relative position?
  - Challenging: information about relative position might change perception about *absolute* outcomes
- Extent to which individuals intrinsically care about their relative position is unclear
  - How far are people willing to go just to improve their relative standing?
  - Existing work mainly uses survey responses as outcomes

This Paper

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  - Good setting for analyzing effects of public recognition
    - high stakes, no control over pilots once battle is joined, well-measured output, social status closely tied to performance
  - *Public recognition*: mentions by name in the German Armed Forces daily bulletin (*Wehrmachtbericht*):
    - rare and reserved for spectacular accomplishments
    - known instantly over a wide area, broadcast on the radio, published in the press, and distributed at command posts throughout German territory
    - no rule for mentions: difficult to predict
    - no *fixed* number of mentions pilots were competing for

Preview of Findings

- When peers are publicly recognized: sharp rise in death rates amongst fellow pilots, as well as a large increase in aerial victories in the same month
  - But death and victory rates typically correlated over time within each squadron
- Focus on the risk-taking and performance of individual pilots whose *former* peer is recognized
- Large increases in both death and victory rates during the month of a peer's public recognition
  - Even while controlling for recognition of other, unconnected pilots
  - Stronger effects the more closely former peers worked together, for closer geographical origins, and when pilot closer to other major, predictable award

Interpretation

- Evidence for relative standing concerns leading to greater effort and increased risk-taking
- Recognition of former peer does not change a pilot's potential future benefits from scoring extra victories or improving his rank in the air force as a whole
  - It only diminishes relative standing in well-defined peer group of (former) comrades
- Expected future benefits – if Germany had won the war – may 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

Anecdotal Evidence

- During Battle of Britain (summer 1940) two German pilots – Adolf Galland and Werner Mölders – were neck-and-neck in terms of total victories
- When Mölders was ordered to confer with the head of the Luftwaffe, Hermann Göring, he went to Berlin for three days of meetings – but on the condition that Galland would also be grounded for the same number of days
- At a time when the air battle against Britain hung in the balance, Göring (himself a WWI fighter ace) accepted that one of his top-scoring pilots would be grounded gratuitously

Related Literature

- Social image concerns and behavior (e.g., DellaVigna et al. 2012, 2017, Perez-Truglia and Cruces 2017, Bursztyn and Jensen)
- Large literature on tournaments (e.g., Genakos and Pagliero 2012, Brown 2011)
- Peer effects in the workplace (e.g., Mas and Moretti 2009, Bandiera et al. 2010)
- Determinants of military performance (e.g., Costa and Kahn 2003, 2007)

Outline

1. Historical Background and Data
2. Main Empirical Results
3. Additional Results and Interpretation
4. Conclusion

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Background

- Aerial combat begins in WWI
- Becomes a key form of military conflict in World War II
- German air force banned under Versailles Treaty
- Rebuilt after 1933 under Herman Göring (WWI fighter ace)
- Sept. 1939, $\sim$4,000 aircraft total; $\sim$1,250 fighters
- By 1943, personnel and the number of planes had doubled

Data (1)

- Jim Perry and Tony Wood's *Oberkommando der Luftwaffe* (OKL) combat claims list
  - We clean it and construct a monthly panel by aggregating the information for every pilot by month and year
- *Kracker Luftwaffe* Archive
  - Detailed personal data on German fighter pilots (from several sources): war status, for many also the starting date of Luftwaffe career
- For every pilot in the sample, information on 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
- Information on pilots with at least one victory claim – 5,081 pilots; 53,008 victory claims; 3,633 exits
- Confirm large share of deaths from pilot biographies
- Claims had to be accompanied by a witness or enemy pilot had to be seen bailing out

Data (2)

- Hugely unequal performance
  - Top 350 pilots = 4,700 bottom pilots
- Average month, average German pilot scored 0.62 victories and faced a risk of 4.1% of exiting the sample permanently
- Seasonality: more aerial activity in the summer

Data (3)

- Information on 60 pilots mentioned in the daily bulletin

  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

- $\sim$1,500 pilots whose peer gets mentioned (various definitions)

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Correlations Within Squadrons and With Contemporary Peers

- Within-squadron (8-12 pilots):
  - Controlling for squadron and time fixed effects and vector of controls
  - If squadron scores one more victory on average (abstracting from pilot's own performance), pilot's individual victory claims increase by almost 0.6
  - If squadron death rate doubles., individual risk goes up by 23%

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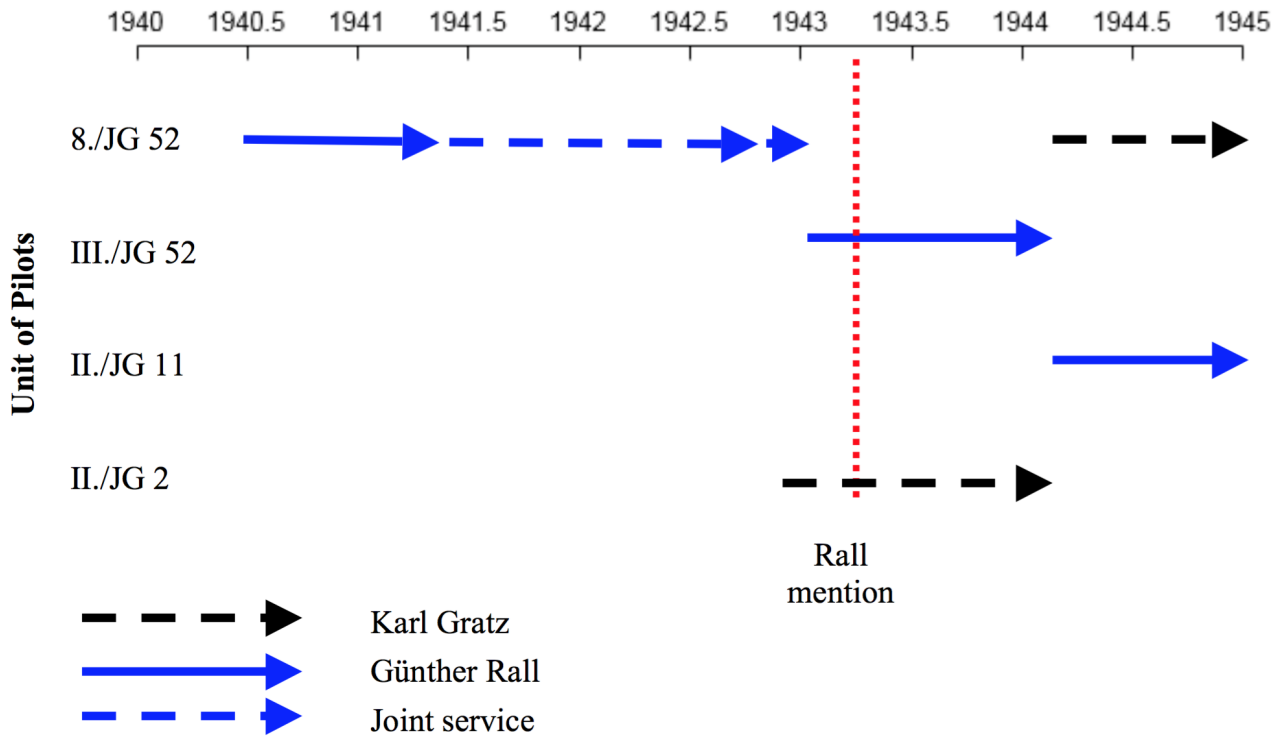
  - If squadron scores one more victory on average (abstracting from pilot's own performance), pilot's individual victory claims increase by almost 0.6
  - If squadron death rate doubles., individual risk goes up by 23%
- Mention of current peers:
  - Add pilot FE, dummy for squadron with mentioned pilot that month
  - Pilots with current peers mentioned: 0.3-0.4 more victories, and die faster (hazard rate up by factor of 1.5 to 1.8)
  - Beyond general effects of mention periods
  - But correlated shocks

Identification Strategy

Figure 4: Identification Strategy



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

Main Specification – Victories

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

- For victory rate V in squadron i at time t for individual j, where α_{v_3} is the pilot FE, $\beta_{v_3}, \gamma_{v_3}$ are squadron and time FE, and Xv_3, ijt is a vector of controls. Controls include Eastern front dummy, experience (number of months pilot already tracked in our data), measure of pilot quality, (prior cumulative victories divided by his experience), and month of mention dummy (when using time FE)
- P_{ijt} is a dummy on whether squadron i contains a past peer of a mentioned pilot, and the associated coefficient δ_{v_3} is the effect of interest

Main Specification – Exits

Cox proportional hazard model:

$$D_{ijt} = d_{3,t} e^{(\alpha_{d_3} E_j + \beta_{d_3,i} + \gamma_{d_3,t} + \delta_{d_3} P_{ijt} + X_{d_3,ijt}\phi_{d_3})} + \varepsilon_{d_3,ijt}$$

- For death rate D in squadron i at time t for individual j, where $d_{3,t}$ is the baseline hazard function after t months (i.e., the baseline risk of death for any pilot t months after entering the war). E_j is a time-invariant dummy for pilots who ever flew with a mentioned pilot (used instead of pilot FE)

Main Findings – Regressions

Table 3: Death and Victory Rates, Past Peers

Panel A: Death rates

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

Panel B: Victory rates

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

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). Panel A displays hazard ratios from Cox regressions as exponentiated coefficients with z-statistics in parentheses. Panel B is based on fixed effect models and displays standard errors instead. Our fixed effect model drops singleton observations. Standard errors are virtually unchanged if singletons are kept. Past squadron peer is a dummy for pilots who, in the past (but not at the moment of the mention), served with the mentioned pilot in the same squadron (*Staffel*). 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.

Main Findings – Interpreting

Death Rates

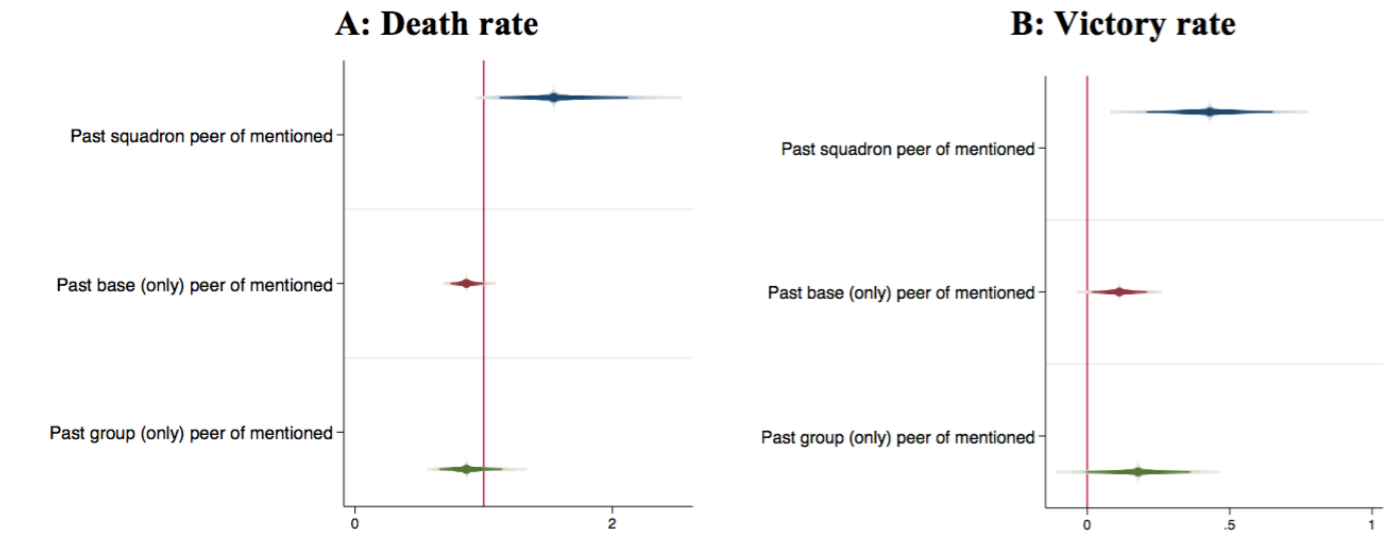
- Pilots whose peers are eventually mentioned survive longer in general (partly reflects the fact that pilots who live longer acquire more peers)
- During month of mention, past squadron peers see their hazard rates additionally rise by more than 50%, on top of the general 23-28% rise in death rates during mention periods

Victory Rates

- Mention periods see more aerial victories in general
- In months when a former peers is mentioned, victory rate jumps by an additional 1/3 to half of a victory on average

Results by Social Distance

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).

Results by Pilot Quality

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)
N	88761	71038	17723	9017
Aircraft type	Y	Y	Y	Y
Pilot quality	Y	Y	Y	Y
Eastern front	Y	Y	Y	Y
Pilot FE	N	N	N	N
Squadron FE	Y	Y	Y	Y
Time FE	Y	Y	Y	Y

Panel B: Victory rates

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

Note: * p < .1, ** p < .05, *** p < .01. Standard errors in parentheses are clustered at the level of the squadron (*Staffel*). Panel A displays hazard ratios from Cox regressions as exponentiated coefficients with z-statistics in parentheses. Panel B is based on fixed effect models and displays standard errors instead. Our fixed effect model drops singleton observations. Standard errors are virtually unaffected. The table repeats the analysis of Table 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.

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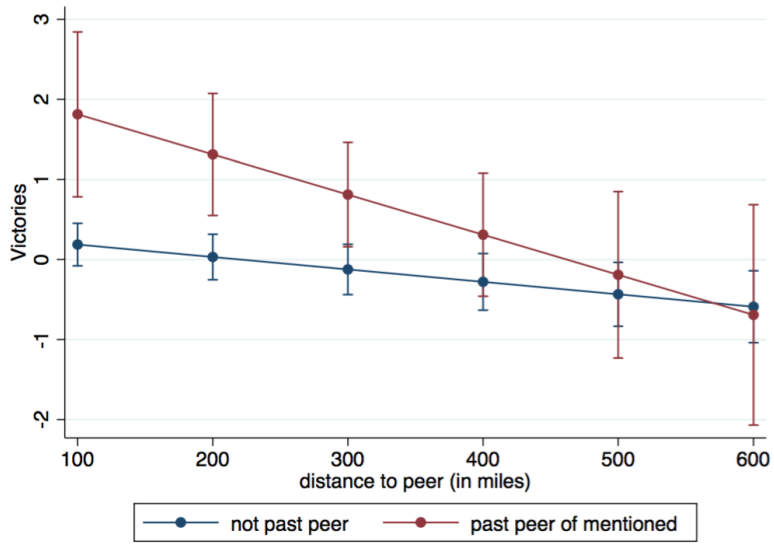
Social Image Concerns? Birthplace Proximity

- Birthplace information for 352 aces
- Few cases of exits among aces
- Share common audience (though might care more about peer too)

Figure A.6: Marginal Peer Effects by Birthplace Distance



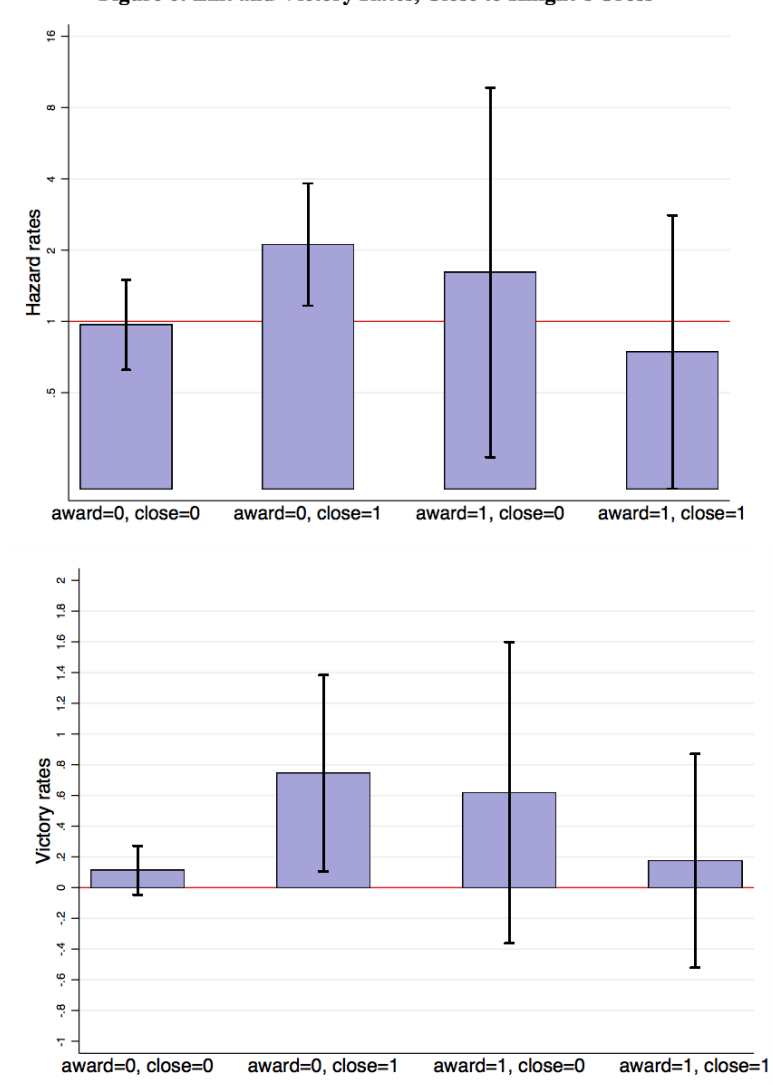
Note: The figure shows a marginplot for the interaction effect of birthplace distance (in miles) and our treatment on the number of victories of peers of a mentioned past peer. Past peers are former squadron peers who are no longer serving in the same unit. The analysis is based on data from 352 aces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

Social Image Concerns? Chances to Get Another Award

- Knight's Cross (KCR): informal quotas to get them
- 414 pilots in sample
- Close to quota: higher social image return to extra effort in response to peer mention

Social Image Concerns? Chances to Get Another Award

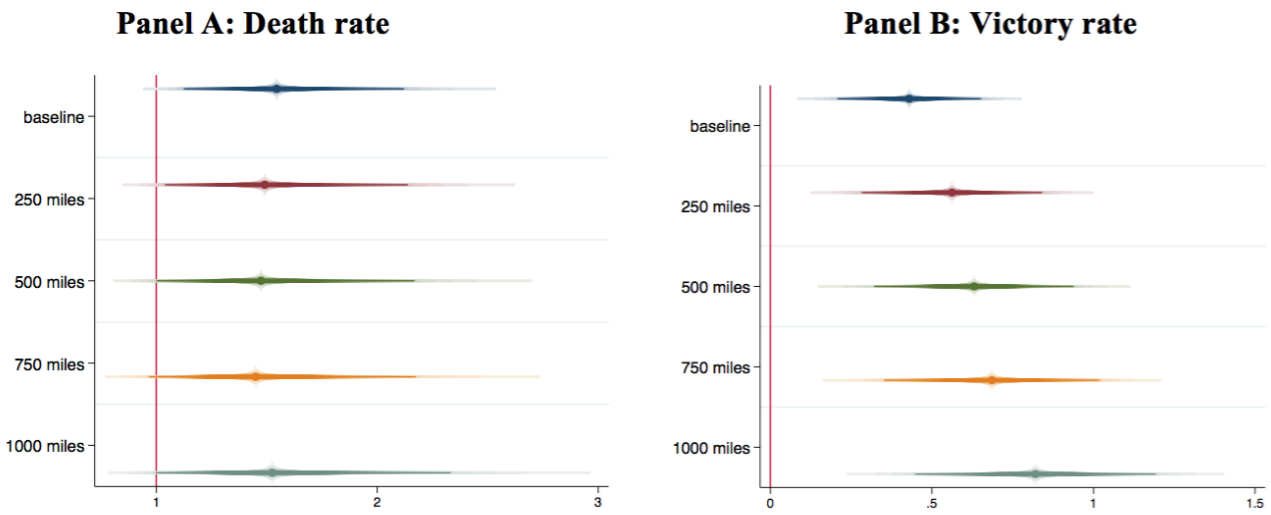
Figure 6: Exit and Victory Rates, Close to Knight's Cross



Alternative Interpretations (1)

- **Correlated shocks**
  - Robust to including minimum distance requirements
  - No correlated equipment upgrades (and control for aircraft type)

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).

Alternative Interpretations (2)

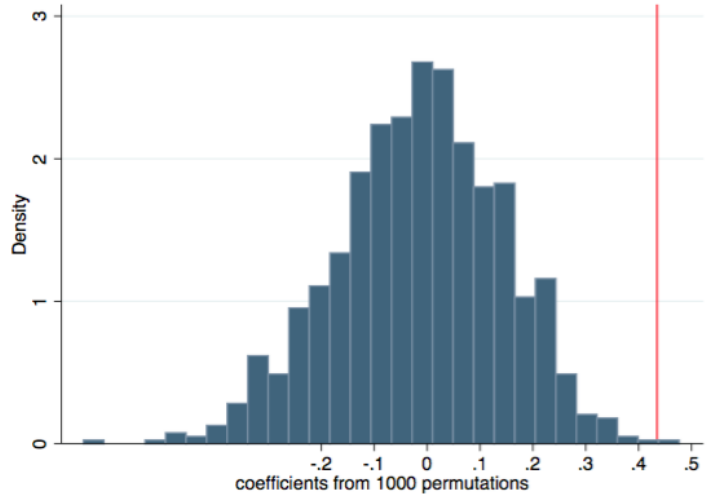
- **Social learning:** control for whether flew together in the past but maybe common skill becomes relevant at some point
  - Regress current month (log) victories on log victories of past peer; interact with mention month
  - Find that co-movement of victories increased in mention periods
  - Correlation during mention periods is more than twice as strong as during quiet periods
- **Learning about one's own ability**
  - Split: those who in the past already scored as much as the mentioned pilot; those who have not yet done so
  - Learning should affect mostly those who have never performed at the same level
  - For victories: effect stronger for those who have already performed at that level

Permutation Tests

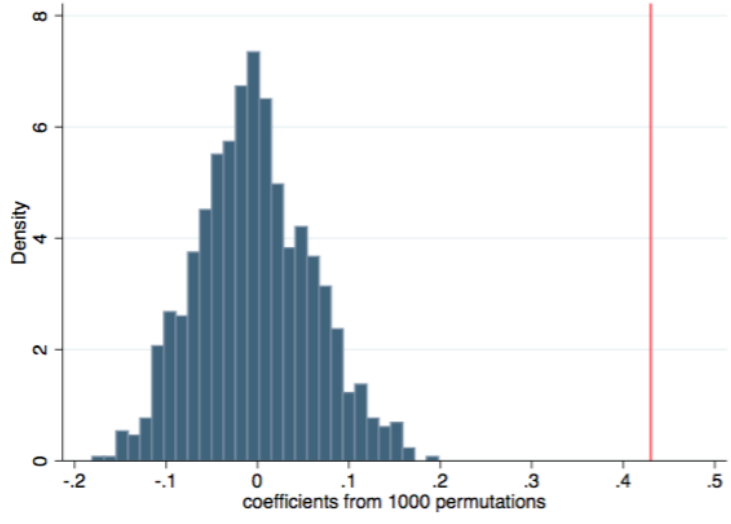
Randomly assigning past peer status and repeating main regressions

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).

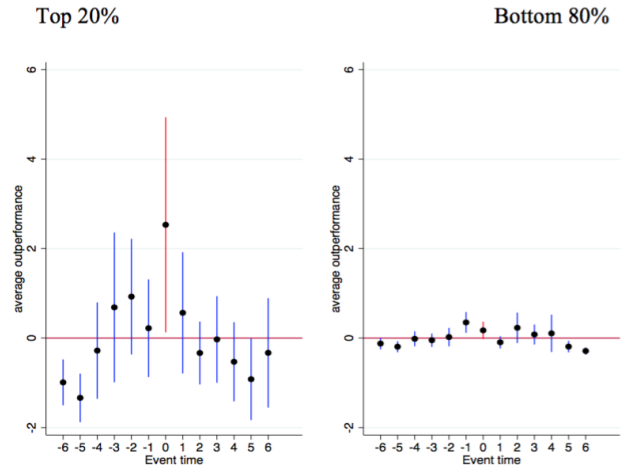
Lags and Leads

- Check if pilots do not react to their peers' performance *before* it actually occurs
- Event-time, drop all pilots never peer of mentioned pilot
- For deaths: can't do leads (since peer status defined by being alive at the time of mention)

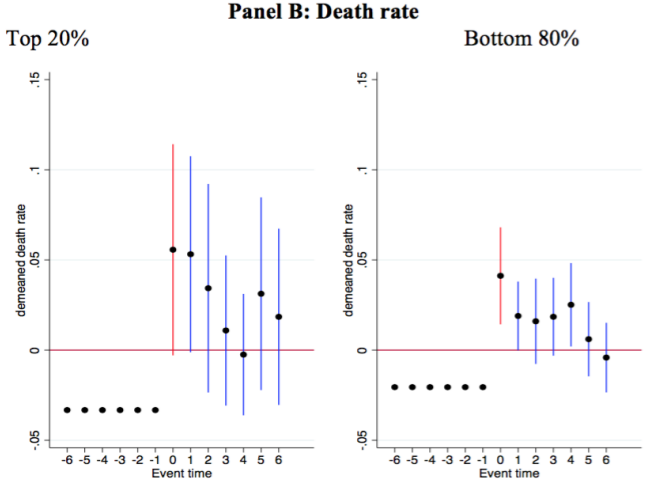
Lags and Leads

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.

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Conclusion

- German WWII pilots responded strongly to public recognition of their peers: more victories and higher risk of death
- Performance gains are concentrated among highly skilled pilots
- Risk increased significantly for the low-skilled pilots
- Interpretation: relative position concerns, likely driven by social image concerns
- High-powered incentives – in the form of public recognition – may backfire because concerns about relative standing can induce too much risk-taking
- Analogy from financial institutions: desire to be the "best" trader or loan officer can lead to losses

Thank you!

Extra Slides

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***	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
Aircraft type	N	Y	Y	Y
Pilot FE	N	N	N	N
Squadron FE	N	N	Y	Y
Time FE	N	N	N	Y

Panel B: Victory rates

	(1)	(2)	(3)	(4)
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
Aircraft type	N	Y	Y	Y
Pilot FE	N	N	N	N
Squadron FE	N	N	Y	Y
Time FE	N	N	N	Y

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

Panel A: Death rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mention period	1.243***	1.241***	1.229***	1.225**	1.269***	1.271***	
	(5.74)	(5.72)	(5.44)	(5.34)	(6.18)	(6.26)	
Ever peer of mentioned		0.563***	0.549***	0.536***	0.623***	0.487***	0.544***
		(-10.88)	(-11.05)	(-11.63)	(-8.83)	(-11.2)	(-8.91)
Current squadron peer			1.619***	1.577**	1.760***	1.808***	1.537**
			(3.10)	(2.95)	(3.60)	(3.77)	(2.71)
N	88761	88761	88761	88761	88761	88761	88761
Aircraft type	N	N	N	N	Y	Y	Y
Pilot quality	N	N	N	Y	Y	Y	Y
Eastern front	N	N	N	N	Y	Y	Y
Pilot FE	N	N	N	N	N	N	N
Squadron FE	N	N	N	N	N	Y	Y
Time FE	N	N	N	N	N	N	Y

Panel B: Victory rates

	(1)	(2)	(3)	(4)	(5)	(6)
Mention period	0.254***	0.243***	0.243***	0.247***	0.246***	
	(0.022)	(0.022)	(0.021)	(0.023)	(0.023)	
Current squadron peer		0.396***	0.392***	0.349***	0.318***	0.290***
		(0.098)	(0.098)	(0.100)	(0.101)	(0.091)
N	88353	88353	88353	88353	88327	88327
R^2	0.210	0.211	0.211	0.223	0.239	0.263
Aircraft type	N	N	N	Y	Y	Y
Pilot quality	N	N	Y	Y	Y	Y
Eastern front	N	N	Y	Y	Y	Y
Experience	N	N	Y	Y	Y	Y
Pilot FE	Y	Y	Y	Y	Y	Y
Squadron FE	N	N	N	N	Y	Y
Time FE	N	N	N	N	N	Y

Note: * p < .1, ** p < .05, *** p < .01. Standard errors 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 *Wehrmachtberichte* 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.