

SUPPLEMENTAL APPENDIX

for

Racial Promotion Gaps [†]

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IA.A Certification Examination

As noted in the paper, promotion from GS-12 to GS-13 requires passing the Certification Exam. A FOIA request to obtain individual examiners' scores in the exam was denied on privacy grounds. The PTO did, however, disclose to us anonymized test scores for all 6,637 patent examiners who took the Certification Exam on one or more of the 71 occasions a test was given between February 2004 and April 2019, along with details of the examiner's technology center, the date of the exam, and the number of times the examiner had taken the exam before passing it.¹

The FOIA disclosure, being anonymized, does not allow us to tie individual exam scores to examiner race. However, the disclosed data do permit us to relate the average test score and pass rate of each cohort of test takers to that cohort's racial composition and other characteristics. To this end, we define a cohort of test takers for a given exam as all examiners from a given technology center who are at grade GS-12 at the time of the exam. In total, there are 519 such test cohorts. We then regress either the test cohort's average score or its pass rate on the fractions of examiners in the cohort with the following characteristics: Asian, Black, Hispanic, female, promotion-eligible, with a PhD, or with a master's degree. We run separate regressions with all examinees and with only first-time takers. When we include all examinees, we also control for the fraction of retakers in the cohort. Because four of the 65 exams were "recycled" in the sense that the same exam paper was given on more than one occasion, raising the possibility that the questions might leak between test occasions, we include an indicator for a "recycled" exam. We include technology-center fixed effects to control for unobserved variation in how well their education, experience, and on-the-job training prepare examiners from different technology fields for the exam.² We include exam fixed effects to control for unobserved variation in the difficulty of the exam. Standard errors are conservatively clustered by exam.

Table IA.A1 reports the results. With one exception, neither average scores nor pass rates vary significantly with a test cohort's racial composition. The exception is Asians: a larger fraction of Asian

¹ The Certification Exam is scored out of 50 with a passing score of 35. Over the 2004-2019 period, scores averaged 35.8 among all examinees and 36.3 among those who passed in their first attempt. Overall, 60.5% of all examinees passed and 64.7% passed in their first attempt. Fig. IA.A1 shows the average score (along with the inter-quartile range) and the pass rate among all examinees (in Fig. IA.A1a) and among first-time takers (in Fig. IA.A1b) over time.

² Examiners from technology center 1700 (Chemical and Materials Engineering) have the highest average test scores according to the FOIA disclosure; those from technology center 2400 (Computer Networks, Multiplex, Cable and Cryptography/Security) have the lowest average test scores.

first-time takers in column 3 is associated with a marginally significantly lower average test score for first-time takers ($p=0.053$).

The variable that explains test scores best in Table IA.A1 is the fraction of promotion-eligible examiners in a test cohort: the more promotion-eligible examiners take the test, the higher are test scores, both among all examinees ($p=0.005$) and among first-time takers ($p=0.024$).

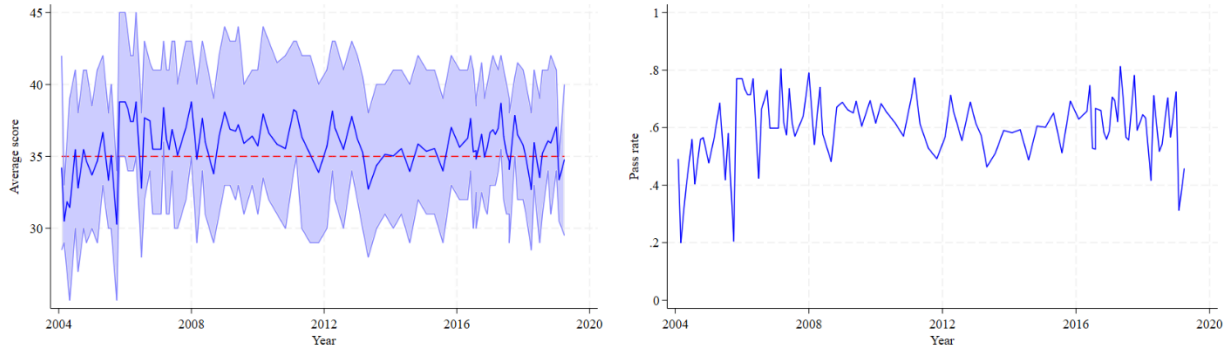
Not surprisingly, more retakers in a cohort are associated with lower test scores ($p=0.052$).

When an exam is recycled, we find significantly higher average test scores on the later occasions the exam is given ($p=0.029$), consistent with leakage between exam dates.

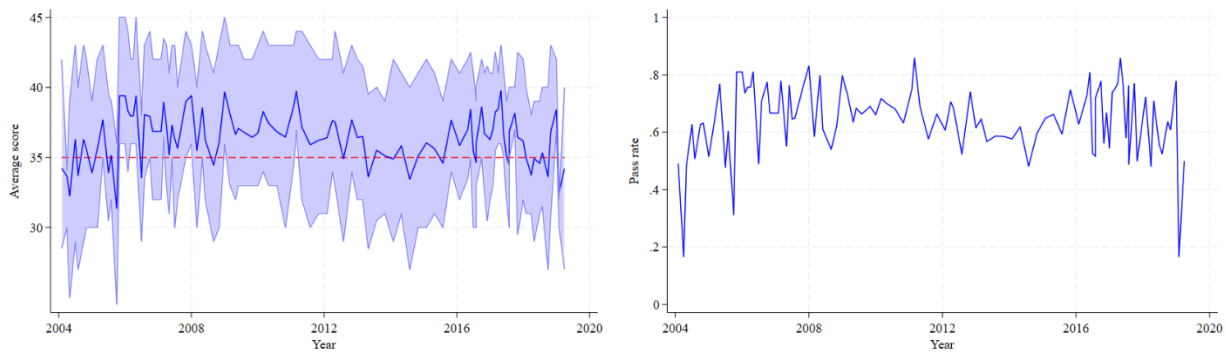
We interpret the results in Table IA.A1 as difficult to reconcile with the notion that Black examiners in GS-12 are systematically less likely to pass the Certification Examination than their White peers. We conjecture that the marginally significantly lower average test scores among Asian examiners could reflect a greater fraction of non-native English speakers.

Figure IA.A1. Certification Examination Score and Pass Rate.

The figure reports examiner performance in the Certification Examination (the passing of which is required for promotion from GS-12 to GS-13). The graphs show the average score (along with the inter-quartile range) and the pass rate among all examinees (in Fig. IA.A1a) and among first-time-takers (in Fig. IA.A1b) over the 71 occasions the test was given between February 2004 and April 2019.



(a) All examinees.



(b) First-time examinees.

Table IA.A1. Examiner Race and Performance in the Certification Examination.

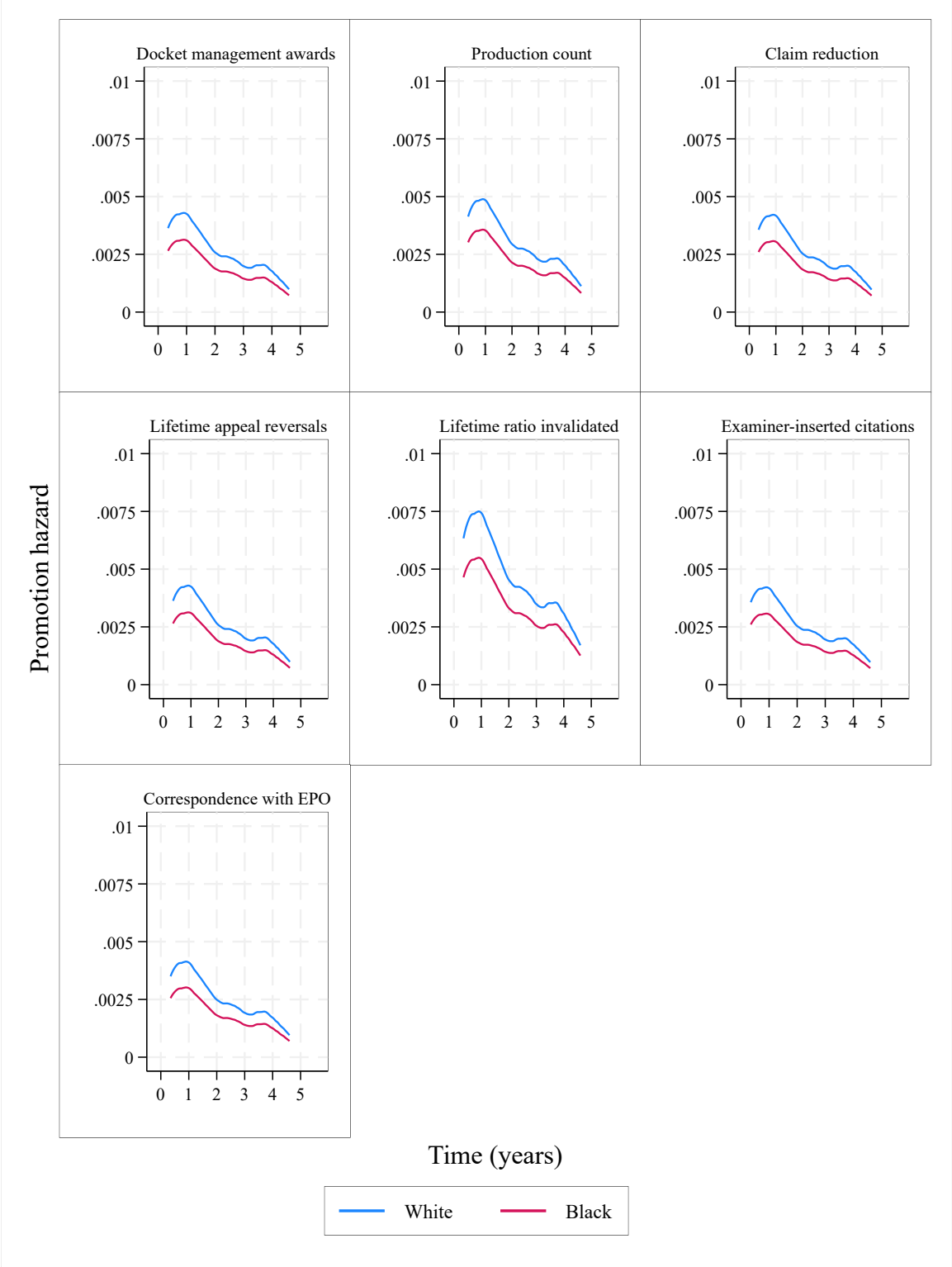
The table relates examiner performance in the Certification Examination (the passing of which is required for promotion from GS-12 to GS-13) to examiner characteristics and attributes of the exam. Pursuant to a Freedom of Information Act request, we have anonymized test scores for all 6,637 examiners who took the Certification Examination one or more times between February 2004 and April 2019. The data comprise 65 exams, four of which were given on two separate occasions and one on three occasions, for a total of 71 test dates. The unit of observation in the regressions reported in this table is a cohort of test takers (not an individual examiner). We define a test cohort for a given exam as all examiners from a given technology center who are at grade GS-12 at the time of the exam. In total, there are 519 such test cohorts. We regress a test cohort's average score (in columns 1 and 3) or its pass rate (in columns 2 and 4) on the fractions of examiners with a certain characteristic in the cohort, including either all examinees (in columns 1 and 2) or only first-time takers (in columns 3 and 4). We include technology-center fixed effects to control for unobserved variation in how well their backgrounds, prior education, experience, and on-the-job training prepare examiners from different technology fields for the exam. We include exam fixed effects to control for unobserved variation in the difficulty of the 65 exams. Heteroskedasticity-consistent standard errors clustered at the exam-number level are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Average score (1)	Pass rate (2)	Average score for first-time takers (3)	Pass rate for first- time takers (4)
Fraction Asian examiners at GS-12 in technology center	-3.092 <i>3.759</i>	-0.103 <i>0.262</i>	-9.468* <i>4.777</i>	-0.415 <i>0.308</i>
Fraction Black examiners at GS-12 in technology center	2.270 <i>4.839</i>	0.004 <i>0.325</i>	-1.794 <i>6.304</i>	-0.234 <i>0.393</i>
Fraction Hispanic examiners at GS-12 in technology center	1.822 <i>7.485</i>	0.128 <i>0.488</i>	0.794 <i>8.698</i>	0.077 <i>0.533</i>
Fraction female examiners at GS-12 in technology center	3.420 <i>3.640</i>	0.255 <i>0.267</i>	4.448 <i>4.345</i>	0.158 <i>0.288</i>
Fraction promotion-eligible examiners at GS-12 in technology center	3.668*** <i>1.278</i>	0.118 <i>0.095</i>	3.558** <i>1.535</i>	0.114 <i>0.114</i>
Fraction of GS-12 examiners with a PhD in technology center	-0.483 <i>2.529</i>	0.049 <i>0.176</i>	-5.027 <i>3.433</i>	-0.231 <i>0.205</i>
Fraction of GS-12 examiners with a master's degree in technology center	-0.127 <i>2.899</i>	0.011 <i>0.191</i>	-2.868 <i>4.141</i>	-0.088 <i>0.239</i>
Fraction retakers in the exam	0.884** <i>0.396</i>	0.044 <i>0.032</i>	-0.055 <i>0.697</i>	0.014 <i>0.031</i>
Recycled exam?	-1.957* <i>0.996</i>	-0.127* <i>0.069</i>		
Constant	34.968*** <i>2.378</i>	0.558*** <i>0.169</i>	38.796*** <i>2.979</i>	0.800*** <i>0.190</i>
Technology center FE?	Yes	Yes	Yes	Yes
Exam FE?	Yes	Yes	Yes	Yes
R-squared	47.2%	39.2%	40.4%	33.6%
Mean of dep. var.	36.2	62.8%	36.8	67.1%
No. of distinct exams	65	65	65	65
No. of test dates	71	71	71	71
No. of observations (test cohorts)	519	519	519	519

IA.B Additional Details, Alternative Specifications, and Robustness Tests

Figure IA.B1. Promotion Hazards of White and Black Top Quartile Examiners.

The figure shows the estimated promotion hazards of White and Black examiners from GS-7 to GS-9 (in Fig. IA.B1.a) and from GS-13 to GS-14 (in Fig. IA.B1.b). For each of the performance and quality measures included in Table IA.B1, we assume the examiner ranks at the 75th percentile of that measure and at the mean of all other measures. (The rankings of lifetime appeal reversals and lifetime ratio invalidated are inverted such that a lower value indicates better performance.)



(a) Promotion from GS-7.

Figure IA.B1. Cont'd.

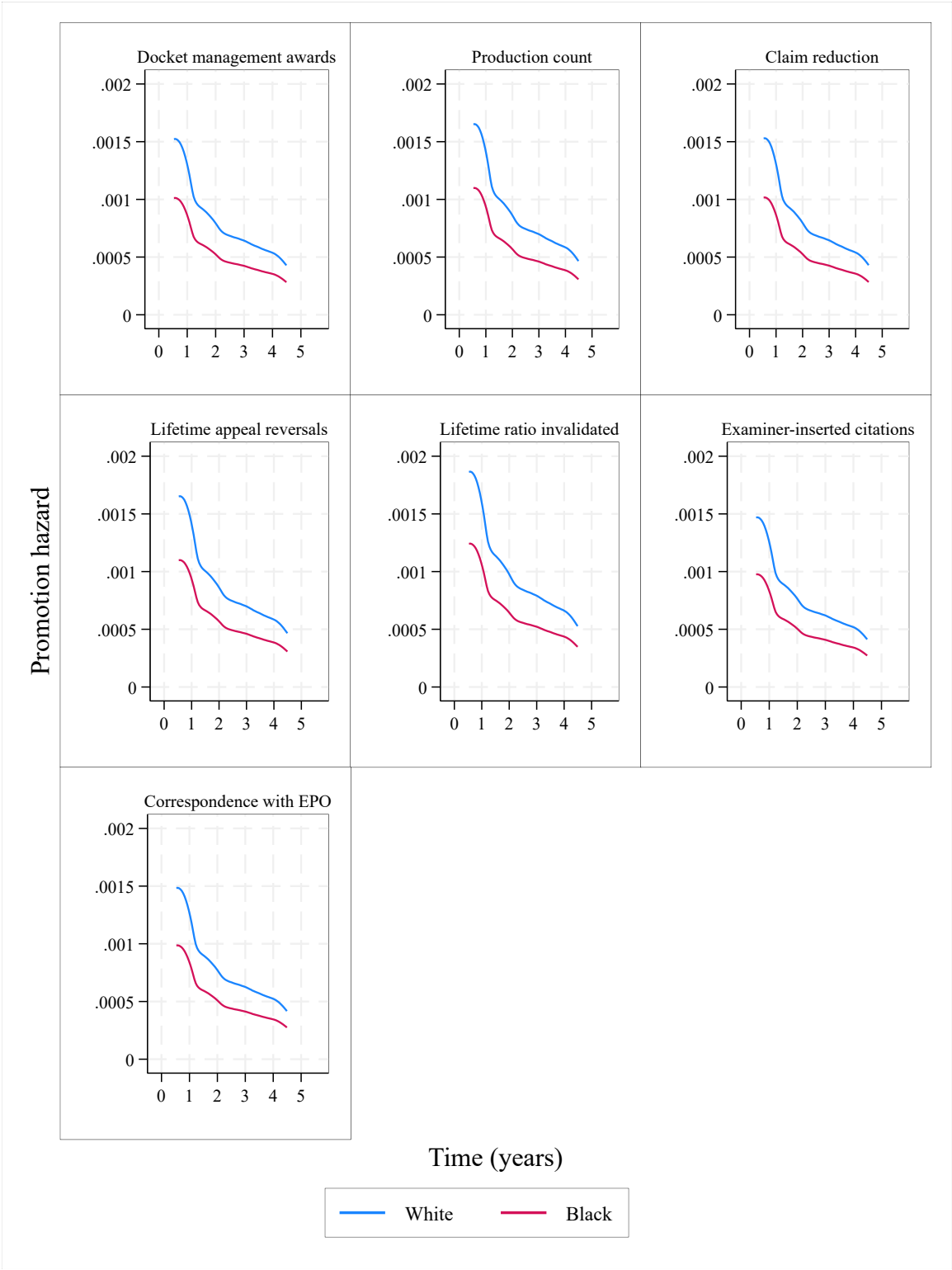


Figure IA.B2. Attrition Rates and the White-Black Attrition Gap.

This figure presents a binned scatterplot reporting the relation between the White-Black attrition gap and the attrition rate constructed at the technology center-level accounting for technology center and year-quarter fixed effects. The attrition rate equals the number of examiners who have exited a technology center in quarters $t - 1$, $t - 2$, $t - 3$ and $t - 4$ divided by the total number of examiners in the technology center in quarter $t - 4$. This variable is missing in the first three quarters of 2001 due to missing data. The attrition gap is constructed as the difference between the attrition rate for White examiners and the attrition rate for Black examiners.

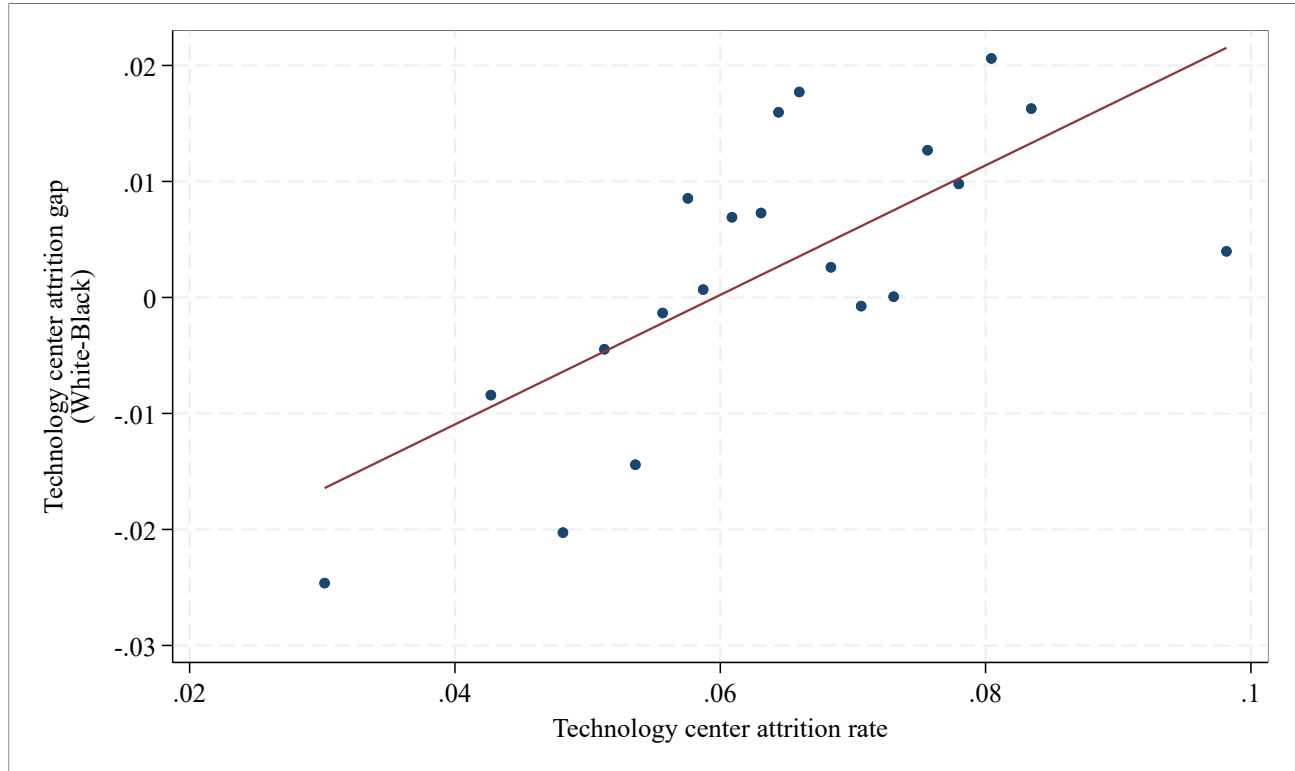


Table IA.B1. The Effects of Race on Promotions Among Potentially Qualified Examiners.

The table reports estimates of the likelihood of examiners who are “potentially qualified” receiving a timely promotion at the PTO. We code examiners as potentially qualified if they (a) are time-eligible for promotion and (b) hold neither a gainsharing award, nor a special achievement award, nor a quality step increase. Actual promotion eligibility for this group of examiners depends on their performance ratings, which we proxy for using administrative data. As in Table 4, all specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. Note that our data do not permit us to control for part-timers in column 9. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades			Promotion from grade					
	All examiners (1)	Male examiners (2)	Female examiners (3)	GS-5 (4)	GS-7 (5)	GS-9 (6)	GS-11 (7)	GS-12 (8)	GS-13 (9)
<i>Demographics</i>									
Asian	0.991 <i>0.018</i>	0.974 <i>0.022</i>	1.017 <i>0.042</i>	0.967 <i>0.103</i>	0.886*** <i>0.031</i>	1.043 <i>0.034</i>	1.096** <i>0.043</i>	1.068 <i>0.050</i>	0.878** <i>0.051</i>
Black	0.739*** <i>0.019</i>	0.725*** <i>0.023</i>	0.780*** <i>0.039</i>	0.704*** <i>0.094</i>	0.678*** <i>0.032</i>	0.788*** <i>0.036</i>	0.809*** <i>0.041</i>	0.780*** <i>0.050</i>	0.582*** <i>0.048</i>
Hispanic	0.912** <i>0.035</i>	0.930 <i>0.043</i>	0.841** <i>0.074</i>	0.693* <i>0.147</i>	0.810*** <i>0.056</i>	1.018 <i>0.071</i>	0.989 <i>0.075</i>	1.032 <i>0.103</i>	0.734** <i>0.102</i>
Female	1.006 <i>0.018</i>			1.155 <i>0.127</i>	1.056 <i>0.036</i>	1.009 <i>0.033</i>	1.036 <i>0.038</i>	0.898** <i>0.042</i>	0.920 <i>0.054</i>
Graduate degree	0.949*** <i>0.019</i>	0.926*** <i>0.022</i>	0.966 <i>0.041</i>		0.966 <i>0.039</i>	0.972 <i>0.031</i>	0.957 <i>0.037</i>	0.981 <i>0.048</i>	0.869** <i>0.054</i>
Doctoral degree	0.981 <i>0.038</i>	0.972 <i>0.046</i>	1.056 <i>0.081</i>		0.887 <i>0.100</i>	0.999 <i>0.056</i>	1.029 <i>0.071</i>	1.032 <i>0.104</i>	0.942 <i>0.123</i>

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Table IA.B1. Continued.

	All examiner grades			Promotion from grade					
	All examiners (1)	Male examiners (2)	Female examiners (3)	GS-5 (4)	GS-7 (5)	GS-9 (6)	GS-11 (7)	GS-12 (8)	GS-13 (9)
<i>Performance proxies</i>									
Delinquent	0.258*** 0.026	0.218*** 0.030	0.232*** 0.051	0.000*** 0.000	0.217** 0.150	0.276*** 0.077	0.376*** 0.075	0.267*** 0.043	0.159*** 0.035
Pendency awards	1.284*** 0.015	1.287*** 0.019	1.303*** 0.038	3.823*** 1.939	1.375*** 0.081	1.628*** 0.056	1.265*** 0.024	1.236*** 0.024	1.178*** 0.028
Production counts	3.438*** 0.108	3.539*** 0.136	3.462*** 0.240	2.438*** 0.534	4.824*** 0.329	4.488*** 0.270	2.401*** 0.148	2.069*** 0.162	2.490*** 0.235
Claim reduction	1.021** 0.009	1.020* 0.010	1.026* 0.015	1.019 0.055	1.041*** 0.015	1.005 0.009	1.064** 0.026	1.046*** 0.016	1.041 0.033
Examiner-inserted cites	1.108*** 0.008	1.110*** 0.010	1.107*** 0.019	1.196*** 0.069	1.116*** 0.016	1.107*** 0.015	1.097*** 0.018	1.074*** 0.019	1.054** 0.024
Correspondence with EPO	1.246*** 0.034	1.296*** 0.043	1.102 0.068	1.419** 0.210	1.075 0.054	1.243*** 0.063	1.399*** 0.087	1.166* 0.094	1.361*** 0.143
Lifetime appeal reversals	0.667*** 0.049	0.673*** 0.062	0.569*** 0.095		1.268 0.513	0.654 0.175	0.485*** 0.089	0.609*** 0.070	0.781** 0.086
Lifetime ratio invalidated	0.368*** 0.034	0.370*** 0.042	0.500*** 0.104		0.191*** 0.078	0.290*** 0.081	0.627** 0.131	0.494*** 0.093	0.436*** 0.090
No. of examiners	11,609	8,381	3,228	900	6,261	7,130	3,999	3,490	2,791
Time at risk	85,529	59,429	26,100	2,763	20,008	22,256	9,793	16,228	14,481

Table IA.B2. Persistence and Art Unit Effects.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a promotion in sub-samples by race. All specifications are estimated using Cox proportional-hazard models, stratified at the grade level. They include the same controls as the corresponding specifications in Table 4. The table shows only the covariate of interest: the gap between the rates at which White and minority examiners were promoted in the art unit, measured over the previous four quarters. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ^{***}, ^{**}, and ^{*} to denote significance at the 1%, 5%, and 10% level, respectively.

	Promotion to next grade			
	White examiners (1)	Asian examiners (2)	Black examiners (3)	Hispanic examiners (4)
Lagged promotion gap:				
White minus minorities	1.106 ^{**} <i>0.044</i>			
White minus own race		0.861 ^{***} <i>0.035</i>	0.810 ^{***} <i>0.053</i>	0.760 ^{***} <i>0.069</i>
No. of examiners	2,950	2,149	892	237
Time at risk	10,924	9,541	4,489	939

Table IA.B3. The Effects of Race on Promotions: Random Assignment.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a timely promotion at the PTO, in the subsample of examiners in IT related technology centers (21, 24, and 26) in which specialization is not considered a threat to the assumption of random assignment according to Righi and Simcoe (2019) or in art units classified by Feng and Jaravel (2020a) year-by-year as likely to assign applications to examiners based on the last digit of the randomly assigned application number (Feng and Jaravel 2020b). All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include the same controls as the corresponding specifications in Table 4 but suppress their hazard ratios to conserve space. Column 1 pools all examiner grades, allowing for multiple failures (corresponding to promotion up the ladder), and includes an additional stratification at the grade level, which allows the baseline hazard to vary by grade. Columns 2-7 report grade-by-grade promotion hazards estimated in sub-samples for each individual grade. Note that column 2 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ^{***}, ^{**}, and ^{*} to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades (1)	Promotion from grade					
		GS-5 (2)	GS-7 (3)	GS-9 (4)	GS-11 (5)	GS-12 (6)	GS-13 (7)
Asian	0.958 [*] <i>0.022</i>		1.144 <i>0.221</i>	1.038 <i>0.059</i>	0.940 ^{**} <i>0.028</i>	0.894 ^{***} <i>0.036</i>	1.048 <i>0.073</i>
Black	0.816 ^{***} <i>0.027</i>		1.381 <i>0.347</i>	1.039 <i>0.084</i>	0.803 ^{***} <i>0.036</i>	0.755 ^{***} <i>0.044</i>	0.703 ^{***} <i>0.069</i>
Hispanic	1.008 <i>0.054</i>		0.742 <i>0.374</i>	1.315 ^{**} <i>0.149</i>	0.995 <i>0.066</i>	1.005 <i>0.100</i>	0.748 <i>0.148</i>
No. of examiners	4,058		375	1,446	2,415	2,342	1,433
Time at risk	15,486		754	2,712	2,956	5,177	3,813

Table IA.B4. Competing Risk Estimates.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a promotion in sub-samples by grade. In contrast to the specifications reported in Table 4, we estimate Fine and Gray's proportional-hazard model which allows for the competing risk of an examiner leaving a grade rather than staying or being promoted. (Examiners may leave for any reason, including voluntary or involuntary separation or death.) Note the baseline model is assumed to be the same across art units and grades, as competing-risk models cannot accommodate stratification. All specifications include the same controls as the corresponding specifications in Table 4 but suppress their hazard ratios to conserve space. Note that column 1 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Promotion from					
	GS-5 (1)	GS-7 (2)	GS-9 (3)	GS-11 (4)	GS-12 (5)	GS-13 (6)
Asian		0.860* <i>0.071</i>	1.003 <i>0.040</i>	0.965 <i>0.024</i>	0.863*** <i>0.026</i>	0.912** <i>0.040</i>
Black		0.795** <i>0.076</i>	1.035 <i>0.061</i>	0.851*** <i>0.029</i>	0.726*** <i>0.031</i>	0.752*** <i>0.045</i>
Hispanic		0.873 <i>0.121</i>	1.215** <i>0.107</i>	0.974 <i>0.052</i>	0.881* <i>0.066</i>	0.907 <i>0.118</i>
No. of examiners		579	2,233	3,991	3,981	2,464
Time at risk		1,082	4,076	4,900	9,056	7,270

Table IA.B5. The Effects of Race on Promotions by Technology Field.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a timely promotion at the PTO by technology field. We classify art units into technology fields based on the modal NBER patent category of their patent applications (Hall, Jaffe, and Trajtenberg, 2021). Art units for which the modal category accounts for less than 75% of applications are excluded from this analysis. All specifications are estimated using Cox proportional-hazard models, stratified at the art unit and grade levels. They include the same controls as the corresponding specifications in Table 4 but suppress their hazard ratios to conserve space. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	NBER technology field				
	Chemical (1)	Computers & communication (2)	Drugs & medical (3)	Electrical & electronic (4)	Mechanical (5)
Asian	0.864** <i>0.063</i>	0.908*** <i>0.025</i>	0.872** <i>0.048</i>	1.046 <i>0.053</i>	0.961 <i>0.074</i>
Black	0.670** <i>0.113</i>	0.781*** <i>0.029</i>	0.727*** <i>0.073</i>	0.766*** <i>0.066</i>	0.777** <i>0.088</i>
Hispanic	0.630 <i>0.217</i>	0.976 <i>0.060</i>	0.797 <i>0.146</i>	1.070 <i>0.105</i>	0.966 <i>0.155</i>
Female	1.037 <i>0.072</i>	0.952* <i>0.027</i>	0.958 <i>0.046</i>	0.996 <i>0.058</i>	1.026 <i>0.077</i>
No. of examiners	321	2,804	788	877	386
Time at risk	1,067	11,963	3,758	3,373	1,265

Table IA.B6. The Effects of Race on Promotions Among Promotion-Eligible Examiners Controlling for Pendency.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a timely promotion at the PTO, controlling for the examiner's pendency awards (if any). We code examiners as promotion-eligible as in Table 4. Note that column 4 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). Column 10 restricts the sample of promotion-eligible examiners to those who passed the signatory authority program on their first attempt and so are definitely eligible for promotion to GS-14. Column 11 restricts the sample further to examiners whose production exceeds the level required to earn an "outstanding" rating (i.e., those who earn a gainsharing award of 3% or higher). Because part-time examiners are permitted to elect to complete the signatory authority program in a longer timeframe, we control for part-timers in columns 9 through 11. We estimate a Cox proportional-hazard model that is separately stratified at the art unit and grade levels and that is specified as in Table 4. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades			Promotion from grade							
	All examiners (1)	Male examiners (2)	Female examiners (3)	GS-5 (4)	GS-7 (5)	GS-9 (6)	GS-11 (7)	GS-12 (8)	GS-13 (9)	GS-13 (10)	GS-13 (11)
Asian	0.945*** <i>0.017</i>	0.966 <i>0.021</i>	0.960 <i>0.036</i>		0.836 <i>0.130</i>	1.045 <i>0.048</i>	0.980 <i>0.023</i>	0.880*** <i>0.027</i>	0.907* <i>0.048</i>	0.984 <i>0.056</i>	0.902 <i>0.102</i>
Black	0.814*** <i>0.022</i>	0.836*** <i>0.029</i>	0.746*** <i>0.041</i>		0.801 <i>0.166</i>	1.014 <i>0.067</i>	0.840*** <i>0.031</i>	0.739*** <i>0.034</i>	0.715*** <i>0.054</i>	0.761*** <i>0.066</i>	0.695** <i>0.111</i>
Hispanic	0.972 <i>0.043</i>	0.985 <i>0.053</i>	0.990 <i>0.085</i>		0.685 <i>0.268</i>	1.194* <i>0.112</i>	0.973 <i>0.056</i>	0.918 <i>0.073</i>	0.875 <i>0.135</i>	1.101 <i>0.176</i>	1.108 <i>0.340</i>
Female	0.959** <i>0.017</i>				0.952 <i>0.150</i>	0.982 <i>0.045</i>	0.950** <i>0.023</i>	0.951* <i>0.029</i>	1.014 <i>0.055</i>	1.050 <i>0.060</i>	1.140 <i>0.120</i>
Part-time									0.549*** <i>0.086</i>	0.985 <i>0.186</i>	0.486** <i>0.162</i>
Pendency awards	1.084*** <i>0.008</i>	1.080*** <i>0.010</i>	1.087*** <i>0.018</i>		0.759 <i>0.147</i>	1.268*** <i>0.046</i>	1.048*** <i>0.012</i>	1.094*** <i>0.012</i>	1.073*** <i>0.020</i>	1.039* <i>0.021</i>	0.998 <i>0.038</i>
No. of examiners	6,303	4,381	1,922		579	2,231	3,987	3,975	2,464	1,704	647
Time at risk	26,465	17,772	8,693		1,082	4,071	4,895	9,044	7,270	2,019	744

Table IA.B7. The Effects of Race on Promotions Among Promotion-Eligible Examiners Conditional on Promotion.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a timely promotion at the PTO, restricting the sample to examiners who are indeed promoted. Restricting the sample ensures that all remaining examiners a) wanted to be promoted and b) were eligible to be promoted. We code examiners as promotion-eligible as in Table 4. Note that column 4 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). Column 10 restricts the sample of promotion-eligible examiners to those who passed the signatory authority program on their first attempt and so are definitely eligible for promotion to GS-14. Column 11 restricts the sample further to examiners whose production exceeds the level required to earn an “outstanding” rating (i.e., those who earn a gainsharing award of 3% or higher). Because part-time examiners are permitted to elect to complete the signatory authority program in a longer timeframe, we control for part-timers in columns 9 through 11. We estimate a Cox proportional-hazard model that is separately stratified at the art unit and grade levels and that is specified as in Table 4. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades			Promotion from grade							
	All examiners	Male examiners	Female examiners	GS-5	GS-7	GS-9	GS-11	GS-12	GS-13	GS-13	GS-13
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Asian	0.930*** 0.016	0.950** 0.020	0.933* 0.035		0.811 0.124	1.054 0.048	0.968 0.023	0.861*** 0.026	0.879** 0.046	0.961 0.054	0.899 0.099
Black	0.811*** 0.022	0.831*** 0.028	0.733*** 0.038		0.728 0.149	1.020 0.066	0.815*** 0.030	0.760*** 0.033	0.721*** 0.055	0.747*** 0.064	0.711** 0.111
Hispanic	0.977 0.042	0.990 0.052	0.987 0.084		0.607 0.224	1.167* 0.107	0.954 0.054	0.940 0.073	0.968 0.146	1.069 0.172	1.114 0.340
Female	0.962** 0.017				0.920 0.145	0.989 0.045	0.961 0.023	0.929** 0.028	1.044 0.057	1.050 0.061	1.150 0.120
Part-time									0.585*** 0.095	0.986 0.186	0.485** 0.161
No. of examiners	6,082	4,225	1,857		570	2,176	3,923	3,688	2,180	1,697	644
Time at risk	21,438	14,570	6,868		1,043	3,849	4,723	6,804	4,921	1,985	733

Table IA.B8. Examiner Race and Enrollment in Teleworking.

The table reports linear-probability model estimates of the probability that an examiner enrolls in one of the PTO's three teleworking programs in a given quarter. The three programs are the Patent Hoteling Program (PHP), introduced in fiscal year 2006, the Telework Enhancement Act Pilot Program (TEAPP), introduced in February 2012, and the Patent Telework Program (PTP), introduced in July 2013. The sample is restricted to examiners who are eligible to enroll in a telework programs. The PHP and TEAPP are open to examiners in grade GS-12 or higher who have been with the PTO for a minimum of one year. The PTP is open to examiners in grade GS-9 or higher who have been with the PTO for a minimum of one year. Data on enrollment in the PTO's teleworking programs are obtained pursuant to a FOIA request. We include the same control variables and fixed effects as in Table 3 but suppress their coefficients to conserve space. For variable definitions and details of their construction see Appendix IA.I. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the coefficients. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Examiner enrolled in teleworking program? (1)
Asian	-0.037*** <i>0.011</i>
Black	-0.013 <i>0.014</i>
Hispanic	0.006 <i>0.025</i>
Female	0.033*** <i>0.010</i>
<i>R</i> -squared	15.2%
No. of examiners	9,481
No. of observations	186,893

Table IA.B9. The Effects of Race on Promotions Among High-Flying Examiners.

The table reports estimates of the likelihood of high-flying examiners receiving a timely promotion at the PTO. We code examiners as highfliers if they earn a gainsharing award corresponding to production at at least 120%. To ensure that they are eligible for promotion, we also require them to have spent the required minimum amount of time in their current grade (generally 26 consecutive two-week pay periods—one year—except in the most junior grades, in which examiners can earn up to two accelerated promotions after 13 consecutive two-week pay periods each on their way to GS-11). All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include time-varying covariates at a quarterly level (here: quarter-of-year fixed effects) and correct for right-censoring (due to examiners potentially being promoted after the end of our sample period). Columns 1-3 pool all examiner grades, allowing for multiple failures (corresponding to promotion up the ladder), and include an additional stratification at the grade level, which allows the baseline hazard to vary by grade. Columns 4-9 report grade-by-grade promotion hazards estimated in sub-samples for each individual grade. Note that columns 4 and 5 are empty as there are too few high-flying examiners in GS-5 or GS-7. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades			Promotion from grade					
	All examiners	Male examiners	Female examiners	GS-5	GS-7	GS-9	GS-11	GS-12	GS-13
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Asian	0.917** <i>0.033</i>	0.969 <i>0.044</i>	1.026 <i>0.084</i>			0.976 <i>0.199</i>	0.960 <i>0.041</i>	0.936 <i>0.054</i>	0.712*** <i>0.092</i>
Black	0.789*** <i>0.041</i>	0.869** <i>0.055</i>	0.749*** <i>0.084</i>			0.728 <i>0.187</i>	0.824*** <i>0.052</i>	0.771*** <i>0.064</i>	0.745* <i>0.127</i>
Hispanic	1.076 <i>0.092</i>	0.957 <i>0.119</i>	1.682*** <i>0.246</i>			1.314 <i>0.397</i>	1.081 <i>0.099</i>	1.143 <i>0.171</i>	0.666 <i>0.265</i>
Female	0.979 <i>0.034</i>					1.192 <i>0.182</i>	0.940 <i>0.043</i>	1.006 <i>0.056</i>	0.950 <i>0.117</i>
No. of examiners	2,378	1,666	712			358	1,147	1,299	714
Time at risk	6,670	4,618	2,052			629	1,330	2,649	1,891

Table IA.B10. Examiner Exits when not Timely Promoted.

The table reports estimates of the likelihood of promotion-eligible examiners exiting the PTO, controlling for whether they were eligible for promotion, whether they were timely promoted to their current grade, and whether their technology field experienced a spike in applications (to proxy for improved outside employment opportunities at patent law firms and patent search firms). We code examiners as promotion-eligible as in Table 4. All specifications are estimated using Cox proportional-hazard models stratified at the grade level as well as at the calendar-year level (to control for the state of the economy). The sample sizes in this table are larger than in our promotion models as examiners are “at risk” of exit at any time, not just when they are time-eligible for promotion. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of exit. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Exit hazard (1)
Asian examiners	0.667*** <i>0.051</i>
Black examiners	0.643*** <i>0.064</i>
Hispanic examiners	0.566*** <i>0.091</i>
Promotion-eligible	0.088*** <i>0.011</i>
x Asian	0.411*** <i>0.113</i>
x Black	0.449** <i>0.170</i>
x Hispanic	0.807 <i>0.483</i>
Not timely promoted	0.536*** <i>0.036</i>
x Asian	0.863 <i>0.088</i>
x Black	1.084 <i>0.138</i>
x Hispanic	1.035 <i>0.222</i>
Application spike	1.198** <i>0.085</i>
x Asian	0.897 <i>0.116</i>
x Black	0.978 <i>0.162</i>
x Hispanic	1.317 <i>0.338</i>
Female examiners	0.892** <i>0.045</i>
No. of examiners	9,497
Time at risk	216,303

Table IA.B11. Cumulative Times from GS-7 to GS-14 by Examiner and SPE Race.

The table reports the average cumulative time (in months) to advance from GS-7 to GS-14 conditional on reaching GS-14 for examiners of a given race serving under an SPE of a given race, for all promotion-eligible examiners. Cumulative times to GS-14 are obtained by summing the average time-in-grade for each grade from GS-7 to GS-13 within each pair formed by a racial group of examiners and a racial group of SPEs. For variable definitions and details of their construction see Appendix B. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively, based on standard errors that are clustered by art unit and grade.

		Examiner is ...				Difference relative to White examiners		
		White	Asian	Black	Hispanic	Asian	Black	Hispanic
SPE is ...	White	70.7	75.0	77.8	72.8	4.2***	7.0***	2.1*
	Asian	72.6	75.6	76.0	72.6	3.0***	3.3**	0.0
	Black	74.4	77.4	85.2	76.1	2.9*	10.8***	1.7
	Hispanic	68.5	69.3	75.9	67.6	0.9	7.4**	-0.8
Difference relative to White SPEs	Asian	1.9**	0.7	-1.8	-0.2			
	Black	3.7**	2.4*	7.4**	3.3			
	Hispanic	-2.2	-5.6**	-1.9	-5.2***			
No. of examiners		4,698	3,248	1,384	429			

Table IA.B12. Examiner Promotions and Caseload Spikes.

The table reports estimates of the likelihood of examiners who are promotion-eligible receiving a timely promotion at the PTO, depending on whether or not the examiner's art unit faces a caseload spike. For ease of comparison, col. 1 reports the baseline specification from Table 8, col. 1, which measures a caseload spike as a quarter in which the art unit's average caseload per examiner increases significantly (at the 95% level) relative to the art unit's own time series variation. Cols. 2 through 5 report the results from using four alternative measures of caseload spikes: any quarter in which the art unit's caseload per examiner significantly exceeds the four-quarter moving average of the art unit's average caseload per examiner (col. 2), and an annual increase in the art unit's average caseload per examiner that exceeds 95% of changes in caseload-per-examiner over time in the art unit (col. 3), the art unit's technology center (col. 4), or the PTO as a whole (col. 5). We code examiners as promotion-eligible as in Table 4. We estimate a Cox proportional-hazard model that is separately stratified at the art unit and grade levels and that is specified as in Table 4. For variable definitions and details of their construction see Appendix IA.I. Throughout the table, we report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of timely promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ^{***}, ^{**}, and ^{*} to denote significance at the 1%, 5%, and 10% level, respectively.

Caseload spike definition:	Timely promotion hazard				
	Quarter with significant increase in the art unit's average caseload per examiner	Quarter in which the art unit's average caseload per examiner exceeds the 4-quarter moving average	An annual increase in caseload-per-examiner that exceeds 95% of changes over time in caseload-per-examiner ...		
	(1)	(2)	... in the art unit	... in the art unit's technology center	... in the PTO as a whole
			(3)	(4)	(5)
Asian	0.924 ^{***} <i>0.017</i>	0.926 ^{***} <i>0.018</i>	0.936 ^{***} <i>0.017</i>	0.934 ^{***} <i>0.017</i>	0.933 ^{***} <i>0.017</i>
Black	0.787 ^{***} <i>0.022</i>	0.788 ^{***} <i>0.023</i>	0.785 ^{***} <i>0.022</i>	0.780 ^{***} <i>0.023</i>	0.784 ^{***} <i>0.023</i>
Hispanic	0.938 <i>0.044</i>	0.931 <i>0.043</i>	0.939 <i>0.045</i>	0.938 <i>0.045</i>	0.934 <i>0.045</i>
Capacity crunch	0.940 [*] <i>0.032</i>	0.958 <i>0.029</i>	1.024 <i>0.042</i>	1.006 <i>0.037</i>	0.996 <i>0.037</i>
x Asian	1.148 ^{***} <i>0.060</i>	1.094 [*] <i>0.051</i>	1.016 <i>0.058</i>	1.039 <i>0.053</i>	1.056 <i>0.055</i>
x Black	1.183 ^{**} <i>0.088</i>	1.121 [*] <i>0.077</i>	1.200 ^{**} <i>0.097</i>	1.229 ^{***} <i>0.089</i>	1.191 ^{**} <i>0.088</i>
x Hispanic	1.245 <i>0.172</i>	1.266 [*] <i>0.160</i>	1.200 <i>0.135</i>	1.201 [*] <i>0.127</i>	1.250 ^{**} <i>0.133</i>
No. of examiners	6,303	6,303	6,303	6,303	6,303
Time at risk	26,465	26,465	26,465	26,465	26,465

Table IA.B13. Examiner Promotions, Attrition Rates, and Attrition Gaps.

The table reports estimates of the likelihood of promotion-eligible examiners receiving a timely promotion at the PTO, depending on attrition rates and attrition gaps at the USPTO. Columns 1 and 3 replicate columns 2 and 3 of Table 8. Columns 2 and 4 add controls for the White-Black attrition gap and interactions between the White-Black attrition gap and the race indicators. The attrition rate variables are continuous variables that are centered at their mean such that the main effects capture promotion gaps relative to White examiners under normal (i.e., average) conditions and scaled such that the interaction effects capture the change in the promotion gaps when the attrition rate or the budget shortfall is 10 percentage points above its mean. (Accordingly, the linear combinations reported at the bottom of the table are computed for a 10-percentage-point increase in each proxy.) We code examiners as promotion-eligible as in Table 4. We estimate Cox proportional-hazard models that are separately stratified at the art unit and grade levels and that are specified as in Table 4. For variable definitions and details of their construction see Appendix B. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

Attrition rate measured at the:	Timely promotion hazard			
	Technology center level		PTO-level	
	(1)	(2)	(3)	(4)
Asian	0.940*** <i>0.017</i>	0.940*** <i>0.017</i>	0.939*** <i>0.017</i>	0.939*** <i>0.017</i>
Black	0.789*** <i>0.022</i>	0.787*** <i>0.022</i>	0.792*** <i>0.022</i>	0.791*** <i>0.022</i>
Hispanic	0.973 <i>0.044</i>	0.973 <i>0.044</i>	0.961 <i>0.043</i>	0.973 <i>0.045</i>
Lagged attrition rate (capacity crunch)	0.842*** <i>0.035</i>	0.809*** <i>0.034</i>	0.832*** <i>0.040</i>	0.757*** <i>0.044</i>
x Asian	0.958 <i>0.057</i>	0.962 <i>0.057</i>	1.021 <i>0.071</i>	0.935 <i>0.081</i>
x Black	1.203** <i>0.088</i>	1.170* <i>0.101</i>	1.498*** <i>0.150</i>	1.398*** <i>0.181</i>
x Hispanic	0.835 <i>0.123</i>	0.859 <i>0.127</i>	0.987 <i>0.164</i>	1.016 <i>0.223</i>
White-Black attrition gap		1.008 <i>0.036</i>		0.978 <i>0.036</i>
x Asian		0.914* <i>0.050</i>		0.902* <i>0.049</i>
x Black		1.059 <i>0.086</i>		1.076 <i>0.087</i>
x Hispanic		0.959 <i>0.133</i>		0.964 <i>0.135</i>
No. of examiners	6,144	6,143	6,303	6,143
Time at risk	25,679	25,652	26,465	25,652
Linear combination: (Black examiners capacity crunch) relative to (White examiners capacity crunch)	0.949 <i>0.072</i>	0.921 <i>0.082</i>	1.187* <i>0.117</i>	1.105 <i>0.145</i>

IA.C Gender Effects

Table IA.C1. The Effects of Race on Promotions Among Time-Eligible Examiners, By Gender.

The table reports estimates of the likelihood of examiners who are time-eligible for promotion in the sense that they have been in their current grade for the required minimum period of time to go up for a promotion, split by gender. Time eligibility is necessary but not sufficient for promotion eligibility. Actual promotion eligibility depends on the examiner's performance ratings, which we proxy for using administrative data. All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include time-varying covariates at a quarterly level (here: quarter-of-year fixed effects) and correct for right-censoring (due to examiners potentially being promoted after the end of our sample period). Examiner grades are pooled; we allow for multiple failures (corresponding to promotion up the ladder) and include an additional stratification at the grade level, which allows the baseline hazard to vary by grade. For variable definitions and details of their construction see Appendix B. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Male examiners (1)	Female examiners (2)
<i>Demographics</i>		
Asian	0.980 <i>0.016</i>	0.998 <i>0.029</i>
Black	0.784*** <i>0.019</i>	0.771*** <i>0.028</i>
Hispanic	0.926** <i>0.033</i>	0.919 <i>0.056</i>
Female		
Graduate degree	0.910*** <i>0.016</i>	0.949* <i>0.028</i>
Doctoral degree	0.977 <i>0.031</i>	0.953 <i>0.047</i>
<i>Performance proxies</i>		
Delinquent	0.231*** <i>0.025</i>	0.215*** <i>0.038</i>
Pendency awards	1.205*** <i>0.009</i>	1.212*** <i>0.017</i>
Production counts	2.659*** <i>0.071</i>	2.597*** <i>0.122</i>
Claim reduction	1.024*** <i>0.009</i>	1.017** <i>0.008</i>
Examiner-inserted cites	1.090*** <i>0.006</i>	1.073*** <i>0.012</i>
Correspondence with EPO	1.193*** <i>0.029</i>	1.085* <i>0.046</i>
Lifetime appeal reversals	0.716*** <i>0.041</i>	0.722*** <i>0.066</i>
Lifetime ratio invalidated	0.548*** <i>0.040</i>	0.555*** <i>0.067</i>
No. of examiners	8,845	3,479
Time at risk	77,198	34,791

Table IA.C2. The Effects of Race on Promotions Among Promotion-Eligible Examiners, By Gender.

The table reports estimates of the likelihood of examiners who are promotion-eligible receiving a timely promotion at the PTO, separately for male examiners (Panel A) and female examiners (Panel B). As in Table 4, we code examiners as promotion-eligible if they (a) are time-eligible for promotion and (b) hold either a gainsharing award, a special achievement award, or a quality step increase. All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include time-varying covariates at a quarterly level (here: quarter-of-year fixed effects) and correct for right-censoring (due to examiners potentially being promoted after the end of our sample period). Column 1 pools all examiner grades, allowing for multiple failures (corresponding to promotion up the ladder), and include an additional stratification at the grade level, which allows the baseline hazard to vary by grade. Columns 2-7 report grade-by-grade promotion hazards estimated in sub-samples for each individual grade. Note that column 2 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ^{***}, ^{**}, and ^{*} to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades (1)	Promotion from grade					
		GS-5 (2)	GS-7 (3)	GS-9 (4)	GS-11 (5)	GS-12 (6)	GS-13 (7)
Panel A. Male examiners							
Asian	0.959 [*] <i>0.021</i>		0.821 <i>0.175</i>	1.044 <i>0.061</i>	0.995 <i>0.028</i>	0.872 ^{***} <i>0.032</i>	0.989 <i>0.063</i>
Black	0.822 ^{***} <i>0.028</i>		1.159 <i>0.344</i>	1.021 <i>0.086</i>	0.868 ^{***} <i>0.040</i>	0.710 ^{***} <i>0.042</i>	0.757 ^{***} <i>0.079</i>
Hispanic	0.977 <i>0.053</i>		0.654 <i>0.346</i>	1.229 [*] <i>0.135</i>	1.018 <i>0.072</i>	0.831 [*] <i>0.086</i>	0.979 <i>0.196</i>
No. of examiners	4,381		399	1,571	2,787	2,765	1,689
Time at risk	17,772		762	2,869	3,384	6,143	4,542
Panel B. Female examiners							
Asian	0.952 <i>0.036</i>		0.497 <i>0.219</i>	1.000 <i>0.110</i>	0.997 <i>0.055</i>	0.975 <i>0.062</i>	0.785 ^{**} <i>0.097</i>
Black	0.724 ^{***} <i>0.039</i>		0.094 ^{**} <i>0.094</i>	1.000 <i>0.140</i>	0.785 ^{***} <i>0.055</i>	0.694 ^{***} <i>0.058</i>	0.539 ^{***} <i>0.080</i>
Hispanic	0.971 <i>0.083</i>		0.205 ^{**} <i>0.162</i>	0.892 <i>0.189</i>	0.899 <i>0.105</i>	1.092 <i>0.158</i>	1.078 <i>0.269</i>
No. of examiners	1,922		180	660	1,200	1,210	775
Time at risk	8,693		320	1,202	1,511	2,901	2,728

Table IA.C3. The Effects of Race on Promotions Among Promotion-Eligible Examiners: Intersectionality.

The table reports estimates of the likelihood of examiners who are promotion-eligible receiving a timely promotion at the PTO, interacting examiner race and gender. As in Table 4, we code examiners as promotion-eligible if they (a) are time-eligible for promotion and (b) hold either a gainsharing award, a special achievement award, or a quality step increase. All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include time-varying covariates at a quarterly level (here: quarter-of-year fixed effects) and correct for right-censoring (due to examiners potentially being promoted after the end of our sample period). Column 1 pools all examiner grades, allowing for multiple failures (corresponding to promotion up the ladder), and include an additional stratification at the grade level, which allows the baseline hazard to vary by grade. Columns 2-7 report grade-by-grade promotion hazards estimated in sub-samples for each individual grade. Note that column 2 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades (1)	Promotion from grade					
		GS-5 (2)	GS-7 (3)	GS-9 (4)	GS-11 (5)	GS-12 (6)	GS-13 (7)
Asian	0.931*** <i>0.019</i>		1.000 <i>0.178</i>	1.042 <i>0.057</i>	0.968 <i>0.026</i>	0.849*** <i>0.030</i>	0.917 <i>0.056</i>
Black	0.815*** <i>0.027</i>		1.170 <i>0.285</i>	0.988 <i>0.080</i>	0.856*** <i>0.038</i>	0.715*** <i>0.041</i>	0.739*** <i>0.071</i>
Hispanic	0.935 <i>0.049</i>		0.580 <i>0.272</i>	1.204* <i>0.130</i>	0.978 <i>0.069</i>	0.827** <i>0.080</i>	0.803 <i>0.171</i>
Female	0.954* <i>0.024</i>		1.508* <i>0.359</i>	0.942 <i>0.065</i>	0.954 <i>0.034</i>	0.905** <i>0.038</i>	1.056 <i>0.086</i>
& Asian	1.025 <i>0.039</i>		0.581* <i>0.186</i>	1.042 <i>0.106</i>	1.027 <i>0.053</i>	1.097 <i>0.070</i>	0.896 <i>0.099</i>
& Black	0.958 <i>0.053</i>		0.310*** <i>0.119</i>	1.114 <i>0.145</i>	0.929 <i>0.070</i>	1.034 <i>0.092</i>	0.865 <i>0.129</i>
& Hispanic	1.067 <i>0.099</i>		0.978 <i>0.765</i>	1.003 <i>0.179</i>	0.965 <i>0.117</i>	1.325* <i>0.223</i>	1.047 <i>0.328</i>
No. of examiners	6,303		579	2,231	3,987	3,975	2,464
Time at risk	26,465		1,082	4,071	4,895	9,044	7,270

Table IA.C4. Examiner Promotions: Conditioning on Childbearing Age.

The table reports estimates of the likelihood of examiners who are promotion-eligible receiving a timely promotion at the PTO. As in Table 4, we code examiners as promotion-eligible if they (a) are time-eligible for promotion and (b) hold either a gainsharing award, a special achievement award, or a quality step increase. All specifications are estimated using Cox proportional-hazard models stratified at the art unit and grade levels; they are specified as in Table 4 and include the same controls as in Table 4. Column 1 reports the baseline specification shown in Table 4, column 1. Column 2 restricts the sample to examiners whose age we can estimate from their graduation year (i.e., those examiners with only an undergraduate degree). Column 3 allows the effect of gender to vary with a woman's childbearing age, by including a control for female examiners of childbearing age (<45 years). Column 4 restricts the sample to female examiners for whom age can be estimated, while column 5 restricts the sample further to female examiners of childbearing age (<45 years). For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Promotion to the next grade				
	(1)	(2)	(3)	(4)	(5)
Asian	0.938*** <i>0.017</i>	0.943** <i>0.022</i>	0.944** <i>0.022</i>	0.902* <i>0.051</i>	0.892** <i>0.051</i>
Black	0.800*** <i>0.022</i>	0.816*** <i>0.029</i>	0.817*** <i>0.029</i>	0.713*** <i>0.056</i>	0.723*** <i>0.059</i>
Hispanic	0.957 <i>0.042</i>	0.955 <i>0.053</i>	0.956 <i>0.053</i>	1.147 <i>0.130</i>	1.163 <i>0.131</i>
Female examiner	0.959** <i>0.017</i>	0.903*** <i>0.022</i>	1.049 <i>0.128</i>		
Female examiner of childbearing age			0.858 <i>0.106</i>		
No. of examiners	6,303	3,694	3,694	1,108	1,078
Time at risk	26,465	15,727	15,727	5,232	4,965

IA.D Education Effects

Table IA.D1. The Effects of Race on Promotions Among Promotion-Eligible Examiners, By Education.

The table reports estimates of the likelihood of examiners who are promotion-eligible receiving a timely promotion at the PTO, separately for examiners with only an undergraduate degree (Panel A) and examiners with a graduate degree (Panel B). As in Table 4, we code examiners as promotion-eligible if they (a) are time-eligible for promotion and (b) hold either a gainsharing award, a special achievement award, or a quality step increase. All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include time-varying covariates at a quarterly level (here: quarter-of-year fixed effects) and correct for right-censoring (due to examiners potentially being promoted after the end of our sample period). Column 1 pools all examiner grades, allowing for multiple failures (corresponding to promotion up the ladder), and include an additional stratification at the grade level, which allows the baseline hazard to vary by grade. Columns 2-7 report grade-by-grade promotion hazards estimated in sub-samples for each individual grade. Note that column 2 is empty as there are few examiners in GS-5 who definitely satisfy promotion criteria (a), (b), and (c). Note further that column 3 in Panel B is empty because there are too few promotion-eligible examiners (97) holding a graduate degree in GS-7. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades (1)	GS-5 (2)	GS-7 (3)	Promotion from grade			
				GS-9 (4)	GS-11 (5)	GS-12 (6)	GS-13 (7)
Panel A. Examiners with undergraduate degrees							
Asian	0.942** <i>0.022</i>			0.863 <i>0.148</i>	1.032 <i>0.055</i>	0.973 <i>0.030</i>	0.846*** <i>0.036</i>
Black	0.816*** <i>0.029</i>			0.908 <i>0.204</i>	1.018 <i>0.078</i>	0.835*** <i>0.040</i>	0.677*** <i>0.043</i>
Hispanic	0.955 <i>0.053</i>			0.551 <i>0.292</i>	1.319*** <i>0.138</i>	0.948 <i>0.063</i>	0.840 <i>0.093</i>
No. of examiners	3,700			482	1,645	2,324	2,194
Time at risk	15,763			918	2,988	2,860	4,798
Panel B. Examiners with graduate degrees							
Asian	0.926** <i>0.028</i>			1.129 <i>0.161</i>	0.975 <i>0.041</i>	0.899** <i>0.042</i>	0.852* <i>0.077</i>
Black	0.766*** <i>0.038</i>			1.083 <i>0.193</i>	0.777*** <i>0.049</i>	0.779*** <i>0.058</i>	0.620*** <i>0.090</i>
Hispanic	0.946 <i>0.083</i>			1.219 <i>0.364</i>	0.966 <i>0.113</i>	0.922 <i>0.138</i>	0.827 <i>0.297</i>
No. of examiners	2,611			586	1,663	1,782	1,020
Time at risk	10,702			1,083	2,035	4,246	3,173

Table IA.D2. The Effects of Race on Promotions Among Promotion-Eligible Examiners, By Education.

The table reports estimates of the likelihood of examiners who are promotion-eligible receiving a timely promotion at the PTO. See Table 4 for details how we classify examiners. Unlike in Table 4, we interact race with an indicator for examiners who hold only an undergraduate degree. All specifications are estimated using Cox proportional-hazard models, stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. They include time-varying covariates at a quarterly level (here: quarter-of-year fixed effects) and correct for right-censoring (due to examiners potentially being promoted after the end of our sample period). Column 1 pools all examiner grades, allowing for multiple failures (corresponding to promotion up the ladder), and include an additional stratification at the grade level, which allows the baseline hazard to vary by grade. Columns 2-7 report grade-by-grade promotion hazards estimated in sub-samples for each individual grade. Note that column 2 is empty as there are too few examiners in GS-5 who hold a graduate degree. Note further that column 3 is empty because there are too few promotion-eligible examiners (97) holding a graduate degree in GS-7. For variable definitions and details of their construction see Appendix IA.I. We report hazard ratios rather than coefficients; a hazard ratio above (below) 1 indicates that the covariate has a positive (negative) effect on the probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level are shown in italics underneath the hazard ratios. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	All examiner grades (1)	Promotion from grade					
		GS-5 (2)	GS-7 (3)	GS-9 (4)	GS-11 (5)	GS-12 (6)	GS-13 (7)
Asian	0.941** <i>0.027</i>			1.222* <i>0.125</i>	0.975 <i>0.035</i>	0.900** <i>0.040</i>	0.867* <i>0.068</i>
Black	0.795*** <i>0.035</i>			1.027 <i>0.131</i>	0.832*** <i>0.046</i>	0.762*** <i>0.053</i>	0.691*** <i>0.085</i>
Hispanic	0.959 <i>0.072</i>			1.102 <i>0.213</i>	0.970 <i>0.103</i>	0.884 <i>0.118</i>	1.041 <i>0.325</i>
Undergraduate	0.996 <i>0.024</i>			0.969 <i>0.077</i>	0.983 <i>0.030</i>	1.032 <i>0.038</i>	1.078 <i>0.077</i>
& Asian	0.994 <i>0.035</i>			0.823* <i>0.095</i>	0.999 <i>0.046</i>	0.944 <i>0.054</i>	1.045 <i>0.106</i>
& Black	1.011 <i>0.055</i>			1.003 <i>0.144</i>	0.999 <i>0.071</i>	0.906 <i>0.081</i>	1.018 <i>0.152</i>
& Hispanic	0.997 <i>0.091</i>			1.128 <i>0.246</i>	0.993 <i>0.122</i>	1.030 <i>0.168</i>	0.731 <i>0.263</i>
No. of examiners	6,302			2,231	3,987	3,974	2,464
Time at risk	26,460			4,071	4,895	9,039	7,270

IA.E Computing career-total pay gaps

Promotion gaps depress minority examiners' earnings relative to White examiners. As Table 2, Panel B shows, Black examiners take longer to reach grade GS-14 than do White examiners. For example, for examiners hired in GS-7, the time to reach GS-14 averages 80 months for promotion-eligible Black examiners, 10 months longer than the 70 months it takes promotion-eligible White examples to reach GS-14. Promotion-eligible Black examiners thus spend longer in the lower grades, which depresses their lifetime earnings relative to White examiners. In this simulation, we estimate the effect of promotion gaps on examiners' earnings.

Assumptions

We assume that examiners are hired in GS-7, step 10; that they are promotion-eligible throughout their careers; and that they stay with the PTO for 15 years. We further assume that within-grade increases in pay (WGI) occur automatically and on schedule.

Step 1: Construct estimated pay paths through GS-14

Based on the time-to-promotion statistics reported in Table 2, Panel B, we construct expected pay paths (i.e., a sequence of grade and step combinations), separately for Black and White examiners, starting from GS-7, step 10 to GS-14, given estimated time-in-grade, eligibility for WGIs, and the two-step rule by which pay is increased upon promotion.³

Step 2: Estimate total expected pay in each grade-step combination

We use Special Rate Table 0576 to estimate the examiner's annual base pay in each grade-step combination along an examiner's expected pay path (in constant 2022 dollars). We then multiply the annual base pay in each grade-step combination with the time the examiner is expected to spend in that grade-step combination. This gives the examiner's total expected pay in each grade-step along her expected pay path.

Step 3: Estimate total expected pay in each grade spell

We aggregate expected total pay in each grade-step across grade-steps within grade. This gives the examiner's total expected pay in each grade spell along her expected pay path.

Step 4: Estimate expected lifetime pay

Expected lifetime pay is the sum of total expected pay in each grade spell across the examiner's assumed 15-year career.

³ According to the PTO's two-step promotion rule, promoted examiners are "entitled to basic pay at the lowest rate of the higher grade that exceeds his or her existing rate of basic pay *by not less than two step increases* of the grade from which promoted." Emphasis added. See the U.S. Office of Personnel Management's "[Fact Sheet: Promotions](#)", accessed August 2023.

The average promotion-eligible Black examiner who enters in GS-7, step 10 and reaches GS-14 in average time can expect to earn \$1,746,995 over a 15-year career (in constant 2022 dollars). This is 2.5% less than the \$1,790,430 the average promotion-eligible White examiner can expect to earn.

Figures IA.E1, and IA.E2 plot annual and cumulative expected pay, respectively.

Figure IA.E1. Expected Annual Base Pay.

The figure graphs estimated annual base pay in 2022 dollars for the average promotion-eligible White and Black examiner over a 15-year career assuming they are hired in GS-7, step 10 and that within-grade increases in pay (WGI) occur automatically and on schedule.

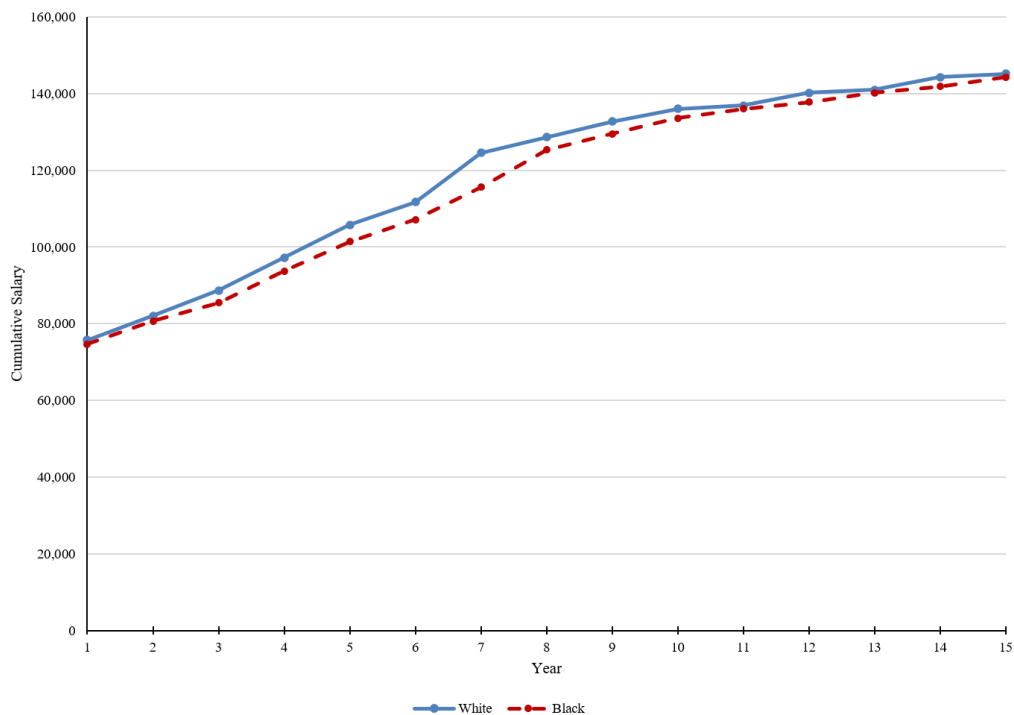
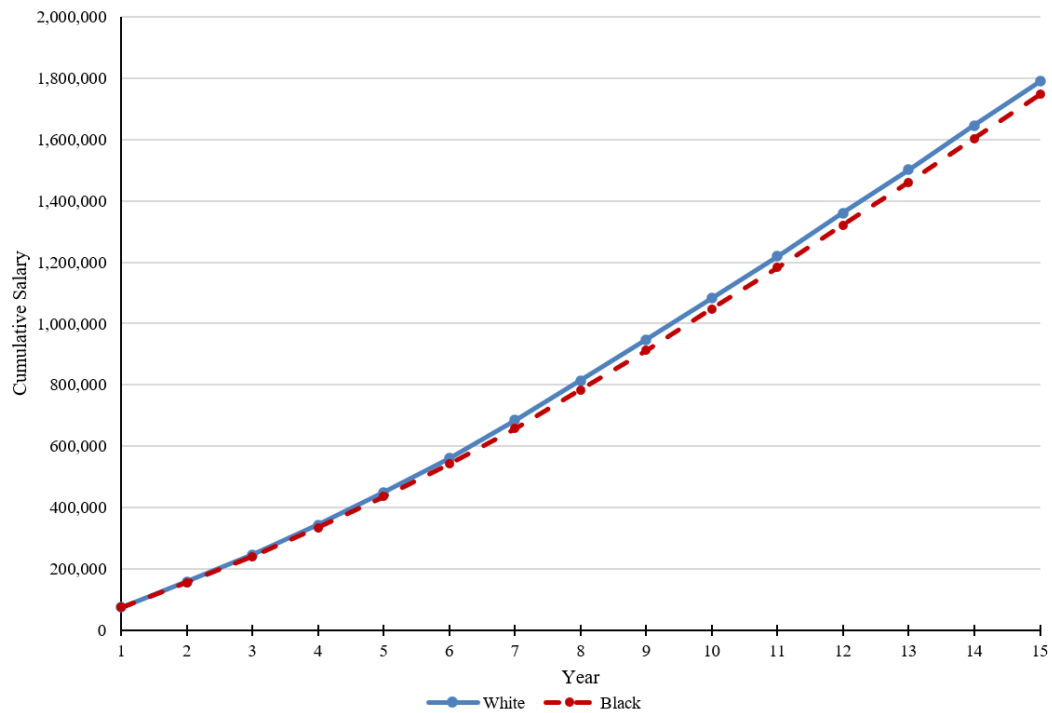


Figure IA.E2. Expected Cumulative Pay.

The figure graphs estimated cumulative base pay in 2022 dollars for the average promotion-eligible White and Black examiner over a 15-year career assuming they are hired in GS-7, step 10 and that within-grade increases in pay (WGI) occur automatically and on schedule.



IA.F Survey of examiner promotion processes

Survey methodology

The survey was sent out to 3,444 patent examiners at the PTO whose email addresses were procured from an external vendor, “rocketreach.” Patent examiners were identified as all current PTO employees who had the words “patent examiner” in their official job title (typically one of “junior patent examiner,” “primary patent examiner,” or “supervisory patent examiner”). The 3,444 patent examiners cover all General Schedule grades from GS-5 to GS-15.

The survey was first sent on April 26, 2023, with three reminders sent at two to three-day intervals and a final deadline of May 18, 2023. Email invitations were sent through an automation tool called pardot that tracks bounce rates, click rates, and open rates.

We sought and obtained approval from our respective Institutional Review Boards (IRB) prior to conducting the survey. Based on the IRBs’ recommendations, we have not retained any personally identifiable information about the survey respondents. Survey respondents were presented with an IRB approved consent form before being invited to submit their responses.

Of the 88 individuals who started the survey, 11 respondents abandoned it after completing the first three or fewer questions. The data below summarizes the responses of the 77 respondents who completed the survey. This response rate is consistent with the 1-5% response rate expected in cold-outreach surveys (Smith et al. 2019).

The following summarizes responses to the key survey questions. The full list of questions and responses are available from the authors upon request.

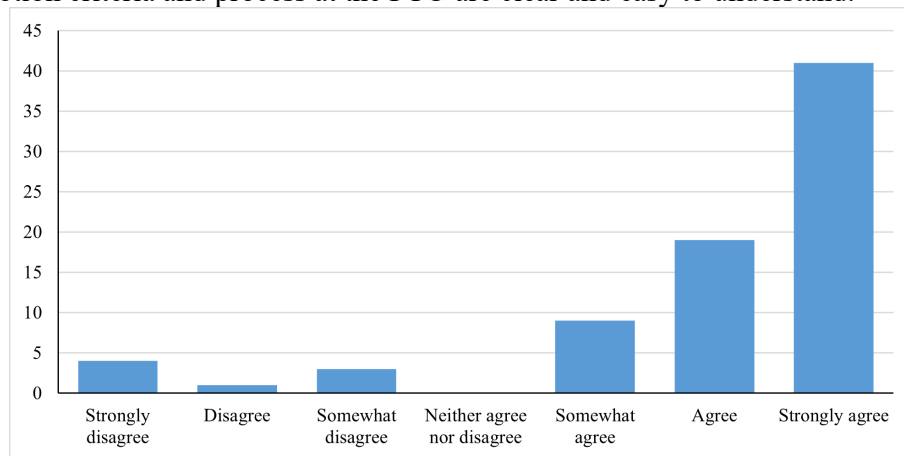
Survey results

1. Basic Demographics and experience

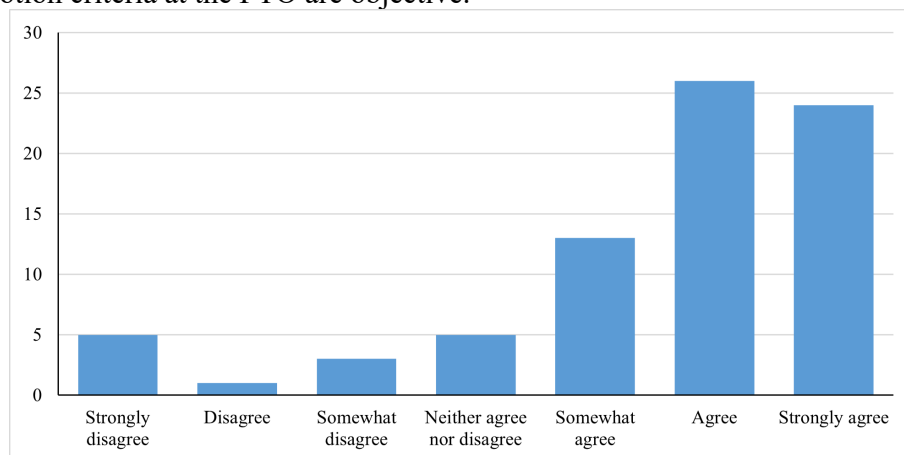
The median survey respondent has worked at the PTO for 10 years (mean = 10.9 years) and is a primary patent examiner (i.e., GS-14). 68.8% of respondents self-identify as male and 27.3% as female, with the remainder choosing not to disclose their gender. 46.8% of respondents self-identify as White (Non-Hispanic), 31.2% as Asian or Pacific Islander, 6.5% as Black, 6.5% as Hispanic, and 2.6% as Other, with the remainder choosing not to disclose their race.

2. “From a scale of 1 (Strongly disagree) to 7 (Strongly agree), please evaluate the extent to which you agree with the following statements about the promotion process at the PTO.”

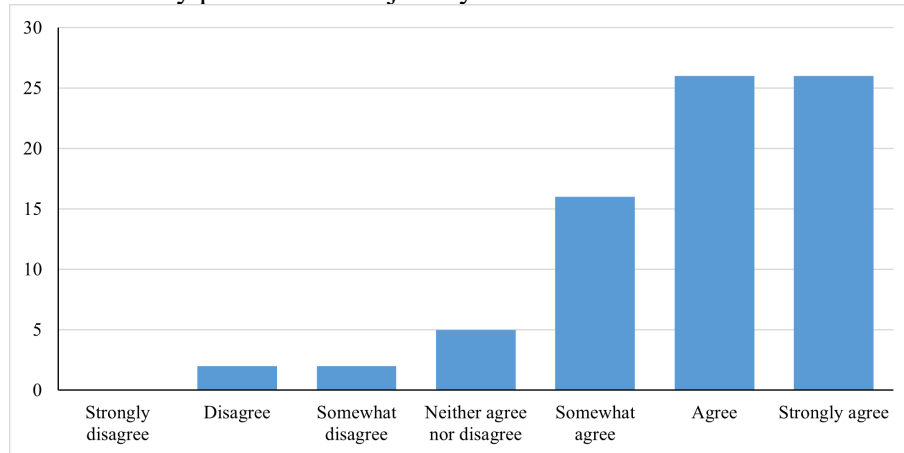
2.a “The promotion criteria and process at the PTO are clear and easy to understand.”



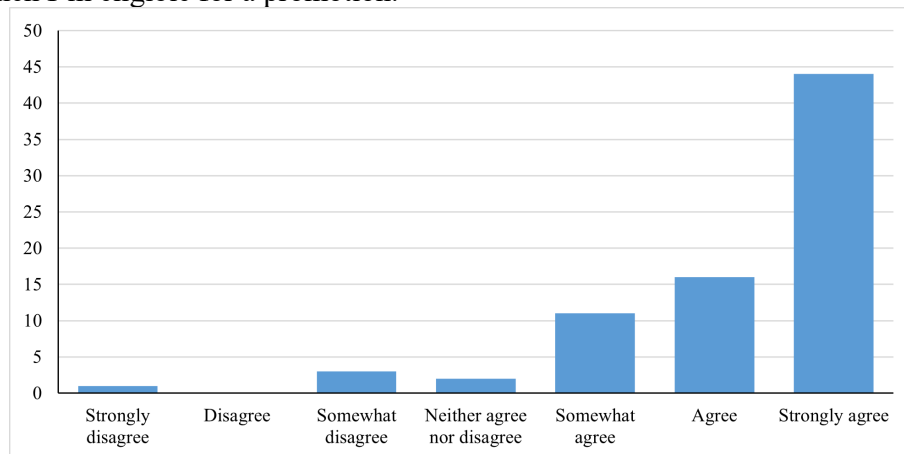
2.b “The promotion criteria at the PTO are objective.”



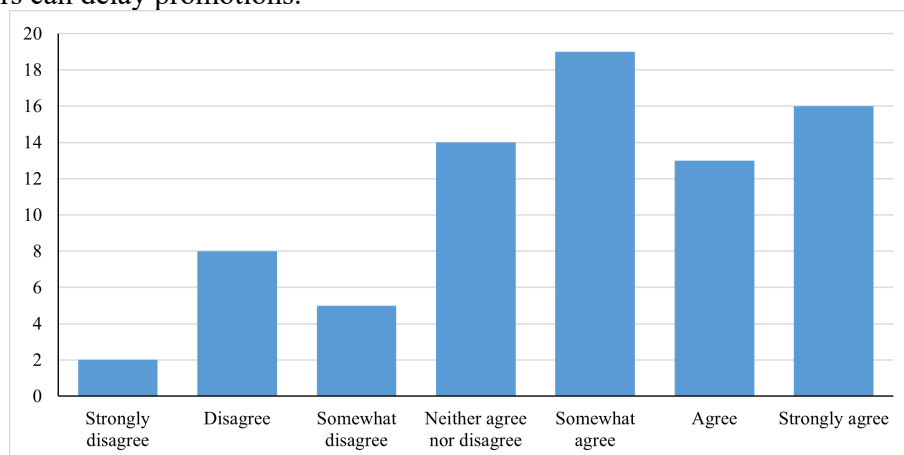
2.c “My supervisor affects my professional trajectory.”



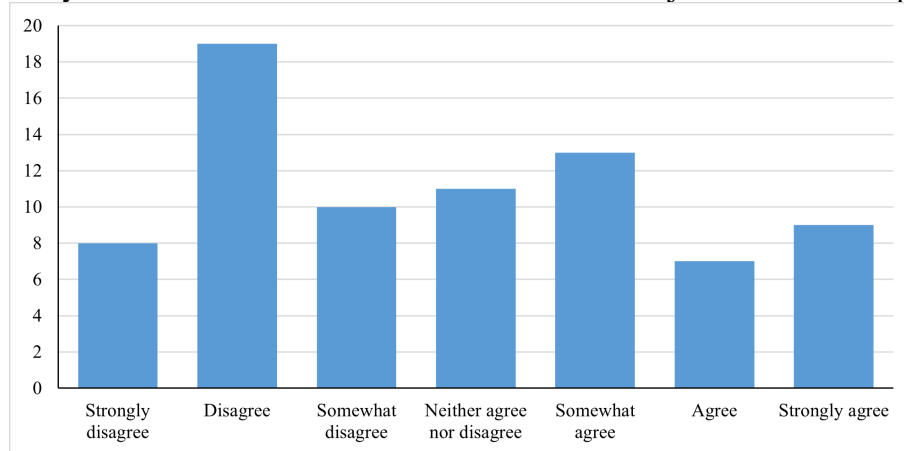
2.d “I know when I’m eligible for a promotion.”



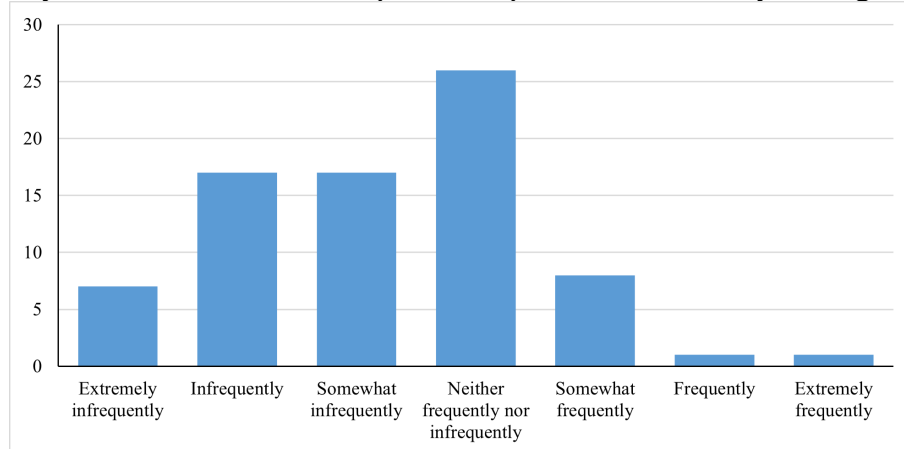
2.e “Supervisors can delay promotions.”



2.f “Promotion delays can occur even for examiners who meet the objective criteria for promotion.”



3. “How frequently do examiners choose to opt out of a promotion when they are eligible?”



4. “To the best of your understanding, please describe the Supervisory Patent Examiner’s role in the PTO’s promotion process.”

We provide a selection of responses that shed light on the SPE’s discretion in the promotion process and the SPE’s ability to affect performance outcomes. The full set of responses can be obtained from the authors.

- “It is terrible. While the PTO has objective metrics, the SPE has total control to bend and manipulate the metrics. SPEs are terrible monsters. I had a SPE Calvin Hewitt for about 4 years at the PTO. He told me once “I can slow you down” if I want. That is, when I asked him for my promotion, he said “no” and delayed it even though I met the objective production metrics by the organization. Finally, I have SPE John Hayes. He is so awesome. When I was under Calvin, I was STRUGGLING to get to 95% (which is the minimum for Fully Successful). Now, under Hayes, I am 110%. FOR NO OTHER REASON other than I have a different SPE.” (*Hispanic male at GS-13.*)

- “Every situation is different. Sometimes the SPE is a big role in the promotion process, while other times they play a smaller role, such as filling out official paperwork. I would say it depends on who is signing your cases.” (*Asian female at GS-11.*)
- “Their review is very subjective, make sure you have a good relation with your SPE.” (*Asian male at GS-14.*)
- “After twenty-six biweeks from last promotion (thirteen biweek for accelerated promotions from GS-7 to GS-9 and GS-9 to GS-11), when an examiner is fully successful in quality and docket management, and has adequate production for the most recent thirteen biweeks (the latter being the key metric because the other metrics are so easy to meet. Adequate production = 95% of average of current grade and next grade), an examiner can notify their SPE that they are eligible for a promotion. The SPE can then process the paperwork and then the promotion goes into effect the following biweek.” (*White male at GS-14.*)
- “Typically an examiner will know when they are on a promotion cycle and inform their SPE. The SPE will check in towards the end of the cycle (the pay periods before the end) and make sure examiner’s production and docket management scores are sufficient for the promotion. The SPE then files paperwork with HR which takes at least 2 weeks to a month to process the promotion.” (*White female at GS-13.*)
- “The SPE is responsible for keeping track and forwarding the paperwork for the promotion.” (*Asian female at GS-14.*)
- “The SPE determines when you have satisfied the requirements for promotion and submits all the necessary paperwork to make that promotion effective.” (*White male examiner at GS-14.*)
- “Putting through the promotion paperwork when an examiner is eligible for a promotion.” (*White male at GS-13.*)
- “The SPEs should be able to tell you when you will be eligible for promotion and signatory program. They verify your production and docket management scores. They also defend (or not) you against alleged errors called on you during your signatory program review.” (*Asian female at GS-14.*)
- “SPEs are involved in initiating promotions for examiners that are fully successful under established criteria. A SPE will also, if a junior examiner’s office actions are being signed by the SPE, have a significant influence on the examiner’s performance (whether an examiner is fully successful) due to accepting or rejecting work and requiring additional rework.” (*White male at GS-13.*)
- “Makes it or breaks it if the supervisor likes/does not like the examiner.” (*Race/gender undisclosed at GS-13.*)
- “It is complicated. Some SPE will return cases and not approved work to delay promotions. Some SPE have told senior Examiners to not help a new employee so that they fail on their work.” (*White male at GS-14.*)
- “The role is supposed to supervise and manage the dockets of examiners, rate examiners’ performance, assist examiners with completing actions, review actions of non-signatories, sign actions that examiners cannot based on examiners’ signatory level, and keep track of time and attendance.” (*Black male at GS-14.*)
- “The SPE (or a primary examiner designated by the SPE) approves all junior examiners’ office actions. Promotions have objective quality and production requirements. Quality is usually not

an issue as your SPE will not approve office actions that do not meet quality standards. Meeting production-based promotion requirements is where your SPE plays more of a role. If your SPE does not give actionable feedback or delays feedback before approving office actions, this can slow you down, and you will not meet production requirements for promotion.” (*Hispanic male at GS-12.*)

- “In most art units, the SPE reviews and ultimately approves the junior examiners actions. Although this is sometimes performed by a primary examiner. This process is how an Examiner is promoted by performing several actions and receiving counts in the production based system. It changes by about 15-20 hours of work per grade scale increases. In some situations the reviewers prevent upward mobility for junior examiners through constant returns to correct errors, that damper the examiners ability to meet production and promotion requirements.” (*Black Male at GS-12.*)

5. “Can Supervisory Patent Examiners affect the timing or outcome of promotion decisions? If so, how?”

We provide a selection of responses that shed light on the SPE’s discretion in the promotion process. The full set of responses can be obtained from the authors.

- “Yes. They can hold up the paperwork, launch accusations of poor performance, negatively impact performance by refusing to sign work, denying opportunities, and ruining the reputation of an examiner.” (*Black male at GS-14.*)
- “For examiners going through partial or full signatory authority program, SPE can play an important role when the results are around the boundary of passing/not passing.” (*Asian male at GS-14.*)
- “Yes, they have to approve it, and send it to directors.” (*Asian male at GS-14.*)
- “I think they are able to affect the timing, by giving reviews of the patent examiner and suggest or not suggesting someone for promotion.” (*Asian male at GS-14.*)
- “Yes. Early in the examiner’s career, the precise criteria for the 6-month promotion may not be clearly stated, and it can be purposefully mis-stated so that the examiner is misled as to what he/she needs to do to get this promotion. This happened to me at the beginning of my career.” (*White female at GS-14.*)
- “Yes, if supervisor forgets to initiate the promotion process, the promotion is delayed. If supervisor gives bad evaluation/rate, the promotion processes automatically is not able to [begin].” (*Asian female at GS-14.*)
- “Yes. SPE can “forget” to process paperwork; falling on the Examiner to keep track and follow up. Also, the are areas that are still subjective in for example Customer Interaction/Service.” (*Hispanic female at GS-14.*)
- “Yes, they can. There is a tool to see if you have met the grade promotion requirement. As long as you have consistently met or exceeded that promotion requirement (about 6 months), you should get a promotion. But, it is up to your SPE to get approval for the promotion.” (*White male at GS-9.*)

- “The timing can be slightly impacted. Most SPE’s will process the paperwork one pay period before the end of the promotion cycle so that the change is made effective the pay period after the promotion cycle ends, but a SPE can wait until the cycle is complete which would slightly delay the pay increase/promotion by one pay period (about 2 weeks).” (*White female at GS-13.*)
- “Yes! They can delay the paperwork, or they can say your quality is not up to snuff.” (*Asian female at GS-14.*)
- “SPE decides the timing.” (*Asian male examiner at GS-13.*)
- “The promotion process is very transparent- if the examiner is meeting the criteria for promotion and the examiner asks for the promotion, the Supervisory Patent Examiner should put the promotion paperwork in. I have never had any issue with this, but there are some aspects of the criteria for promotion that are slightly more subjective than just the number of patent applications examined (production) and the timing of completion of office actions (docket management) that the Supervisory Patent Examiner must evaluate before determining if the promotion should go through.” (*White female at GS-11.*)
- “I believe SPEs have a little leeway in when a promotion is processed, but this shouldn’t affect the timing by more than one biweek (two-week period).” (*White male at GS-13.*)
- “Delays of paperwork are common. Most promotions happen 1-2 months after they are due to occur. SPE’s are also supposed to provide correct information regarding the metrics for promotions, but often do not.” (*Asian male at GS-14.*)
- “Tangentially by not processing paperwork. Direct SPEs do not review applications for partial or full signatory promotions, so being overly detailed on case reviews does not affect those promotions. Within grade steps are directed by SPEs, so some aspects of those steps can be affected.” (*White male at GS-14.*)

6. “Please provide any additional comment on the role of Supervisors in examiners’ career development.”

- “At lower GS levels, even a really malicious SPE would have a hard time significantly affecting examiner’s grade advancement, although they can make examiner’s life difficult in other ways. At higher GS, a “bad” SPE can delay a grade increase and make it more difficult, but probably not block it, provided the examiner is actually qualified.” (*White male at GS-14.*)
- “Supervisors make or break an examiner’s career development based very little on merit. Racism, sexism, sexual harassment, Islamophobia, Xenophobia are rampant throughout the Agency and are well documented.” (*Black male at GS-14.*)
- “SPEs play a significant role in evaluating the work product of examiners and in encouraging or discouraging levels of performance that may lead to promotion, and SPEs that approve junior examiners’ cases play an even more significant role in the performance of examiners leading to promotion and other career opportunities such as detail assignments.” (*White male at GS-12.*)
- “Supervisors mentor the examiner after they leave the academy. They have a big role in shaping how the examiner does his/her job in the first few years. Your fate is their hands during the first few years. After you become a primary examiner (usually after five years if you come in at GS-9), their role is limited to reviewing your cases (occasionally). They can also deny your going to the next step. But again, if you have met your numbers it is hard for them to justify it and they almost never do it.” (*Other race male at GS-14.*)

- “If they are reasonable people, they can really speed you on your way. If they are sticklers for every little detail, it can greatly hamper your ability to get all the work done that you need to. Unfortunately, the people who get promoted to supervisor tend to be perfectionists. This is unfortunate because so much of this job is gray area that has multiple “right” (or acceptable) answers. You can spend a lot of extra time trying to find your particular supervisor’s “right” answer.” (*White male at GS-14.*)
- “My previous Supervisor did not care about my career growth. My present supervisor is much more active and concerned with my career. He has notified me about detail opportunities, provided warnings and encouragement about the management track. When I was denied becoming primary during my first attempt at the program, he argued my case to the director. After my (parked) car was totaled and my production numbers tanked, he had meetings with another specialist and explained the probationary period to me.” (*White male at GS-14.*)

IA.G SPE Promotions

Primary examiners who wish to transition to an administrative career can apply to become SPEs. SPE promotions differ from the other promotions we study in three respects: they require a vacancy and so are competitive; they require a candidate to actively apply; and they are not formulaic, instead involving criteria such as “leadership” that we have no data on.

Figure IA.G1 and accompanying Table IA.G1 show non-parametrically that minorities are significantly underrepresented among SPEs: while 19.7% of White examiners at GS-14 become SPEs, only 15.5% of Asian and 13.3% of Black examiners become SPEs. Holding their performance as an examiner constant, column 1 in Table IA.G2, Panel A shows that Asian and Black examiners are 25.5% and 32.6% less likely to become SPEs, respectively.

Performance as examiner may or may not correlate with a candidate’s performance against the eligibility criteria for promotion to SPE. The large promotion gaps we see in Figure IA.G1 and Table IA.G2 therefore need not reflect a glass ceiling; they could instead reflect unlucky timing (perhaps minority examiners become eligible for promotion at times of fewer SPE vacancies), self-selection (perhaps minority examiners are less likely to apply for advertised SPE vacancies), or imperfectly observed skill gaps (perhaps minority candidates, while performing well as examiners, lack the managerial skills required to become SPEs).

We evaluate these three potential sources of bias using data on SPE vacancies obtained from the PTO pursuant to a FOIA request. Between fiscal years 2011 and 2020, the PTO issued 61 vacancy announcements for one or more SPE vacancies in its eight technology centers. Vacancy data allow us to directly address the first potential source of bias (“unlucky timing”). Since a separate FOIA request for data on applications was denied, we create pools of potential candidates for each vacancy announcement using the PTO’s minimum eligibility criteria: (1) at least one year’s time-in-grade at the GS-14 level along with full signatory authority, and (2) subject matter expertise and experience in one of the art units of the technology center in which the vacancy or vacancies are advertised. Since we lack data on applications, our 61 candidate pools may include eligible examiners who chose not to apply. Eligible examiners who do apply are evaluated on a range of observable and unobservable metrics (called KSAs, short for “knowledge, skills, abilities, and competencies”). We evaluate the extent of the second potential source of bias (self-selection out of the candidate pool) and the third (imperfectly observed KSAs) using Oaxaca-Blinder decompositions and Oster (2019) bounds.

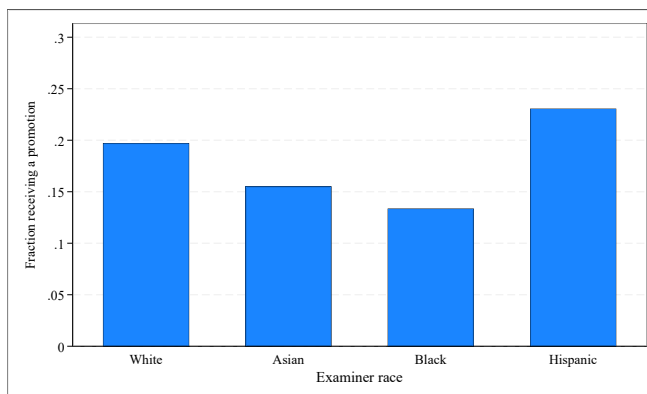
Columns 2 and 3 in Table IA.G2, Panel A report the results of conditional logit and linear probability models, respectively. Both specifications confirm the finding in column 1 that Asian and Black examiners are significantly less likely to be promoted to an SPE position (here: for a given

vacancy). Time variation in the existence of a vacancy is thus unlikely to explain the observed promotion gaps at the SPE level. The gaps are large: holding gender, education, tenure, time-in-grade, and examination performance constant, eligible Asian and Black examiners are 28.3% ($p=0.018$) and 44.0% ($p=0.001$) less likely to be appointed to an advertised SPE position than eligible White examiners, respectively.

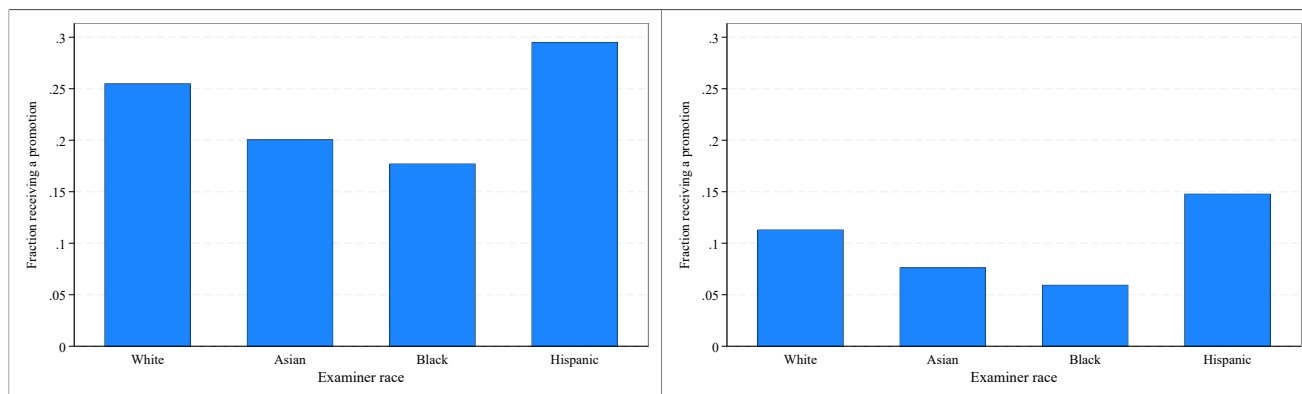
Table IA.G2, Panel B reports Oaxaca-Blinder decompositions of the promotion gaps based on the linear probability model in Panel A. For Asian examiners, differences in observed group characteristics cannot explain any part of the promotion gap. For Black examiners, the Oaxaca-Blinder decomposition implies that White examiners should be less likely to be promoted than the minority group based on observables, and because that is not the case, more than 100% of the promotion gap is unexplained. The Oster (2019) bounds tell a similar story: for both Asian and Black examiners, the Oster bounds comfortably exclude zero, suggesting that the observed promotion gaps are unlikely to be driven by unobservables.

Figure IA.G1. Fraction of Examiners Promoted to SPE.

The figure graphs the fractions of time-eligible examiners of a given race at GS-14 who receive a promotion to SPE, for all examiners (Fig. IA.G1(a)) and separately for high-performing examiners (Fig. IA.G1(b)) and all other examiners (Fig. IA.G1(c)). To be time-eligible for promotion, the examiner must have spent at least a year at GS-14. We code examiners as high-performing if they hold either a gainsharing award, a special achievement award, or a quality step increase one year following their promotion to GS-14. For tests of equality of fractions within grade across races see Table IA.G1 in the Internet Appendix.



(a) All time-eligible examiners at GS-14



(b) High-performing examiners at GS-14

(c) All other examiners at GS-14

Table IA.G1. Fraction of Examiners Promoted to SPE and Time to Promotion to SPE for Ultimately Promoted Examiners.

The table reports the fractions of time-eligible examiners of a given race at GS-14 who receive a promotion to SPE (Panel A) and the average time to promotion from GS-14 to SPE (in months) for ultimately promoted examiners (Panel B). To be time-eligible for promotion, the examiner must have spent at least a year at GS-14. We report statistics for all time-eligible examiners as well as separately for high-performing and all other examiners. We code examiners as high-performing if they hold either a gainsharing award, a special achievement award, or a quality step increase one year following their promotion to GS-14. For variable definitions and details of their construction see Appendix IA.I.

					<i>t</i> -tests of difference relative to White examiners (<i>p</i> -value)		
	White	Asian	Black	Hispanic	Asian	Black	Hispanic
Panel A: Fraction of examiners promoted to SPE							
No. of time-eligible examiners	1,998	1,611	544	139			
All time-eligible examiners	19.7%	15.5%	13.3%	23.0%	0.001	0.001	0.340
High-performing time-eligible examiners	25.5%	20.0%	17.7%	29.5%	0.003	0.003	0.431
All other time-eligible examiners	11.3%	7.6%	5.9%	14.8%	0.022	0.024	0.412
Panel B: Average time to promotion to SPE for ultimately promoted examiners							
No. of time-eligible examiners	394	250	73	32			
All time-eligible examiners	35.6	38.7	34.7	34.1	0.107	0.764	0.730
High-performing time-eligible examiners	34.6	38.8	31.6	33.8	0.048	0.340	0.873
All other time-eligible examiners	39.0	38.6	50.4	34.9	0.929	0.166	0.643

Table IA.G2, Panel A. SPE Promotions.

The table reports estimates of the likelihood of an examiner being promoted from grade GS-14 to an SPE position. Column 1 models the promotion hazard estimated using a Cox proportional-hazard model stratified at the art unit level to allow for art unit-specific fixed effects in the baseline promotion hazard. To control for the examiner's observable characteristics and performance, we include the same control variables as in Table 3 but suppress their hazard ratios to conserve space. Columns 2 and 3 model promotions to specific SPE vacancies advertised by the PTO as a function of observable examiner characteristics and performance. Between fiscal years 2011 and 2020, the PTO issued 61 vacancy announcements for one or more SPE vacancies in its eight technology centers. The unit of observation in these two promotion models is a candidate-vacancy announcement pair. The pool of potential candidates for each vacancy announcement consists of all examiners who are eligible for promotion to an SPE position. The PTO's minimum criteria for eligibility are (1) at least one year's time-in-grade at the GS-14 level along with full signatory authority and (2) subject matter expertise and experience in one of the art units of the technology center in which the vacancy or vacancies are advertised. Eligible examiners have to actively apply for a vacancy. Since we were denied data on applications, the 61 candidate pools we construct may include eligible examiners who chose not to apply. Eligible examiners who do apply are evaluated on a range of observable and unobservable metrics (called KSAs, short for "knowledge, skills, abilities, and competencies"). We evaluate the extent of biases due to self-selection out of the candidate pool and to partially unobserved KSAs using an Oaxaca-Blinder decomposition and Oster (2019) bounds, reported in Panel B. Successful applicants are identified from FOIA disclosures. We model promotion to an SPE vacancy using either a conditional logit model (column 2) or a linear probability model (column 3). The dependent variable in either model equals 1 if an eligible examiner is promoted to an SPE position in the technology center advertising a vacancy, and zero otherwise. Each specification includes control variables for examiner gender, education, tenure, time-in-grade, and performance (as revealed through examiner bonuses) as well as vacancy-level fixed effects (not reported to conserve space). For variable definitions and details of their construction see Appendix IA.I. The coefficient of interest in all three columns is the candidate's race. To ease comparison with the hazard model in column 1, we report odds ratios for the conditional logit model in column 2. An odds ratio below 1 indicates a lower probability of promotion. Heteroskedasticity-consistent standard errors clustered at the examiner level (in column 1) or the vacancy level (in columns 2 and 3) are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Promotion from GS-14	Promotion to SPE vacancy	
	Proportional hazard model	Conditional logit model	Linear probability model
	(1)	(2)	(3)
Asian	0.745*** <i>0.064</i>	0.717** <i>0.101</i>	-0.008*** <i>0.002</i>
Black	0.674*** <i>0.081</i>	0.560*** <i>0.099</i>	-0.013*** <i>0.003</i>
Hispanic	0.842 <i>0.153</i>	1.053 <i>0.272</i>	0.000 <i>0.005</i>
Female	1.023 <i>0.083</i>	1.392*** <i>0.152</i>	0.006*** <i>0.002</i>
R-squared	n.a.	0.144	0.034
Time at risk/no. of obs.	105,262	22,101	23,394

Table IA.G2, Panel B. Oaxaca-Blinder Decompositions and Oster Bounds.

Panel B reports an Oaxaca-Blinder decomposition of the promotion gaps between minority examiners and White examiners and Oster (2019) bounds on the estimated promotion gaps, both based on the estimated promotion gaps in Panel A, column 3. Before computing the Oaxaca-Blinder decomposition, the group differential in promotion probability is adjusted for sample selection biases that may arise due to the fact that the candidate pool varies across the 61 vacancy announcements. Oster's δ is the coefficient of proportionality of selection on unobservables and selection on observables for which the true promotion gap would be zero. $\delta > 1$ provides an estimate of how much more important the omitted variables would have to be compared to the included controls for the true promotion gap to be zero. $\delta < 0$ implies that Oster's method is uninformative about the size of any omitted-variable bias and that the correlation between the unobservables and race has the opposite sign compared to the correlation between the observables and race. Following convention, the Oster bounds are presented for $\delta = 0$ (i.e., the absence of omitted variable bias, corresponding to the promotion gaps reported in Panel A, column 3) and for $\delta = 1$ (i.e., the case in which selection on unobservables is as important as selection on observables). If these Oster bounds exclude zero, the estimated promotion gaps reported in Panel A, column 3 are unlikely to be biased due to omitted variables for this range of selection. (Following Oster's recommendation, we conservatively set $R_{max}^2 = 1$ when we calculate bounds on our estimates.)

		Asian vs. White (1)	Black vs. White (2)	Hispanic vs. White (3)
Oaxaca-Blinder decomposition				
Difference in promotion probability	mean	-0.004	-0.005	-0.010
	<i>p</i> -value	0.000	0.000	0.002
Explained difference	mean	0.000	0.004	0.000
	<i>p</i> -value	0.568	0.000	0.893
Unexplained difference	mean	-0.004	-0.009	-0.009
	<i>p</i> -value	0.000	0.000	0.001
Oster's (2019) δ		-0.292	-0.065	-0.003
Oster (2019) bounds		[-6.834, -0.008]	[-3.024, -0.013]	[-2.347, 0.000]

IA.H The broader consequences of racial disparities at the PTO

Table IA.H1 investigates potential detrimental effects of discriminatory promotion practices on individual examiner productivity. We estimate panel regressions of an examiner's log quarterly production counts on two variables of interest: the art unit's lagged promotion gaps relative to White examiners (as in Table IA.B2) and a measure of the tendency of the SPE in charge of the art unit to favor White examiners in promotion decisions.⁴ The production-count regressions include fixed effects at the level of individual examiners and control for grade, art unit, and calendar time fixed effects. They are continuous-treatment differences-in-differences models that ask how an individual examiner's productivity responds to changes in her art unit's treatment of minority examiners and binary-treatment differences-in-differences models that ask how an individual examiner's productivity responds to the arrival or departure of an SPE with a history of favoring White examiners.

The results show that minority examiners produce significantly fewer counts as promotion gaps widen in their art unit. To illustrate, a one-standard-deviation increase in the promotion gap between White examiners on the one hand and Asian, Black, or Hispanic examiners on the other hand in the previous four quarters reduces an Asian, Black, or Hispanic examiner's quarterly production counts by 1.4% ($p<0.001$), 1.5% ($p<0.001$), and 1.4% ($p=0.034$), respectively.⁵ We see no offsetting increase in the productivity of White examiners ($p=0.277$). The arrival of an SPE with a history of favoring White examiners over minority examiners hurts the productivity of Black examiners, whose quarterly production counts fall by 2.2% for a one-standard-deviation increase in the SPE's tendency to favor White over Black examiners ($p=0.028$). Interestingly, White examiners too produce fewer counts when an SPE who favors White examiners over minorities is appointed ($p=0.073$), suggesting that supervisors who discriminate against minorities depress productivity even among White examiners.

⁴ The latter variable is obtained from an Abowd, Kramarz, and Margolis (1999) style model of promotions that relies for identification on the movements across art units of SPEs and examiners; see Appendix B for further details.

⁵ As Callaway, Goodman-Bacon, and Sant'Anna (2021) show, a stronger version of the standard parallel-trends assumption is required to interpret a change in "dose" in a continuous-treatment diff-in-diff design as causal.

Table IA.H1. Do Promotion Gaps Harm Patent Examinations?

The table reports the results of ordinary-least-squares panel regressions of examiner productivity on promotion gaps in an art unit and a measure of the tendency of the SPE in charge of the art unit to favor White examiners in promotion decisions. The unit of observation is an examiner-quarter. The dependent variable is the examiner's log production counts in a quarter. We control for time-varying examiner characteristics (i.e., education), examiner fixed effects, grade fixed effects, art unit fixed effects, and calendar-quarter fixed effects. For variable definitions and details of their construction see Appendix IA.I. Given that the regressions involve a generated regressor (the SPE's tendency to favor White examiners), we report wild bootstrapped standard errors (Wu 1986) clustered at the examiner level. These are shown in italics underneath the coefficient estimates. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	Log production counts			
	White examiners (1)	Asian examiners (2)	Black examiners (3)	Hispanic examiners (4)
Lagged promotion gap:				
White minus minorities	-0.010 <i>0.009</i>			
White minus own race		-0.054*** <i>0.010</i>	-0.050*** <i>0.013</i>	-0.035** <i>0.017</i>
SPE fixed effects:				
SPE favors White examiners over minority examiners	-0.061* <i>0.034</i>			
SPE favors White examiners over examiner's race		-0.046 <i>0.062</i>	-0.155** <i>0.071</i>	-0.141 <i>0.113</i>
Controls?	Yes	Yes	Yes	Yes
Examiner FE?	Yes	Yes	Yes	Yes
Grade FE?	Yes	Yes	Yes	Yes
Art unit FE?	Yes	Yes	Yes	Yes
Calendar quarter FE?	Yes	Yes	Yes	Yes
R-squared	0.778	0.793	0.801	0.815
No. of observations	141,937	105,756	45,232	11,286

IA.I Variable definitions

Examiner-quarter level variables

Examiner grade is the examiner's grade level in the U.S. Government's general schedule (GS). Most examiners start at grade GS-5 or GS-7. Examiners at grades GS-5 through GS-12 need senior examiners to sign off on their decisions. GS-13 examiners undergo a period in which they have partial signatory authority (during which time their work is subject to random checks). Examiners at levels GS-14 and above have full signatory authority. Data on examiner grades are obtained from the PTO pursuant to a FOIA request.

Promotion is an indicator variable set equal to one if an examiner is promoted to the next grade level in the U.S. Government's general schedule (GS) in a given quarter, and zero otherwise. In the hazard models, promotion is considered the failure state and the time to failure is the difference between the date of promotion and the first date in the grade measured in days. Data on examiner promotions are obtained from the PTO pursuant to a FOIA request.

Timely promotion is an indicator variable set equal to one if an examiner is timely promoted. Whether a promotion is timely depends on the examiner's grade and tenure with the PTO. Examiners in GS-5 through GS-9 have the option to go up for accelerated promotion after six months in the current grade, as long as they have not been with the PTO for more than two years and have not already received two accelerated promotions. Examiners in grades GS-5 through GS-9 who are eligible for an accelerated promotion are coded as receiving a timely promotion if promoted within a grace period of one week of their six-month anniversary in the current grade. All other examiners are coded as receiving a timely promotion if promoted within a grace period of two weeks of their first-year anniversary in the current grade, except that examiners in GS-13 are coded as receiving a timely promotion if promoted within four weeks of the 92-week minimum time for completing the signatory authority program. Data on examiner promotions are obtained from the PTO pursuant to a FOIA request.

Time-eligible for promotion is an indicator variable set equal to one through grade GS-13 once the examiner has spent the required minimum amount of time in her current grade to be considered for promotion, and zero otherwise. For examiners hired into GS-11 and for all examiners in GS-11 and GS-12, the required minimum amount of time-in-grade is one year (26 consecutive two-week pay periods). For examiners hired below GS-11, special rules concerning accelerated promotions come into play. Examiners hired in GS-5 become time-eligible for accelerated promotion to GS-7 after six months (13 consecutive pay periods). All examiners in GS-7 become time-eligible for accelerated promotion to GS-9 after six months (13 consecutive pay periods) unless they have spent more than 18 months at the PTO (in which case they become time-eligible for promotion after one year in the grade). All examiners in GS-9 become eligible for accelerated promotion to GS-11 after six months (13 consecutive pay periods) unless they have spent more than 18 months at the PTO or were hired in GS-5 (in which case they become time-eligible for promotion after one year in the grade). For examiners in GS-13, the required minimum amount of time-in-grade is the 92 weeks it takes to complete the signatory authority program plus 4 weeks for the decision to be processed.

Promotion-eligible is an indicator variable set equal to one if both of the following two necessary and sufficient conditions are met: (a) the examiner is time-eligible for promotion (necessary condition); and (b) the examiner holds either a special achievement award or a gainsharing award or has earned a quality step increase (QSI), all of which require production of at least 110% of current-grade quota and fully successful performance in the other elements of the Performance Appraisal Plan (sufficient condition). Data on time-in-grade and awards are obtained from the PTO pursuant to FOIA requests. Data on QSIs are obtained from the Office of Personnel Management (OPM) pursuant to a FOIA request.

Potentially qualified is an indicator variable set equal to one if the examiner is time-eligible for promotion but not promotion-eligible as defined above.

Asian examiner is an indicator variable set equal to one if an examiner is classified as Asian, and zero otherwise. Data on examiner race are obtained from the PTO pursuant to a FOIA request.

Black examiner is an indicator variable set equal to one if an examiner is classified as Black, and zero otherwise. Data on examiner race are obtained from the PTO pursuant to a FOIA request.

Hispanic examiner is an indicator variable set equal to one if an examiner is classified as Hispanic, and zero otherwise. Data on examiner race are obtained from the PTO pursuant to a FOIA request.

Female examiner is an indicator variable that is equal to 1 if an examiner is classified as a woman, and zero otherwise. Gender classifications are based on OriginsInfo's database of first and last names and augmented with information from LinkedIn and public marriage records.

Examiner age is estimated as current year minus graduation year plus 22 and is available only for examiners whose highest degree is a Bachelor's degree. Data on educational qualifications and graduation years are obtained from the PTO pursuant to a FOIA request.

Fraction of females of childbearing age is estimated assuming women complete their childbearing years at the age of 45.

Part-time examiner is an indicator variable that is equal to 1 if the examiner works part-time. We infer part-time work from the bonus data (which unlike the pay data, records actual payments that take time worked into account). Because it relies on the bonus data, the part-time indicator is populated for all promotion-eligible examiners and mostly missing for potentially qualified examiners (with the exception of those examiners who hold pendency awards but no productivity awards).

Technology center is an administrative unit at the PTO headed by one or more technology center directors. Technology centers consist of dozens of art units.

Art unit is an administrative unit at the PTO headed by a supervisory patent examiner (SPE) and consisting of around 10-20 patent examiners. Art units represent narrow areas of expertise at the PTO.

Quarter-of-year is a set of binary indicators for the calendar quarter an observation falls in. Q1 is the first three months of the year, Q2 is the second three months of the year, Q3 is the third three months of the year, and Q4 is the last three months of the year.

Graduate degree is an indicator variable set equal to one if the highest level of education an examiner has achieved at a point in time is a non-doctoral graduate degree, and zero otherwise. Data on educational qualifications are obtained from the PTO pursuant to a FOIA request.

Doctoral degree is an indicator variable set equal to one if the highest level of education an examiner has achieved at a point in time is a doctoral degree, and zero otherwise. Data on educational qualifications are obtained from the PTO pursuant to a FOIA request.

Delinquent is an indicator variable set equal to one if the examiner fails to earn a scheduled within-grade increase (WGI)⁶ in pay, is moved down a step within the grade (a pay cut), is demoted by one or more grades, or has pay docked, and zero otherwise. These events are coded using salary data obtained from the Office of Personnel Management (OPM) pursuant to a FOIA request.

Pendency awards is the percent of base salary that an examiner received as an award for her performance in the docket management element of the PAP in a given year. Data on examiner awards are obtained from the PTO pursuant to a FOIA request.

Special achievement awards is an indicator variable set equal to one if an examiner received a special achievement award in a given year, and zero otherwise. Special achievement awards are earned for "outstanding" production (the highest rating on the PAP's five-point scale) and require at least a "fully successful" rating on the other three elements of the PAP. Data on examiner awards are obtained from the PTO pursuant to a FOIA request.

⁶ Subject to being fully successful in all four elements of their PAP, examiners are entitled to a one-step WGI every year if currently on step 1, 2, or 3, every other year if currently on step 4, 5, or 6, and every third year if currently on step 7, 8, 9, or 10.

Gainsharing awards is the percent of base salary that an examiner received as a gainsharing award in a given year. Gainsharing awards are primarily earned for productivity at or above the “outstanding” level, and to a small extent for docket management. Data on examiner awards are obtained from the PTO pursuant to a FOIA request.

Production counts is the percentile rank of the examiner’s production counts based on the office actions issued by the examiner with a first-action date in quarter t or the previous three quarters, relative to all other examiners of the same grade in the same art unit over that time period. To generate the production counts measure, we follow the PAP and allocate 1.25 counts for a non-final rejection, 0.75 counts for an allowance or final rejection after the initial non-final rejection, 0.75 counts if the applicant abandons the application after first-action, or the full 2 counts for a first-action allowance. Data on examiner office actions are obtained from the PTO’s public datasets.

Claim reduction is the average reduction in independent claims from patent application to patent grant for ultimately allowed applications reviewed by an examiner with a first-action date in quarter t and the previous three quarters. Data on claim reduction are obtained from the PTO’s public datasets.

Examiner-inserted cites is the examiner’s average number of examiner-inserted citations for ultimately allowed applications reviewed by an examiner with a first-action date in quarter t and the previous three quarters. Data on examiner-inserted citations are obtained from the PTO’s public datasets.

Correspondence with EPO is the examiner’s rate of correspondence between her examination decisions (i.e., allowance or rejection) and those decisions made at the EPO for applications, constructed using those patent applications that have a corresponding application filed at the EPO and that have a first-action date in quarter t and the previous three quarters. Data on corresponding EPO patent applications are obtained from the PATSTAT datasets.

Lifetime appeal reversals is the percentile rank of the cumulative count of decisions by an examiner that have been reversed on appeal as of quarter t divided by the cumulative count of decisions by the examiner that have been appealed and have a final decision (affirmed, revised, or reversed) as of quarter t , both measured over her career at the PTO and relative to all other examiners of the same grade in the same art unit over that time period. Data on reversals on appeal are obtained from the PTO’s public datasets.

Lifetime ratio invalidated is the percentile rank of the cumulative count of applications with a first-action date as of quarter t that are eventually invalidated by a court divided by the cumulative count of first-actions an examiner has taken as of quarter t , both measured over her career at the PTO and relative to all other examiners of the same grade in the same art unit over that time period. Data on invalidations are obtained from Lex Machina, Inc.

Pay increase upon promotion equals the percentage increase in the examiner’s annualized base pay following promotion, less the mean percentage pay increase in the examiner’s grade. The size of the pay increase depends on the step the examiner is on before promotion and is constructed using the PTO’s so called two-step promotion rule, applying any within-grade-increase in pay the examiner may be entitled to given her current step assuming that promotion takes a year.

Exit is an indicator variable set equal to one if an examiner exits from the PTO. Exits can occur either voluntarily (resignation) or involuntarily (e.g., death or dismissal), and zero otherwise. Data on examiner exits are obtained from the PTO pursuant to a FOIA request.

Quarter with significant increase in the art unit’s average caseload per examiner is an indicator variable set equal to one if the average caseload per examiner in the examiner’s art unit has increased significantly over the quarter (at the 5% level of significance based on the art unit’s own rate of variation in application flow), and zero otherwise.

Application spike is an indicator variable set equal to one if the total application flow in the examiner’s art unit has increased significantly in the previous quarter (at the 5% level of significance based on the art unit’s own rate of variation in application flow), and zero otherwise.

Log production counts is the natural logarithm of one plus the sum of the production counts an examiner earns in a

quarter. To generate the production counts measure, we follow the PAP and allocate 1.25 counts for a non-final rejection, 0.75 counts for an allowance or final rejection after the initial non-final rejection, 0.75 counts if the applicant abandons the application after first-action, or the full 2 counts for a first-action allowance. Data on examiner office actions are obtained from the PTO's public datasets.

Vacancy-level variables

SPE promotion conditional on vacancies is an indicator set equal to one if an eligible examiner is promoted to an SPE position in the technology center advertising a vacancy, and zero otherwise. The PTO's minimum criteria for eligibility are (1) at least one year's time-in-grade at the GS-14 level along with full signatory authority and (2) subject matter expertise and experience in one of the art units of the technology center in which the vacancy or vacancies are advertised. Data on SPE vacancies and on promotions are obtained from the PTO pursuant to FOIA requests.

Art unit-quarter level variables

Lagged promotion gap is the difference in the lagged promotion rates for White examiners and non-White examiners in an art unit measured over the previous four quarters. We calculate race-specific promotion gaps as well as a promotion gap comparing the promotion rate for White examiners to the promotion rate for all minority examiners as a group.

SPE favors White examiners over minority examiners is constructed as follows. First, we estimate a linear probability version of the pooled baseline hazard model reported in Table IA.B2, column 1. We do so because fixed effects cannot be recovered from hazard models. We include in the linear probability model examiner fixed effects, grade fixed effects, and SPE fixed effects, with the latter interacted with examiner race. Second, we use the SPE fixed effects interacted with examiner race to compute the conditional average rates at which the SPE has promoted examiners from each of the four races over her SPE career. Third, we compute the difference between each SPE's promotion rate for White examiners and the lowest of her promotion rates for minority examiners.

SPE favors White examiners over examiner's race is a race-by-race version of ***SPE favors White examiners over minority examiners***.

Table IA.J1, Panel A. Fraction of Examiners Receiving a Timely Promotion.

The table reports the fractions of examiners of a given race in a given GS grade who receive a timely promotion, for all time-eligible examiners and separately for time-eligible examiners who definitely satisfy promotion criteria (a), (b), and (c) and for potentially qualified examiners. This table is equivalent to Table 2, Panel A in the manuscript except it includes significance levels for differences relative to White examiners. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	White	Asian	Black	Hispanic	Difference relative to White examiners		
					Asian	Black	Hispanic
No. of examiners	5,877	4,062	1,883	543			
All time-eligible examiners							
GS-5 to GS-7	1.1%	2.2%	1.3%	0.0%	1.0%	0.2%	-1.1%
GS-7 to GS-9	2.6%	2.6%	3.8%	2.3%	0.1%	1.2%*	-0.3%
GS-9 to GS-11	12.3%	12.0%	14.6%	13.8%	-0.3%	2.2%**	1.4%
GS-11 to GS-12	63.0%	66.5%	54.0%	56.2%	3.5%***	-9.0%***	-6.8%**
GS-12 to GS-13	53.2%	49.3%	37.9%	44.7%	-3.9%***	-15.3%***	-8.5%***
GS-13 to GS-14	13.2%	9.8%	5.9%	8.8%	-3.4%***	-7.3%***	-4.3%*
Promotion-eligible examiners							
GS-5 to GS-7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
GS-7 to GS-9	13.6%	14.7%	30.4%	0.0%	1.0%	16.8%**	-13.6%
GS-9 to GS-11	33.3%	35.7%	43.7%	45.3%	2.4%	10.4%***	12.0%*
GS-11 to GS-12	83.4%	83.4%	76.3%	80.0%	0.0%	-7.0%***	-3.4%
GS-12 to GS-13	70.9%	62.9%	51.7%	67.4%	-8.0%***	-19.2%***	-3.5%
GS-13 to GS-14	18.7%	14.1%	8.5%	14.1%	-4.6%***	-10.2%***	-4.6%
Potentially qualified examiners							
GS-5 to GS-7	1.1%	2.2%	1.4%	0.0%	1.1%	0.2%	-1.1%
GS-7 to GS-9	2.2%	2.2%	2.5%	2.4%	0.0%	0.3%	0.2%
GS-9 to GS-11	7.6%	7.4%	7.1%	7.8%	-0.3%	-0.5%	0.1%
GS-11 to GS-12	44.6%	49.9%	35.0%	39.3%	5.3%***	-9.6%***	-5.3%
GS-12 to GS-13	33.4%	33.4%	23.8%	27.3%	0.1%	-9.6%***	-6.0%
GS-13 to GS-14	9.1%	5.9%	4.0%	5.8%	-3.1%***	-5.0%***	-3.2%

Table IA.J1, Panel B. Time to Promotion Conditional on Promotion.

The table reports the average time to promotion (in months) conditional on promotion for examiners of a given race in a given GS grade, for all time-eligible examiners and separately for promotion-eligible examiners and potentially qualified examiners. This table is equivalent to Table 2, Panel B in the manuscript except it includes significance levels for differences relative to White examiners. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	White	Asian	Black	Hispanic	Difference relative to White examiners		
					Asian	Black	Hispanic
No. of examiners	4,698	3,248	1,384	429			
All time-eligible examiners							
GS-5 to GS-7	10.7	11.3	12.3	13.0	0.6	1.7**	2.3**
GS-7 to GS-9	11.3	12.3	13.8	12.8	1.0***	2.5***	1.5***
GS-9 to GS-11	11.6	12.0	13.2	11.9	0.4**	1.5***	0.3
GS-11 to GS-12	13.6	13.6	14.9	14.3	0.0	1.2***	0.7*
GS-12 to GS-13	15.7	16.9	19.0	17.4	1.2***	3.4***	1.7**
GS-13 to GS-14	27.3	29.3	31.7	30.3	2.1***	4.4***	3.0***
Promotion-eligible examiners							
GS-5 to GS-7	6.6	6.4	7.0	6.9	-0.2	0.4	0.2
GS-7 to GS-9	8.8	9.9	11.2	9.5	1.1*	2.4***	0.7
GS-9 to GS-11	9.8	10.3	11.0	9.9	0.5**	1.2***	0.1
GS-11 to GS-12	12.4	12.6	13.0	12.5	0.2**	0.6***	0.1
GS-12 to GS-13	13.8	15.6	17.2	14.1	1.9***	3.4***	0.3
GS-13 to GS-14	25.8	27.4	27.9	26.1	1.6***	2.1***	0.3
Potentially qualified examiners							
GS-5 to GS-7	10.7	11.3	12.4	13.1	0.6	1.7**	2.4**
GS-7 to GS-9	11.4	12.4	13.9	12.9	1.0***	2.6***	1.5***
GS-9 to GS-11	12.1	12.5	13.9	12.4	0.3	1.8***	0.2
GS-11 to GS-12	15.0	14.8	16.9	16.0	-0.2	1.9***	1.0
GS-12 to GS-13	18.5	18.8	21.6	20.9	0.4	3.1***	2.4*
GS-13 to GS-14	28.8	31.7	35.5	33.1	2.9***	6.7***	4.3**

Table IA.J2. Examiner Pendency and Quality Measures.

The table reports examiner pendency and quality measures for the average promotion-eligible examiner of a given race in a given GS grade measured as of the quarter when they first become time-eligible for promotion. This table is equivalent to Table 5 in the manuscript except it includes significance levels for differences relative to White examiners. We use ***, **, and * to denote significance at the 1%, 5%, and 10% level, respectively.

	White	Asian	Black	Hispanic	Difference relative to White examiners		
					Asian	Black	Hispanic
No. of examiners	2,776	2,027	810	215			
Pendency awards							
GS-7	21.8%	25.3%	27.0%	32.8%	3.5%	5.2%	10.9%
GS-9	32.1%	36.3%	33.1%	42.8%	4.2%*	1.0%	10.7%*
GS-11	43.3%	41.0%	36.8%	43.6%	-2.2%	-6.5%***	0.3%
GS-12	46.9%	44.3%	39.4%	43.1%	-2.6%	-7.5%***	-3.8%
GS-13	64.3%	56.8%	60.4%	51.1%	-7.5%***	-3.9%	-13.1%**
Claim reduction							
GS-7	0.36	0.39	0.21	0.11	0.03	-0.14	-0.24**
GS-9	0.49	0.43	0.33	0.32	-0.06	-0.16***	-0.17**
GS-11	0.53	0.53	0.49	0.45	-0.01	-0.04	-0.08
GS-12	0.56	0.59	0.41	0.54	0.02	-0.16***	-0.02
GS-13	0.43	0.47	0.38	0.58	0.05	-0.04	0.15**
Examiner-inserted citations							
GS-7	9.9	11.8	12.4	11.8	1.9	2.5	1.9
GS-9	14.1	11.9	16.6	14.9	-2.2	2.5	0.8
GS-11	15.2	13.2	11.3	12.2	-1.9*	-3.9**	-2.9
GS-12	12.6	11.5	9.9	11.6	-1.1	-2.7**	-1.0
GS-13	11.6	11.2	16.7	10.2	-0.4	5.1	-1.4

Table IA.J2. Continued.

	White	Asian	Black	Hispanic	Difference relative to White examiners		
					Asian	Black	Hispanic
No. of examiners	2,776	2,027	810	215			
EPO correspondence							
GS-7	61.6%	55.1%	59.0%	56.8%	-6.6%*	-2.6%	-4.8%
GS-9	58.9%	58.6%	59.0%	53.2%	-0.3%	0.1%	-5.7%*
GS-11	59.1%	57.0%	57.9%	55.9%	-2.1%**	-1.2%	-3.2%
GS-12	57.9%	57.1%	54.1%	57.1%	-0.8%	-3.8%***	-0.8%
GS-13	54.1%	56.5%	53.6%	56.9%	2.4%**	-0.5%	2.7%
Lifetime ratio appeal reversal							
GS-7	1.8%	1.9%	1.2%	-0.2%	0.1%	-0.7%	-2.1%
GS-9	2.1%	2.2%	2.0%	0.6%	0.1%	-0.1%	-1.5%
GS-11	3.8%	4.9%	3.7%	3.9%	1.1%*	-0.1%	0.2%
GS-12	7.5%	7.6%	7.8%	8.9%	0.0%	0.2%	1.3%
GS-13	18.4%	17.6%	17.3%	11.5%	-0.8%	-1.1%	-6.9%***
Lifetime ratio invalidated							
GS-7	0.0%	-1.4%	12.5%	1.4%	-1.4%*	12.5%*	1.4%**
GS-9	3.1%	2.2%	3.7%	2.0%	-0.9%	0.6%	-1.1%
GS-11	2.5%	2.3%	2.3%	6.0%	-0.2%	-0.2%	3.6%*
GS-12	3.0%	3.6%	2.3%	5.5%	0.6%	-0.7%	2.5%
GS-13	3.7%	3.4%	5.3%	6.0%	-0.3%	1.6%	2.3%

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