Supplement to “Screening Property Rights for Innovation”

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May 12, 2026

A Additional Tables and Figures

Table A.1. Regression Results

	(1)	**(2)**
Variable	**Negotiation**	**Grant**
GS-9	-0.012 (0.003)	0.013 (0.003)
GS-11	-0.013 (0.003)	0.050 (0.003)
GS-12	-0.014 (0.002)	0.075 (0.002)
GS-13	-0.016 (0.002)	0.131 (0.002)
GS-14	-0.047 (0.002)	0.191 (0.002)
Chemicals (1700)	0.036 (0.002)	0.034 (0.002)
Comp. Software (2100)	0.103 (0.003)	0.150 (0.003)
Comp. Networks (2400)	0.099 (0.003)	0.173 (0.003)
Communications (2600)	0.055 (0.002)	0.162 (0.002)
Electronics (2800)	-0.018 (0.002)	0.181 (0.002)
Other (3600)	0.046 (0.002)	0.083 (0.002)
Engineering (3700)	0.032 (0.002)	0.102 (0.002)
Small Entity	-0.151 (0.001)	-0.205 (0.001)
Year Dummies	Yes	Yes
N	753,206	753,206

Notes: Column (1) shows estimates from a regression of a binary variable equal to one if the application process lasts more than one round against dummies for examiner seniority grade, technology center, year of application, and a small entity indicator (applicant with fewer than 500 employees). In column (2), the dependent variable is equal to one if the examiner grants a patent; the regressors are the same as column (1). The omitted grade is GS-7, and the omitted technology center is Biotechnology and Organic Fields (1600). Technology center “Other” refers to center 3600, which is “Transportation, Electronic Commerce, Construction, Agriculture, Licensing and Review.” Following Frakes and Wasserman (2017), we omit GS-15 examiners and we omit GS-5 examiners. Standard errors, in parentheses, are clustered at the examiner level.

TABLE A.2. ESTIMATED AND ASSIGNED PARAMETERS

Estimated Parameters

Variable	**Notation**	**Distribution**	**Parameters**
Examiner			
Intrinsic motivation	$\theta \sim G_{S,\theta}(\cdot)$	Log-normal	σ_θ, μ_θ^J or μ_θ^S
Error	$\varepsilon \sim G_{e,\varepsilon}(\cdot)$	Normal	σ_ε
Delay cost	π	-	-
Threshold by technology center	τ_T	-	-
Applicant			
Initial claim returns	$v_j^* \sim G_v(\cdot)$	Log-normal	μ_v, σ_v
Initial claim distances	$D_j^* \sim G_D(\cdot)$	Multivariate Beta	α_D, γ_D, ρ
Obsolescence	$\boldsymbol{\omega}$	Bernoulli	P_ω^{pre} or P_ω^{post}
Application legal costs	f^{app}	Log-normal	$\boldsymbol{\mu}_{f^{\text{app}}}, \boldsymbol{\sigma}_{f^{\text{app}}}$
Amendment legal costs	F^{amend}	Log-normal	$\boldsymbol{\mu}_{F^{\text{amend}}}, \boldsymbol{\sigma}_{F^{\text{amend}}}$
Issuance legal costs	F^{iss}	Log-normal	$\boldsymbol{\mu}_{F^{\text{iss}}}, \boldsymbol{\sigma}_{F^{\text{iss}}}$
Renewal legal costs	F^{renew}	Log-normal	$\boldsymbol{\mu}_{F^{\text{renew}}}, \boldsymbol{\sigma}_{F^{\text{renew}}}$
Narrowing	η	-	-

Assigned Parameters

Variable	**Notation**	**Values**
Discount rate	β	0.95
Depreciation	δ	$\frac{0.14-P_\omega^{\text{post}}}{1-P_\omega^{\text{post}}}$
Credits	$g_y^r(S,T)$	See Appendix E
PTO application fee	ϕ^{app}	\$1,260
PTO amendment fees	$\phi_3^{\text{amend}} = \phi_5^{\text{amend}}$	\$930
PTO issuance fee	ϕ^{iss}	\$1,770
	ϕ_4^{renew}	\$1,600
PTO renewal fees	ϕ_8^{renew}	\$3,600
	ϕ_{12}^{renew}	\$7,400

Notes: To generate correlated multivariate Beta draws for unpadded distances, we draw a vector of size M_0 from a standard multivariate normal with correlation coefficient ρ. We apply the quantile function of the normal to the draws to create correlated uniform random variables. Then for the estimation values (α_D, γ_D), we apply the inverse CDF of a Beta distribution with these parameters to the uniform draws to generate correlated beta distributed initial distances. For ρ, we use the empirical correlation of granted distances. Simulations confirm that the correlation of the multivariate copula is very close to the correlation of the distances. See Nelsen (2007) for details. PTO fees are halved for small entities. Renewal fees are in 2016 USD, all others are in 2011 USD.

Table A.3. Estimated Attorney Costs by Technology Area (Application)

Parameter	**Symbol**	**Estimate**	**S.E.** ($\times 10^{-3}$)
Chemical application fighting cost log-mean	$\mu_{f\text{app}}^{\text{chem}}$	9.12	3.65
Chemical application fighting cost log-sigma	$\sigma_{f\text{app}}^{\text{chem}}$	0.26	4.07
Electrical application fighting cost log-mean	$\mu_{f\text{app}}^{\text{elec}}$	8.86	1.53
Electrical application fighting cost log-sigma	$\sigma_{f\text{app}}^{\text{elec}}$	0.89	1.75
Mechanical application fighting cost log-mean	$\mu_{f\text{app}}^{\text{mech}}$	8.91	1.63
Mechanical application fighting cost log-sigma	$\sigma_{f\text{app}}^{\text{mech}}$	0.24	2.96

Notes: Standard errors are bootstrapped.

Table A.4. Estimated Attorney Costs by Technology Area (Other)

Parameter	**Symbol**	**Estimate**
Simple amendment fighting cost log-mean	$\mu_{F\text{amend}}^{\text{simple}}$	7.60
Simple amendment fighting cost log-sigma	$\sigma_{F\text{amend}}^{\text{simple}}$	0.36
Chemical amendment fighting cost log-mean	$\mu_{F\text{amend}}^{\text{chem}}$	8.13
Chemical amendment fighting cost log-sigma	$\sigma_{F\text{amend}}^{\text{chem}}$	0.45
Electrical amendment fighting cost log-mean	$\mu_{F\text{amend}}^{\text{elec}}$	8.07
Electrical amendment fighting cost log-sigma	$\sigma_{F\text{amend}}^{\text{elec}}$	0.38
Mechanical amendment fighting cost log-mean	$\mu_{F\text{amend}}^{\text{mech}}$	7.95
Mechanical amendment fighting cost log-sigma	$\sigma_{F\text{amend}}^{\text{mech}}$	0.43
Issuance cost log-mean	$\mu_{F\text{iss}}$	6.55
Issuance cost log-sigma	$\sigma_{F\text{iss}}$	0.62
Renewal cost log-mean	$\mu_{F\text{renew}}$	5.67
Renewal cost log-sigma	$\sigma_{F\text{renew}}$	0.46

Notes: Standard errors are not included here, since we only observe the fighting costs moments rather than underlying microdata.

Table A.5. Robustness of Model Estimates

Symbol	(1) Baseline	(2) Distance FF	(3) 1% $\boldsymbol{\tau}$	(4) η by round	(5) η by seniority	(6) IM FF (i)	(7) IM FF (ii)	(8) π by round	(9) σ_ε by seniority
μ_v	9.51	9.58	9.48	9.11	9.61	9.68	9.56	9.48	9.48
σ_v	1.13	1.09	1.13	1.40	0.87	0.71	1.01	1.04	1.11
P_ω^{pre}	0.17	0.17	0.17	0.17	0.17	0.18	0.17	0.18	0.17
P_ω^{post}	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
α_D	3.88	7.25	3.93	4.21	3.92	4.06	3.59	4.00	3.73
γ_D	7.01	6.06	6.80	7.50	8.51	6.90	6.35	7.21	6.62
$\mu_{f\text{app}}^{\text{simple}}$	8.69	8.68	8.71	8.69	8.92	8.67	8.73	8.74	8.65
$\sigma_{f\text{app}}^{\text{simple}}$	0.85	1.05	0.82	1.00	1.10	0.82	1.59	1.16	0.87
μ_θ^J	4.02	3.67	3.75	4.93	4.25	4.17	3.79	3.69	3.85
μ_θ^S	2.61	2.58	2.61	3.28	3.14	2.89	2.64	2.64	2.65
σ_θ	1.00	0.80	0.85	1.26	1.05	1.23	1.06	0.82	0.91
η	0.36	0.37	0.35	η^1 =0.35 η^{2+} =0.25	η^J=0.29 η^S=0.37	0.36	0.38	0.35	0.37
π	1.29	2.18	1.85	2.79	3.68	0.16	1.22	π^{INIT} =2.21 π^{RCE} =1.70	1.86
σ_ε	0.16	0.21	0.14	0.05	0.25	0.11	0.20	0.20	σ_ε^J =0.23 σ_ε^S=0.09
ϑ	-	1.77	-	-	-	-	-	-	-
ς	-	-	-	-	-	1.09	-	-	-

Notes: This table provides parameter estimates for various alternative specifications of the model. Column (1) reproduces the baseline estimates; (2) adjusts the functional form (FF) for padded distance to $\tilde{D}_j = (D_j^*)^\vartheta p^{-1}$; (3) uses the 1% of each examiner's distance granted for the threshold estimator; (4) allows narrowing to vary by rounds 1 and 2+; (5) allows narrowing to vary by seniority; (6) adjusts the functional form for intrinsic motivation cost to $\mathcal{R}(M_r, \theta) = \theta \left(\frac{M_r}{M_0}\right)^\varsigma$; (7) adjusts it to $\mathcal{R}(M_r, \theta) = \theta M_r$; (8) allows delay cost to differ in RCEs; (9) allows error variance parameter to vary by seniority.

Table A.6. Net Social Costs of Patent Prosecution: Robustness

	Patent Premium (Ψ) = 0.05				Patent Premium (Ψ) = 0.025						
Counterfactual	$\boldsymbol{T_1}$ **(1.5)**	$\boldsymbol{T_2}$ **(1.5)**	$\boldsymbol{T_3}$	**Sum (1.5)**	$\boldsymbol{T_1}$ **(1.5)**	$\boldsymbol{T_1}$ **(2.0)**	$\boldsymbol{T_2}$ **(1.5)**	$\boldsymbol{T_2}$ **(2.0)**	$\boldsymbol{T_3}$	**Sum (1.5)**	**Sum (2.0)**
Baseline ($Bn)	2.98	0.19	12.08	15.25	3.14	3.14	0.03	0.34	14.72	17.89	18.20
25K Round Fee	2.62	0.32	11.15	14.09	2.84	2.84	0.16	0.65	13.29	16.29	16.78
Three Rounds	2.48	0.55	11.17	14.20	2.59	2.59	0.18	0.36	13.46	16.22	16.41
Two Rounds	2.29	1.74	8.43	12.46	2.59	2.59	2.02	4.13	9.97	14.57	16.68
One Round	0.40	2.77	3.61	6.79	0.54	0.54	1.05	2.19	4.14	5.73	6.87
Credit↘	2.39	0.15	12.12	14.65	2.54	2.54	0.03	0.34	14.75	17.32	17.64
5% IM	14.83	0.44	14.75	30.02	17.93	15.55	0.03	0.08	17.60	35.56	33.23
Credit↘ + 5% IM	18.19	0.00	16.21	34.40	21.59	19.21	0.00	0.01	19.25	40.85	38.48

Notes: This table presents the values of net social costs for alternative values of the patent premium and social multiplier. Columns denoted $\boldsymbol{T_j}$ **(1.5)** and $\boldsymbol{T_j}$ **(2.0)** provide values of type j net social costs when ρ^S/ρ^P is equal to 1.5 and 2.0, respectively. Columns **Sum (1.5)** and **Sum (2.0)** provide the total net social costs when ρ^S/ρ^P is equal to 1.5 and 2.0, respectively.

Table A.7. Counterfactual Confidence Intervals

CF	**Not Apply** (%)	**Pad** (%)	**# Rounds**	$\tilde{v}_j$	**T1 Err** (%)	**T1 Egr** (%)	**T2 Err** (%)	**T2 Egr** (%)	$\boldsymbol{T_1}$ **Cost**	$\boldsymbol{T_2}$ **Cost**	$\boldsymbol{T_3}$ **Cost**
Baseline	[13.94, 14.39]	[20.45, 20.53]	[2.08, 2.08]	[29.32, 29.42]	[12.54, 12.69]	[4.03, 4.12]	[31.14, 31.48]	[12.46, 12.64]	[2.98, 3.02]	[0.11, 0.28]	[12.10, 12.16]
25K Round Fee	[18.17, 18.58]	[16.89, 16.99]	[1.97, 1.97]	[30.04, 30.14]	[12.08, 12.28]	[4.15, 4.24]	[33.43, 34.01]	[14.22, 14.58]	[2.41, 2.62]	[0.19, 1.04]	[11.13, 11.19]
Three Rounds	[17.47, 17.98]	[15.52, 15.60]	[1.96, 1.96]	[29.90, 30.01]	[12.30, 12.45]	[3.83, 3.90]	[35.97, 36.36]	[15.59, 15.79]	[2.51, 2.59]	[0.85, 0.94]	[11.19, 11.23]
Two Rounds	[32.09, 32.44]	[7.56, 7.62]	[1.64, 1.64]	[31.84, 31.95]	[11.70, 11.89]	[3.94, 4.03]	[38.51, 38.80]	[15.68, 15.80]	[2.25, 2.29]	[3.18, 3.59]	[8.43, 8.49]
One Round	[65.83, 65.99]	[-4.78, -4.72]	[1.00, 1.00]	[36.91, 37.06]	[4.16, 4.22]	[1.08, 1.18]	[75.46, 76.36]	[59.51, 60.21]	[0.40, 0.40]	[5.37, 6.14]	[3.60, 3.62]
Credit↘	[13.84, 14.28]	[20.38, 20.46]	[2.09, 2.09]	[29.36, 29.47]	[11.78, 11.94]	[3.22, 3.27]	[31.36, 31.73]	[12.58, 12.81]	[2.31, 2.36]	[0.11, 0.17]	[12.12, 12.18]
5% IM	[5.14, 5.37]	[52.29, 52.49]	[1.66, 1.67]	[46.34, 46.62]	[91.76, 91.95]	[78.23, 78.57]	[7.61, 8.12]	[3.56, 3.89]	[10.19, 11.69]	[0.85, 1.39]	[14.77, 14.87]
Credit↘ 5% IM	[4.26, 4.48]	[68.86, 69.24]	[1.58, 1.59]	[53.29, 53.68]	[92.57, 92.79]	[78.54, 78.94]	[6.29, 6.78]	[2.34, 2.81]	[11.50, 12.62]	[0.05, 0.05]	[16.23, 16.41]

Notes: This table provides 95% percentile bootstrapped confidence intervals for outcomes and social costs for different counterfactuals. See Tables IV and V for description of columns and rows.

Figure A.1. Distribution of Padded Granted Distances

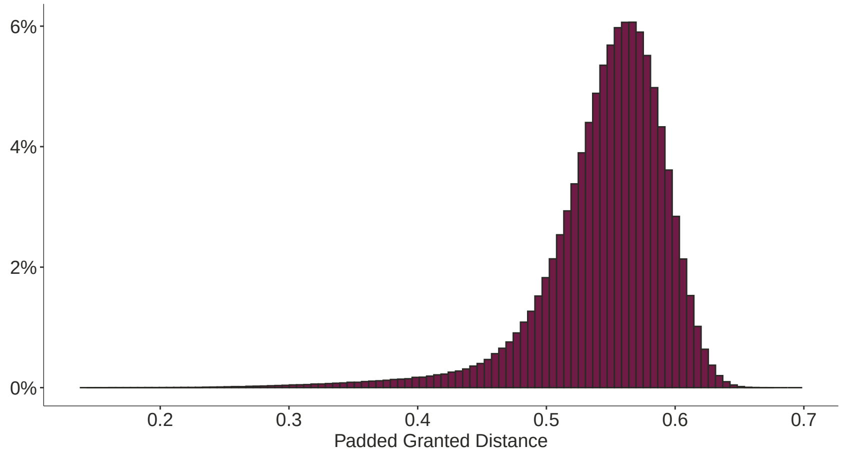


Figure A.2. Match of internal data and model moments

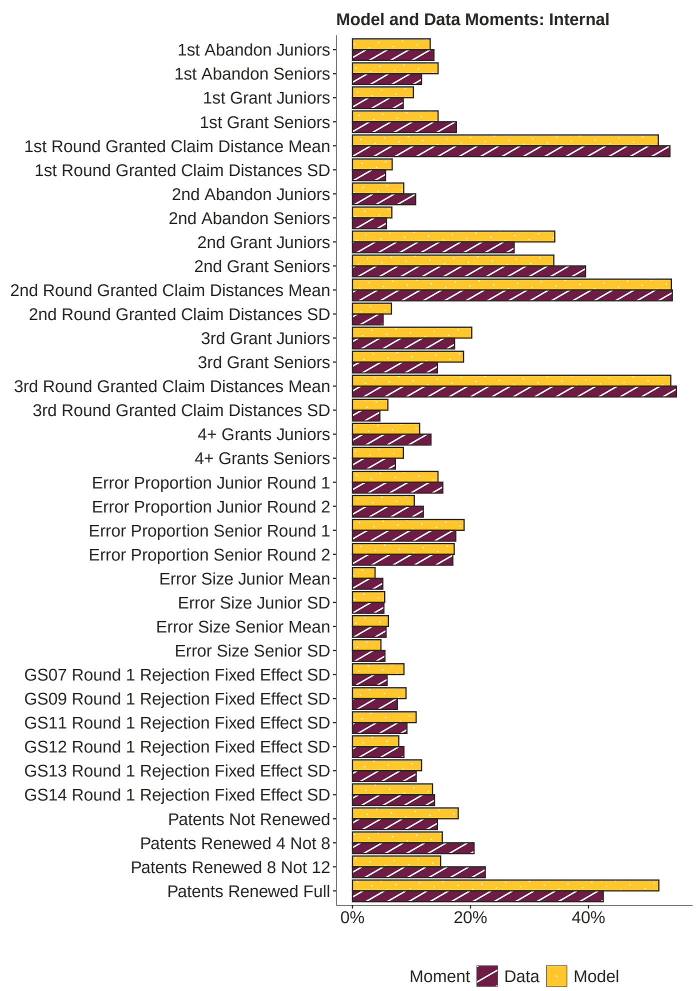
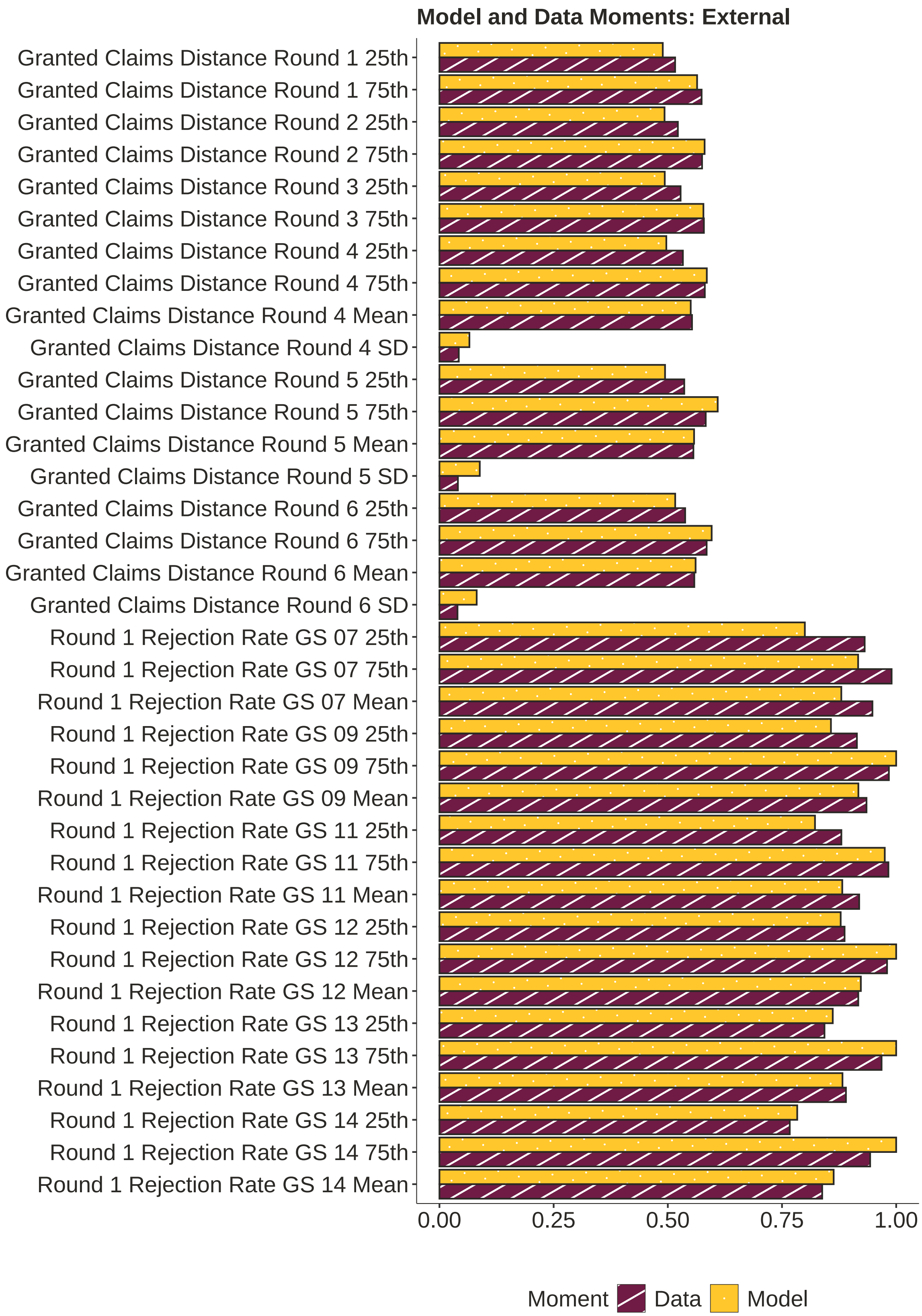


Figure A.3. Match of external data and model moments



B Examples of Patent Examinations and Text Narrowing

We provide two examples of patents to illustrate the effect of narrowing during patent prosecution, one granted after one round of narrowing and the other after three. In each example, we present the first (primary) independent claim both at application (also referred to as "publication") and at grant. A comparison of the text at application and grant in each case shows how the wording is extended to introduce more specificity/qualifications, which limit the scope of the property right after narrowing. Note that this involves a *higher* word count in the granted claim relative to the published claim. The exerpt of the claim edited increases in words by 65% and 71% in these two cases.

These examples are consistent with more general evidence from Marco, Sarnoff, and deGrazia (2019), which shows that the average claim word count (for the shortest independent claim) increases from application to grant across every technology center we analyze. The increase varies from a low of 31% in technology center 2800 (Semiconductors), to a high of 71% in technology center 2400 (Computer Networks).

Sanding Machine In February 2011, applicant Hans Kündig of small mechanical engineering firm Kündig Schleifmittel AG, filed a patent application for the invention of "a control unit for a sanding machine, which winds and unwinds the abradant paper over a contact device." Oliff & Berridge, PLC, provided legal representation for Kündig. Examiner Timothy Eley, seniority grade GS-14 in art unit 3723 (inside working group "Manufacturing Devices & Processes, Machine Tools & Hand Tools"), was assigned. In March 2012, Eley rejected the patent in the first round, rejecting the sole claim on the grounds of novelty/nonobviousness. The examiner cited prior art of patent 6,746,320 in their rejection, which they argued also "discloses a control unit for a sanding machine". Kündig resubmitted in June 2012, amending the independent claim and adding two dependent claims. Patent 8,317,570 was granted in November 2012, less than two years after filing.

Sanding Machine Example

1. Control unit for a sanding machine, which winds and unwinds a sanding belt over a contact mechanism, characterized in that the detection, control and optimization of the position of one or more of these sanding machines, abradant unwinding, feed movement and positioning of the workpiece makes possible the machine feed and sanding operation in continuum.

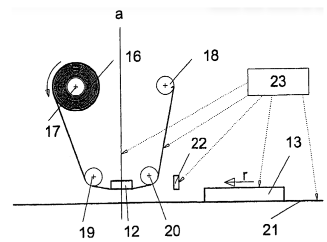
(a) Claim 1 at publication

(55 words)

1. A control unit configured to operate a sanding machine utilizing one or a plurality of sanding units, each sanding unit configured to wind and unwind a backing of coated abrasives over a contact mechanism, the control unit being configured to detect, control and adjust a position of at least one of the sanding units, the winding and unwinding of the backing of coated abrasives of at least one of the sanding units, feed movement and positioning of a workpiece so as to continuously perform a sanding operation in a constant direction.

(b) Claim 1 at grant

(91 words)



(c) Image of invention

Google Glasses In August 2011, Olsson et al. of Google Inc. filed a patent application for the invention of "an electronic device including a frame configured to be worn on the head of a user," the so-called "Google Glasses". Their attorney firm was Lerner, David, Littenberg, Krumholz & Mentilk LLP. Junior Examiner Xuemei Zheng, in art unit 2693 (inside working group "Videophone and Telephonic Communications; Audio Signals; Digital Audio Data Processing"), was assigned and rejected the patent in February 2014. The examiner rejected the first independent claim on the grounds of novelty/nonobviousness, citing ongoing application 2010/0110368, which they argued also "discloses an electronic device, comprising: a frame ... configured to be worn on the head of a user". There was a final rejection in September 2014, a Request for Continued Examination in January 2015, and a further non-final rejection in May 2015, before Patent 9,285,592 was granted in March 2016, nearly five years after filing.

Google Glasses Example

1. An electronic device, comprising:
a frame configured to be worn on the head of a user, the frame including a bridge configured to be supported on the nose of the user, a brow portion coupled to and extending away from the bridge to a first end remote therefrom and configured to be positioned over a first side of a brow of the user, and a first arm having a first end coupled to the first end of the brow portion and extending to a free end, the first arm being configured to be positioned over a first temple of the user with the free end disposed near a first ear of the user, wherein the bridge is adjustable for selective positioning of the brow portion relative to an eye of the user;

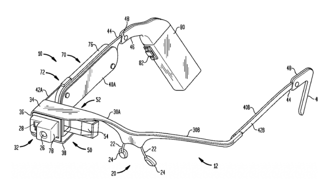
(a) Claim 1 excerpt at publication

(132 words)

1. An electronic device, comprising:
a frame configured to be worn on the head of a user, the frame including a bridge configured to be supported on the nose of the user, a brow portion having a body coupled to and extending away from the bridge to a first end remote therefrom and configured to be positioned over a first side of a brow of the user, and a first arm having a first end coupled to the first end of the brow portion and extending to a free end, the body including a flange along at least a portion thereof, and the first end of the brow portion including a first wall substantially perpendicular to the flange, the flange and the first wall together defining a receiving portion, and the first arm being configured to be positioned over a first temple of the user with the free end disposed near a first ear of the user, wherein the bridge includes a pair of bridge arms that are substantially longitudinal and extend toward a nose of the user, each bridge arm having a nose pad configured to rest on a nose of the user, wherein each of the bridge arms are deformably bendable and repositionable relative to the bridge such that the bridge arms are adapted to move closer together, farther apart, or fore and aft;

(b) Claim 1 excerpt at grant

(226 words)



(c) Image of invention

C Propositions and Proofs

C.1 Functional Forms for Distance and Value

Proposition 1. *There exist functions $\mathcal{W}_v$ and $\mathcal{W}_D$ such that*

$$\tilde{v}_G(v_j^*, p, \boldsymbol{\eta}) = \mathcal{W}_v(\tilde{v}_j^1, \boldsymbol{\eta}) \tag{C.1}$$

for all $(v_j^*, p, \boldsymbol{\eta})$ and

$$\hat{D}_G(D_j^*, p, \varepsilon, \boldsymbol{\eta}) = \mathcal{W}_D(\hat{D}_j^1, \boldsymbol{\eta}) \tag{C.2}$$

for all $(D_j^*, p, \varepsilon, \boldsymbol{\eta})$ if and only if there exist functions $\mathcal{X}_v, \mathcal{X}_D$ and functions $\mathbb{V}(\cdot, \boldsymbol{\eta})$, $\mathbb{D}(\cdot, \boldsymbol{\eta})$ that are strictly increasing in their first argument at $\boldsymbol{\eta} = \mathbf{0}$, which satisfy

$$\tilde{v}_G(v_j^*, p, \boldsymbol{\eta}) = \mathbb{V}(\mathcal{X}_v(v_j^*, p), \boldsymbol{\eta}) \tag{C.3}$$

for all $(v_j^*, p, \boldsymbol{\eta})$ and

$$\hat{D}_G(D_j^*, p, \varepsilon, \boldsymbol{\eta}) = \mathbb{D}(\mathcal{X}_D(D_j^*, p, \varepsilon), \boldsymbol{\eta}) \tag{C.4}$$

for all $(D_j^*, p, \varepsilon, \boldsymbol{\eta})$.

Proof. Suppose first that $\mathcal{W}_v$ and $\mathcal{W}_D$ exist satisfying Equations (C.1) and (C.2). Take $\mathbb{V} = \mathcal{W}_v$, $\mathbb{D} = \mathcal{W}_D$. Substituting $\tilde{v}_j^1 = \mathcal{V}(v_j^*, p)$ and $\hat{D}_j^1 = \mathcal{D}(D_j^*, p, \varepsilon)$ into (C.1) and (C.2) yields the required conditions in Equations (C.3) and (C.4) as required, with $\mathcal{X}_v = \mathcal{V}$ and $\mathcal{X}_D = \mathcal{D}$. To show that $\mathbb{V} = \mathcal{W}_v$ and $\mathbb{D} = \mathcal{W}_D$ are increasing in their first arguments at $\boldsymbol{\eta} = \mathbf{0}$, consider $v_{j,1}^* < v_{j,2}^*$ so that $\tilde{v}_{j,1}^1 = \mathcal{V}(v_{j,1}^*, p) < \mathcal{V}(v_{j,2}^*, p) = \tilde{v}_{j,2}^1$ by $\mathcal{V}$ being increasing in first argument. We have that

$$\mathcal{W}_v(\tilde{v}_{j,1}^1, \mathbf{0}) = \tilde{v}_G(v_{j,1}^*, p, \mathbf{0}) = \tilde{v}_{j,1}^1 < \tilde{v}_{j,2}^1 = \tilde{v}_G(v_{j,2}^*, p, \mathbf{0}) = \mathcal{W}_v(\tilde{v}_{j,2}^1, \mathbf{0})$$

as required. An exactly analogous argument works for showing that $\mathbb{D} = \mathcal{W}_D$ is increasing in its first argument at $\boldsymbol{\eta} = 0$.

For the other direction of the proof, note that $\mathbb{V}(\mathcal{X}_v(v_j^*, p), \mathbf{0}) = \tilde{v}_G(v_j^*, p, \mathbf{0}) = \tilde{v}_j^1$ and also that $\mathbb{D}(\mathcal{X}_D(D_j^*, p, \varepsilon), \mathbf{0}) = \hat{D}_G(D_j^*, p, \varepsilon, \mathbf{0}) = \hat{D}_j^1$, and so by the fact that $\mathbb{V}$ and $\mathbb{D}$ are strictly increasing in their first argument at $\boldsymbol{\eta} = \mathbf{0}$, we have

$$\mathcal{X}_v(v_j^*, p) = \mathbb{V}^{-1}(\tilde{v}_j^1, \mathbf{0}) \tag{C.5}$$

and

$$\mathcal{X}_D(D_j^*, p, \varepsilon) = \mathbb{D}^{-1}(\hat{D}_j^1, \mathbf{0}) \tag{C.6}$$

for some $\mathbb{V}^{-1}$ and $\mathbb{D}^{-1}$. Substituting Equations (C.5) and (C.6) into (C.3) and (C.4) respectively we have

$$\tilde{v}_G(v_j^*, p, \boldsymbol{\eta}) = \mathbb{V}(\mathbb{V}^{-1}(\tilde{v}_j^1, \mathbf{0}), \boldsymbol{\eta}) = \mathcal{W}_v(\tilde{v}_j^1, \boldsymbol{\eta})$$

and

$$\hat{D}_G(D_j^*, p, \varepsilon, \boldsymbol{\eta}) = \mathbb{D}(\mathbb{D}^{-1}(\hat{D}_j^1, \mathbf{0}), \boldsymbol{\eta}) = \mathcal{W}_D(\hat{D}_j^1, \boldsymbol{\eta})$$

where we define $\mathcal{W}_v(\tilde{v}_j^1, \boldsymbol{\eta}) \coloneqq \mathbb{V}(\mathbb{V}^{-1}(\tilde{v}_j^1, \mathbf{0}), \boldsymbol{\eta})$ and $\mathcal{W}_D(\hat{D}_j^1, \boldsymbol{\eta}) \coloneqq \mathbb{D}(\mathbb{D}^{-1}(\hat{D}_j^1, \mathbf{0}), \boldsymbol{\eta})$, as required. □

C.2 Threshold Consistency

For the proof of threshold consistency, let A_e denote the number of examinations conducted by examiner e and, to simplify exposition, suppose that $A_e = A$ for all e.

Proposition 2. *Suppose that the following conditions hold:*

2.1 The number of claims on any application is bounded above (i.e., there exists $\bar{M} > 0$ such that the number of claims $M_a \leq \bar{M}$ for all applications a).

2.2 For every application a, $\varepsilon_a \sim \mathcal{N}(1 + \mu(\theta), \sigma(\theta)^2)$ with $\mu(\theta)$ and $\sigma(\theta)$ converging to 0 as θ converges to infinity.

2.3 For all positive δ and A, there exists an examiner whose θ is such that

$$A\bar{M}\left[1 - \Phi\left(\frac{H - \mu(\theta)}{\sigma(\theta)}\right)\right] < \delta \tag{C.7}$$

for all $H > 0$. Then $\hat{\tau} \xrightarrow{P} \tau$ as $A \to \infty$.

First, we state and prove a lemma that will be used in the proof of Proposition 2.

Lemma 1. *Suppose condition 2.1 in Proposition 2 holds. Then, for an examiner with sufficiently large intrinsic motivation, $\hat{D}_j \geq \tau$ for all j granted, that is, the examiner will never grant a claim with an assessed distance below the threshold.*

Proof. In round r, an examiner will refuse to grant a patent to an application with a claim below the threshold (i.e., an application with $\mathcal{R}^r > 0$) if $g_{GR}^r - \theta\mathcal{R}^r < g_{REJ}^r + \mathbb{E}(W_e^r)$ where we have dropped the (S, T) terms on credits for ease of notation. We show that if θ is sufficiently large, this inequality holds when replacing $\mathbb{E}(W_e^r)$ with W_e^r, *for all* realizations of W_e^r. This ensures that the inequality will hold with the expected value of W_e^r, as required.

The realizations of W_e^r depend on the terminal round of the application, either through obsolescence, in which case we have abandonment, or from choices to abandon/grant. When the terminal round is $r+s$ for $s \geq 1$ there are two inequalities to consider. In the case of grant in round $r+s$, the inequality is

$$\theta > \frac{-\left(-g^r_{GR} + \beta^s g^{r+s}_{GR} + \sum_{s'=0}^{s-1} \beta^{s'} \left[g^{r+s'}_{REJ} + g^{r+s'}_{FIGHT} - \beta\pi\right]\right)}{\mathcal{R}^r - \beta^s \mathcal{R}^{r+s}}$$

and in the case of abandonment in round $r+s$ the inequality is[1]

$$\theta > \frac{-\left(-g^r_{GR} + \beta^s (g^{r+s}_{REJ} + g^{r+s}_{ABN}) + \sum_{s'=0}^{s-1} \beta^{s'} \left[g^{r+s'}_{REJ} + g^{r+s'}_{FIGHT} - \beta\pi\right]\right)}{\mathcal{R}^r}$$

Both will hold for sufficiently intrinsically motivated examiners. For the denominators, by condition 2.1, $\mathcal{R}^r$ cannot be smaller than $\bar{M}^{-1}$ and for all r, s, we have $\mathcal{R}^r - \beta^s \mathcal{R}^{r+s}$ is positive and bounded, because $\beta < 1$ and by narrowing, and $\mathcal{R}^r \geq \mathcal{R}^{r+s}$ for all $s > 0$. The numerators are either negative, in which case the inequality holds for all θ; otherwise, the numerators are positive but bounded.

Therefore, for a sufficiently motivated examiner, the key inequality holds for all realizations of W^r_e and thus for $\mathbb{E}(W^r_e)$, as required. The intuition is that if the examiner is sufficiently intrinsically motivated, and they are looking at an application with claims they believe invalid ($\mathcal{R} > 0$), it is always better for them to wait for a future round, where $\mathcal{R}$ will fall, potentially to zero. □

Now we can provide a proof of Proposition 2.

Proof. First, we reformulate $\hat{\tau}$ in a way that lends itself to the appropriate asymptotic analysis. Note that examiner e's minimum padded distance across all claims they grant can be written as the minimum, across examinations $a = 1, \ldots, A_e$ by examiner e, of the minimum padded distance of the granted claims on patent a.[2] The latter quantity just described is given by $\min_{j=1,\ldots,M^{GR}_a} \tilde{D}_j$, where $j = 1, \ldots, M^{GR}_a$ are the granted claims on patent a. Hence,

$$\tau_e = \min_{j \in M^{GR}_e} \tilde{D}_j = \min_{a=1,\ldots,A_e} \min_{j=1,\ldots,M^{GR}_a} \tilde{D}_j \tag{C.8}$$

As mentioned, we focus on the case of $A_e = A$ for all e. To prove consistency, we must show that for every $\vartheta > 0$, $\mathbb{P}(|\max_e \tau_e - \tau| > \vartheta) \underset{A\to\infty}{\longrightarrow} 0$. Since

$$\mathbb{P}(|\max_e \tau_e - \tau| > \vartheta) \leq \underbrace{\mathbb{P}(\max_e \tau_e > \tau + \vartheta)}_{\mathcal{A}} + \underbrace{\mathbb{P}(\max_e \tau_e < \tau - \vartheta)}_{\mathcal{B}},$$

[1] The case for abandonment in round r is covered by taking $s = 0$, in which case the latter summation is empty.

[2] If examination a yields abandonment, then the minimum padded distance over granted claims is said to be positive infinity.

it suffices to show that $\mathcal{A}$ and $\mathcal{B}$ converge to 0. For the first, note that

$$\mathcal{A} = \mathbb{P}\left(\bigcup_{e=1}^{E}(\tau_e > \tau + \vartheta)\right) \leq \sum_{e=1}^{E} \mathbb{P}(\tau_e > \tau + \vartheta). \tag{C.9}$$

Now, using Equation (C.8) and the fact that $\min_{j=1,\ldots,M_a^{GR}} \tilde{D}_j$ is an iid random variable across applications for a given examiner, we have that[3]

$$\mathbb{P}(\tau_e > \tau + \vartheta) \quad = \quad G(\tau + \vartheta)^A \underset{A\to\infty}{\longrightarrow} 0$$

where $G(\tau + \vartheta) = \mathbb{P}\left(\min_{j=1,\ldots,M_a^{GR}} \tilde{D}_j > \tau + \vartheta\right)$ is strictly less than one.

Now, we show that $\mathcal{B}$ converges to 0. Consider the examiner meeting condition in Equation (C.7) in the text, and denote them by e^*. Then,

$$\mathcal{B} = \mathbb{P}(\tau_e < \tau - \vartheta,\, \forall e) \leq \mathbb{P}(\tau_{e^*} < \tau - \vartheta).$$

Note that, the minimum of $\tilde{D}_j$ among $j \in M_{e^*}^{GR}$ is strictly less than $\tau - \vartheta$ if and only if there exists $j \in M_{e^*}^{GR}$ such that $\tilde{D}_j < \tau - \vartheta$. Hence

$$\begin{aligned}
\mathcal{B} \quad &\leq \quad \mathbb{P}\left(\min_{j\in M_{e^*}^{GR}} \tilde{D}_j < \tau - \vartheta\right) = \mathbb{P}\left(\bigcup_{a=1}^{A}\bigcup_{j=1}^{M_a^{GR}} \tilde{D}_j < \tau - \vartheta\right) \leq \sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \mathbb{P}\left(\tilde{D}_j < \tau - \vartheta, j \in M_a^{GR}\right) \\
&\leq \quad \underbrace{\sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \mathbb{P}\left(\tilde{D}_j < \tau - \vartheta \,\cap\, 0 < \tilde{D}_j\varepsilon_a \leq 1\right)}_{\mathcal{G}} + \underbrace{\sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \mathbb{P}\left(\tilde{D}_j < \tau - \vartheta \,\cap\, \tilde{D}_j\varepsilon_a > 1\right)}_{\mathcal{K}}
\end{aligned}$$

where it is understood that the events in $\mathcal{G}$ and $\mathcal{K}$ (and in probability terms that follow) are intersected with $j \in M_a^{GR}$. We will show that $\mathcal{G}$ and $\mathcal{K}$ converge to zero. Note that the case of $\vartheta \geq \tau$ is not of interest as $\tilde{D}_j$ cannot be negative. Hence, we focus on the case of $0 < \vartheta < \tau$. In the model, since the examiner cannot understand a distance assessment outside $[0, 1]$, if ε_a is negative, then $\hat{D}_j$ is zero, and if ε_a is such that $\tilde{D}_j\varepsilon_a > 1$, then $\hat{D}_j$ is one. Since all claims $j \in M_a^{GR}$ are granted, by Lemma 1, ε_a cannot be negative for these claims as then $\hat{D}_j$ would be zero.

First, we show that $\mathcal{K}$ converges to zero. Note that $\tilde{D}_j < \tau - \vartheta$ and $\tilde{D}_j\varepsilon_a > 1$ imply that $\varepsilon_a > \frac{1}{\tau-\vartheta}$. Hence, since $\varepsilon_a \sim \mathcal{N}(1 + \mu, \sigma^2)$ after standardizing, we have

$$\mathcal{K} \quad \leq \quad \sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \left[1 - \Phi\left(\frac{(\tau - \vartheta)^{-1} - 1 - \mu(\theta)}{\sigma(\theta)}\right)\right] = A\bar{M}\left[1 - \Phi\left(\frac{H_1 - \mu(\theta)}{\sigma(\theta)}\right)\right]$$

[3] $\min_{j=1,\ldots,M_a^{GR}} \tilde{D}_j$ is independent across examinations because examiner errors, padding, and unpadded distances are independent across examinations.

where $H_1 = (\tau - \vartheta)^{-1} - 1 > 0$ as $\tau < 1$. The final term can be made arbitrarily small for the examiner in equation, as given by the condition in Equation (C.7) in the proposition.

Second, we show that $\mathcal{G}$ converges to zero. Consider a constant $H_2 \in (0, \frac{\vartheta}{\tau-\vartheta})$, for which it holds that $\tau_l := (\tau - \vartheta)(1 + H_2) < \tau$. Then for claim j on application a, because $0 < \tilde{D}_j \varepsilon_a \leq 1$, we can write $\tilde{D}_j = \frac{\hat{D}_j}{\varepsilon_a}$. Note that $\frac{\hat{D}_j}{\varepsilon_a} < \tau - \vartheta$ implies that either $\hat{D}_j < \tau_l$ or $\varepsilon_a > 1 + H_2$. Hence,

$$\begin{aligned}
\mathcal{G} &\leq \sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \mathbb{P}\left(\hat{D}_j < \tau_l \cup \varepsilon_a > 1 + H_2\right) \leq \sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \left[\mathbb{P}\left(\hat{D}_j < \tau_l\right) + \mathbb{P}\left(\varepsilon_a > 1 + H_2\right)\right] \\
&= \underbrace{\sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \mathbb{P}\left(\hat{D}_j < \tau_l\right)}_{\mathcal{C}} + \underbrace{\sum_{a=1}^{A}\sum_{j=1}^{\bar{M}} \mathbb{P}\left(\varepsilon_a > 1 + H_2\right)}_{\mathcal{F}}
\end{aligned}$$

Regarding $\mathcal{C}$, since claims j here are granted and $\tau_l = (\tau - \vartheta)(1 + H_2) < \tau$, by Lemma 1 we have that $\mathbb{P}\left(\hat{D}_j < \tau_l\right) = 0$ for all j granted, so $\mathcal{C} = 0$ for this examiner. For $\mathcal{F}$, similar to above,

$$\mathcal{F} \leq A\bar{M}\left[1 - \Phi\left(\frac{H_2 - \mu(\theta)}{\sigma(\theta)}\right)\right]$$

As with $\mathcal{K}$, the final term here can be made arbitrarily small for the examiner e^*. □

D Microfounding Examiner Search

An examiner with intrinsic motivation θ chooses time spent searching and interpreting prior art, denoted $\mathcal{T}$. From their search, the examiner makes an error ε, denominated as a proportional error in interpreting claim distance (i.e., $\varepsilon = 1.2$ means a 20% overestimation of claim distance). The distribution of ε is $\mathcal{N}(1 + \mu(\mathcal{T}), \sigma^2(\mathcal{T}))$, where $\mu(\mathcal{T})$ and $\sigma(\mathcal{T})$ are non-negative and decreasing in $\mathcal{T}$. The μ term converges to zero as $\mathcal{T}$ converges to infinity. The intuition for the mean of ε declining to one in $\mathcal{T}$ is that the more intensive the examiner's search, the more likely they are to identify *all relevant* prior art. While the examiner may misinterpret what they read, leading to realizations of (two-sided) errors, on average they should be right. We also assume that the variance of errors the examiner makes converges to zero as the amount of prior art revealed and interpreted increases (i.e., as $\mathcal{T}$ increases).

The examiner incurs a search cost $c(\mathcal{T})$, which is increasing and convex in the time spent $\mathcal{T}$.[4] The examiner minimizes their mean-squared error of search, $\mathcal{E} = \mathbb{E}\left[(\varepsilon - 1)^2\right]$, weighted by the disutility of making errors. Examiners with higher intrinsic motivation experience greater utility

[4]We can also let the cost depend on an examiner's productivity without any adjustment to the results.

costs from search errors, so they minimize $\mathcal{H}(\theta, \mathcal{E})$, which is increasing in both arguments with a positive cross derivative. For simplicity, we specify $\mathcal{H}$ as $f(\theta) \times \mathcal{E}$ where $f(\theta)$ is positive and increasing in θ. Hence, the examiner solves

$$\min_{\mathcal{T}} f(\theta)\mathcal{E}(\mathcal{T}) + c(\mathcal{T})$$

The first order condition is $f(\theta)\mathcal{E}'(\mathcal{T}) + c'(\mathcal{T}) = 0$. The second order condition requires that $f(\theta)\mathcal{E}''(\mathcal{T}) + c''(\mathcal{T}) > 0$. We assume this condition is met. Differentiating the first order condition with respect to θ yields

$$\frac{d\mathcal{T}}{d\theta} = \frac{-f'(\theta)\mathcal{E}'(\mathcal{T})}{f(\theta)\mathcal{E}''(\mathcal{T}) + c''(\mathcal{T})} \geq 0.$$

The denominator is positive by the second order condition, assumed to hold. Because $f'(\theta) > 0$, the inequality holds if and only if $\mathcal{E}'(\mathcal{T}) \leq 0$. Note that $\mathcal{E}(\mathcal{T}) = \mu(\mathcal{T})^2 + \sigma^2(\mathcal{T})$ hence $\mathcal{E}'(\mathcal{T}) = 2\mu(\mathcal{T})\mu'(\mathcal{T}) + 2\sigma(\mathcal{T})\sigma'(\mathcal{T})$, which is non-positive because $\mu(\mathcal{T}), \sigma(\mathcal{T}) \geq 0$ and $\mu'(\mathcal{T}), \sigma'(\mathcal{T}) < 0$. Since μ and σ are decreasing in $\mathcal{T}$, these comparative statics indicate that the moments of the error distribution, $\mu(\theta)$ and $\sigma(\theta)$, are lower for examiners with higher intrinsic motivation.

E Examiner Credit Structure

Here, we provide expressions for $g_y^r(S,T)$, for all (S,T) and $y \in \{GR, ABN, REJ, FIGHT\}$. We write $g_y^r(S,T) = \nu_y^r \cdot c(S,T)$ and detail the values of the raw credit terms ν_y^r and the adjustment terms $c(S,T)$ in turn. Granting in the first round gives the examiner a payoff of $\nu_{GR}^1 = 2$ credits. Rejecting in the first round gives $\nu_{REJ}^1 = 1.25$. If the applicant abandons in round one, the examiner obtains $\nu_{ABN}^1 = 0.75$. Since g_{FIGHT}^r is only received upon submission of an RCE (rounds 3+), $v_{FIGHT}^r = 0$ for all odd r. Granting in the second round gives $\nu_{GR}^2 = 0.75$ credits. Rejecting in the second round gives $\nu_{REJ}^2 = 0.25$ credits, with an extra $\nu_{ABN}^2 = \nu_{FIGHT}^2 = 0.5$ credits whether the applicant abandons or continues to an RCE. Ultimately, the examiner obtains two credits irrespective of what happens in the first two rounds. The only difference is whether they get the credits immediately (say, from an immediate grant) or spread out over two rounds.

The structure of the payoffs in the first RCE (starting round 3) is the same, with $\nu_{ABN}^3 = 0.75$, except that $\nu_{GR}^3 = 1.75$ and $\nu_{REJ}^3 = 1$. Similar to before, $\nu_{GR}^4 = 0.75$. In the first RCE, irrespective of what occurs, the examiner will obtain 1.75 credits. The distinction is whether examiners earn the full 1.75 credits immediately by granting, or one credit from their non-final rejection and $\nu_{REJ}^4 = 0.25$ plus $\nu_{ABN}^4 = \nu_{FIGHT}^4 = 0.5$ credits from the applicant's response. In the second and any subsequent RCEs, the structure of the payoffs is same, except that $\nu_{ABN}^{2r+1} = \nu_{REJ}^{2r+1} = 0.75$ and $\nu_{GR}^{2r+1} = 1.5$ $(r > 1)$. There is no difference for $\nu_{GR}^{2r+2} = 0.75$, $\nu_{REJ}^{2r+2} = 0.25$, and $\nu_{ABN}^{2r+2} = \nu_{FIGHT}^{2r+2} = 0.5$ $(r > 1)$.

Seniority and Technology Complexity Adjustments The seniority and technology complexity adjustment term is $c(S,T) = \frac{c_{TECH}(T)}{c_{SEN}(S)}$. Table E.1 gives the values of $c_{SEN}(S)$ across the GS categories. Higher seniority factors imply larger values of c_{SEN} and, thus, lower values of credits. Table E.2 gives the values of $c_{TECH}(T)$ we created for the different technology centers. The Patent Office does not have adjustments at the technology center level but rather at the more detailed U.S. Patent Class (USPC) level. We obtained USPC-level adjustments from the Patent Office and constructed an average for each technology center.

Table E.1. Seniority Corrections for Examiner Credit Adjustments

Seniority Grade	**Signatory Authority**	$c_{SEN}(S)$
GS-5	None	0.55
GS-7	None	0.7
GS-9	None	0.8
GS-11	None	0.9
GS-12	None	1.0
GS-13	None	1.15
GS-13	Partial	1.25
GS-14	Partial	1.25
GS-14	Full (primary examiner)	1.35

Notes: This table provides the seniority factors for credit adjustment. In the empirical work, we use 1.15 for GS-13 and 1.25 for GS-14.

Table E.2. Technology Center Corrections for Examiner Credit Adjustments

Technology Center T	**USPTO ID**	**Correction** ($c_{TECH}(T)$)
Chemical and Materials Engineering	1700	22.2
Computer Architecture, Software, and Information Security	2100	31.0
Computer Networks, Multiplex, Cable, and Cryptography/Security	2400	29.0
Communications	2600	26.5
Semiconductors, Electrical, and Optical Systems and Components	2800	21.4
Transportation, Electronic Commerce, Construction, Agriculture...	3600	22.2
Mechanical Engineering, Manufacturing, and Products	3700	19.9

F Moment Selection

Available Moments We have eight sets of moments available. The first set corresponds to examiners' grant and applicants' abandonment decisions. For each round in the model and each seniority level, we calculate the proportion of applications examiners grant and the proportion that applicants abandon. Across nine seniority grades and six rounds, this implies 108 moments.

Second, we observe the distribution of the proportion of rejected claims, both by round and by seniority grade. These observations generate another 54 moments. Third, we obtain 4 moments from the proportion of granted patents that renew at 4, 8, and 12 years after grant. Thirdly, we estimate an external model of patent renewals for the U.S., which delivers the parameters of the distribution of padded patent flow returns. From this distribution, we can use any estimated quantiles as moments for the structural model.

Fourth, we calculate the distribution of claim distances by round. We calculate the mean and standard deviation of the distance distribution by round for six rounds, implying 12 moments on distance. Fifth, we calculate the average rejection rate across all applications, for *each* examiner. Hence, for each seniority grade, we obtain a distribution of examiner rejection rates, for which we can calculate the mean and standard deviation of this distribution. From this, we obtain another 18 moments.

Next, since we can identify the distance threshold externally, we calculate the proportion of granted patents that contain at least one invalid claim. Hence, for each round and each seniority level, we calculate the proportion of patents granted containing an invalid claim, implying another 54 moments. Another 108 moments come from calculating the mean and standard deviation of the size of errors (threshold less granted distance) for each seniority and in each round.[5]

Finally, we observe the distribution of application fighting costs. We have six moments on the distribution of legal application fees for four technology categories (simple, chemical, electrical, and mechanical), which we match to the technology centers on which we estimate the model. This implies another 24 moments.

Choosing Moments We have over 400 data moments and only 21 parameters to estimate with simulated method of moments. However, some of the moments may not aid the estimation procedure in identifying the parameters, so we prune the set of moments for estimation. To do this, we follow a data-driven methodology to select a subset of the moments that best estimate the

[5]To calculate these moments, we take the subset of claims for which the granted distance $\tilde{D}_j$ is below the distance threshold τ, and then work out the mean and variance of $\tau - \tilde{D}_j$, which represents the size of the error.

parameters. We calculate the sensitivity matrix, described in Section 4.3 in the text. We removed moments that had minimal sensitivity values across all parameters and that we believed to be superfluous to parameter identification. Since we split many parameters into two seniority groups (junior and senior), we split some moments into the same seniority categories.

Full Set of Moments

1. The proportion of applications granted in each round for juniors and seniors, for rounds one, two, three, and all rounds after four combined [eight moments]
2. The standard deviation of the distribution of examiner rejection rates for the six seniority categories used by the Patent Office (GS levels 7, 9, 11, 12, 13, and 14) [six moments]
3. The proportion of patents granted containing an invalid claim (for juniors and seniors) for rounds one and two [four moments]
4. The mean and standard deviation of the error size for juniors and seniors [four moments]
5. The proportion of abandonments in each round, when the assigned examiner is junior and senior, for rounds one and two [four moments]
6. The proportion of granted patents not renewed, renewed at year four but not eight, renewed at year eight but not twelve, and renewed at year twelve [four moments]
7. The mean and standard deviation of the distribution of granted claim distances for rounds one, two, and three [six moments]
8. Mean and median of legal application fees for simple applications and complex applications in electrical, mechanical, and chemical technologies [eight moments]
9. The 75^{th} and 90^{th} percentiles of the estimated distribution of flow returns in the value of patent rights in the U.S [two moments]

G Quantification of Social Costs

G.1 Type 1 Social Cost

As discussed in the main text, the expected social cost of granting an invalid patent s with value at stake in litigation VSL_s is

$$S_{1s} = I_s DWL_s + (1 - I_s)\left[0.836 \times (DWL_s + 2M(VSL_s)) + 0.164 \times 2\mathcal{C}(VSL_s)\right], \tag{G.1}$$

where $I_s = I(VSL_s \leq \check{V})$ represents a dummy equal to one if the patent's value at stake in litigation is below the exposure threshold, DWL_s is the deadweight loss, $M(VSL_s)$ and $\mathcal{C}(VSL_s)$ are mediation and litigation costs (all of which are described below), and 0.836 is the probability of not being challenged in court conditional on exposure to litigation. Then, the total type 1 cost is $T_1 = \sum_{s \in S_G} S_{1s}$ where S_G is the set of invalid granted patents.

Details on Deadweight Loss Calibration Under perfect competition among licensees,

$$DWL = \frac{1}{2}\Delta\wp\Delta q = \frac{1}{2}\frac{\Delta q}{q}q\Delta\wp = \frac{\lambda}{2}\frac{\Delta\wp}{\wp}\bar{V},$$

by the definitions of $\bar{V}$ and λ. We calibrate the term $\Delta\wp/\wp$ using the following derivation:

$$\frac{\Delta\wp}{\wp} = \frac{q\Delta\wp}{q\wp} = \frac{\text{lic. rev}}{\text{R\&D}} \cdot \frac{\text{R\&D}}{\text{sales}}$$

We use the Schankerman and Schuett (2022) value of 0.393 for the ratio of licensing revenue to R&D and data from the Bureau of Economic Analysis to obtain a value of 0.041 for the ratio of R&D to sales.

Calibrating Litigation and Mediation Costs To calibrate litigation costs, $\mathcal{C}(VSL)$, we use data from the American Intellectual Property Law Association (AIPLA) surveys on litigation costs as a function of the value at stake, which we assume is the same for the patentee and challenger. We use the linear specification $\mathcal{C}(VSL) = l_0 + l_1 VSL$ and take the estimates of $l_0 = \$624,000$ (2018 USD) and $l_1 = 0.162$ from Schankerman and Schuett (2022). For mediation, we use the AIPLA's reported mediation costs by value at stake categories. Both litigation and mediation costs are at the patent level.

Implementing Type 1 Social Cost A key challenge in implementing our calculation of type 1 social costs is that our estimates of the value of patent rights V^r, as given in Equation (6), for *invalid* patents net out expected litigation costs, rendering them inappropriate to use as the value at stake in litigation. To impute the value at stake in litigation for these patents, we adjust our methodology to exclude these expected litigation costs.

To make this adjustment, we rely on two assumptions:

A1: Valid patents are not litigated. This assumption holds in a model with perfect courts, where a competitor either knows or pays a fee to discover whether a patent is valid, and then chooses whether to litigate based on the result. This assumption implies that the value of patent rights V^r for valid patents is equal to the value that would be at stake, VSL, if these valid patents were to be litigated.

A2: The *distribution* of the value at stake, $G_{VSL}(\cdot)$, is the same for invalid patents as valid patents. The basis for this assumption is that initial distances and values are assumed to be uncorrelated in the model. This assumption allows us to draw values from the simulated distribution of V^r for valid patents and use them as draws for the values of VSL for invalid patents.

Given A1 and A2, the distribution of the value of patent rights V^r for valid patents is equal to the distribution of the value at stake for invalid patents. Our procedure for calculating type 1 social costs is as follows:

1. Estimate the parameters of a log-normal distribution for the value of patent rights for valid patents. Let the estimated distribution be denoted as $\hat{G}_{VSL}(\cdot)$.

2. Let $\bar{P}$ be the total number of invalid patent grants for the given period we simulate. Then, for each invalid patent $p = 1, \ldots, \bar{P}$:

   (a) Draw from $\hat{G}_{VSL}(\cdot)$ and use this for VSL_p and $\bar{V}_p$

   (b) Using the draw, calculate S_{1p} using Equation (G.1).

3. Calculate the total social cost of type 1 error as $\sum_{p=1}^{\bar{P}} S_{1p}$.

Finally, note that we calculate the threshold for exposure to litigation from the estimated distribution of the value of patent rights for valid patents, $\hat{G}_{VSL}(\cdot)$.

G.2 Type 2 Social Costs

Implementing Type 2 Social Cost Calculation The primary challenge in calculating type 2 social costs comes from calibrating the value of the invention without patent rights (Π). This task is particularly difficult for inventions with a negative expected value of applying for a patent (Γ^*), for which we cannot use the patent premium. Similar to our approach to type 1 social costs, we assume that the distributions of Π for those with positive and negative Γ^* are the same, say $G_\Pi(\cdot)$. Then, for those inventions for which Γ^* is negative we draw values of Π from $G_\Pi(\cdot)$. To be precise, our implementation is:

1. Draw a random set of potential inventions. Run this set of potential inventions through the model and calculate Γ^* for each invention. Take the positive values of Γ^* and estimate the distribution of Π, $\hat{G}_\Pi(\cdot)$, using the relationship $\Pi = \Gamma^*/\Psi$, where Ψ is the patent premium.

2. Start the simulation for type 2 social costs by drawing a new set of potential inventions (returns, distances, number of claims, fighting costs, examiner, etc.). For each potential

invention i, draw a development cost κ_i, and also calculate Γ_i^*. If $\Gamma_i^* > 0$, calculate $\Pi_i = \frac{\Gamma_i^*}{\Psi}$. If $\Gamma_i^* \leq 0$, draw a value of Π_i from $\hat{G}_\Pi(\cdot)$.

3. For each of the potential inventions i, work out the subset $\ell \in \mathcal{L}$ that do not develop as those with $\max\{\Gamma_\ell^*, 0\} + \Pi_\ell < \kappa_\ell$.

4. For $\ell \in \mathcal{L}$, run the potential invention through a model where, at the point of abandonment, the inventor obtains all valid claims they have, and so obtains the patent value of their valid claims, instead of a payoff of zero. By definition, this scenario has the property that all abandoned claims are invalid, so that there is no type 2 error. Let Γ'_ℓ denote the expected value of patent rights in this new scenario.

5. From $\ell \in \mathcal{L}$ calculate the subset $q \in \mathcal{Q}$ of potential inventions that have $\max\{\Gamma'_q, 0\} + \Pi_q \geq \kappa_q$ This subset characterizes the potential inventions that do not develop with type 2 error but would develop in the absence of type 2 error.

6. For $q \in \mathcal{Q}$, calculate $SNB_q = \frac{\rho^S}{\rho^P}\left(\frac{\max\{0,\Gamma_q^*\}+\Pi_q}{p_q}\right) - \kappa_q$ and calculate the total type 2 social cost as $T_2 = \sum_{q \in \mathcal{Q}} SNB_q$.

Calibrating Development Costs and the Number of Ideas Development costs κ are exponentially distributed with mean $k_0 + k_1 z$, where z is the size of the unit cost reduction from an invention. We assume that z is log-logistic distributed. We use the implied mean value of z as calculated using the estimates of the log-logistic parameters ($\beta_0 = 1.02$ and $\beta_1 = 1.14 \times 10^{-6}$) in Schankerman and Schuett (2022), along with their estimates of $k_0 = 254.6 \times 10^3$ and $k_1 = 2.33 \times 10^{10}$.

In the baseline quantification, we draw values of κ from the distribution described above, which assumes that development costs are independent of Γ^* and Ψ. In this model, inventors know their development costs before they decide to develop their idea. We also experiment with another version of the model in which inventors do not know their development costs and use the expected value of $\bar{\kappa} = k_0 + k_1 \bar{z}$, to make their development decision. Both models produce similar conclusions; results are available upon request.

To compute the number of ideas (potential inventions), we start with the average annual number of utility patent applications in the period 2011-2013, approximately half a million. We convert this into the number of ideas using two sets of estimates from Schankerman and Schuett (2022): first, their finding that about two-thirds of applications are "low-type" inventions (defined in Schankerman and Schuett (2022) as those that would have been developed even without patent protection); and second, their finding that one-third of ideas become a low-type application.

Together, these imply about one million potential inventions for the cohort of applications we simulate.

G.3 Patent Prosecution Costs

The amendment cost for application s is the per-negotiation cost F_s^{amend} drawn from the estimated distribution, multiplied by the equilibrium number of negotiations for application s (equal to the number of rounds r_s minus 1). We also include the fixed application attorney cost F_s^{app} implied by the equilibrium padding choice. For administrative costs, we calculate the average Patent Office cost per round and claim, denoted RCC, and multiply it by the number of rounds r_s, and claims M_s. To calculate RCC, we take the official USPTO operations budget per application, which equals \$4,117, and divide it by the average number of rounds and independent claims in our baseline model. We exclude Patent Office fees and the loss in patent value from pre-grant obsolescence, since these represent pure transfers from the applicant to either the Patent Office or the owner of the invention that superseded it.

The total social cost of patent prosecution is thus

$$T_3 = \underbrace{\sum_s F_s^{\text{app}} + (r_s - 1)F_s^{\text{amend}}}_{\text{Attorney Costs}} + \underbrace{\sum_s M_s r_s RCC}_{\text{Administrative Costs}}.$$

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