The Value of Patent Portfolios: Numbers vs Average Quality

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Quick agenda

- A survey-based measure of patent value (PatVal-EU 1 & 2)
- Features, checks and curiosities about the distribution
- Portfolios of technically-related patents
  - Numbers (size of portfolio; individual vs related patents?)
  - Distribution
- Determinants of number vs average value?

Value of Patents?

- Many approaches
  - Renewal fees (Schankerman and Pakes, 1986)
  - Citations (Trajtenberg, 1990)
  - Multiple indicators (Lanjouw & Schankerman, 2004)
  - Impact on market value of firms (Hall et al. 2005)
  - Commercial transfer of patent rights (Serrano, 2010)

Our approach – survey measure

- Following Scherer & Harhoff (2000), we ask

  - *Suppose that on the day at which this patent was granted, the applicant had all the information about the value of the patent that is available today. In case a potential competitor of the applicant was interested in buying the patent, what would be the minimum price (in Euro) the applicant should demand?*

  - Menu of intervals: < 30K€; 30-100k€; …; to > 300M€

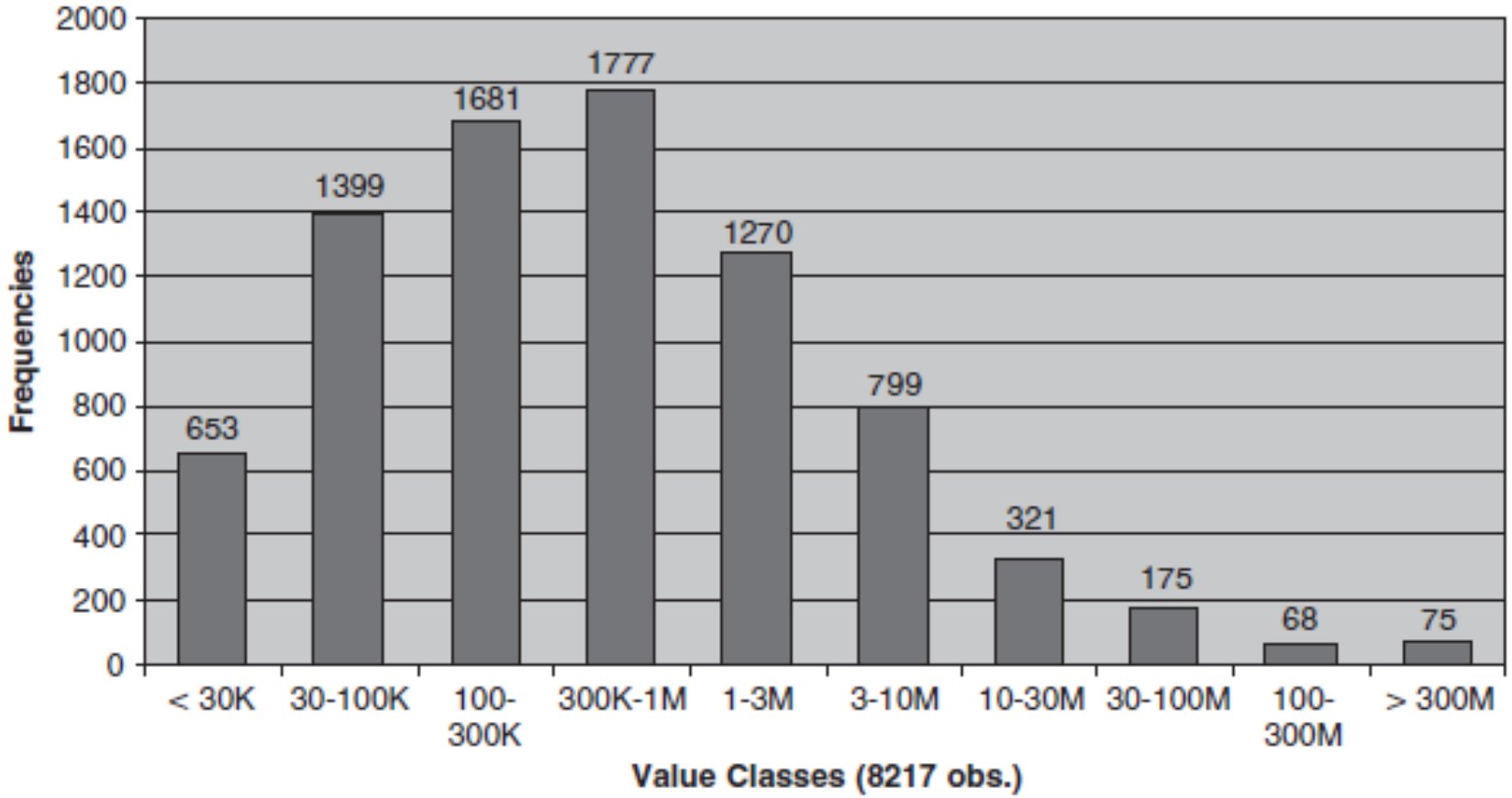
Patent Portfolio – N, V

- We also ask
  - *"How many patents in this portfolio"?*
  - Define portfolio: "group of patents related technically or in value"
  - Menu: 1; 2-5; 6-10; 11-20; > 20
- … and we ask the value question for the portfolio

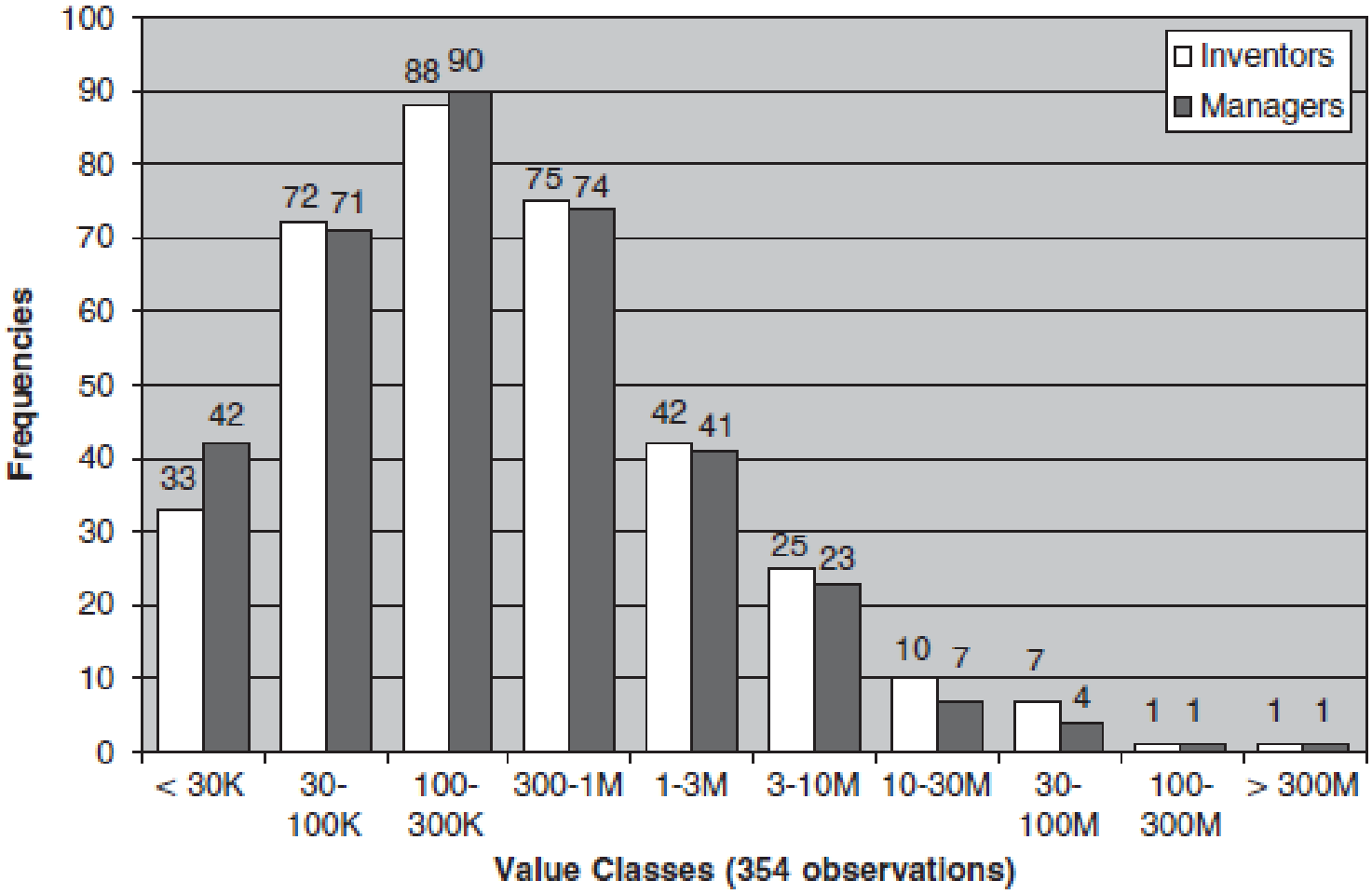
PatVal-EU Surveys

- Population: all EPO patents with priority dates 1993-7 (PatVal1), 2003-5 (PatVal2)
- PatVal1: FR, DE, DK, ES, HU; IT, NL, UK. PatVal2: many more countries (including US, Japan)
- questionnaire sent to first inventor (if not available: any other inventor) … questions on inventor biography, employer, invention process, invention characteristics
- PatVal1: 27,000 questionnaires mailed, about 9,000 responses. PatVal2: 120,000; 20,000
- For details (about PatVal1): Giuri, Mariani et al. (2007) "Inventors and invention processes in Europe: Results from the PatVal-EU survey", *Research Policy*, 36 (8), 1107-1127

Patent Value Distribution (Individual Patents, PatVal-EU1)



Inventors vs Managers



Correlations with indirect indicators

Table 7 OLS and interval regressions of patent value

	Dependent Variable log(VALUEM) (OLS)	*Dependent Variable VALUE (Interval regression)*	*Dependent Variable log(log(VALUEM)) (OLS)*
CONST	5.066***	4.834***	1.573***
	(0.000)	(0.000)	(0.000)
LOG(1+CITES)	0.343***	0.353***	0.056***
	(0.000)	(0.000)	(0.000)
LOG(1+REFS)	0.158**	0.163**	0.026**
	(0.010)	(0.010)	(0.013)
LOG(CLAIMS)	0.171***	0.175***	0.030***
	(0.000)	(0.000)	(0.000)
LOG(STATES)	0.372***	0.387***	0.062***
	(0.000)	(0.000)	(0.000)

- 8217 obs.; time, country, technology class dummies

Features of the distribution

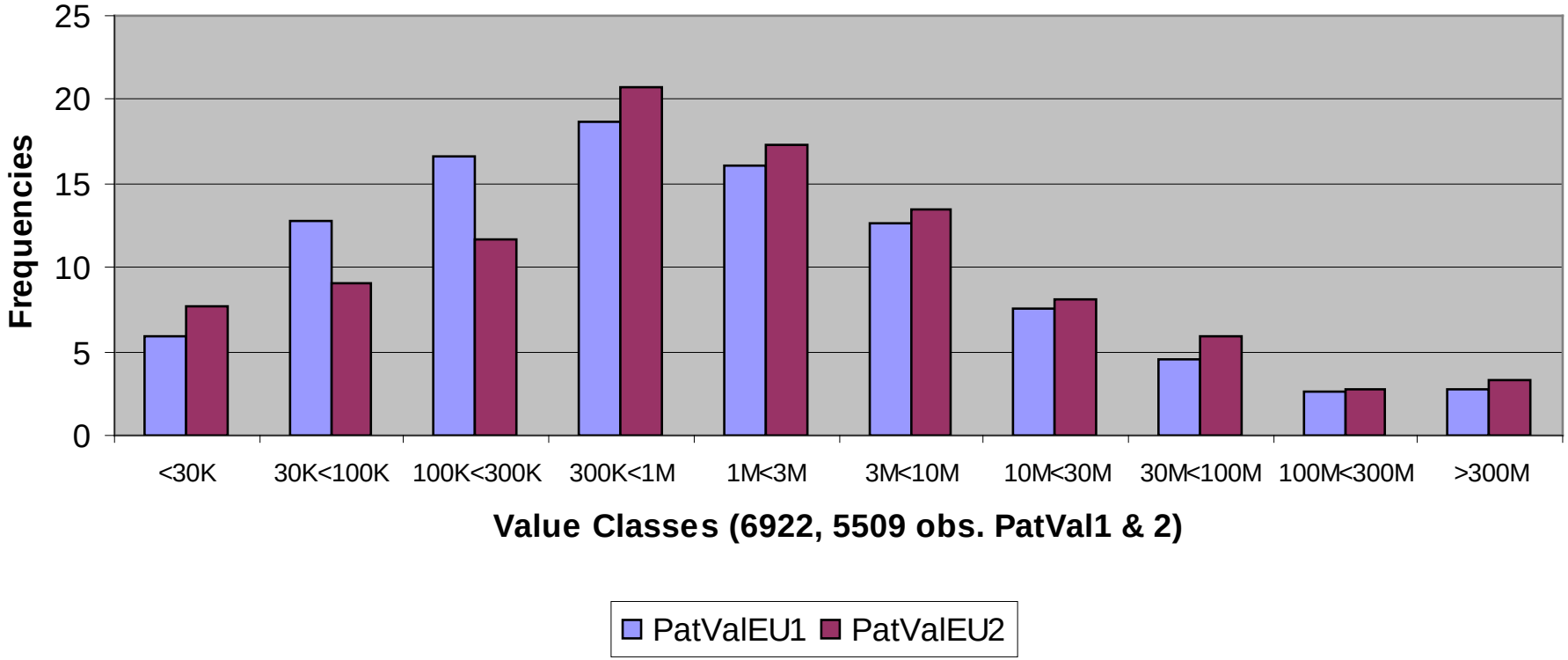
Table 8 Estimated moments of the patent value distribution, assuming log-normality (values in 000 2003 euros, corrected by German dummy)

Moment	*Theoretical expression for the log-normal distribution*[a,b]	*Estimated moment*[b,c]
Mean	$exp(\mu+\sigma^2/2)$	*Average of* $exp(\mu_i+\sigma^2/2)$
PatVal-EU sample ($N=8217$)	3138.6	3550.8
All patents ($N=49{,}941$)[d]	3015.6	3422.6
Median	$exp(\mu)$	*Median of* $exp(\mu_I)$
PatVal-EU sample ($N=8217$)	397.4	382.7
All patents ($N=49{,}941$)[d]	381.8	365.3
Mode	$exp(\mu-\sigma^2)$	*Average of* $exp(\mu_i-\sigma^2)$
PatVal-EU sample ($N=8217$)	6.4	7.2
All patents ($N=49{,}941$)[d]	6.1	6.9

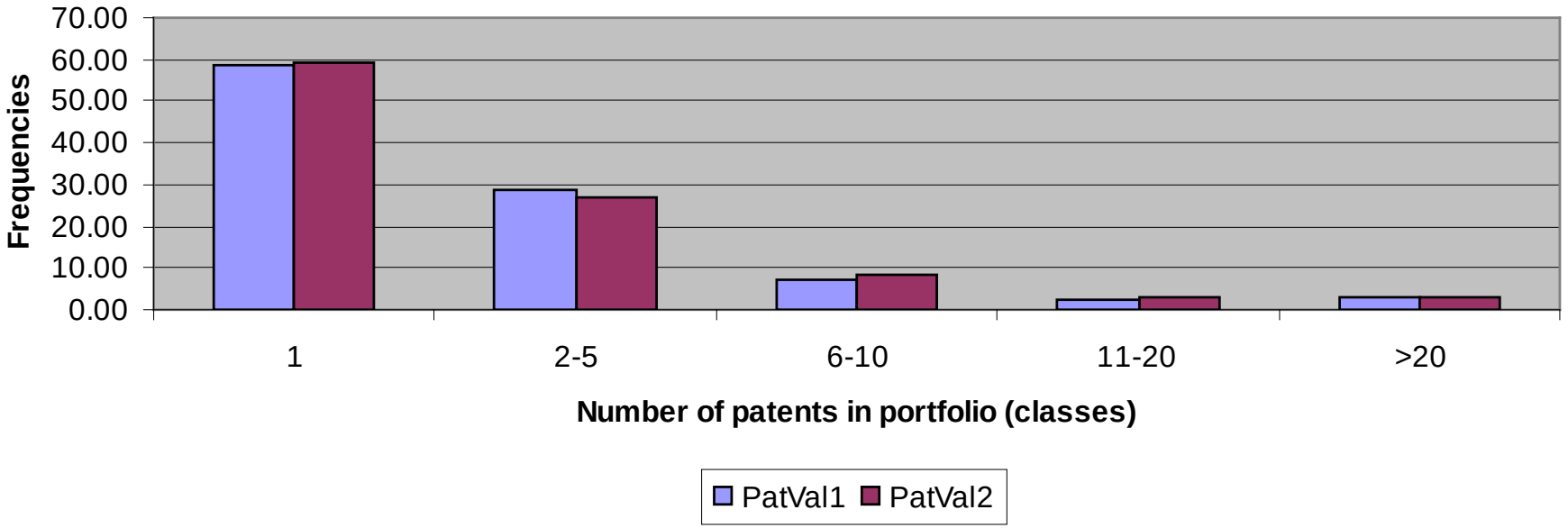
[a]The parameter μ is the average of the fitted values of the first equation in Table 7, viz. *E*(log(VALUEM), using the German constant for all the observations. For the PatVal-EU sample the average is computed across the 8217 PatVal-EU observations, and it is $\mu=5.985$. For the full set of patents is predicted from the available regressors for all the 1993–1997 EPO patents, and it is $\mu=5.945$.
[b]The estimated $\sigma=2.033$ is the standard error of the first regression in Table 7.
[c]The parameter μ_i denotes the fitted values of log(VALUEM) for the generic *i*th observation.
[d]All EPO patents with priority year 1993–1997 granted by 2003.

Gambardella, A. , Harhoff, D. and B. Verspagen (2008) "The Value of European Patents," *European Management Review* 5: 69-84

Patent Value Distribution (Portfolios, PatVal-EU1 & 2)



Distribution of numbers (PatVal-EU1 & 2)



What determines the economic value of patent portfolios?

- Question is important
  - *Markets for technology*
  - *Firms want to understand value created by their labs*

N vs Average Value

$$V = N \cdot \bar{V}(N)$$

Value of patent portfolio V increases because of N or $\bar{V}$*?*

Determinants of N vs. $\bar{V}$*?*

- *We focus on*
  - *Resources invested in invention (R&D, man-months)*
  - *Inventor characteristics (past citations, education)*

Extensive mg

$$V = N \cdot \bar{V}(N, M, Z)$$

R&D (man-months) on average value (intensive margin)

$$N = N(M, Z)$$

complementarity (+)

R&D (man-months) on N

- "Theory"
  - There are diminishing returns to creating value from a single invention (limits to intensive margin)
  - Value is created via "adds-on" … additional "features"/inventions: values grows by breadth
  - N feeds back on average value b/c inventions are complementary
  - And resources (M) affect N

$$V = N \cdot \bar{V}(N, M, Z)$$

$$N = N(M, Z)$$

Net effect on on V?

Science, positive on N via M

Science, negative on N

- In addition
  - **Science** → N : focus (lower N)
  - **Science** → M : more ideas (higher N)
  - **Science** → V : net effect
  - **Originality** → opposite effects

- **Two models** (which one dominates?)
  - scientific (low N, high M)
  - empiricist (high N, low M)

GMM results

	Dependent Variables		
Covariates	*V*	*N*	*M*
N	1.503***		
	0.000		
M	0.347***	0.495***	
	0.000	0.000	
SCIENCE	0.056	-0.074***	0.173***
	0.463	0.006	0.000
ORIGINALITY	-0.058	0.036*	-0.022
	0.410	0.062	0.537

Many controls (including strategic patenting for N), 4638 obs., N, M endogenous

Elasticity wrt	*Elasticity of N (1)*	*Elasticity of Average Value (2)*	*Total Elasticity*	*Total Elasticity of V wrt N*
	n_m	$v_m + (v_n - 1) \cdot n_m$	*(1) + (2)*	$v_n \cdot n_m$
M	0.495***	0.596***	1.091***	0.744***
	0.000	0.000	0.000	0.000
	$n_x + n_m \cdot m_x$	$v_x + v_m \cdot m_x + (v_n - 1) \cdot (n_x + n_m \cdot m_x)$	*(1) + (2)*	$v_n \cdot (n_x + n_m \cdot m_x)$
INVENTOR_CITES	0.212***	0.298***	0.510***	0.319***
	0.000	0.001	0.000	0.000
PhD vs. High-School	0.192***	0.220	0.412***	0.288***
	0.000	0.112	0.005	0.001
BA/Master vs. High-School	0.049	0.152	0.201*	0.073
	0.131	0.139	0.070	0.146
SCIENCE	0.012	0.122	0.133	0.018
	0.673	0.101	0.102	0.674

Extensive mg

$$V = N \cdot \bar{V}(N, M, Z)$$

R&D (man-months) on average value (intensive margin)

$$N = N(M, Z)$$

complementarity (+)

R&D (man-months) on N

Conclusions

- Considerable impact of N on V
  - Direct & via average value (complementarity)
- True of
  - Resources
  - Inventor's experience (past successes, education)
- Empiricist vs scientific approach

Thank You!

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APPENDIX 1: Correlation b/w average value of the patent portfolio and indirect indicators, OLS

Variable	Estimates	Variable	Estimates	Variable	Estimates
CITES	0.315***	OP	0.240**	CONSTANT	5.266***
	0.000		0.011		0.000
CLAIMS	0.143***	ACCEX	0.145		
	0.006		0.202	*Statistics*	
STATES	0.165**	PCT	0.229***	# obs.	6160
	0.011		0.003	Adjusted R^2	0.103
EQUIVALENTS	0.263***	OBS3PARTY	0.830**		
	0.000		0.033		

Dependent variable: *V/N*. All variables, but dummies, in logs; log(1+variable) if variable can take value 0; robust *p*-values below estimates; $^{***}p < 0.001$, $^{**}p < 0.05$, $^{*}p < 0.10$; equation includes country dummies, 30 dummies for technological sectors, dummies for patent priority years, and weights to adjust the oversampling of important patents in PatVal-EU. (Weights, SEE TABLE 2.) All observations clustered around the ultimate parent of the applicant. CITES = # forward citations up to 5 years after the priority date; CLAIMS = # of claims at grant; STATES = # of EPO countries in which the patent has been applied for; EQUIVALENTS = # of equivalent patents; OP, ACCEX, PCT, OBS3PARTY = dummies = 1 if the patent was opposed, the applicant requested an accelerated examination procedure, the patent is a PCT, the patent was subject to observations by 3rd parties before the grant (according to art.115 of the EPC). All these indicators refer to the focal PatVal-EU patent. Regression employs all the available observations (6160).

Robustness check 1

APPENDIX 2: GMM estimation using indirect indicators of *V*

Variables	*Dependent Variable of the V-equation*		
	CITES	STATES	EQUIVALENTS
N	0.225**	-0.038	-0.085
	0.024	0.619	0.379
M	0.019	0.046***	0.035**
	0.197	0.000	0.030
# obs.	4639	4639	4639

Same log-log GMM system as in Table 2 with CITES (= # forward citations up to 5 years since the patent's grant), STATES (# of countries in which the patent is applied for), and EQUIVALENTS (# of patent offices in which the invention has been patented), as dependent variables; *** $p < 0.001$, ** $p < 0.05$, * $p < 0.10$.

Robustness check 2

APPENDIX 3: Probit estimation, dependent variable = 1 for the 4639 observations in the sample

Variable	Estimates	Variable	Estimates	Variable	Estimates
CITES	-0.016	OP	0.028	CONSTANT	0.498***
	0.536		0.624		0.000
CLAIMS	-0.043	ACCEX	0.008		
	0.149		0.925	# obs.	8515
STATES	-0.045	PCT	-0.015		
	0.173		0.697	H0: 8 coeff. = 0	
EQUIVALENTS	0.018	OBS3PARTY	-0.011	Wald test statistics	5.11
	0.438		0.961	p-value, χ^2 (8, d.f.)	0.746

All variables, but dummies, in logs; log(1+variable) if variable can take value 0; robust p-values below estimates; $^{***}p < 0.001$, $^{**}p < 0.05$, $^{*}p < 0.10$; equation includes country dummies, 30 dummies for technological sectors, dummies for patent priority years, and weights to adjust the oversampling of important patents in PatVal-EU. (Weights, see Table 2. Definition of covariates, see Appendix 1.) All observations clustered around the ultimate parent of the applicant.