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CGEH Working Paper Series

A latent democracy measure 1850-2000

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June 2014

Working paper no. 59

www.cgeh.nl/working-paper-series/

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Abstract: In this paper we apply a factor analysis with a measurement error model to extract the latent democracy variable from the components of polity2 and Vanhanen's Index of Democracy, under the assumption that each of these components are driven by a common latent factor with different amount of measurement errors. We use the estimated latent democracy variable to estimate the distribution of democracy across countries over the 1860-2000 period.

Keywords: latent variable estimation, democracy, factor analysis.

JEL Codes: N40, O17.

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1. Introduction

The number of potential measures of democracy is high, even though only a handful are available for such a long period that allows for a long-run analysis. The two most popular long-term measures are the polity2 of the PolityIV project (Marshall et al, 2012) and Vanhanen's Index of Democracy (ID) (Vanhanen 2000, 2003). While there are other measures with the same scope such as the Democracy-Dictatorship data (Alvarez et al 1996, Przeworksy et al 2000) beginning in 1948 or Boix et al. (2012) these are binary data reflecting if a regime was democratic or not, and hence convey basically no information on the degree of democratization, making PolityIV and Vanhanen's data the only two viable choices for long-run analysis.

Even though different sources and methods are used to create them, all democracy measures can be placed into a single theoretical framework as demonstrated by Coppedge et al. (2011). Basically all known indicators can be connected to the seminal work by Dahl (1972) that identifies contestation (or political competition) and inclusiveness (or participation) as the two basic aspects of democracy. Yet, the degree to which they succeed in capturing these two concepts differ considerably, even though Coppedge et al. (2008) show that the role of the factors competition and participation are predominant in all available datasets and account for about three-quarter of the total variation.

Since all indicators are necessarily imperfect approximations of a latent democracy factor, it is unavoidable that methodological and quality differences translate into occasionally severe consequences in empirical applications (Munck and Verkuilen 2002). A possible way to arrive at more accurate estimates of democracy is the utilization of multivariate techniques, and especially latent variable estimation method that directly takes measurement errors into account. Pemstein et al (2010) used a latent variable extraction method to create a Unified Democracy Score from 1960 on, utilizing many available measures. In this paper we focus on the two datasets with the longest time dimension to create a comparable indicator of democracy that takes measurement errors directly into account, and we use this measure to estimate the distribution of democracy in the World between 1860 and 2000. This paper adopts the following structure: in section 2 we present the data sources, in section 3 we discuss the methodology, in section 4 we present the estimated latent democracy measure and the distribution estimates. Section 5 concludes.

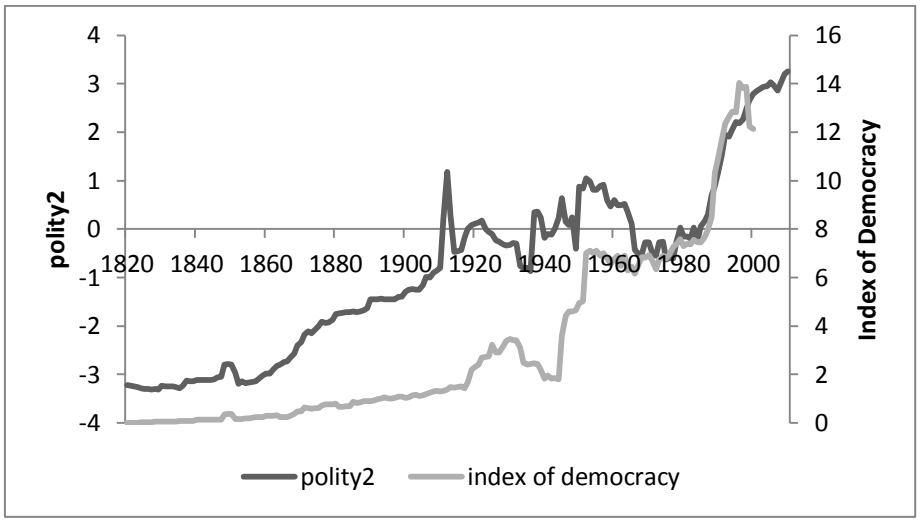
2. Data description

This papers relies on the two datasets measuring the degree of democracy that have the longest time dimensions and hence can be utilized to arrive at some long-term estimates of democracy in a way that is comparable over time. As mentioned in the introduction, these measures, like all others, can be seen as empirical counterparts of the theoretical concepts contestation and inclusiveness by Dahl (1972).

While Vanhanen attempts to directly capture these aspects by observing the share of adult population turning up at elections (participation) and one minus the share of the winning party (competition), the PolityIV project employs a number of component variables referring to different aspects of competition and participation with the scores being based one expert opinion (see Table 1). A fundamental difference between the two measures is that while Vanhanen relies on statistical data on voter turnout and the composition of national parliaments, the PolityIV project relies on secondary data and reports. Another important difference is observed by Munck and Verkuilen (2002) who claim that the polityIV rather focuses on the regulatory aspects of participation and competition, while the Index of Democracy (ID) reflects the actual outcomes in terms of statistics. This fundamental difference gives rise to several striking differences regarding the comparative development of democratization as noted by Foldvari and Buzasi (2014). Figure 1 visualize the secular trends of democratization measured by the two aggregate measures.

Figure 1

World average scores in different measures of the degree of democracy of political institutions, 1820-2010, polity2 score of the Polity IV project (-10/+10) and the Index of Democracy



Sources: the polity IV dataset by Marshall et al (2012) and the polyarchy data by Vanhanen (2000, 2003)

The most striking difference is that while polity2 aggregate suggest an early start of worldwide democratization, confirming the three waves of democratization theory by Huntington (2001, 2003), while the ID rather suggests that the democratization started to gain impetus only in the 20th century. Both aggregate measures suffer from aggregation problems, though, as there is no clear theoretical reason to prefer a weighted summation (polity2), or the multiplicative aggregation (ID) above one another.

Table 1
Components of the polity2 index and coding rules

variable	possible outcomes	values	weight in polity2
XRCOMP Competitiveness of Executive Recruitment	Election	3	2
	Transitional	2	1
	Selection	1	-2
	Unregulated	0	0
XROPEN Openness of Executive Recruitment	Open ("Election")	4	1
	Dual: hereditary and election	3	1
	Dual: hereditary and designation	2	-1
	Closed	1	-1
	Unregulated	0	0
	Open("No election"	4	0
XCONST Constraint on Chief Executive	Parity or subordination	7	4
	Intermediate 1	6	3
	Substantial limitation	5	2
	Intermediate 2	4	1
	Slight moderation	3	-1
	Intermediate 3	2	-2
	Unlimited Authority	1	-3
PARCOMP Competitiveness of Political Participation	Competitive	5	3
	Transitional	4	2
	Factional	3	1
	Restricted	2	-1
	Suppressed	1	-2
	Not applicable	0	0
PARREG Regulation of participation	Regulated	5	0
	Multiple identity	2	0
	Sectarian	3	-1
	Restricted	4	-2
	Unregulated	1	0

Source: Marshall et al (2013)

The two measures are also measured on different scales. The components of the polity2 aggregate are measured on a nominal scale. These can either be transformed into ordinal variables, such as done by Treier and Jackman (2008) or they can be assigned some arbitrary numbers reflecting theoretical consideration as done by Marshall et al (2013). While it would look tempting to use each possible outcomes as binary variables, the presence of perfect multicollinearity due to the redundant information contained by the different components would render any meaningful analysis unfeasible. Since the ordinal transformation approach also often causes problems in estimation, in this paper we choose an compromise solution and use the weighting scheme by Marshall et al (2013), while treating all components as independent realization of the same underlying latent democracy index.

In this paper we follow the geographical categorization adopted by the Clio-Infra project (www.clio-infra.eu). While the Polity IV reports data on current political units, the Vanhanen dataset reflect historical changes in naming and also report data for non-existing countries. The transformation into the Clio-Infra template result in a minor loss of observations for the early periods. Also, when the PolityIV assigns weight to special events like foreign interruption, interregnum and transition (codes -66, -77, -88 respectively), we treated these as missing values. The number of available observation for a few benchmark years is summarized in Table 2.

Table 2
Number of countries in different benchmark years

year	polity2	ID	log of GDP p.c.	av. years of educ.
1860	40	44	28	8
1870	50	44	66	23
1890	51	47	44	49
1910	56	51	44	63
1930	68	64	54	96
1950	78	79	139	117
1970	127	135	146	149
1990	141	157	162	145
2000	158	171	161	144

3. Methodology

The underlying assumption of this paper is that all seven observed components are all empirical realizations of the same underlying democracy variable (D). This allows us to express the vector of components (**y**) as a function of a single underlying factor for each year.

$y_{ij} = \alpha_{0j} + \alpha_{1j} D_i + \varepsilon_{ij}$ (1) where i denotes the country (i=1…n) and j denotes the indicator (j=1…7). The parameters α_{0j} and α_{1j} are the indicator specific constants and loadings, D_i is the latent democracy score for country i assumed to have zero mean, and ε_{ij} denotes the random country and indicator specific part of y_{ij} with zero mean, such as the effect of measurement errors, or even the effect of incorrect scaling.

Equation (1) can be rewritten in terms of variances:

$\mathbf{\Sigma_Y} = \boldsymbol{\alpha}^{\mathbf{T}} \boldsymbol{\alpha} \sigma_D^2 + \mathbf{\Sigma_\varepsilon}$ (2) where Σ_Y and Σ_ε denote the covariance matrices for the observed variables and the errors respectively, $\boldsymbol{\alpha}$ is the loading vector and σ_D^2 is the variance of the latent democracy measure. Since we assumed that the measurement errors are uncorrelated,

Σ_ε is a positive semidefinite diagonal matrix and all observed covariance between the indicator variable y must be caused by the underlying single factor D. These results in a system of equations that can be compactly written in matrix form:

$$\begin{bmatrix} \sigma_{y_1}^2 & \sigma_{y_1y_2} & \cdots & \sigma_{y_1y_k} \\ \sigma_{y_1y_2} & \sigma_{y_2}^2 & \cdots & \sigma_{y_2y_k} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{y_1y_k} & \sigma_{y_2y_k} & \cdots & \sigma_{y_k}^2 \end{bmatrix} = \begin{bmatrix} \alpha_{11}^2 & \alpha_{11}\alpha_{12} & \cdots & \alpha_{11}\alpha_{1k} \\ \alpha_{11}\alpha_{12} & \alpha_{12}^2 & \cdots & \alpha_{12}\alpha_{1k} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{11}\alpha_{1k} & \alpha_{12}\alpha_{1k} & \cdots & \alpha_{1k}^2 \end{bmatrix} \sigma_D^2 + \begin{bmatrix} \sigma_{\varepsilon_1}^2 & 0 & \cdots & 0 \\ 0 & \sigma_{\varepsilon_2}^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{\varepsilon_k}^2 \end{bmatrix} \quad (3)$$

Since the measurement scale of the indicators is different we rather use standardized indicators, which modifies (3) slightly:

$$\begin{bmatrix} 1 & \rho_{y_1y_2} & \cdots & \rho_{y_1y_k} \\ \rho_{y_1y_2} & 1 & \cdots & \rho_{y_2y_k} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{y_1y_k} & \rho_{y_2y_k} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} \tilde{\alpha}_{11}^2 & \tilde{\alpha}_{11}\tilde{\alpha}_{12} & \cdots & \tilde{\alpha}_{11}\tilde{\alpha}_{1k} \\ \tilde{\alpha}_{11}\tilde{\alpha}_{12} & \tilde{\alpha}_{12}^2 & \cdots & \tilde{\alpha}_{12}\tilde{\alpha}_{1k} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{\alpha}_{11}\tilde{\alpha}_{1k} & \tilde{\alpha}_{12}\tilde{\alpha}_{1k} & \cdots & \tilde{\alpha}_{1k}^2 \end{bmatrix} \sigma_D^2 + \begin{bmatrix} \sigma_{\eta_1}^2 & 0 & \cdots & 0 \\ 0 & \sigma_{\eta_2}^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{\eta_k}^2 \end{bmatrix} \quad (4)$$

That is we use the correlation matrix instead of the covariance matrix.

So that the system is identified the loading of the first indicator (xrcomp) is set to unity, that is $\alpha_{11} = \tilde{\alpha}_{11} = 1$. Since the system is overidentified the parameters were estimated by an ML method. While the above model is estimated for every year from 1850 to 2000, we only report the results for some benchmark years in the Appendix.

Another way to visualize the underlying model is a measurement model or factor model:

Figure 2

The measurement model behind the latent democracy indicator

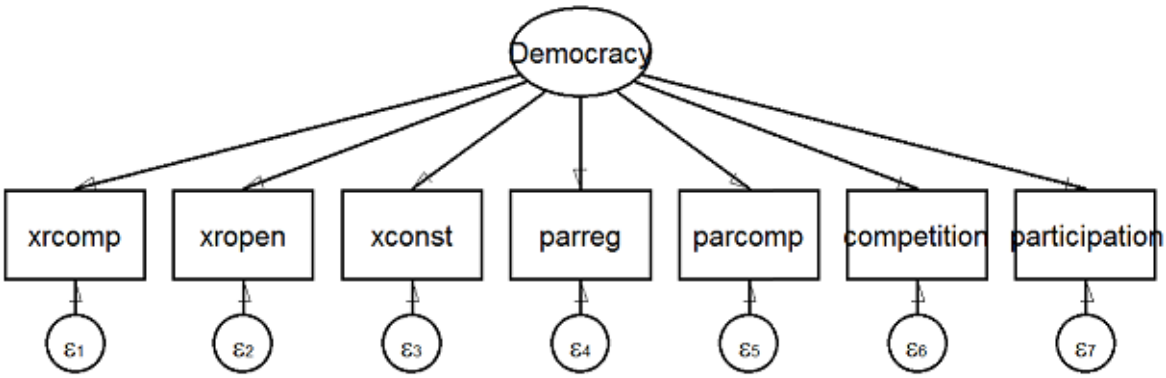


Table 3 reports the summary statistics of the estimated latent indicator D for a few benchmark years.

Table 3

Descriptive statistics of the estimated Democracy variable (D) in benchmark years

year	number of obs	mean	standard deviation
1850	38	0.018	0.654
1870	40	0	0.827
1890	46	-0.009	0.866
1910	49	0.015	0.897
1930	59	-0.019	0.802
1950	76	-0.011	0.871
1970	120	-0.054	0.828
1990	132	-0.004	0.848
2000	139	0.003	0.869

Note: estimated from standardized indicators

Table 4 reports the portion of variance of the indicators not explained by the common factor D (specific variance or one minus communality).

Table 4

Proportion of specific variance in a few benchmark years

	1850	1870	1890	1910	1930	1950	1970	1990	2000
XRCOMP	19%	23%	17%	15%	33%	20%	28%	25%	23%
XROPEN	24%	28%	22%	25%	32%	29%	32%	31%	32%
XCONST	69%	53%	74%	54%	14%	23%	19%	12%	11%
PARREG	78%	87%	57%	61%	39%	31%	6%	12%	23%
PARCOMP	88%	88%	66%	65%	34%	28%	7%	9%	18%
competition	88%	86%	89%	72%	12%	28%	16%	14%	18%
participation	72%	24%	79%	66%	27%	83%	82%	59%	49%

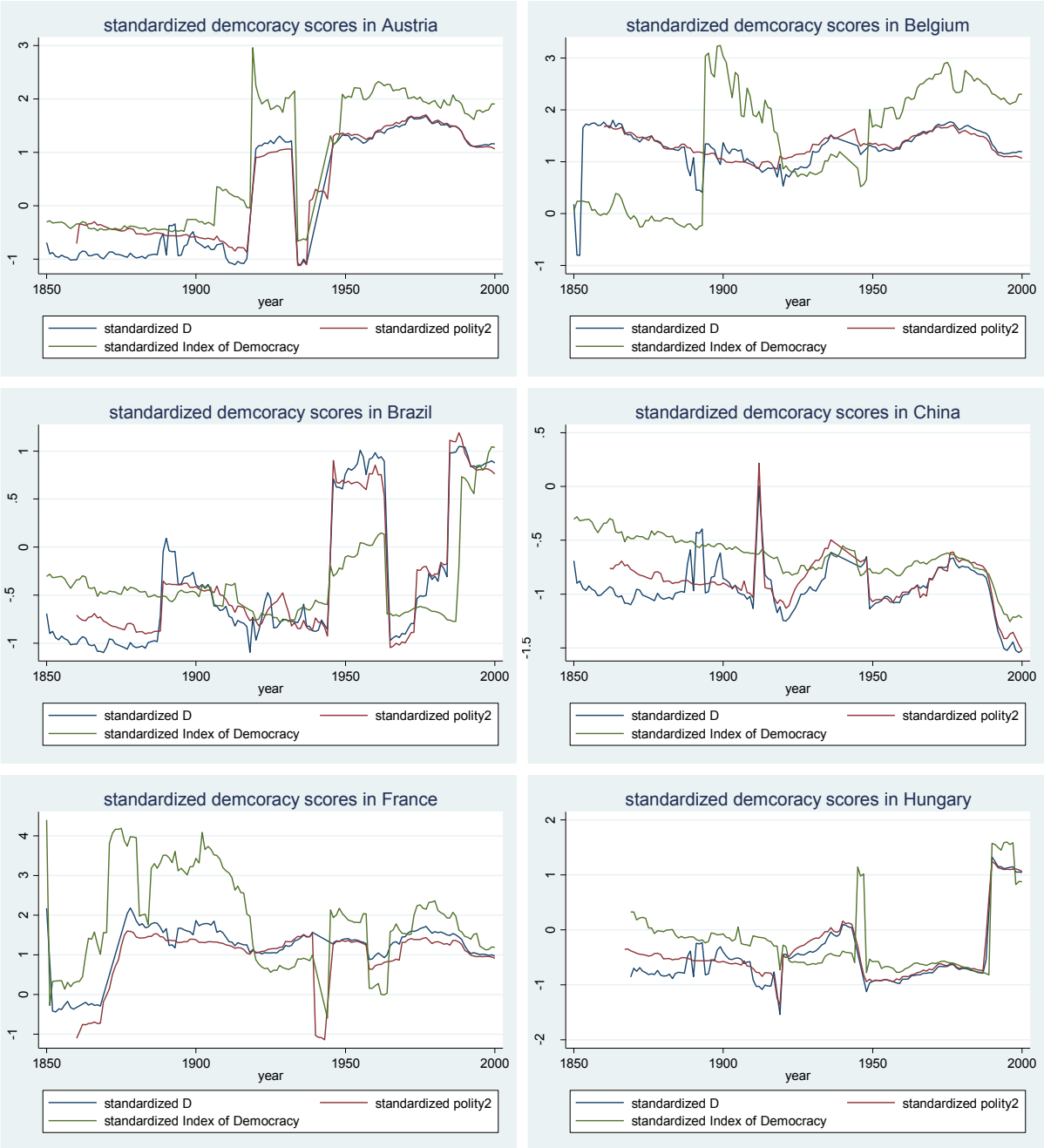
Table 4 reveals that the different democracy components were reflecting the latent democracy to different extents. The quality of the indicators improved over time, while the average share of individual specific effects, including measurement errors decreased from 62% in 1850 to 25% in 2000 on average. The communality of the competitiveness of executive recruitment process remains relatively stable indicating that if one were to select only a single component to obtain a picture of democracy it should be the XRCOMP. Nevertheless, the changing communality of the components over time reveals a structural change in the factors behind democracy. It is noteworthy that it are the PARCOMP and PARREG components of the polity2 together with the competition component of the ID that show the greatest degree of improvement, indicating that once the last wave of democratization began in the 1970s, competition became the primary factor behind democracy, while the relative importance of participation decreased.

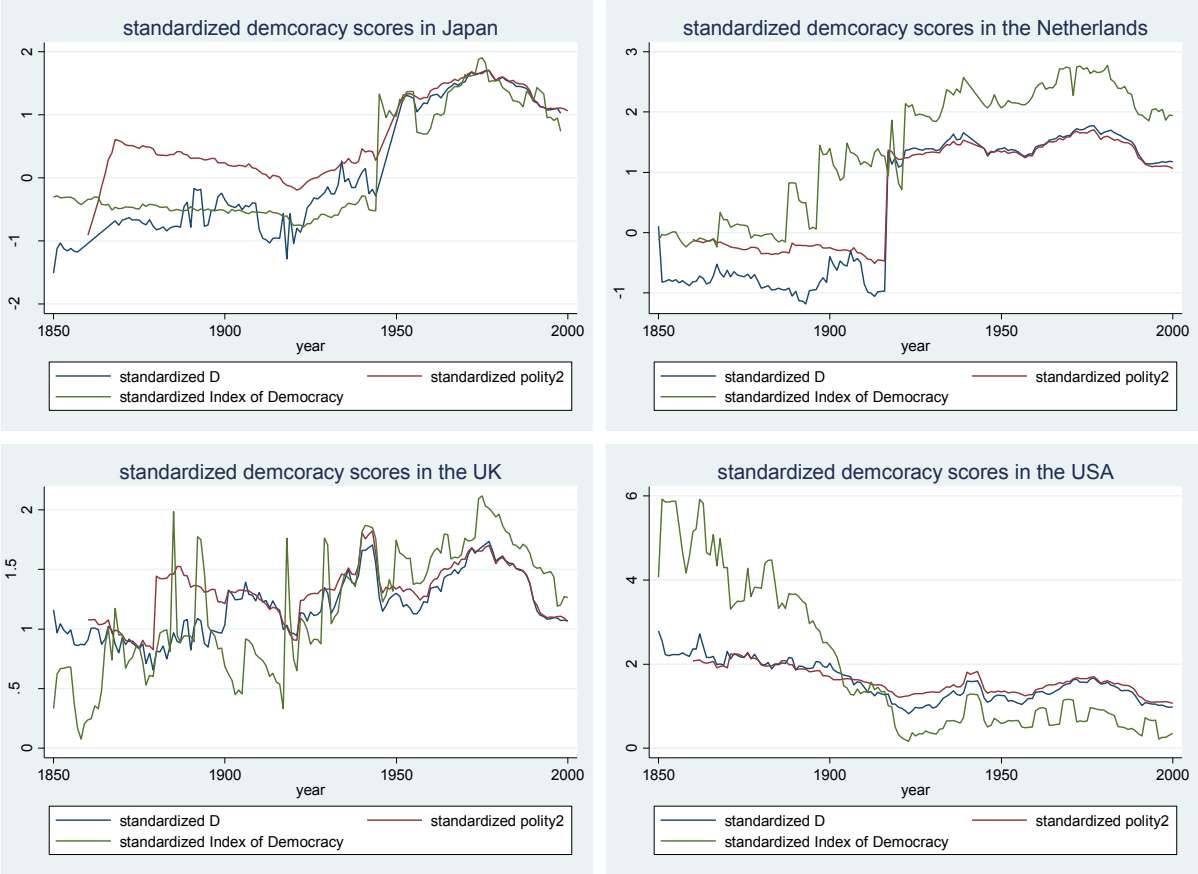
4. Trends in democracy

Using the latent democracy variable D, we can visualize some patterns. Figure 3 visualizes the relationship between the polity2, the ID and the latent D in a few countries over time. Due to differences in measurement units, we report standardized indicators.

Figure 3

Comparison the latent democracy indicator and polity2 and ID scores in eight countries 1850-2000



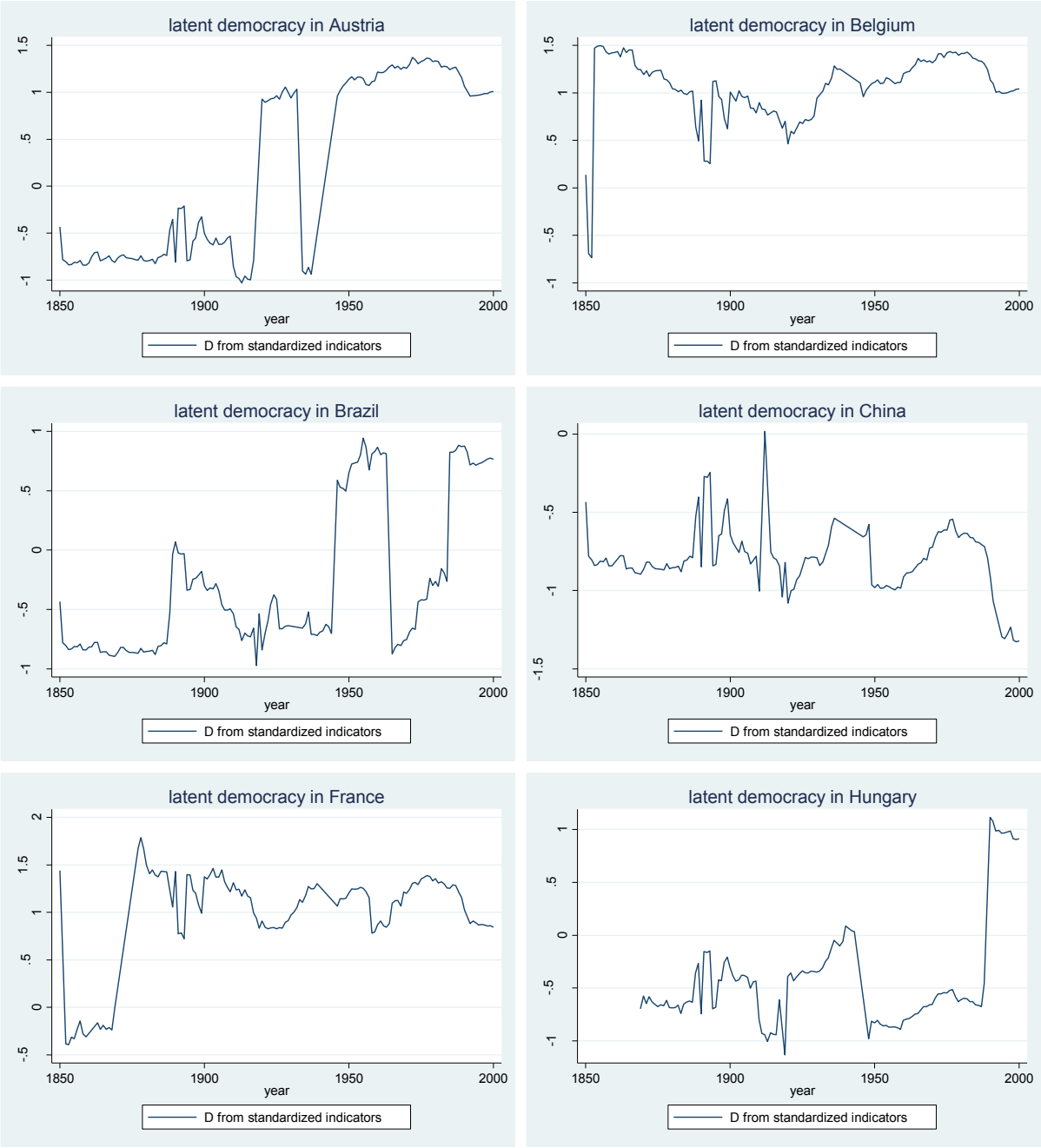


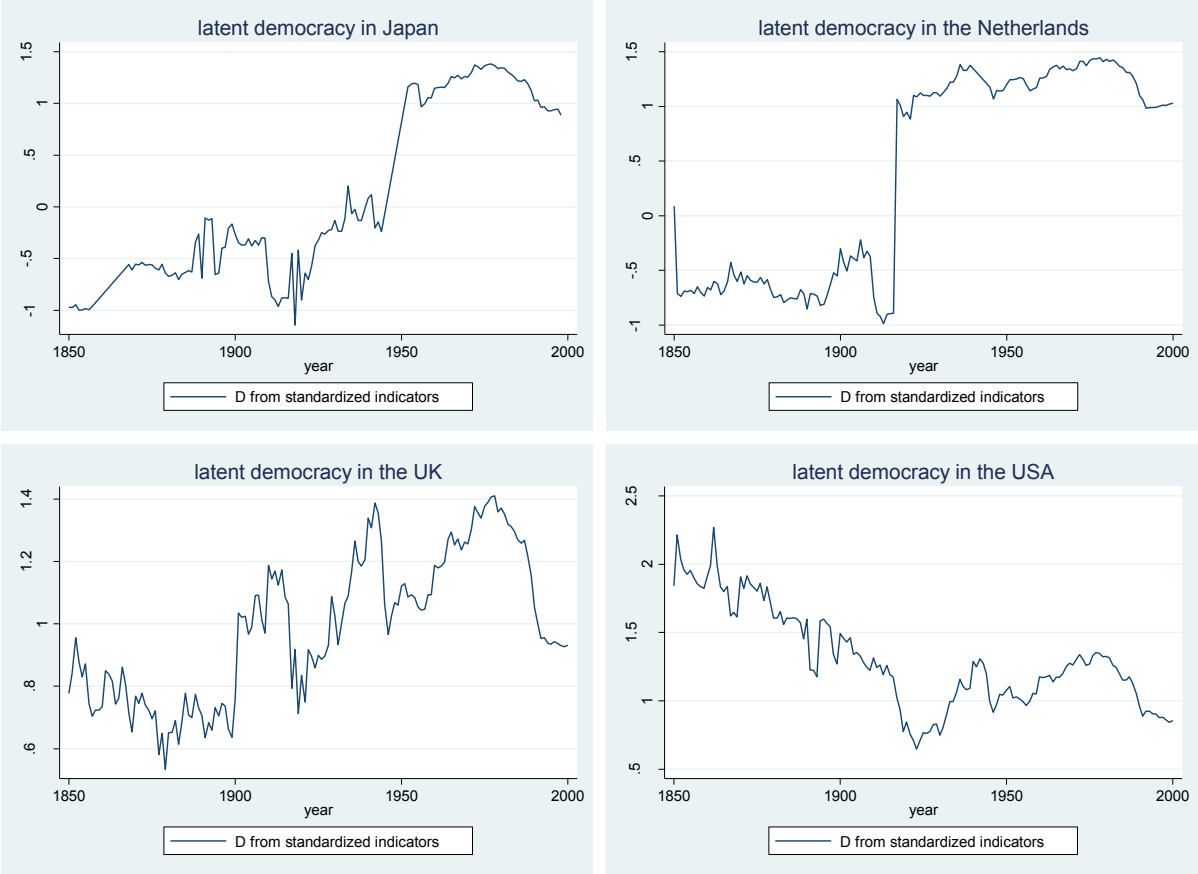
Note: the indicators are standardized by year, that is a value 1 on this graph means that an indicator in a particular country was one standard deviation above the mean in that year.

The latent democracy measure reflects broadly the same trend as polity2 and the Index of Democracy. It should be born in mind, though, that standardization itself fundamentally changes the interpretation of the graphs above, since by subtracting the annual mean scores and normalizing the standard deviation, the democracy is now depicted as a relative phenomenon, and not a concept measurable on an absolute scale. A high score refers to a score that is exceptional relative to the rest of the countries in the sample, and the effect of this can be seen the most explicitly on the USA, where he relative degree of democracy is falling in terms of all measures. The unstandardized latent democracy scores reveal a similar picture in Figure 4, the reason being that these are also based on cross-sectional estimates per years, hence the trends over time reflect a change in the relative rather than in the absolute position of a country. The score should be compared only within the same year. For example, the D score of the USA in 2000 was 0.856, which is lower than that of the UK in the same year (0.932), which coincides with the picture derived from the Index of Democracy, but it is still higher than that of 79% of the 181 countries in the sample.

Figure 4

The latent democracy variable in ten countries (absolute scores)



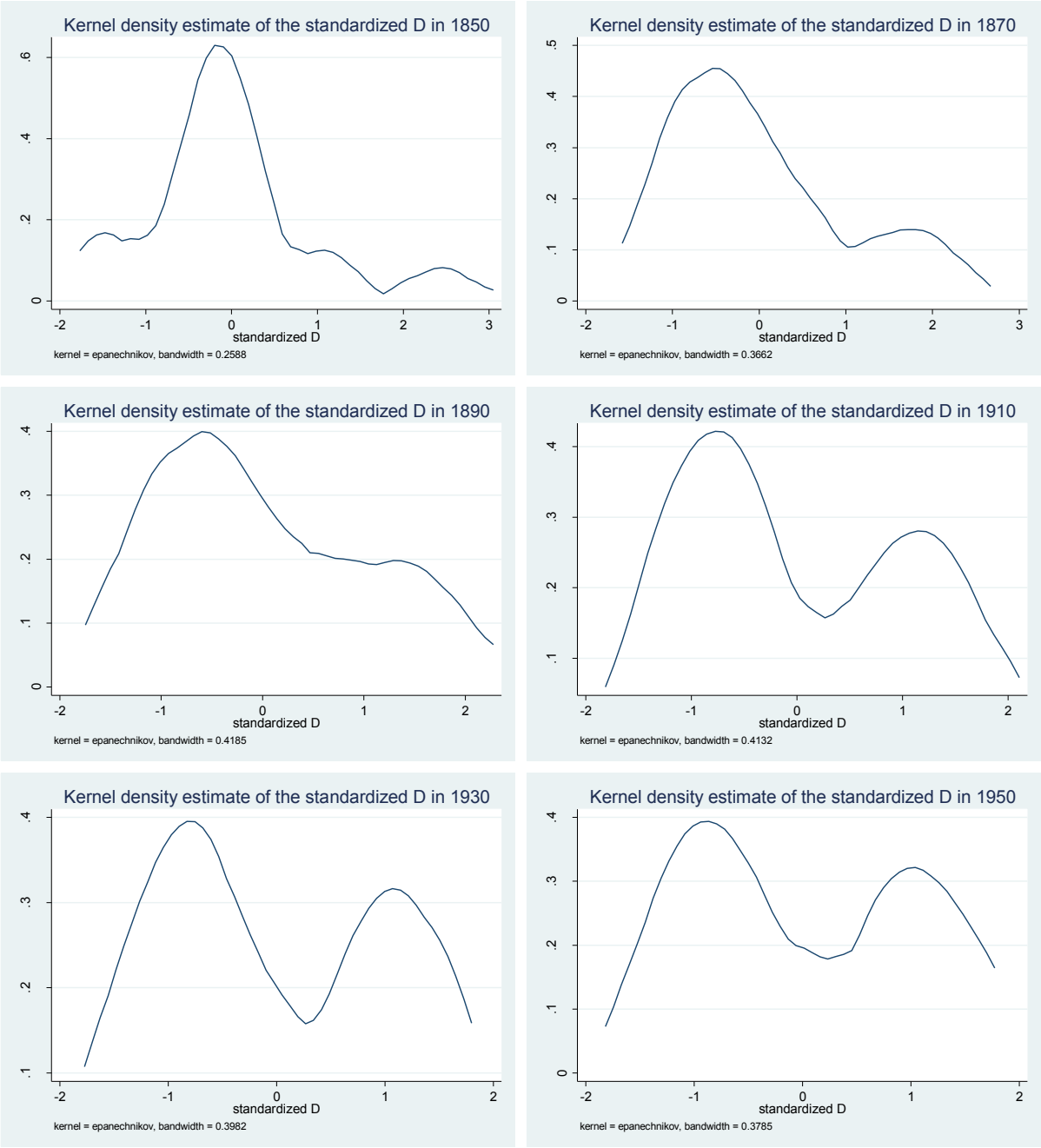


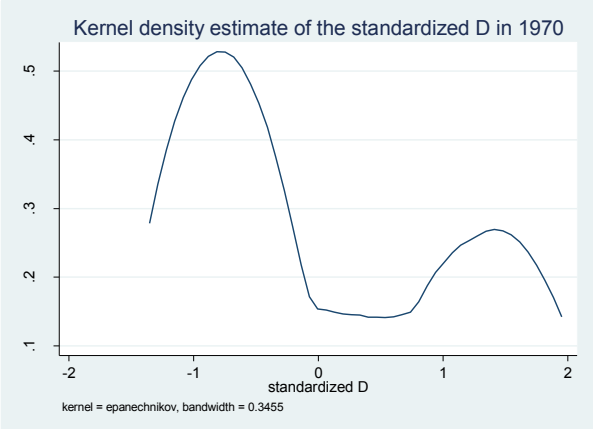
We find that while the USA had some initial advantage in terms of democracy over the rest of the World, it slowly eroded over time and converged to the level of other Western democracies. We can observe the effects of exogenous regime changes as well. Japan experienced a jump in democratization after World War 2, just like Hungary after 1989, lending credibility to the above figures.

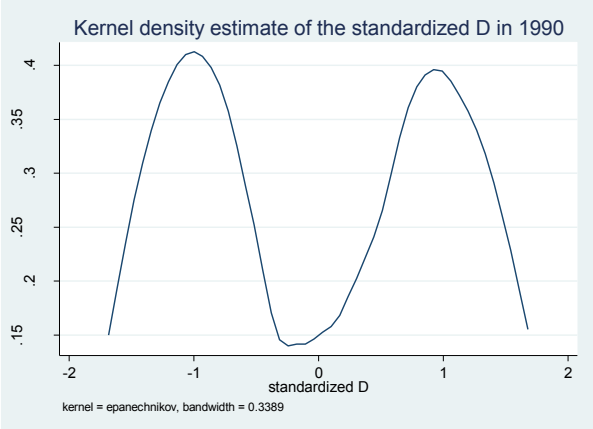
The distribution of the latent democracy variable is estimated with kernel density estimators for a few benchmark years (Figure 5). We find that the initial unimodal distribution, which reflects a degree of relative homogeneity of democracy, was soon replaced by a bimodal distribution, taking shape in the beginning of the 20th century, and remaining in place for the rest of the 1900s. We find the strongest bifurcation of regimes in 1990, when most regimes seem to have been gravitated to one of the two centres. It is only in the last year, 2000, that we find a movement toward a unimodal distribution again, signifying the effect of a global democratization process.

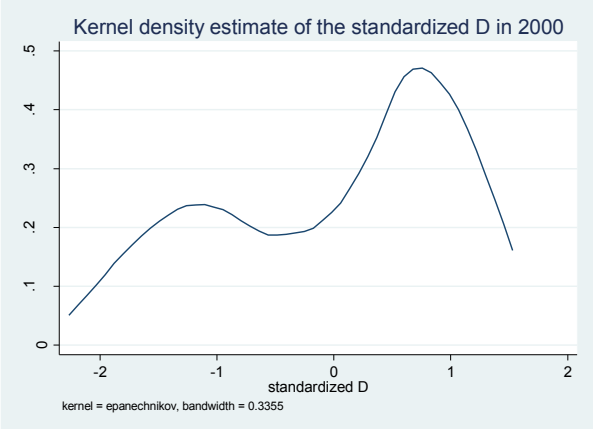
Figure 5

Kernel density estimates of the latent democracy index (D) for benchmark years









5. Conclusion

In this paper we applied a factor analysis based on a measurement error model to extract a latent democracy measure from five components of the Polity IV project and two components of Vanhanen's Index of Democracy. Since both set of indicators reflect the basic components of democracy as introduced by Dahl (1972) there is a reason to assume that the cross-sectional variance of the observable components reflect the effect of a single underlying latent factor.

An obvious advantage of using the estimated factor in further statistical analysis is that the model takes the measurement and observation errors directly into account. Yet, this comes at a price, since the resulting component reflect cross-country differences and should accordingly be treated as a relative and not absolute measure of democracy.

The distribution of the estimated latent democracy reflect an initial divergence in the second half of the 19th century, only replaced by a divergence in the last decade of the 20th century.

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Appendix

Table A.1

Results from the measurement error model for benchmark years

	1850	1870	1890	1910	1930	1950	1970	1990	2000
xrcomp	1	1	1	1	1	1	1	1	1
t-stat	fixed	fixed	fixed	fixed	fixed	fixed	fixed	fixed	fixed
constant	0.072	0.042	0.055	0.053	0.084	0.037	0.005	0.018	-0.009
t-stat	-0.44	-0.27	-0.38	-0.37	-0.65	-0.32	-0.06	-0.21	-0.11
xropen	0.948***	0.950***	0.961***	0.876***	0.861***	0.927***	0.985***	0.973***	0.946***
t-stat	-7.14	-6.45	-8.87	-8.94	-7.02	-10.39	-11.5	-12.78	-13.35
constant	0.068	0.056	0.038	0.082	0.147	0.039	-0.01	0.009	-0.014
t-stat	-0.42	-0.36	-0.26	-0.6	-1.25	-0.34	-0.11	-0.1	-0.16
xconst	0.527***	0.737***	0.481***	0.685***	1.127***	0.982***	1.071***	1.097***	1.066***
t-stat	-3.21	-4.33	-2.93	-4.49	-8.68	-10.9	-13.38	-16.34	-17.76
constant	0.016	0.027	0.09	0.111	0.086	0.033	-0.017	-0.002	0
t-stat	-0.1	-0.18	-0.62	-0.79	-0.66	-0.28	-0.18	-0.02	-0.00
parreg	0.519***	0.340*	0.749***	0.648***	0.933***	0.913***	1.158***	1.094***	0.994***
t-stat	-2.87	-1.83	-4.38	-4.04	-6.82	-9.26	-15.66	-16.21	-14.88
constant	-0.05	-0.065	-0.049	0.001	0.053	0.017	0.016	-0.005	-0.011
t-stat	-0.31	-0.42	-0.33	-0.01	-0.42	-0.15	-0.18	-0.06	-0.12
parcomp	0.466**	0.364*	0.721***	0.583***	0.964***	0.941***	1.158***	1.109***	1.010***
t-stat	-2.43	-1.91	-4.01	-3.55	-7.16	-9.68	-15.35	-16.83	-15.79
constant	-0.031	-0.061	-0.024	0.021	0.081	0.037	0.012	-0.006	-0.011
t-stat	-0.18	-0.39	-0.15	-0.15	-0.63	-0.32	-0.13	-0.06	-0.13
competition	0.387**	0.446**	0.342*	0.499***	1.140***	0.952***	1.091***	1.073***	1.020***
t-stat	-2.14	-2.2	-1.94	-3.1	-8.82	-10.23	-13.85	-15.94	-16.06
constant	0.035	-0.024	0.042	-0.036	0.075	-0.019	0.01	-0.013	0.009
t-stat	-0.22	-0.15	-0.28	-0.26	-0.58	-0.16	-0.11	-0.15	-0.11
participation	0.601***	0.395***	0.512***	0.666***	1.074***	0.439***	0.502***	0.738***	0.789***
t-stat	-3.46	-3.64	-2.98	-4.09	-7.71	-3.51	-4.77	-8.37	-10.04
constant	0.019	-0.178*	0.029	0.03	0.067	-0.026	0.031	0.038	0
t-stat	-0.11	-1.89	-0.19	-0.2	-0.5	-0.23)	-0.34	-0.43	-0.01

var(e.xrcomp)	0.187**	0.229**	0.165*	0.146	0.329***	0.198***	0.284***	0.248***	0.228***
t-stat	-2.05	-2.33	-1.92	-1.53	-4.6	-4.19	-7.22	-7.36	-7.18
var(e.xropen)	0.235***	0.277***	0.218***	0.248***	0.315***	0.285***	0.324***	0.314***	0.323***
t-stat	-2.69	-2.88	-2.64	-2.82	-4.84	-4.77	-7.28	-7.5	-7.57
var(e.xconst)	0.689***	0.530***	0.742***	0.540***	0.144***	0.232***	0.188***	0.120***	0.105***
t-stat	-4.16	-3.86	-4.54	-4.09	-3.8	-4.88	-6.78	-6.31	-5.63
var(e.parreg)	0.784***	0.873***	0.569***	0.608***	0.391***	0.312***	0.058***	0.124***	0.232***
t-stat	-4.16	-4.4	-3.77	-4.18	-4.79	-4.88	-4.62	-6.32	-7.18
var(e.parcomp)	0.875***	0.878***	0.656***	0.650***	0.342***	0.279***	0.072***	0.093***	0.183***
t-stat	-4.19	-4.39	-3.93	-4.28	-4.81	-4.63	-5.29	-5.66	-6.83
var(e.competition)	0.876***	0.856***	0.886***	0.715***	0.117***	0.281***	0.162***	0.136***	0.176***
t-stat	-4.27	-4.27	-4.64	-4.56	-3.28	-5.17	-6.58	-6.62	-6.82
var(e.participation)	0.716***	0.237***	0.788***	0.657***	0.274***	0.827***	0.819***	0.593***	0.491***
t-stat	-4.1	-4.05	-4.51	-4.28	-4.62	-6.05	-7.67	-7.94	-7.98
var(D)	0.838***	0.757***	0.817***	0.863***	0.650***	0.793***	0.697***	0.736***	0.782***
t-stat	-3.42	-3.29	-3.73	-3.87	-3.71	-4.89	-5.69	-6.21	-6.54
N	34	40	45	48	58	75	119	131	138