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Assessment and Explanation of the Human Rights Situation of an Ubiquitous Minority in Europe

Indicators for the comparison of countries by their HR (human rights) compliance, based on country reports, have been used for 40 years. However, they aim at giving a comprehensive picture of the HR situation of each country. Does this suffice to draw conclusion about the well-being of small groups? The paper explores this problem for a test population that in each country is in about the same vulnerable situation: women in sex work (SW). Using data from Council of Europe (CoE) countries, the paper uncovers several explanations for the HR situation in SW in terms of comprehensive indicators. Further, the paper uncovers a dependency on proven HR violations (based on international jurisprudence), if the societal preferences of countries are modelled by their pattern of the ratification of certain CoE treaties. This is insofar surprising, as generally the indicators ‹proven HR violations› and ‹reported HR violations› are uncorrelated.

Category: Articles
Field of law: Legal Theory
Region: Austria

Contents

Abbrevations: CaRT (Classification and Regression Trees) CIRI (Cingranelli & Richards HR database) CoE (Council of Europe) ECHR (European Convention of Human Rights) ECtHR (European Court of Human Rights) EU (European Union) FN (Footnote) HR (Human Rights) ML (Maximum Likelihood) PCA (Principal Component Analysis) SW (Sex Work or Sex Worker) TIPs (Trafficking In Persons) UNO (United Nations Organization) UK (United Kingdom) US (United States) USDS (US Department of State) VP (human rights Violation Propensity)

JEL (Journal of Economic Literature) codes: K33, K42, I28, J88

1   Introduction

[Rz 1] Since forty years, political economy uses statistical methods to assess and compare HR fulfilment of countries.[1] As outlined in a complementary paper,[2] this empirical approach has brought far reaching and often controversial conclusions about the relevance of HR-treaties for actual HR protection. This paper contributes to the methodological debate about limitations of empirical approaches in comparative international law.

[Rz 2] The **first agenda** of this paper is an analysis of the following aspects of this debate:

- First, country comparisons are based on reported HR violations, but what does this say about the actual HR situation? An evaluation of UN Human Rights Committee judgments led to the conclusion that empirical «HR measures were largely unrelated to [that committee's] verdicts».[3] Thus, there appears to be a discrepancy between HR violations that are just reported and HR violations that are proven by international jurisprudence. Can these different types of assessment be reconciled?

- Second, as HR violations are driven by societal problems, it is meaningful to consider HR in relation to specific problem fields. However, the assessment of the HR situation is based on comprehensive indices, such as CIRI (section 5). For such indices certain issues might eclipse

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[1] Hɪʙʙs, D.A. (1973). *Mass Political Violence: A Cross-National Causal Analysis*. Wiley, New York.

[2] Bʀᴜɴɴᴇʀ, N., Tsᴄʜᴏʜʟ, C. (2013). Do Patterns of Treaty Ratifications Reveal Societal Preferences? Analysis of Twelve Council of Europe Conventions, in: Jusletter IT 20. Februar 2014 (*Conference Proceedings to IRIS (Internationales RechtsInformatik Symposium in Salzburg) 2014*). In addition the empirical data used are available in a *Supporting Information* for this paper. An S in the numbering of sections, tables and figures refers to it. The Supporting Information is available for download **here**.

[3] Cᴏʟᴇ, W.M.(2011). Individuals v States: The Correlates of Human Rights Committee Rulings, 1979—2007. *Social Science Research*, **40**, 985—1000.

all other HR related factors.[4] Are they nevertheless capable of assessing or even explaining the HR problems of specific social groups?

- Third, in responding to the same societal problems, why do some countries respect HR, while others fail in often dramatic ways? Can HR respecting countries be distinguished from others by means of objective criteria? Here, the paper elaborates on the hypothesis of the corresponding paper (FN 2) that societal preferences of each country are root causes on the one hand of the country specific pattern of HR-related treaty ratifications, where states declare their societal preferences by the accession to treaties, and on the other of the country's response to societal problems, including the level of HR protection.

[Rz 3] The paper addresses these questions in a specific context.

- First, it focuses on Council of Europe (CoE) countries in order to reduce disparities between countries with different political systems (see the corresponding paper, FN 2).
- Second, within these countries the focus is on a «model population», (mainly) women in sex work (SW). There are three motives for this choice: A) As the corresponding paper explained (FN 2), SWs are a vulnerable group. In some countries there even exist «social attitudes [that] allow police a free hand for extortion, unlawful detention, and sexual abuse of women in prostitution».[5] B) SWs are ubiquitous, with about 1.4% of adult women in the reproductive age.[6] This amounts to 0.35% of the population (50% women and of them 50% in the reproductive age). Hence inferences can be drawn from reports about HR deficiencies as well as from the lack of such reports. C) However, the topic of SW was long ignored: Ten years ago it was too controversial for many authors, whence they did not document SWs' rights abuses.[7] In the meantime SW has become a focal issue in HIV prevention.[8] UNAIDS promotes the insight that respect for HR of SWs is a key element of successful policies.[9] Other organizations, e.g. ILO, confirm this.[10]
- Third, in order to identify societal preferences the paper focuses on the accession to twelve CoE conventions. Although the ratification to a single treaty may be uncorrelated to HR deficiencies, ratification patterns matter. Indeed, the paper identifies five types A to E with prognostic value for explaining the HR situation of SWs.

[Rz 4] The **second agenda** of this paper is methodological and related to the overall topic of the 2014 issue of *IRIS*. It illustrates by means of an example (accessible to readers with a legal background) a rationale of indiscriminate data collection: Data mining may find surprising and useful structure in apparently unstructured data. This paper explores several routes to comparing countries and finding structure in ratification data that relates both to a country's HR performance and

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4   This paper uses the term «factor» colloquially without reference to «factor analysis» (instead of which this paper applies principal component analysis).

5   Csete, J., Seshu, M.S. (2004). Still Underground: Searching for Progress in Realizing the Human Rights of Women in Prostitution. *HIV/AIDS Policy & Law Review*, **9**, 8—13.

6   Vandepitte, J., Lyerla, R., Dallabetta, G., Crabbé, F., Alary, M., Buvé, A. (2006). Estimates of the Number of Female Sex Workers in Different Regions of the World. *Sexually Transmitted Infections*, **82**, Suppl 3, 18—25.

7   Vanwesenbeeck, I. (2001). Another Decade of Social Scientific Work on Sex Work: A Review of Research 1990-2000. *Annual Review of Sex Research*, **12**, 242—289.

8   Bennet, N. (2009). Sex Work: A Survey of Social, Philosophical and Human Rights Issues. *International Journal of Green Economics*, **3**, 93—100.

9   UNAIDS (2006). *International Guidelines on HIV/AIDS and Human Rights*, Joint UN Programme on HIV/AIDS, Geneva.

10   ILO (2010). *HIV & AIDS Recommendation R200*, International Labour Organization, Geneva.

its societal preferences.

2 Materials and Methods of Data Analysis

[Rz 5] The paper uses *classification and regression trees* (CaRT),[11] first studied 30 years ago,[12] as a novel method for studies in comparative international law. CaRT is a class of data mining methods to identify explanatory patterns in a way that resembles differential diagnostics in medicine. Actually, most applications of CaRT are in medical research, where CaRT is known to perform well, when compared to the more traditional regression models.[13] Section S1 outlines the wide range of other applications, including US homeland security.

[Rz 6] The present paper applies CaRT as a diagnostic tool for identifying country risks for certain societal failures. Specifically (first agenda), CaRT explains the HR situation of SWs. Section 4 maps it by an index SWDEF. (SWDEF for a country is 1/0, if there are some/are no reported serious HR problems related to SWs.) CaRT successively asks diagnostic questions. Such questions check thresholds for observed data (e.g. population size). Depending on the answer, this leads to the next diagnostic question, until finally the proposed diagnosis is SWDEF = 0 or SWDEF = 1. The paper applies *chi-squared automatic interaction detection* (CHAID).[14] For this application, CaRT has the major advantage that it does neither make assumptions about underlying probability distributions, nor does it assume a parametric model to explain interactions. Instead, CaRT aims at the optimization of the information gain, measured here in terms of the reduction of the expected *Shannon information entropy* of the SWDEF = 0/1 data.[15] (Authors subsequently simplified trees for the ease of presentation.) As for CaRT there is no generally accepted criterion for model selection, it is recommended to consider prediction errors (accepting some error to avoid over-fitting, where the model falsely «explains» even random variations) and judge, if the unveiled structure is reasonable and plausible.[16] Simple models, which use few explanatory factors, are preferred.

[Rz 7] In view of the second agenda, the paper compares CaRT with other methodological approaches. In particular, it uses an ad-hoc method and characterizes SWDEF by means of an index of vulnerability, measuring the exposure of SWs to certain HR deficiencies in a country. Thereby, vulnerability is defined as a weighted mean of CIRI indices. Such indices are based on the CIRI data-set (explained in section 5) and its specific HR-performance measures (e.g. degree of the respect for the prohibition of torture). Thereby, for the present problem there exist *feasible indices*. They are defined by certain criteria weights (non-negative with sum 1) and a threshold, such that

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[11] Hastie, T., Tibshirani, R., Friedman, J. (2011). *The Elements of Statistical Learning: Data Mining, Inference and Prediction*. Springer Series in Statistics, Heidelberg.

[12] Breiman, L., Friedman, J., Olshen, R.A., Stone, C.J. (1984). *Classification and Regression Trees*. Wadsworth.

[13] Segal, M.R., Bloch, D.A. (1989). A Comparison of Estimated Proportional Hazards Models and Regression Trees. *Statistics in Medicine*, **8**, 539—550.

[14] Hand, D.J., Mannila, H., Smyth, P. (2001). *Principles of Data Mining*. MIT Press, Boston.

[15] Borda, M. (2011). *Fundamentals in Information Theory and Coding*. Springer, Berlin.

[16] «Big data» applications divide the sample into a learning population, where the model is developed, and a test population, where it is verified. In the present context, this approach is not meaningful, as first, 47 countries is a comparatively small sample and second, these countries represent the whole investigated «population». Also, in commercial applications different misclassifications may have different costs; e.g. credit rating (refusing credits is less costly than accepting high risks).

the following characterization of SWDEF holds for all countries without misclassification:

SWDEF = 1 if vulnerability threshold, and SWDEF = 0, otherwise, where vulnerability = weightsxCIRI and «x» is the scalar product of vectors.

[Rz 8] That feasible indices of vulnerability exist is true for the present data, only. To choose one, the paper uses *data envelopment analysis*, a decision-aid methodology:[17] It selects weights that maximize the minimal distance of country index values from the respective threshold.[18] The purpose is better visualization, to clearly distinguish countries with SWDEF = 0 from those with SWDEF = 1. The optimal weights and thresholds are obtained from linear programming, solving the above inequalities that characterize SWDEF.

[Rz 9] Further, the paper defines a «probabilistically optimal» index, which needs not be feasible.[19] Thereby, «probabilistically optimal» is defined with reference to a method of generalized regression analysis. (This type of analysis is common in comparative statistical HR studies; references in the introduction and the corresponding paper, FN 2.) Specifically, the paper applies censored *Poisson* regression.[20] *Poisson* regression assumes that the number of reports about SW HR deficiencies follow a *Poisson* distribution, which is a familiar assumption for rare events. The parameters of the index are determined by the *maximum likelihood* (ML) method.

[Rz 10] The analysis of ratification data uses another classical method of descriptive statistics, *principal component analysis* (PCA):[21] Pictorially, data are perceived as a cloud, roughly of the form of a multi-dimensional ellipsoid; its axes are the principal components. In a similar context of country comparisons (fulfilment of HR in relation to achievement of Millennium Development Goals), PCA was used to better discriminate between countries.[22]

[Rz 11] The paper applies also conventional methods, such as analysis of significant correlations or contingencies (T-test respectively x^2-test/Fisher exact test with 95% significance).

[Rz 12] As to the materials, CaRT and PCA use *XL-STAT*® commercial software of *Addinsoft*®, optimization uses the *Solver*® Add-In of *Microsoft*® *Excel*® and *Mathematica*® computer algebra of *Wolfram Research*®. Simulations use random number generators from *XL-Sim*® of *AnalyCorp*®.

3   Data 1: Relevant European Treaties

[Rz 13] Twelve CoE treaties were selected. The corresponding paper (FN 2, Chapter 3) explains the rationale. **Group 1** is comprised of the following six treaties: *Convention on Action against Trafficking in Human Beings* (CETS 197), *Convention for the Protection of Individuals with Regard*

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17 Brunner, N., Starkl., M. (2004). Decision Aid Systems for Evaluating Sustainability: A Critical Survey. *Environmental Impact Assessment Review*, 24, 441—469.

18 This approach resembles the latent-variable approach to define an index in a probit-model. However, it is different, as it does not maximize the likelihood of the above system of inequalities, and it does not use probability distribution assumptions.

19 Components as defined by means of PCA, considered below, are yet another class of indices of vulnerability, which do not satisfy the condition of feasibility.

20 Casella, G., Berger, R.L. (2001). *Statistical Inference*. Pacific Growe.

21 Jolliffe, I.T. (2002). *Principal Component Analysis*. Springer Series in Statistics, Heidelberg.

22 Adler, N., Yazhemsky, E, Tarverdyan, R. (2010). A Framework to Measure the Relative Socio-Economic Performance of Developing Countries. *Socio-Economic Planning Sciences*, 44, 73—88.

to Automatic Processing of Personal Data (CETS 108), *Additional Protocol to the Convention for the Protection of Individuals with Regard to Automatic Processing of Personal Data, Regarding Supervisory Authorities and Transborder Data Flows* (CETS 181), *Convention on Cybercrime* (CETS 185), *European Charter for Regional or Minority Languages* (CETS 148), *Framework Convention for the Protection of National Minorities* (CETS 157). **Group 2** is comprised of *European Social Charter* (CETS 035), *European Code of Social Security* (CETS 048), *European Convention on the Obtaining Abroad of Information and Evidence in Administrative Matters* (CETS 100), *European Convention on the Control of the Acquisition and Possession of Firearms by Individuals* (CETS 101), *European Convention for the Protection of Pet Animals* (CETS 125), *European Agreement on the Restriction of the Use of certain Detergents in Washing and Cleaning Products* (CETS 064).

4   Data 2: HR Deficiencies in SW (SWDEF)

[Rz 14] SWDEF is an *HR-deficiency index* about SWs' HR situation in Europe: SWDEF of a country is 1, if there are verified reports, published between 2007 and 2012, about deficiencies affecting SWs. It is 0, otherwise. Table 5 summarizes it: Amongst 47 CoE countries authors could identify 13 countries with SWDEF = 0. Thereby reports/complaints were not counted: If each victim personally identified by a researcher (or court) counts as report, most reports are from Russia, with 30 victim respondents in an Open Society Foundation study.[23] If SWDEF is to be refined by counting reports, then the more complex ILO methodology for case tracking and counting would be needed.[24]

[Rz 15] Assessment of SWDEF was based on the following sources (see Section S2 for details).

- First, authors screened ECtHR judgments (HUDOC) for proven HR violations with a direct or indirect negative effect on SWs: Relevant violations were found for *Bulgaria*, *Cyprus*, *Finland*, *Italy*, *Russia*, *Spain*, *Switzerland*, and *Turkey*.
- Next, authors did a similar search for UN HR instruments, in particular concluding observations by treaty-based HR bodies about country reports (OHCHR homepage): Concerns about systematic deficiencies were noted for *Albania*, *Austria*, *Germany*, *Ireland*, *Montenegro*, and *Ukraine*.
- Third, authors screened USDS country reports: Concerns were voiced for *Belgium*, *Bosnia & Herzegovina*, *Croatia*, *Georgia*, *Greece*, *Moldova*, and *Romania*.
- Fourth, authors searched literature for documented HR violations (Google Scholar, Medscape, PubMed of NIH, or homepages of publishers, e.g. Elsevier, Sage etc.): Police misconduct (brutality, rape, extortion)[25] or institutional deficiencies were reported e.g. from *Armenia*, *Czech Republic*, *Latvia*, *Lithuania*, *Macedonia*, *Poland*, *Serbia*, and *Slovak Republic*.
- Fifth, authors checked media (Google, Wikipedia) and NGO reports (e.g. Amnesty International). There are reports about HR-relevant incidents or deficiencies from *Azerbaijan*, *Hungary*,

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23 Crago, A.L. (2009). *Arrest the Violence — Human Rights Abuses against Sex-Workers in CEE/CA*. SWAN and Open Society Foundation, Budapest.

24 ILO(2012). *ILO Global Estimate of Forced Labor; Results and Methodology*. International Labor Organization, Geneva.

25 Rape of SWs by police officers in points 4 and 5 strictly speaking would not count as HR violation, if perpetrators are punished and victims redressed. However, incidents which become known due to reports about prosecution of perpetrators are just the tip of an iceberg, indicating a culture, which perceives women in SW as lawless. Thus, there are also reports from countries of points 1 to 3 about the rape of SWs by police officers (e.g. Germany: Hannoversche Allgemeine of 9 March 2012).

France, *Sweden*, and *UK*.

- The remaining 13 countries are classified as SWDEF = 0: *Andorra, Denmark, Estonia, Iceland, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino*, and *Slovenia*. Thereby, as explained in Section S2, Estonia, Netherlands, and Norway are borderline cases for SWDEF = 0 and Finland for SWDEF = 1.

[Rz 16] For obvious reasons, SWDEF depends on population size: There is a significant positive correlation (coefficient 0.31) between population size (pop) and SWDEF;[26] SWDEF = 0 for microstates with pop < ½ million,[27] and SWDEF = 1 for pop > 20 million.[28]

5   Data 3: Other Country Data (VP, CIRI, etc.)

[Rz 17] Table 5 informs about legal regulations of prostitution. The paper distinguishes prostitution laws and their implementation, based on the above mentioned sources for SWDEF. Authors used a standard classification of legal concepts:[29] *prohibitionist, abolitionist, neo-abolitionist* («Swedish model»), or *regulationist*. Thereby, the assessments of this paper, e.g. of Finland as abolitionist, differs from other literature.[30] Further, implementation of prostitution laws (even, if there are none) is *conservative*, if law enforcement actually restricts SW, and *liberal* otherwise.[31] Thereby, a country was assessed as «liberal», if it was liberal for a significant time span during the observation period (Netherlands) or for a significant part of the country (Germany). Here, too, the present assessments may differ from literature. It would be expected that SWDEF depends on the type of prostitution laws. However, authors did neither observe a 95% significant correlation nor a significant contingency. Rather, implementation seems to matter: SWDEF is significantly correlated with implementation and for conservative countries (except Malta) SWDEF = 1, while for liberal prohibitionist countries SWDEF = 0 (with the exception of Slovenia all are microstates).

[Rz 18] Proven HR violations are measured by the *violation propensity* (VP) of countries. It is the average annual rate of ECtHR judgments finding violations per million citizens. Data for population size uses UNO sources for 2010,[32] data for judgments are from ECtHR,[33] and the average is taken for each country between 2012 and the year, when the convention entered into force with respect to this country. VP ranges between 0.04 for Germany and 15.2 for San Marino, whereby for unknown reasons VP is generally higher for smaller countries.

[Rz 19] For comprehensive indices of reported HR violations, the paper uses the *Cingranelli & Richards* HR database (CIRI).[34] Since 1981 CIRI tracks the annual HR performance of 195 coun-

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[26] Correlation compares vectors in dimension 47, the number of CoE countries. T-test shows that correlation coefficient is positive with 95% significance.

[27] Microstates: Andorra, Iceland, Liechtenstein, Luxembourg, Malta, Monaco, San Marino

[28] For the correlation between SWDEF and country size see also Figure 3 below.

[29] PACE (2007). Prostitution — Which Stance to Take? Parliamentary Assembly of the Council of Europe, Recommendation 1815, Document 11352 of 9 July 2007.

[30] Niemi, J. (2010). What We Talk About When We Talk About Buying Sex. *Violence against Women*, **16**, 159—172. There Finland was classified as neo-abolitionist, although other than in Sweden also SWs are prosecuted.

[31] SWFV(2012). *Human Rights of Sex Workers in Europe. A Survey and Critical Analysis*. Sex-Worker Forum of Vienna, www.sexworker.at.

[32] UNO (2011). *World Population Prospects*. Department of Economic and Social Affairs, New York.

[33] ECtHR(2012). *Violations by Article and by State*, 1959 to 2011. Registry, ECtHR, Strasbourg.

[34] Cingranelli, D.L., Richards, D.L. (2013). The Human Rights Dataset, www.humanrightsdata.org.

tries, based on Amnesty International Annual Reports and USDS Country Reports. It is currently the most influential dataset, used e.g. by World Bank in good governance assessments.[35] In order to make CIRI comparable with SWDEF, the paper rescales CIRI linearly between 0 = no reports and 1 = maximal level of reported HR violations. Further, for each index the average over 2006 to 2010 is considered. Table S6 lists these average CIRI values for CoE.

[Rz 20] Confirming an observation from FN 3, there are no significant correlations between VP and CIRI indices, except for women's political rights.[36] Moreover, there is no significant correlation between SWDEF and VP, even though SWDEF utilizes also ECtHR information. The reason might be the different methods of data collection: SWDEF, which is defined by a methodology similar to CIRI, is highly and significantly correlated with several CIRI indices. With 99% significance (T-test) there is a positive correlation of SWDEF with torture (correlation coefficient 0.66), speech & press (0.55), religion (0.55), independent judiciary (0.50), women's economic rights (0.45) and assembly (0.43). Further significant (95%) positive correlations were observed with workers' rights (0.35), extrajudicial killing (0.33), and free election (0.30). There are no significant (95%) correlations with movement, neither across nor within borders, political prisoners, women's political rights or disappearance.

[Rz 21] There are significant negative correlations between the number of years since the ratification of ECHR and the CIRI indices torture, assembly, international movement, speech & press, free elections, workers rights, women's economic and political rights and independence of the judiciary. This seems to supports a hypothesis of a process of acculturation of CoE countries.

6   Results 1: Definition and Explanation of Ratification Types

[Rz 22] The paper distinguishes five types A to E of ratification patterns (see Table 5). The corresponding paper (FN 2) motivated them by their links to SWDEF and other SW issues.

> Type A: Countries did not ratify all three data protection conventions (CETS 108, 181, 185) and did not ratify CETS 101, 125, or 064.
> Type B: Countries ratified CETS 035, 101, 125 and at least one of CETS 100 or 064.
> Type C: Countries ratified all three data protection conventions (CETS 108, 181, 185) plus CETS 157, but did not ratify CETS 048, 100, 101, or 064. Type D: Countries ratified CETS 048, but not CETS 035. Type E: All other countries.

[Rz 23] PCA explains the classifications by means of pattern recognition: The principal component F1 indicates the direction of maximal variation in the table of correlation coefficients between treaty ratifications (Table S2). The principal component F2 is the orthogonal direction of maximal residual variation, and similarly for F3 to F12. This defines the rotated coordinate system of Table S3 (rotation centre in Table S5). Table S4 displays ratification data in these coordinates.

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[35] ROBERTS, S.M., WRIGHT, S., O'NEILL, P. (2007). Good Governance in the Pacific? Ambivalence and Possibility. *Geoforum*, **38**, 967—984.

[36] This correlation might be spurious; c.f. Section S5 in the context of SWs' HR situation.

Figure 1. Number of ratifications in groups 1 or 2 as a function of F2 and F1

Table 1. Parameters *a*, *b*, *c* for the prediction of ratifications from the number of ratifications in groups 1 and 2, using the formula: ratification-entry = *a* + *b*xgroup-1-ratifications + *c*xgroup-2-ratifications, rounded to 0 or 1

	CETS 197	CETS108	CETS 181	CETS 185	CETS 148	CETS 157
a	0.130	-0.046	0.159	-0.147	-0.250	0.168
b	0.139	0.189	0.140	0.183	0.153	0.171
c	0.014	0.060	-0.042	0.029	0.040	-0.052
	CETS 035	CETS 048	CETS 100	CETS 101	CETS 125	CETS 064
a	0.273	0.216	-0.080	-0.160	0.229	-0.191
b	-0.003	-0.040	-0.031	0.037	-0.020	0.006
c	0.147	0.191	0.161	0.144	0.154	0.176

Explanation of the formula: First, using the trend-lines in Figure 1, ratification counts in groups 1 and 2 define estimates for F1, F2. Next, the inverse of the coordinate transformation used for Table S4 (explanation there) is applied. Finally, the result is rounded to the next integer 0 or 1; it predicts approximately the treaty ratification status of a country.

[Rz 24] Based on this transformation and using CHAID, PCA provides characterizations of types A to E. Types (except D) are closely related to the components F1 and F2 and tend to change as follows with increasing F1: Types A and C relate to low F1 (main difference: high or low F2), type E to intermediate F1 and type B to high F1.

- With the exception of Iceland (type E), countries are of type A, if F1 < 0.184, F2 < 0.038 and F12 —0.307.
- With the exception of Belgium (type E), countries are of type B, if F1 0.932.
- Countries are of type C, if F1 < 0.184, F2 0.038, F12 —0.307 and F7 —0.36.

- With the exception of Germany (type B), countries are of type D, if either F8 —0.599 and F6 < —0.546, or if F8 < —0.599.
- With the exception of Romania and Switzerland (type D), and missing Belgium and Moldova, countries are in type E, if either 0.184 F1 < 0.932 (11 of 15 type E countries) or if F1 < 0.184 and F6 0.715.

[Rz 25] F1 is also instrumental in distinguishing the legal approach towards SW. With increasing F1, there is a change from prohibitionist to regulationist to abolitionist approaches.[37] Similarly, with 83% precision,[38] the conditions F1 < 0.583 and F7 —0.327 characterize conservative implementation. Using more complex combinations of components, quite precise characterizations of SWDEF are possible, too.[39] Also VP may be partially explained by ratifications alone.[40] Taken together, the observations support the hypothesis that ratifications express societal preferences relevant for SW and HR.

7 Results 2: Explaining SWDEF by Tree Models

[Rz 26] The paper introduces two tree models. Both models impose additional structure on the raw data. For the raw data, CoE is partitioned into 34 countries with SWDEF = 1 and 13 countries with SWDEF = 0. Without additional structure entropy is $H = 0.851$ (maximal entropy: 1).

[Rz 27] Figure 2 correctly classifies 44 countries (94%) using CIRI data; see Table 2.[41] Differentiating first by torture (threshold 0.35) correctly classifies 41 countries (87%). Level 2 criteria are assembly (threshold 0.3) and speech & press (threshold 0.05).

- End-node 4 is classified as SWDEF = 0. For its 13 countries records in torture and assembly are amongst the best; 7 have a population below 1 million. Belgium and Finland (SWDEF = 1) are misclassified.[42]
- End-node 5 is pure, with SWDEF = 1. It consists of Croatia and Germany.
- End-node 6 is classified as SWDEF = 0. Cyprus is misclassified (SWDEF = 1).[43]
- End-node 7 is the largest node with 29 countries, whose records in torture and speech & press

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[37] All 11 countries with F1 < —0.683 are prohibitionist, as are 50% of 10 countries with —0.683 F 1 < —0.192. For intermediate —0.192 F1 < 0.508 no approach dominates, but amongst these 14 countries there is a concentration of the regulationist ones (5 of 8). Finally, 75% of the 12 countries with F1 0.508 are abolitionist. Together with other components, more precise descriptions are possible.

[38] France, Italy, Moldova and UK are conservative countries misclassified as liberal, and Estonia, Finland, Norway and San Marino are liberal countries misclassified as conservative.

[39] Using CHAID, «ratification components» together with population size characterize SWDEF correctly for all, except one country. This supports the hypothesis of this paper that ratifications capture the societal preferences, which also govern policies towards SW. However, the tree models of section 7 are preferred, as the empirical meaning of components is difficult to interpret.

[40] If VP is classified in three classes (high to low) as in Figure 3, «ratification components» explain 85% of VP, using CHAID.

[41] The authors tested other tree models, too. For instance, there is a manually generated tree (3 misclassifications) with only two criteria: The first split is by torture (threshold 0.35). If torture is low, the next split asks for high violations of speech & press (threshold 0.45), if torture is high, the next split asks for any violation of speech & press (threshold 0.05).

[42] By Section S2, Finland is a borderline case for SWDEF = 1. Node 4 contains also the Netherlands and Norway, which are borderline cases for SWDEF = 0.

[43] The other countries are Estonia and Portugal. Estonia is a borderline case for SWDEF = 0. If it is reclassified as SWDEF = 1, then end-node 6 will switch to SWDEF = 1 and now Portugal will be misclassified.

are amongst the worst in Europe. It is pure and classified as SWDEF = 1.
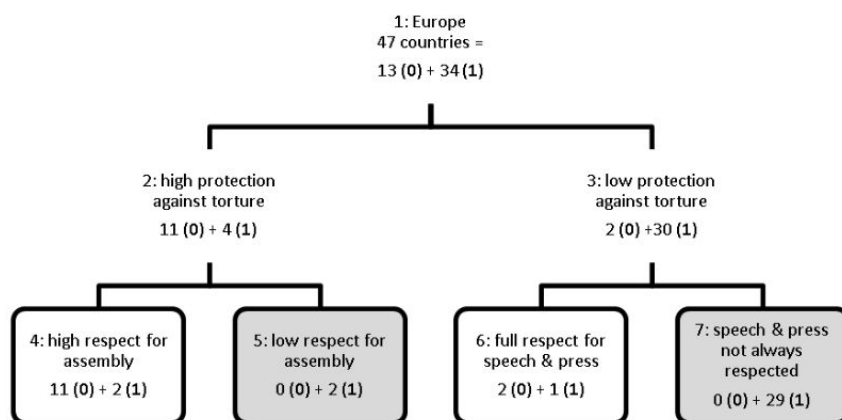
Figure 2. Classification tree to explain SWDEF in terms of CIRI (see Table 2)

Explanation: 47 Council of Europe countries in node 1 are split into 13 countries with SWDEF = 0 and 34 countries with SWDEF = 1. For 15 countries, CIRI index for torture is < 0.35, they are in node 2; the other are in node 3. Node 2 is further split according to index for assembly <0.3 or not. Node 3 is split according to index for speech & press <0.05 or not. Nodes 5 and 7 are pure (SWDEF = 1 for all 2 respectively 29 countries, grey colour). Nodes 4 and 6 are mixed, whereby predominantly SWDEF = 0 (white colour).

Table 2. Description of the classification tree of Figure 2

node number	number of countries	% of all countries	predecessor node	successor node	decision-criterion	threshold	forecast for node	how often correct	% correct (purity)	decision rule
1	47	100	root node	2; 3			1	34	72,3	SWDEF = 1 with 72.3% probability
2	15	31,9	1	4; 5	Torture	<0.35	0	11	73,3	If Torture <0,35, then SWDEF= 0 with 73,3% probability
3	32	68,1	1	6; 7	Torture	0.35	1	30	93,8	If Torture 0,35, then SWDEF = 1 with 93,8% probability

4	13	27,7	2	end node	As- semb- ly	<0.3	0	11	84,6	If Assembly <0.3 and Torture <0.35,then SWDEF = 0 with 84,6% probability
5	2	4,3	2	end node	As- semb- ly	0.3	1	2	100	If Assembly 0.3 and Torture <0.35, then SWDEF = 1 with 100% probability
6	3	6,4	3	end node	Speech & Press	<0.05	0	2	66,7	If Speech <0.05 and Torture 0.35, then SWDEF = 0 with 66,7% probability
7	29	61,7	3	end node	Speech & Press	0.05	1	29	100	If Speech 0.05 and Torture 0.35, then SWDEF = 1 with 100% probability
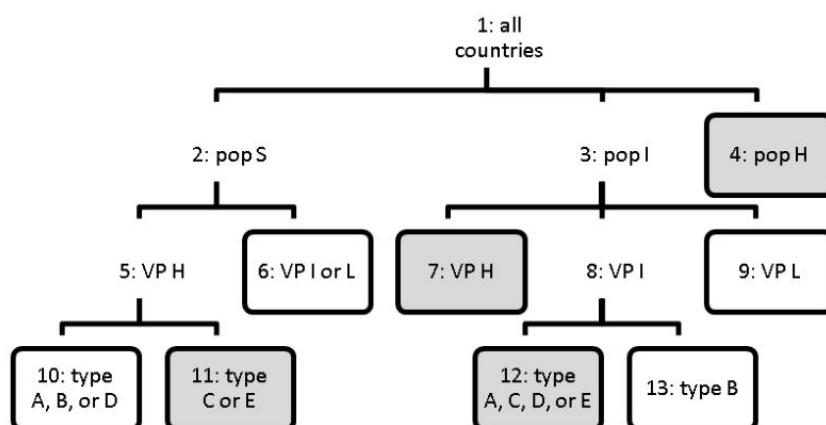
Figure 3. Classification tree to explain SWDEF using ratification types (see Table 3)

Explanation: SWDEF = 1 for grey nodes; SWDEF = 0 for white nodes; other nodes transient.

[Rz 28] The first branching is by population size, with SWDEF = 1 for high population size (thresholds: H > 45.5 million, S < 2.1 million, I in between). At the transient level 1 nodes VP is inquired

(thresholds: L < 0.1, H > 1.395, I in between). SWDEF = 0 for small countries and intermediate or low VP; SWDEF = 0 for medium sized countries and low VP; SWDEF = 1 for medium sized countries and high VP. At the transient level-2 nodes ratification type is considered: For small countries with high VP SWDEF = 0 for types A, B or D, and SWDEF = 1 for types C or E. For medium sized countries with intermediate VP SWDEF = 0 for type B (Portugal), and = 1, otherwise.

Table 3. Description of the classification tree of Figure 3 (thresholds explained there; alternative description: Table S1)

node number	number of countries	% of all countries	predecessor node	successor node	decision-criterion	threshold	forecast for node	how often correct	% correct (purity)	decision rule
1	47	100.0	root node	2, 3, 4			1	34	72,3	SWDEF = 1 with 72.3% probability
2	12	25.5	1	5, 6	population size	S	0	9	75.0	If pop = S, then SWDEF = 0 with 75% probability
3	28	59.6	1	7, 8, 9	population size	I	1	24	85.7	If pop = I, then SWDEF = 1 with 85.7% probability
4	7	14.9	1	end node	population size	H	1	7	100.0	If pop = H, then SWDEF = 1 with 100% probability
5	9	19.1	2	10, 11	violation propensity	H	0	6	66.7	If pop = S and VP = H, then SWDEF = 0 with 66.7% probability
6	3	6.4	2	end node	violation propensity	I, L	0	3	100.0	If pop = S and VP < H, then SWDEF = 0 with 100% probability
7	9	19.1	3	end node	violation propensity	H	1	9	100.0	If pop = I and VP = H, then SWDEF = 1 with 100% probability

8	16	34.0	3	12, 13	violation propensity	I	1	15	93.8	If pop = I and VP = I, then SWDEF = 1 with 93.8% probability
9	3	6.4	3	end node	violation propensity	L	0	3	100.0	If pop = I and VP = L, then SWDEF = 0 with 100% probability
10	6	12.8	5	end node	ratification type	A, B, D	0	6	100.0	If pop = S, VP = H, type = A, B, or D, then SWDEF = 0 with 100% probability
11	3	6.4	5	end node	ratification type	C, E	1	3	100.0	If pop = S, VP = H, type = C or E, then SWDEF = 1 with 100% probability
12	15	31.9	8	end node	ratification type	A, C, D, E	1	15	100.0	If pop = I, VP = I, and type is not B, then SWDEF = 1 with 100% probability
13	1	2.1	8	end node	ratification type	B	0	1	100.0	If pop = I, VP = I, and type = B, then SWDEF = 0 with 100% probability

[Rz 29] The more complex CaRT model of Figure 3 is a tree with three criteria in three levels, explained in Table 3. It first observes that country size is a key factor that determines if there are reports (e.g. large countries) or not (e.g. microstates). The second step asks for VP. It says that whereas amongst a larger population incidents are more likely, better compliance with ECHR enhances respect for SWs' HR. The third step differentiates by ratification types. (Note that there is no significant correlation between SWDEF and ratifications of any single treaty.) Using country size and VP, the classification tree of Figure 3 is unambiguous for nodes 4, 6, 7 and 9 (47% of countries). If the ambiguous nodes 5 and 8 were resolved by majority, this would result in four misclassifications, i.e. 91% prediction rate (43 of 47 countries are correctly classified), 91% sensitivity (31 of 34 SWDEF = 1 are correctly identified) and 92% specificity (12 of 13 SWDEF =

0 are correctly identified). Hence, as expected, better compliance with ECHR may improve the HR situation for SWs. However, for about half the countries also ratification types are needed to identify SWDEF correctly.

[Rz 30] The partitioning by country size results in expected entropy 0.560 (= average of the entropies of the three classes of small, medium sized and large countries), which is a mere 34% relative information gain (i.e. expected entropy is by this amount smaller than entropy of the full data set, CoE). VP alone provides barely information about SWDEF (7% relative information gain). However, as is seen from Table S1, if VP is considered together with country size, SWDEF is correctly classified for 22 countries (47% of 47 countries), which results in 66% relative information gain. The legal framework for prostitution control has two dimensions, the legal concepts and their implementation. Implementation gives 36% information gain about SWDEF. However, legal concepts provide only a small relative information gain of 6% about SWDEF. The four factors country size, VP, legal regulations and implementation together result in 91% relative information gain.[44]

8 Results 3: Explaining SWDEF by Indices of Vulnerability

[Rz 31] The tree models may be supplemented by quantitative models with different purposes. The paper considers first a *ML-model*. It is a generalized regression model, whose purpose is the explanation of the relative importance, in the context of the Figure 3 tree model, of population size, VP and ratification type for explaining SWDEF. It does not aim at characterizing SWDEF (c.f. feasible indices). Rather, it estimates for each country probabilities for SWDEF = 0 (whereby the probabilities for SWDEF = 1 may be interpreted as vulnerability).

[Rz 32] The ML-model counts HR-deficiency reports for SW as a hidden variable, modelled by censored *Poisson* regression:

expected count of deficiency reports = $E(def)$ = popx($ctype$ + kxVP)

[Rz 33] Here, $E(\mathrm{x})$ is expected value, *def* is the variable «deficiency report count» for each country, *pop* is its population size (in million people), *ctype* is a constant for the specific SW aversion in ratification type A to E, *k* is a constant of proportionality and VP measures ECHR fulfilment. This model postulates that the number of (reported) HR violations against SWs is proportional to population size. Assuming a roughly equal proportion of SWs across European countries (section 1), the factor of proportionality, $E(def)/pop = ctype + k$xVP, then quantifies HR mal-performance, as felt by individual SWs: It depends on the one hand on societal SW aversion *ctype*, and on the other on the overall HR situation VP; Table 5 displays it.

[Rz 34] Model parameters are obtained by ML, assuming *Poisson*-distribution with mean x = $E(def)$ for the number x of reports: probability for x reports = $Poisson(x, \mathrm{x})$. Defining equations are:

«SWDEF = 0» (event $x = 0$): likelihood = $Poisson(0, \mathrm{x})$ = exp(—x)

«SWDEF = 1» (event $0 < x < 51$): likelihood = sum over $n = 1$ to 50 of $Poisson(n, \mathrm{x})$

[Rz 35] The latter term uses the additional information (section 4) that for no country there were

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[44] They fail to distinguish Portugal (SWDEF = 0) from Belgium, Czech Republic, Finland and Poland (SWDEF = 1).

more than 50 reports (this keeps cC/cB smaller). The following parameters maximize the product of the likelihoods of the observations: $k = 0.02$ and $cA = 0.255$, $cB = 0.026$, $cC = 0.924$, $cD = 0.155$, $cE = 0.134$, whence impact of type (SW-aversion) is relatively high compared to VP.

[Rz 36] The following indices of vulnerability (where vulnerability = weightsxCIRI is a weighted average of CIRI indices) have a different purpose: They aim at improving the Figure 2 tree model by using feasible indices:[45] Countries with SWDEF = 0 could be distinguished without misclassification from those with SWDEF = 1 by a condition vulnerability threshold. One feasible index is special (parameters in Table 4, row #3; for other feasible indices: section S5). As explained in section 2, it maximally separates countries with SWDEF = 1 from those with SW-DEF = 0.[46] With the exception of judicial independence, it uses only criteria that need to have positive weights. Figure 5 plots the values of the vulnerability indices. Its second dimension is co-vulnerability, whose weights (Table 4, row #4) maximize the correlation coefficient (0.9) with vulnerability, subject to the condition that no criteria are used that were used to define vulnerability. For 21 countries (62% of SWDEF = 1 countries), co-vulnerability exceeds 0.085, while co-vulnerability of all countries with SWDEF = 0 is below this threshold. Hence, also the criteria used in co-vulnerability may explain SWDEF.

Table 4. Examples of feasible criteria weights: SWDEF = 1, if and only if vulnerability threshold

Number	threshold	Disappearance	extrajudicial killing	political prisoner	Torture	assembly	move in / out county	move within country	speech & press	free election	religion	worker: rights	women: economic rights	women: political rights	independent judiciary
#1	>0	0	0	>0	>0	0	0	0	>0	0	>0	0	0	0	0
#2	0.17	1	0.27	0.39	0.32	0.27	1	1	0.2	0.11	0.5	0.1	0.1	0.09	0.63
#3	0.15	0	0	0.32	0.28	0	0	0	0.06	0	0.34	0	0	0	0.01
#4	na	0	0.45	0	0	0.1	0.14	0.17	0	0.03	0	0.01	0.09	0	0
#5	0.15	0	0	0.3	0.3	0	0	0	0.18	0	0.22	0	0	0	0
#6	0.11	0	0	0.21	0.19	0	0	0	0.04	0	0.23	0	0	0	0.34

Explanation: Numbers are rounded to two decimals. Row #1 explains, if the minimal weight 0 can be attained, row #2 gives upper bounds for the weights and the threshold (not attained), #3

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[45] Similarly, there exists an index for the Figure 3 model, which identifies SWDED = 0/1 by means of a weighted sum of ratification data (including EC-membership), population size (in million persons) and VP: The positive and negative weights for the CoE treaties are 1.79, 5.87, 2.19, —0.44, —1.44, 2.07, —0.73, —2.74, —2.82, —2.71, 4.91, 1.61 (order of Table S5) and the weights of EC-membership, population size and VP are 0.99, 0.15, and 0.1. If the sum is below the threshold 10.05, then SWDEF = 0, otherwise SWDEF = 1.

[46] The distance of the country index value closest to the threshold from the threshold is 3/343 x 0.0087, which is about 6% of the applicable threshold 0.149 (Table 4, row #3).

displays the parameters for the index of vulnerability used in Figure 4, #4 is a corresponding index of co-vulnerability, and #5, #6 are explained in Section S5.

9 Discussion of CIRI Models

[Rz 37] The tree model of Figure 2 selected the three most salient CIRI indices as explanatory factors for SWDEF. It is the simplest of the considered models and explains SWDEF, up to three misclassifications, by the vulnerability of SWs to certain general societal problems.

- As the tree model demonstrates, a high level of torture predicts for 94% of countries SWDEF = 1, whereas a low level predicts for 73% of countries SWDEF = 0. This is plausible: Where police brutality is common, SWs inevitably suffer from it, as police is responsible for the enforcement of prostitution laws, irrespective of their content (no significant correlation of SWDEF with legal regulations).
- For countries with lower levels of torture, the tree model branches by assembly. There is a significant correlation of SWDEF with assembly, as of 23 countries with problems, SWDEF = 0 for Estonia and Liechtenstein, only. Lacking tolerance, which causes problems with assembly, may also cause reactions to the visibility of SWs at public places, e.g. police interventions against street prostitution. This in turn increases the risk of abuse, even if the general level of police brutality is lower.
- For countries with higher levels of torture, the tree model predicts that high respect for speech & press could check police brutality: SWDEF = 0 for 66% of such countries, and SWDEF = 1 for 100% of all other countries. Indices of vulnerability complement this: If there are sufficiently strong violations of both torture and speech & press, then this alone suffices for SWDEF = 1 (Table 4, row #5). The importance of speech & press becomes plausible under the aspect that systematic deficiencies could be remedied by political decisions, but without an open public discourse policy makers may not even know that there is a HR problem about SWs.

[Rz 38] For a correct description of SWDEF in terms of vulnerability, in addition to the above used criteria torture, assembly and speech & press, two more criteria have positive weight in all feasible indices of vulnerability (Table 4, row #1; for other criteria: Section S5).

- The criterion «political prisoners» is needed to correctly classify Finland in terms of vulnerability. However, there is neither a significant correlation with SWDEF, nor did any reported deficiency concern political persecution of SWs. The tree model, which does not aim at perfect representation of SWDEF, is free of this peculiarity.[47]
- For religion a causal link with SWDEF is plausible: In conservative societies concerns about an alleged display of immorality may cause intolerance against visibility of SWs, which the tree model describes through assembly. There is a significant correlation with SWDEF: Of 29 countries with problems about religion, SWDEF = 1 for all, except two.[48]

[Rz 39] The authors developed the models in the European context, only. Therefore it is possible to test their predictions independently by means of international data (Figure 5). As the authors

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[47] If Finland, a borderline case of SWDEF = 1 (Section S2), is reclassified, the peculiarity will vanish.

[48] The exceptions are Iceland (a micro-state), and the Netherlands (a borderline case).

do not attempt to assess the HR situation of SWs globally, since this would require expertise for each country,[49] the following considerations are for illustrative purposes, only. In terms of the tree model of Figure 2, 26 countries are in node 4 (e.g. Australia, New Zealand, Uruguay), 11 in node 5 (e.g. Southern Korea, Singapore, Taiwan), 15 in node 6 (e.g. Canada, Japan, USA), and 140 in node 7. In terms of vulnerability, 20 countries do not exceed vulnerability (0.14) or co-vulnerability (0.085) of European countries with SWDEF = 0.[50]

[Rz 40] The two CIRI-type models make two empirically testable predictions.

- First, *in countries with a generally good HR situation, HR of SWs may be respected.* In terms of the models, these are countries in node 4 (not pure) with low vulnerabilities (torture < 0.35, assembly < 0.3, vulnerability < 0.14, co-vulnerability < 0.085), namely 11 European and 5 other countries: Australia, Marshall Islands, Nauru, New Zealand, and Palau; all with SWDEF = 0 (Section S3). This confirms the same model prediction with 98% significance.[51]

- Second, *in countries with a generally poor HR situation, where e.g. police brutality is common, SWs are expected to suffer from police misconduct.* In terms of the tree model, this is node 7 (torture > 0.35, speech & press > 0.05) with 29 European (SWDEF = 1) and 111 countries of other parts of the world. Best candidates for a refutation of the forecast SWDEF = 1 would be node 7 countries with low co-vulnerability < 0.085, namely 13 European and 4 other countries: Antigua & Barbuda, Barbados, Cap Verde, and Mauritius; all with SWDEF = 1 (Section S3). At the worst end, there are 3 countries in node 7 with vulnerability = 1 and co-vulnerability > 0.9; for them SWDEF = 1, too (Section S3): China, Iran, and Northern Korea.[52]

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[49] For instance, in Mexico (tree model: node 7) national law prohibits forced HIV testing of SWs, as it discriminates against women, but communal ordinances may overrule it (see government response to UNGASS Country Progress Report 2010).

[50] These are 13 European countries and Australia, Japan, Marshall Islands, Micronesia, Nauru, New Zealand, and Palau.

[51] Taking into account that Palau is a borderline case, if at most 28% of countries in the world have SWDEF = 0 (rate of Europe), then with 97.7% chance amongst five countries there will be at least two with SWDEF = 1.

[52] However, due to small sample size significance is low: The observation that all seven countries mentioned in this paragraph have SWDEF = 1 is 90% significant (assuming 28% countries with SWDEF = 0).
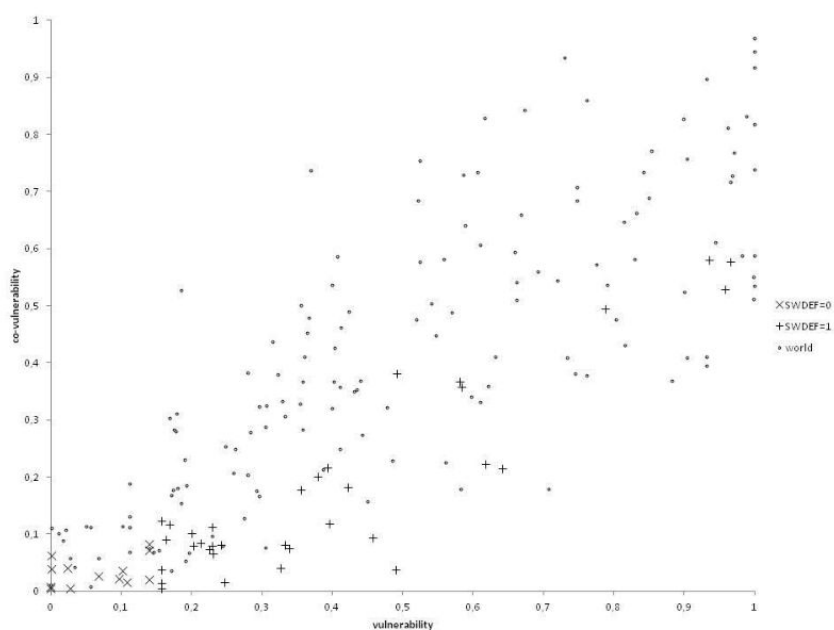
Figure 4. Country plot of vulnerability and co-vulnerability in the world and of SWDEF in CoE

Explanation: Vulnerability is a weighted mean of CIRI indices political prisoners, torture, speech & press, religion, and independence of the judiciary; the weights (Table 4, row #3) maximize the distance between SWDEF = 0 (country positions plotted as «x») and SWDEF = 1 (plotted as «+»). Co-vulnerability is a weighted mean of CIRI indices extrajudicial killing, assembly, move international, move domestic, election, workers» rights, and women's economic rights; the weights maximize correlation with vulnerability (Table 4, row #4) for CoE countries. For countries not in CoE (plotted as «x») SWDEF is not evaluated. Thereby, due to lacking data, the Kosovo, Somalia and Vatican (Holy See) was not considered. For the USA «religion» was missing in 2006 and for Sierra Leone, «political prisoners» was missing in 2009; in both cases the same value was inserted, as in all other years. During the considered period, Sudan was still united.

10   Discussion of Ratification-Type Models

[Rz 41] The tree model of Figure 3 is more complex than the model of Figure 2, but it predicts SWDEF correctly. However, it and the corresponding ML-model depend on ratification types, using CoE treaties, whence a direct verification by international data is not possible.

[Rz 42] The following observations corroborate the relevance of ratification types:

- The ML-model computes for each country the probabilities for SWDEF = 1, which may be interpreted as forecasts, based on the prolongation of present policies. The following corroborates these ML-model predictions: Amongst Baltic countries, the model predicts lowest probability for SWDEF = 1 in Estonia (22%) and highest probability for Lithuania (96%), followed by Latvia (89%). The same ranking (not used in the present assessment) was observed

previously:[53] 46% of 158 SWs in Estonia reported sexual violence by clients and police, but 98% of 154 SWs in Lithuania and 86% of 162 SWs in Latvia.

- Both ratification models confirm each other with respect to the following conclusion: *If societal preferences on SW-aversion are related to ratification types*, *then that aversion is higher for type C, than for type B, while the other types are in between.* For the Figure 3 model, this follows from the level-3 end-nodes: SWDEF = 0 in end-node 13 with a type-B country; SWDEF = 1 in end-nodes 11 and 12 with type-C countries. Further, Table S1 illustrates that only Germany and Italy are type-B countries with SWDEF = 1; there population size explains deficiency reports. For the ML-model, $E(def)/pop$ is lowest (best) for all type-B countries and highest for all type-C countries; types A, D, E are in between.

- Therefore, with respect to $E(def)/pop$ of the ML-model, the five worst SW destinations are type-C countries with high VP:[54] Bulgaria (maximal), Croatia, Latvia, Macedonia and the Slovak Republic. The latter countries, except Croatia, were studied by Open Society Foundation (FN 23) and the stunning reports of lawlessness confirm the model prediction about a high rate of problems, although the country classifications for SWDEF used as input only the existence of certain problems, not their endemic character.

- There are also geographical similarities of type-C countries: 73% are situated along river Danube drainage basin. Across these countries deficiencies related to independence of the judiciary were observed, though not used as input for SWDEF.[55] SWDEF is correlated to the judiciary-CIRI-index.

- For tier-1 countries $E(def)/pop$ is stochastically lower than for tier-2 countries (*Mann-Whitney-Wilcoxon* test), which is as expected, because SWDEF is related to trafficking. However, the tier-classification was not used as input for these models or the country assessments for SW-DEF.

[Rz 43] In addition to these empirical checks, the models were tested by simulations:

- A key issue for CaRT is the potential loss of information by over-fit: If all countries were in *singleton nodes* (consisting of one country only), then all nodes would be pure and the model would correctly «predict» all outcomes, even from a random distribution. The tree of Figure 3 has only one singleton node (#13: Portugal), but there may be «hidden» singletons: The paper therefore considers the *maximally split model*, where the maximal split of nodes is achieved by defining a class for each possible combination of parameter values.[56] In this maximally split model, 13 countries are in singleton nodes. Thus, the remaining 72% of countries (34 countries) are not singletons; for them there is no over-fit.

- A random shuffle (permutation) of the 34 SWDEF = 1 and 13 SWDEF = 0 classifications amongst 47 countries indicates that even for the maximally split model (where within a class, majority decides assessment) 99% of shuffles result in four or more misclassifications and an information gain of less than 69%. Comparing this with the performance of the Figure 3 model, it follows (99% significance) that deficiencies are not randomly distributed over

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[53] KALIKOV, J. (2002). *Survey of Sex Workers in the Baltic States*. AIDS Information and Support Center, Tallinn, Estonia.

[54] The models are not intended to support country rankings and such rankings would depend strongly on the chosen index. For instance, with respect to the feasible CIRI-type vulnerability index, the three worst SW destinations would be Azerbaijan, Russia and Turkey, owing to their poor overall HR performance.

[55] BÁRD, K. (2012). *Menschenrechte und richterliche Unabhängigkeit in den Ländern des Donauraumes*. Discussion Paper, 3/12, Institute for European Integration, Europa-Kolleg, Hamburg.

[56] Here country size, VP, and ratification type are considered, resulting in 45 = 3x3x5 classes.

countries. Instead there is a non-trivial link of SWDEF with country size, VP and ratification types.

- More specifically, ratification types matter. For, if only countries with the same types of county size and VP are shuffled, then in the maximally split model 95% of shuffles result in two or more misclassifications and for 99% of shuffles information gain is below 91%.

- If the probabilities for SWDEF = 1 predicted by the ML-model are used to assess the risk for yet undetected additional deficiencies, then (using simulations) with 95% confidence there remain at least eight countries (62% of 13 countries) with SWDEF = 0. Considering such additional deficiencies, with 95% confidence the tree of Figure 3 would generate at most three misclassifications. Similarly, for the maximally split model information gain would be at least 84% and there would be at most two misclassifications. In order to falsify the maximally split model with additional deficiencies, the focus would be on Norway (46% chance of misclassification), Malta (12%) and the Netherlands (5%).[57]

- For the ML-model, the probabilities for SWDEF = 1 were used for two types of simulations, namely A) randomly changing SWDEF only for countries with SWDEF = 0 to allow for additional deficiencies, and B) changing SWDEF-values for all countries. Parameters k and $ctype$ were obtained from ML estimation under the condition that they are non-negative. These simulations result in different country ranking by $E(def)/pop$, but confirm the conclusion that type B is rather beneficial for SWs' HR, while type C is not.

- Pair-wise comparisons of the simulated maximum-likelihood parameters $ctype$ for each simulation (matched samples) indicate in each of the above cases A and B that at least three groups of countries need to be distinguished: Parameters $ctype$ for types B and C are significantly different from all other types, but the remaining types A, D, E may have equal parameters.[58] Thus, the ML-model confirms the need to distinguish at least three country types.

11   Conclusion

[Rz 44] SWs suffer from HR violations in 34 of 47 (72%) countries in Europe, representing 95% of the European population. The reasons for this societal failure are complex, as SW issues are interlinked with a variety of other HR topics. The significant correlations of SWDEF with 10 of 14 CIRI indices illustrate the high interdependency of HR issues, in general.

[Rz 45] As concerns the first agenda of this paper, the models demonstrate that, at least in the case of SWs in Europe, the HR situation of this small population is correctly mapped by more comprehensive HR indicators. Even if there is barely international jurisprudence specifically about SWs' HR, also proven HR violations (VP) explain SWDEF (Figure 3). Thereby all models (tree models and indices of vulnerability) are simple and based on observations that for some factors even indicate a possible causality. Thereby the explanations of different models (summarized in Table 5) complement each other.

- The tree model of Figure 3 and the ML-model of section 8 utilize the obvious causal relati-

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[57] By Section S2, Norway and the Netherlands are borderline cases for SWDEF = 0.

[58] This uses Milton Friedman's non-parametric test at 95% level of significance, followed by Nemenyi'stest for pairwise comparisons at 99.5% confidence level to take care of spurious significances due to multiple comparisons. Nonparametric tests are used, as asymptotic normality of ML estimates is not guaranteed (e.g. the boundary value $k= 0$ is reached for more than 1/3 of simulations).

onship that the number of incidents, therefore the number of reported deficiencies, is proportional to the size of the population of a country, whereby (ML-model) the constant of proportionality may depend on the country.

- The tree model of Figure 2 and the feasible index of vulnerability of section 7 point out the following causality: The SW population suffers from most HR problems that are endemic in a country. Thereby there is a strong link to torture, where lacking awareness for torture, as measured by CIRI, may be the root cause for SWDEF = 1. This reflects the focus of SWDEF on torturous treatment of SWs, such as legal obligations for SWs that could be discriminatory and potentially degrading (forced HIV tests or gynaecological inspections), administrative practices that might make SWs vulnerable to extortion and brutality by criminals (lacking protection against trafficking), or deficient prevention of police misconduct (brutality, rape, extortion).
- A similar conclusion with respect to VP is supported by the tree model of Figure 3 and the ML-model. Both models explain that the general HR situation VP matters for SWDEF, even though there is no significant correlation between VP and SWDEF (as population size may hide this effect).
- In addition, the ratification-type models indicate a relationship between the HR situation of SWs and the ratification of treaties. Here, the paper assumes causality, too, but further research is needed to confirm this hypothesis: It says that there are societal preferences, which become visible through ratification types, and which cause specific aversions against vulnerable groups. This may reinforce domestic authorities to act in a way that makes HR violations more likely. If this causality is accepted, then societal preferences of type C are key hindrances to better HR fulfilment. This would indicate that the improvement of SWs' HR requires long-term measures, where countries promote more tolerance towards vulnerable populations and unconventional lifestyles. Considering the negligible information gain from prostitution laws about SWDEF, the authors expect that legal changes alone would influence the situation of SWs only marginally.

[Rz 46] As concerns the second agenda of this paper, the analytic and problem-oriented approach of this paper to analyze HR fulfilment has provided plausible explanations for HR deficiencies in SW. In particular, contrary to conclusions from other empirical studies with a focus on single treaties (references in section 1 and the corresponding paper, FN 2), treaty ratifications matter, if one considers their pattern. Thus, this approach is promising for applications in a wider context, such as for other regions with comparable HR instruments (Inter-American system), or for other social problems (see the corresponding paper, FN 2).

12   Appendix: Summary Table

Table 5. Summary of results (country types, node affiliations, other index values)

State	SW-DEF	pop mill	le-gal	im-ple-me-nt	VP	ECHR Viola-tions	years in CoE	ra-tif. ty-pe	Fi-gu-re 2 EN	Fi-gu-re 3 EN	E(def) / pop	prob (%) of SW-DEF =0	vul-ner-abil-ity	co-vul-ner-abil-ity
Alba-nia	1	3.20	P	C	1.17	60	16	C	7	12	0.95	5	0.20	0.10
An-dorra	0	0.09	P	L	1.47	2	16	A	4	10	0.29	98	0.00	0.06
Ar-me-nia	1	3.09	P	C	1.39	43	10	C	7	12	0.95	5	0.79	0.50
Aus-tria	1	8.39	R	C	0.61	274	54	C	7	12	0.94	0	0.23	0.07
Azer-bai-jan	1	9.19	P	C	0.94	86	10	E	7	12	0.15	25	0.97	0.58
Bel-gium	1	10.71	A	L	0.28	169	57	E	4	12	0.14	22	0.16	0.04
Bos-nia	1	3.76	P	C	0.77	29	10	C	7	12	0.94	3	0.39	0.22
Bul-garia	1	7.49	A	C	5.36	804	20	C	7	7	1.03	0	0.42	0.19
Croa-tia	1	4.40	P	C	3.50	231	15	C	5	7	1.00	1	0.16	0.12
Cy-prus	1	1.10	A	L	1.40	77	50	E	6	11	0.16	84	0.24	0.08
Czech Rep.	1	10.49	A	L	1.01	201	19	E	7	12	0.15	20	0.16	0.09
Den-mark	0	5.55	A	L	0.05	17	59	B	4	9	0.03	86	0.1	0.02
Esto-nia	0	1.34	A	L	1.31	28	16	D	6	6	0.18	78	0.14	0.07
Fin-land	1	5.37	A	L	1.25	147	22	C	4	12	0.95	0	0.16	0.02
Fran-ce	1	62.79	A	C	0.31	741	38	E	7	4	0.14	0	0.33	0.08
Geor-gia	1	4.35	P	C	1.18	67	13	A	7	12	0.28	30	0.49	0.38
Ger-many	1	82.30	R	L	0.04	211	59	B	5	4	0.03	11	0.23	0.11

Gree-ce	1	11.36	R	C	1.96	846	38	E	7	7	0.17	14	0.64	0.22
Hun-gary	1	9.98	R	C	1.23	246	20	C	7	12	0.95	0	0.23	0.07
Ice-land	0	0.32	N	L	0.48	9	59	E	4	6	0.14	96	0.07	0.03
Ire-land	1	4.47	A	C	0.10	27	59	A	7	12	0.26	32	0.25	0.02
Italy	1	60.55	A	C	0.59	2,030	57	B	7	4	0.04	10	0.40	0.12
Lat-via	1	2.25	R	C	2.99	101	15	C	7	7	0.99	11	0.36	0.18
Liech-ten-stein	0	0.04	P	L	5.55	6	30	A	4	10	0.37	99	0.00	0.04
Lithua-nia	1	3.32	P	C	1.52	86	17	C	7	7	0.96	4	0.17	0.12
Lu-xem-bourg	0	0.51	A	L	1.30	39	59	B	4	6	0.05	97	0.00	0.01
Ma-cedo-nia	1	2.06	P	C	2.82	87	15	C	7	11	0.98	13	0.46	0.09
Malta	0	0.42	A	C	2.35	44	45	A	4	10	0.30	88	0.11	0.02
Mol-dova	1	3.57	P	C	8.10	434	15	E	7	7	0.30	35	0.62	0.22
Mo-naco	0	0.04	P	L	4.04	1	7	A	4	10	0.34	99	0.02	0.04
Mon-tene-gro	1	0.63	P	C	2.11	8	6	C	7	11	0.97	54	0.23	0.08
Net-her-lands	0	16.61	R	L	0.09	91	58	E	4	9	0.14	10	0.14	0.02
Nor-way	0	4.88	N	L	0.07	21	59	E	4	9	0.14	51	0.03	0.01
Poland	1	38.28	A	L	1.33	968	19	E	7	12	0.16	0	0.20	0.08
Por-tugal	0	10.68	A	L	0.52	188	34	B	6	13	0.04	68	0.14	0.08
Ro-ma-nia	1	21.49	P	C	3.13	1,209	18	D	7	7	0.22	1	0.58	0.36

Country	SWDEF	Pop.	Legal	Impl.	VP	Total viol.	Years	Ratif.	EN2	EN3	ML1	ML2	Vuln1	Vuln2
Russia	1	142.96	P	C	1.52	3,041	14	A	7	4	0.29	0	0.94	0.58
San Marino	0	0.03	P	L	15.18	11	23	A	4	10	0.56	98	0.00	0.00
Serbia	1	9.86	P	C	1.12	88	8	C	7	12	0.95	0	0.38	0.20
Slovak Rep.	1	5.46	A	C	2.80	291	19	C	7	7	0.98	0	0.34	0.08
Slovenia	0	2.03	P	L	12.07	441	18	D	4	10	0.40	45	0.10	0.04
Spain	1	46.08	A	L	0.05	68	33	E	7	4	0.14	0	0.49	0.04
Sweden	1	9.38	N	L	0.11	61	59	E	7	12	0.14	28	0.16	0.01
Switzerland	1	7.66	R	C	0.27	79	38	D	7	12	0.16	29	0.33	0.04
Turkey	1	72.75	R	C	0.88	3,692	58	E	7	4	0.15	0	0.96	0.53
Ukraine	1	45.45	P	C	2.13	1,449	15	C	7	7	0.97	0	0.58	0.37
UK	1	62.04	A	C	0.10	380	59	E	7	4	0.14	0	0.21	0.09

Explanation. The table lists SWDEF, population size (not considering territories outside Europe or with special status) in million people, the legal approach and its implementation (by initial letters), three rows related to ECtHR judgments (VP = violations per million people and years since accession to ECHR and 2012, and the raw data: total ECHR violations, years at CoE), ratification type, end-nodes (EN) of figures 2 and 3, two parameters of the ML model, and vulnerability indices.

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The Supporting Information is available for download here.