Quantitative analysis of disparate effects of RisCanvi for estimating the risk of violent recidivism

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Abstract. This technical report describes a quantitative analysis of potential disparate effects of RisCanvi, a risk assessment tool used in Catalonia, for the purposes of estimating the risk of violent recidivism. It analyses data from 2010 to 2016 along various groupings of inmates according to type of release, gender, nationality, age, birthplace, age of commencing criminal activity, mental disorders and/or substance abuse, and socioeconomic status.

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1. Methodology

The database consists of inmates who were released from Catalonia prison centers from 2010 to 2016, and were obtained through a data request for research to the Department of Justice of Catalonia. We requested data from all inmates released from jail at any point during those years to "*Libertad Definitiva*" (definitive release) or "*Libertad Condicional*" (conditional release, i.e., parole). We note that these are not the only reasons why inmates are released, as there are people who have, e.g., convictions overturned, who are also released.

The RisCanvi protocol¹ was established in 2009 and indicates that every inmate should undergo an evaluation at least every six months. The RisCanvi evaluation begins with a "screening" evaluation of 10 items (RisCanvi_S), with two possible outcomes: "low risk" or "high risk". If the outcome of RisCanvi_S is "high risk", the inmate undergoes a "full" evaluation of 43 items with three possible outcomes: "low risk", "medium risk", or "high risk." The evaluation is written by a team of experts, and can match the one generated by the RisCanvi algorithm, or can be different. In other words, the final decision about the risk of an inmate is taken by a team of experts.

In the next table, we indicate the number and percentage of cases with a RisCanvi_S or RisCanvi_C evaluation completed at most 9 months before their release.

RisCanvi evaluation per release year

¹ Antonio Andrés-Pueyo, Karin Arbach-Lucioni, and Santiago Redondo. 2018. The RisCanvi: a new tool for assessing risk for violence in prison and recidivism. Recidivism Risk Assessment: A Handbook for Practitioners (2018), 255–268.

Release year	2010	2011	2012	2013	2014	2015	2016
Number of people released	3494	3766	4152	4010	3999	3596	3288
With RisCanvi evaluation	634 (18%)	1776 (47%)	2320 (56%)	2501 (62%)	2702 (68%)	2582 (72%)	2514 (76%)
With RisCanvi_S only	172	670	1021	1036	916	836	807
With RisCanvi_C	462	1106	1299	1465	1786	1746	1707

Our analysis focuses on the risk of violent recidivism, defined as the commission of a new violent crime leading to imprisonment after the release date. The appendix contains the list of crimes that are considered "violent" for the purposes of this analysis. This list was provided by the *Center for Legal Studies and Specialized Training* (CEJFE) of Catalonia.²

Regarding the type of excarcelation, as shown in the next table, the majority of people are excarcerated with LD (Definitive Release, *Libertad Definitiva*), and the minority with LC (Conditional Release, *Libertad Conditional*), the proportion of excarcerated people receiving conditional release has increased from 22.6% in 2010 to 34.5% in 2016. The proportion is not the same in each REVI (Violent Recidivism) risk level. Of the excarcerated people in which RisCanvi predicts a low REVI risk, from 1/3 to about 1/2 receive conditional release, while of the excarcerated people in which RisCanvi predicts a high REVI risk, only 1% to 3% receive conditional release. The interpretation is that RisCanvi probably plays a role on whether a person receives conditional release or not, while not determining this outcome.

Excarcerated of a given type (conditional LC or definitive LD) per RisCanvi REVI Level								
	%LC 2010	%LD 2010	%LC 2011	%LD 2011	%LC 2012	%LD 2012	%LC 2013	%LD 2013
REVI low	33%	67%	37%	63%	38%	62%	43%	57%
REVI medium	10%	90%	12%	88%	9%	91%	10%	90%
REVI high	2%	98%	2%	98%	2%	98%	3%	97%
%Excarcerated with LC	22.6%		24.2%		26.5%		29.9%	
	%LC 2014	%LD 2014	%LC 2015	%LD 2015	%LC 2016	%LD 2016		
REVI low	44%	56%	46%	54%	48%	52%		
REVI medium	10%	90%	9%	91%	6%	94%		
REVI high	3%	97%	1%	99%	1%	99%		

² http://cejfe.gencat.cat/en/centre/

%Excarcerated	30.4%	31.8%	34.5%		
with LC					

2. Accuracy analysis results

RisCanvi generates five scores corresponding to the risk of: general (any) recidivism, violent recidivism, breaking of permits, violence within prison, and self-harm. The violent recidivism score (dubbed "REVI", for *reincidencia violenta*) uses 24 out of the 43 items. The specific items used by REVI are in the RisCanvi formula provided at the end of this document.

While RisCanvi generates a REVI score, for the purposes of this analysis we consider only the outcome (high, medium, or low), as this is the information that professionals performing RisCanvi evaluations can access.

In the next table, we show the percentage of people categorized with different risk levels in the most recent year for which we have a 5-years follow-up period.

	20	16
Release year	% of people categorized as:	% of violent recidivism (within 5 years)
REVI_high	10.5%	11.7%
REVI_medium	16.7%	9.0%
REVI_low	72.8%	2.9%
Number of cases	2514	
Recidivists %		4.9%

Our interpretation of the above table is that the percentage of people categorized as "high risk" of violent recidivism doubles the percentage of people who actually recidivate. This means that the "high risk" indication, used as a binary prediction with respect to "medium risk" and "low risk", is not a calibrated indicator (i.e., its output cannot be interpreted as a probability).

We also observe that there is a monotonic increase in the probability of recidivism as the risk increases, which is a desirable property. Indeed, people categorized as "high risk" by RisCanvi are four times more likely to commit a new violent crime than people categorized as "low risk".

3. Bias analysis results

In the next tables, we perform an analysis of RisCanvi for different groups of inmates, accompanying each table with a brief interpretation of the figures shown.

The main criteria³ we evaluate are:

³ For definitions, see, e.g., Solon Barocas, Moritz Hardt, Arvind Narayanan: Fairness and machine learning (Work in progress), chapter 2: <u>https://fairmlbook.org/classification.html</u>

- **Independence**: this means that the prediction (high, medium, low) should be independent of the groups (e.g., male vs. female). In general, this criterion does not hold, and probably should not hold, if the rates of recidivism of groups are different.
- **Separation**: this means that the prediction should be independent of the groups, *conditioned on the outcome*. Specifically, we check whether, among people who recidivate, the percentage of people labeled as high risk is equal among groups (row labeled "REVI_high% among the ones who recidivated" in the tables).

3.1. By sex

Please note that in some cells, the number of cases is very small (e.g., there is 1 woman who recidivate among all the 15 women who were categorized as "medium risk"), and hence it is not possible to derive a statistical finding from those cells only.

Release year		201	16	
	% of people ca	tegorized as:	% of recidivists	(within 5 years)
Group	Male	Female	Male	Female
REVI_high	11.2%	2.0%	11.9%	0.0%
REVI_medium	17.5%	7.5% (n=15)	9.1%	6.7% (n=1)
REVI_low	71.3%	90.5%	3.1%	1.1%
Number of cases	2314	2314 200		200
Recidivists %			5.1%	1.5%
REVI_high% among the ones who recidivated			26.1%	0.0%
Interpretation	On average, males a more often than females correct as they recidivate	re given high risk a, which seems e more	Risk is non-monoto note the small number recidivists	onous for females, but of cases and

3.2. By national vs foreigners

Release year	2016							
	% of people cat	egorized as:	% of recidivists (within 5 years)					
Group	National	Foreigner	National	Foreigner				
REVI_high	13.5%	5.8%	13.0%	7.0%				
REVI_medium	19.3%	12.7%	8.4%	10.5%				
REVI_low	67.2%	81.5%	2.7%	3.1%				
Number of cases	1534	980						
Recidivists %			5.2%	4.3%				
REVI_high% among the ones who recidivated			33.8%	9.5%				

	On average, nationals are given high risk more often than foreigners, which seems	Risk is non-monotonous for foreigners
Interpretation	correct as they recidivate more	Leven if we consider only those who recidivate, nationals are given higher risk scores than foreigners

3.3. By age

Release year		2010	6	
	% of people cate	egorized as:	% of recidivists	s (within 5 years)
Group	Young (≤30)	Old (>30)	Young (≤30)	Old (>30)
REVI_high	12.7%	9.9%	14.5%	10.8%
REVI_medium	15.1%	17.2%	11.0%	8.6%
REVI_low	72.2%	72.9%	4.3%	2.5%
Number of cases	544	1970		
Recidivists %			6.6%	4.4%
REVI_high% among the ones who recidivated			27.8%	24.4%
Interpretation	On average, young are often than old cases, which they recidivate more	e given high risk more h seems correct as	Risk is monotonou Risk is similar amo recidivate.	us for both groups

3.4. By birthplace

With rest of Africa, Asia, non-EU countries in Europe, and rest of world: omitted, as the number of cases is too small to draw a conclusion.

Release year		2016							
	%	6 of peop	ole categor	ized as:	% of recidivists (within 5 years)				
Group (birth_place)	Spain	EU	Maghreb	Center/South Amer.	Spain	EU	Maghreb	Center/South Amer.	
REVI_high	13.8%	7.0%	9.8%	2.9%	13.8%	16.7%	2.9% (n=1)	9.1%	
REVI_medium	20.3%	15.1%	14.5%	8.8%	8.7%	3.8%	16.0% (n=7)	3.0%	
REVI_low	65.8%	77.9%	75.7%	88.2%	3.0%	1.5%	3.8%	3.3%	
Number of cases	1417	172	346	373					
Recidivists %					5.6%	2.9%	5.5%	3.5%	

REVI_high% among the ones who recidivated					33.8%	40.0%	5.3%	7.7%
Interpretation	On ave high risk n seem to re	erage peo nore ofter ecidivate	ople born in n than othe more	n Spain are given rs, and they	 ▲ Risk is nor Maghreb ▲ Risk comp for people bor than for people America. 	n-monotonou uted for reci n in Spain ai e born in the	is for people divists seen nd the rest Maghreb c	e born in the ns to be higher of EU countries or Center/South

3.5. By age of beginning of criminal or violent activity

Release year			2016	
	% of people c	ategorized as:	% of recidivists	(within 5 years)
Group (beginning of criminal or violent activity)	Less than 16	More than 16	Less than 16	More than 16
REVI_high	31.8%	8.5%	16.2%	10.2%
REVI_medium	25.2%	15.9%	22.2%	7.1%
REVI_low	43.0%	75.5%	10.9%	2.5%
Number of cases	214	2297		
Recidivists %			15.4%	3.9%
REVI_high% among the ones who recidivated			33.3%	22.5%
Interpretation	On average, starting at age le given high risk n others, and they	cases with ess than 16 are nore often than recidivate more	 Risk is non-mon cases with starting a Considering only recidivate, risk is hig starting age under 1 with starting age over 	otonous for age less than 16 y those who gher for people with 6 than for people er 16

3.6. By mental disorders and/or substance abuse

We consider three groups:

- 1. "NoMentalDis NoSubAbuse": corresponds to people with a "no" in all five of the following items:
 - 32 (severe mental disorder)
 - 35 (personality disorder related to anger or violent behavior)
 - 39 (low mental ability)
 - 30 (drug abuse or dependence)
 - 31 (alcohol abuse or dependence)
- 2. "MentalDis NoSubAbuse": corresponds to people with

- A "yes" in one or more of the following:
 - 32 (severe mental disorder)
 - 35 (personality disorder related to anger or violent behavior)
 - 39 (low mental ability)
- A "no" in both of:
 - 30 (drug abuse or dependence)
 - 31 (alcohol abuse or dependence)
- 3. "NoMentalDis SubAbuse": corresponds to people with
 - A "no" in all of the following:
 - 32 (severe mental disorder)
 - 35 (personality disorder related to anger or violent behavior)
 - 39 (low mental ability)
 - A "yes" in one, or both, of:
 - 30 (drug abuse or dependence)
 - 31 (alcohol abuse or dependence)
- 4. "MentalDis SubAbuse": corresponds to people with:
 - A "yes" in one or more of the following:
 - 32 (severe mental disorder)
 - 35 (personality disorder related to anger or violent behavior)
 - 39 (low mental ability)
 - A "yes" in one, or both, of:
 - 30 (drug abuse or dependence)
 - 31 (alcohol abuse or dependence)

Release year		2016							
	%	of people ca	f people categorized as: % of recidivists (within 5 years)					rs)	
Group mental disorder and substance abuse)	NoMental Dis NoSubAb use	MentalDis NoSubAbu se	NoMentalD is SubAbuse	MentalDi s SubAbu se	NoMentalDi s NoSubAbu se	MentalDis NoSubAbu se	NoMentalD is SubAbuse	MentalDi s SubAbus e	
REVI_high	2.7%	25.3%	22.7%	55.2%	16.7%	10.5%	11.9%	8.7%	
REVI_medium	10.0%	36.0%	32.2%	28.8%	6.9%	9.3%	12.3%	5.6%	
REVI_low	87.3%	38.7%	45.1%	16.0%	2.5%	3.4%	4.6%	10.0%	
Number of cases	1757	150	481	125					
Recidivists %					3.4%	7.3%	8.7%	8.0%	
REVI_high% among the ones who recidivated					13.6%	36.4%	31.0%	60.0%	
Interpretation	V On aver substance a	✓ On average, cases with mental disorder and substance abuse are given high risk more often ↑ Risk is non-monotonous for cases v disorder and substance abuse and cases					s for cases w use and case	ith mental s with no	

than others, and cases with no mental disorder and substance abuse recidivate more	mental disorder and substance abuse Even considering only those who recidivate, risk is higher for people with mental disorders and substance abuse
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3.7. By socioeconomic status

We consider four groups:

- 1. SocioEcon0: corresponds to people with a "No" in both of the following items:
 - a. 19 (problems related to employment)
 - b. 20 (lack of financial resources)
- 2. *SocioEcon1*: corresponds to people with a "Yes" in one, and only one, of the following items:
 - a. 19 (problems related to employment)
 - b. 20 (lack of financial resources)
- 3. SocioEcon2: corresponds to people with
 - a. A "Yes" in both of the following items:
 - i. 19 (problems related to employment)
 - ii. 20 (lack of financial resources)
 - b. None of the following items:
 - i. 1 (primary only) in item 18 (educational level)
 - ii. 22 (criminal history of family or parents)
 - iii. 23 (difficulties in the socialization or development in the origin family)
 - iv. 24 (lack of family or social support)
- 4. SocioEcon2bis: corresponds to people with
 - a. A "Yes" in both of the following items:
 - i. 19 (problems related to employment)
 - ii. 20 (lack of financial resources)
 - b. Any of the following items:
 - i. NOT 1 (primary only) in item 18 (educational level)
 - ii. NOT 22 (criminal history of family or parents)
 - iii. NOT 23 (difficulties in the socialization or development in the origin family)
 - iv. NOT 24 (lack of family or social support)
- 5. SocioEcon3: corresponds to people with
 - a. A "Yes" in both of the following items:
 - i. 19 (problems related to employment)
 - ii. 20 (lack of financial resources)
 - b. One or more of the following items:
 - i. 1 (primary only) in item 18 (educational level)
 - ii. 22 (criminal history of family or parents)
 - iii. 23 (difficulties in the socialization or development in the origin family)
 - iv. 24 (lack of family or social support)
- 6. SocioEcon3bis: corresponds to people with
 - a. A "Yes" in both of the following items:

- i. 19 (problems related to employment)
- ii. 20 (lack of financial resources)
- b. All the following items:
 - i. 1 (primary only) in item 18 (educational level)
 - ii. 22 (criminal history of family or parents)
 - iii. 23 (difficulties in the socialization or development in the origin family)
 - iv. 24 (lack of family or social support)

We note that SocioEcon2bis and SocioEcon3 do not overlap.

Release year	2016											
	% of people categorized as:				% of recidivists (within 5 years)							
Group (SocioEcon)	SocioE con0	SocioE con1	SocioE con2	SocioE con2bis	SocioE con3	SocioE con3bis	SocioE con0	SocioE con1	SocioE con2	SocioE con2bis	SocioE con3	SocioE con3bis
REVI_high	4.3%	16.6%	37.5%	33.6%	36.5%	73.7%	7.5%	14.3%	33.3%	12.5%	12.1%	14.3%
REVI_medium	11.9%	24.4%	25.0%	32.4%	31.7%	21.1%	8.0%	9.7%	0.0%	11.7%	11.4%	0.0%
REVI_low	83.8%	59.0%	37.5%	34.0%	31.7%	5.3%	3.0%	3.2%	0.0%	3.7%	3.8%	0.0%
Number of cases	1575	590	8	238	249	19						
Recidivists %							3.7%	6.6%	12.5%	9.2%	9.2%	10.5%
REVI_high% among the ones who recidivated							8.5%	35.9%	100.0%	45.5%	47.8%	100.0 %
Interpretation	On average cases in group SocioEcon3bis are given high risk more often than others, and SocioEcon3bis cases recidivate more				 Risk is non-monotonous for cases in group SocioEcon0. Recidivists in groups SocioEcon2 and SocioEcon3bis are given higher risk scores than recidivists in other groups 							

4. RisCanvi complete (RisCanvi_C) formulas for violent recidivism risk (REVI)

We have used this formula, and it seems to match what the system is doing, although there are differences in some cases, probably due to implementation details we are not aware of.

Item description	ltem	Resp	Value
Sex	sex	dona	-2
Nac	Nac	estr	-2

Situacio	Situa	penat	-3
Delicte base violent	it1	si	3
Intoxicacion delibase	it3	? o si	3
Violencia previa	it7	? o si	3
Increment gravetat viol.	it9	? o si	3
Conflictes amb interns	it10	? o si	3
Expedients disciplin	it12	? o si	3
Desajust infantil	it16	si	3
Distancia residencia	it17	1	2
Nivell educatiu	it18	si	-3
No recursos econ.	it20	? o si	3
Absencia plans futur	it21	si	3
Antecedents delic. Famil	it22	si	2
Rol delictiu	it27	si	3
Victima VIOGEN	it28	? o si	-3
Abús drogues	it30	? o si	3
Abús alcohol	it31	? o si	3
Resposta lim. Tractament	it34	? o si	3
Intents Auto-lesio	it37	si	-3
Actitut pro-criminals	it38	si	3
Capacitat cognitiva	it39	? o si	3
Temeritat	it40	? o si	2 o 3
Hostilitat	it42	? o si	2 o 3
Irresponsabilitat	it43	si	2

Score is computed as REVI_score=(REVI_items_summation-(-18))*10/(57-(-18)).

REVI_score intervals are: lowest to 4.46 = low, 4.46 to 6 = medium, 6 to highest = high

5. Further Reading

- Marzieh Karimi-Haghighi, Carlos Castillo: Efficiency and Fairness in Recurring Data-Driven Risk Assessments of Violent Recidivism. SIGAPP Symposium on Applied Computing (SAC), pp. 994-1002, ACM Press. https://doi.org/10.1145/3412841.3441975
- Marzieh Karimi-Haghighi, Carlos Castillo: Enhancing a recidivism prediction tool with machine learning: effectiveness and algorithmic fairness. ICAIL 2021 (Short papers), pp. 210-214. https://doi.org/10.1145/3462757.3466150

Appendix

List of violent crime codes, considering only those leading to reincarceration committed by people released in 2016:

Code	Cases
Robatori amb violència i intimidació	69
Maltractaments de violència de gènere	12
Lesions	11
Amenaces de violència de gènere	7
Atemptat contra l'autoritat	6
Amenaça	5
Homicidi	4
Lesió de violència de gènere	2
Homicidi de violència de gènere	1
Violencia domestica no habitual	1
Falta d'amenaces, coacció	1
Violència habitual de gènere	1
Lesions per imprudència	1
Falta de lesions de violència de gènere	1