



**UNODC**  
United Nations Office on Drugs and Crime



Center for Human  
Trafficking Victims Protection

## RESEARCH BRIEF

# Monitoring Target 16.2 of the United Nations Sustainable Development Goals: multiple systems estimation of the numbers of presumed victims of trafficking in persons

*Serbia*



In partnership with Walk Free Foundation



## Introduction and methodology<sup>1</sup>

The statistical technique to estimate the size of hidden populations, known as capture/recapture analysis, multiple systems analysis or multiple record systems analysis, was originally developed by biologists to estimate animal populations. The quintessential idea to estimate the number of fish in a pond is as follows. One catches a number of fish (say 100), tags them, and then throws them back into the same pond. Sometime later, one takes a new catch (say another 100) from the same pond, and counts how many of the second catch are tagged, as having been part of the returned original first catch. If the overlap between the two catches is zero, or very small, this suggests that the population of fish in the pond is much larger than 100. If the overlap is considerable, say 50, this suggests that the population is smaller. The larger the overlap, the smaller the size of the total fish population. If out of the 100 fish in the second catch, 20 are tagged, it follows that the tagged fish in the pond had a chance of one in five of being caught. Assuming that the non-tagged fish have similar catchment chances, the total number of fish in the pond can be estimated at 500, of which 400 are untagged.

The capture-recapture approach of biologists has translated into a well-known method for estimating the size of a hidden human population using two independent recording systems (or registers) which partially list its members. Linking the individuals in the two registers allows for the estimation of the number of individuals that are not recorded in any of the registers. For example, with two registers A and B, linkage gives a count of individuals in A but not in B, a count of individuals in B but not in A, and a count of individuals in both A and B. The counts form a contingency table denoted by  $A \times B$ , with the variable labeled A being short for “inclusion in register A” differentiating between the categories “yes” and “no,” and likewise for register B. The statistical problem is to estimate the value in the cell “no, no”. An estimate of the total population size is obtained by adding the estimated count of doubly missed individuals to the counts of individuals found in at least one of the registers.

The capture-recapture method has been successfully applied to estimate the size of hidden human populations by determining the overlaps between unique individuals appearing in separate recording systems (or lists). Using such capture-recapture analysis, estimates have, for example, been made of the numbers of casualties of human rights violations in Peru and irregular migrants in the Netherlands (Lum, Price & Banks, 2013; Van der Heijden, et al, 2015).

Capture-recapture analysis depends on certain assumptions about the lists and the population from which they are drawn. Arguably the most problematic condition to fulfill when using recording systems of human individuals is the condition that recording systems are independent of each other. In the case of records of persons, this assumption of independence of lists is usually not met. For example, persons identified by law enforcement authorities as possible victims of human trafficking are likely to be referred to social assistance programs, and they consequently have a higher probability of being included in the recording systems of the involved NGOs. In this case the inclusion in the list of a service provider is far from independent from registration by the police. This is an example of positive dependence. Since such positive dependence increases the overlap between the two lists, the number of the unobserved population is consequently underestimated. In practice, negative dependence may

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<sup>1</sup> UNODC research based on contributions by Jan J. M. van Dijk (University of Tilburg, Netherlands), Maarten Cruyff and Peter G. M. van der Heijden (University of Utrecht, Department of Psychology, Netherlands).

also occur, for example, when inclusion in one register lowers the chance of being registered in another register, which leads to an overestimation.

A promising approach to relax the condition of independence is to include a third register, or multiple additional registers, and to analyse the three-way, or multiple-way contingency tables. With three (or more) lists the independence assumption in the two-list case is replaced by the less severe assumption that three (or more) factor interaction is absent. In official statistics, this extension of the two-list capture-recapture method is known as multiple systems estimation (MSE).<sup>2</sup>

In collaboration with the three countries concerned, and in partnership with the Walk Free Foundation, UNODC carried out MSE studies to estimate the total number of victims of trafficking in persons in Ireland, Romania and Serbia. This Research Brief presents the findings from Serbia.

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<sup>2</sup> See also Van Dijk, J.J.M. and P.G.M. van der Heijden (2016).

## Serbia

### *Introduction*

Statistical information on presumed victims of trafficking in Serbia is collected by the Centre for Human Trafficking Victims Protection, which is responsible for maintaining a database on victims. Police officers, social work centers and other stakeholders who may come into contact with victims of trafficking are obliged to contact the Centre when they suspect that a person is a victim of trafficking. The Centre has developed an electronic form for entering data concerning individual cases and another electronic form for monthly reporting. This enables the collection and processing of data according to different criteria, including sex, age, form of trafficking (i.e. transnational or domestic), type of exploitation, and nationality of the victim. Monthly statistical information and annual reports are published on the website of the Centre.<sup>3</sup> The numbers of presumed victims should not be mistaken for the numbers of formally identified victims which are, as in the United Kingdom, considerably smaller.

During the reporting period, the great majority of the recorded presumed victims were Serbian nationals. Domestic trafficking makes up 40 per cent of all recorded cases. The latter covariate was not included in the available dataset.

The Centre has made available the datasets on the presumed victims reported to it during the years 2013 -2016. The covariates were age, sex, nationality and type of exploitation. Since the numbers of recorded presumed victims showed an exceptional pattern in 2014, caused by the detection of some big cases of trafficking for forced labour, the data for 2014 were deemed unrepresentative for the period, and excluded from the final analysis.

### *Results*

The estimated numbers of victims of trafficking in persons in Serbia are 720 for 2013, 830 for 2015 and 970 for 2016, suggesting an upward trend. The rate of trafficking victimization in 2015 was 12 per 100,000 population (18 for females and 4 for males).

In Serbia, 40 per cent of all recorded trafficking cases relate to victimization on Serbian territory. This means that the trafficking victimization rate on Serbian territory can be estimated at 4 to 5 per 100,000 (6 for females and 1.5 for males).

Most of the victims are Serbian nationals. With the exception of 2014, the majority of cases relate to female victims trafficked for sexual exploitation. In 2015, 55 per cent of the estimated cases related to this form of trafficking, 10 per cent to trafficking for begging and 34 per cent to other types (mainly trafficking for forced labour).

The results indicate that in the period between 2013 and 2016, the estimated victim numbers were four to nine times higher than the recorded numbers of identified victims.

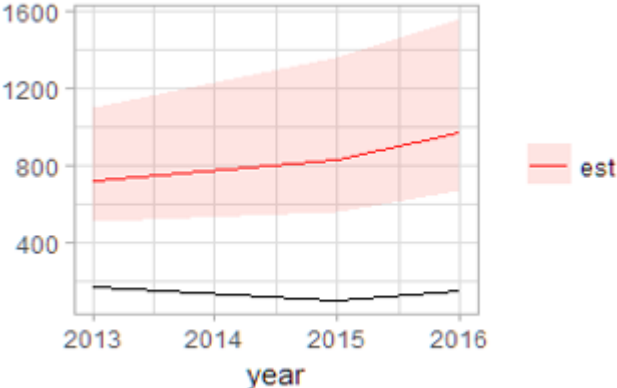
The ratios between recorded and estimated cases of sub-categories of victims are based on such small numbers that no firm conclusions can be drawn. The ratios for non-Serbian nationals are somewhat higher than for Serbian nationals, suggesting that they are less likely to be detected. This is possibly because Serbian nationals are largely detected abroad.

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<sup>3</sup> Available in English at: <http://www.centarzztlj.rs/eng/index.php/stats-and-reports>

The ratios between recorded and estimated numbers are similar for female and male victims. The ratios are significantly larger for minors than for adults, implying that cases of trafficking of minors are less likely to be detected.

Figure 1: Trends in observed presumed victims (in black) and estimated totals of presumed victims (in red) in Serbia, 2013-2016

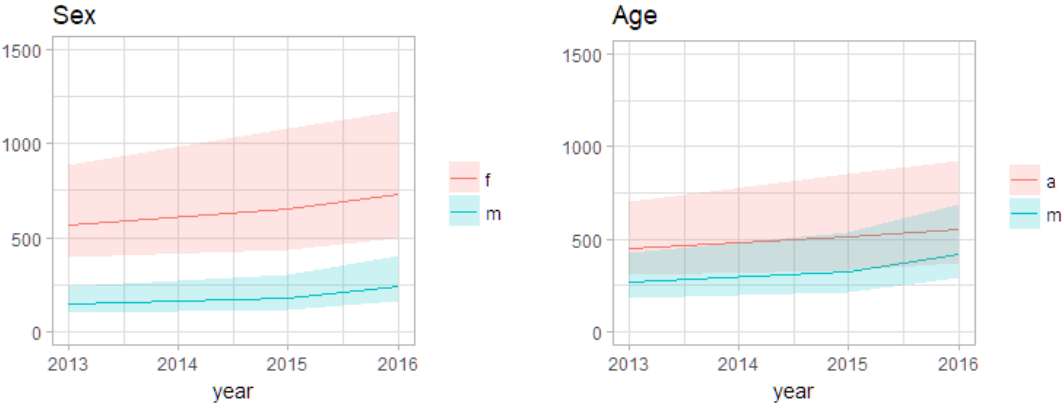


(est=estimated number of victims)

The 95 per cent confidence interval around the estimates is depicted in shaded red. The estimated numbers of trafficking victims in Serbia are 720 for 2013, 830 for 2015 and 970 for 2016. As explained above, the findings for 2014 are seen as outliers and have not been incorporated into the model. In the plots, the results for 2014 are expressed as the mean of 2013 and 2015.<sup>4</sup>

In the period 2013-2016, the estimated numbers of trafficking victims show an upward trend, although the recorded numbers remained stable. The differences between the estimated numbers per year, however, stay within the margins of error.

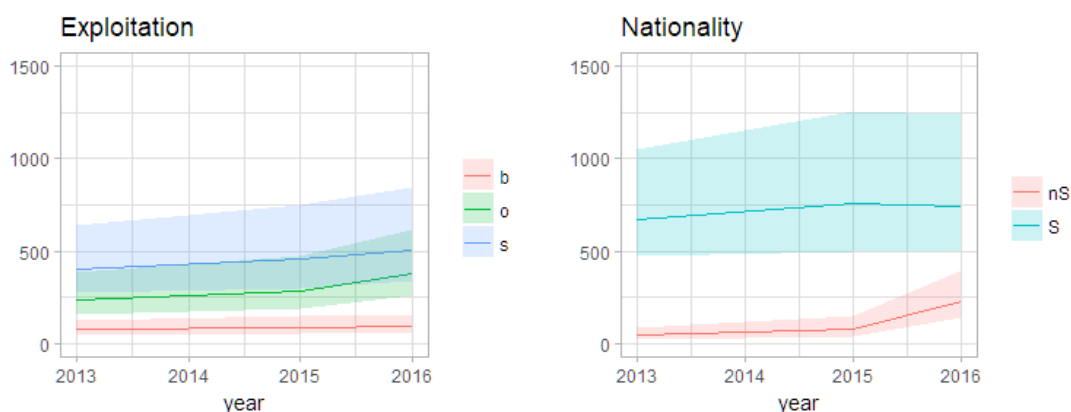
Figure 2: Trends in estimated totals of presumed victims in Serbia, 2013-2016, by sex, age, type of exploitation and nationality



(f=female; m=male)

(a=adult; m=minor)

<sup>4</sup> A separate MSE on the data from 2014 alone resulted in an estimate of 698 presumed victims, of which 559 were males, and 536 victims of other types of exploitation (forced labor). This result confirms the atypical nature of the cases recorded in that year.



(b=begging; o=forms of exploitation other Than begging or sexual; s=sexual exploitation) (nS=non-Serbian citizen; S=Serbian citizen)

The plots show that most of the estimated victims are female and that a large part of all victims are minors (43 per cent in 2016). Most victims were trafficked for sexual exploitation or labour exploitation. A large majority of the estimated victims are Serbian nationals.

### Data

#### Registers

- R1: Police
- R2: NGO
- R3: SPS (Social Protection Centre)
- R4: other

#### Covariates

- S: Sex (311 females, 95 males)
- A: Age (202 adults, 204 minors)
- N: Nationality (337 Serbs, 69 non-Serbs)
- E: Exploitation, (205 sexual, 47 begging, 154 other)
- Y: Year - 2013 (164), 2015 (96) 2016 (146)

Categories: Exploitation (original variable had combined descriptions)

- s: any reference to “sexual”, “pornographic”
- b: any reference to “begging” unless in combination with sexual
- o: all other categories, e.g. “labour”, “adoption”, “forced marriage” and “forced criminality”

#### Overlap registers

V1	V2	R1xR2	R1xR3	R1xR4	R2xR3	R2xR4	R3xR4
0	0	145	81	146	244	316	241
1	0	216	207	212	44	42	117

0	1	43	107	42	117	45	47
1	1	2	11	6	1	3	1

### ***Model selection***

The model selection procedure was basically the same as in the analysis of the Dutch data, presented in Annex V.

The model search started with a simple model and included interaction terms until the fit of the model to the data became adequate. As explained, this time the additional variables sex (S), age (A), exploitation (E), nationality (N), and year (Y) were included. In the STEP procedure, the BIC was again preferred over the AIC as the selection criterion, because of its protection against overfitting when the sample is relatively large.

	DEV	par	df	AIC	BIC	Nhat
Linear Independence model	885	11	1069	1200	1253	2517
Linear step model (BIC)	453	26	1054	799	923	2502
Linear step model (AIC) model	319	48	1032	709	939	2795
Quadratic Independence model	867	12	1068	1184	1242	2517
Quadratic step model (BIC)	421	29	1051	773	912	2519
Quadratic step model (AIC)	142	96	984	627	1087	3.57E+25

The model that was selected as the most parsimonious is presented below.

### ***Effects of Quadratic step model (BIC):***

A, AE, AN, ANE, E, N, NE, NQ, Q, S, SA, SE, SN

R1, R1Q, R2, R3, R3A, R4, R4N

## Literature

Bales, K., O., Hesketh & B. Silverman (2015), 'Modern slavery in the UK: How many victims?', *Significance*, 12(3), 16-21.

Lum, K. M. E. Price & D. Banks (2013), 'Applications of Multiple Systems Estimation in Human Rights Research,' *The American Statistician*, 67:4, 191-200.

Silverman, B. (2014), *Modern slavery: an application of multiple systems estimation*. Gov.UK.

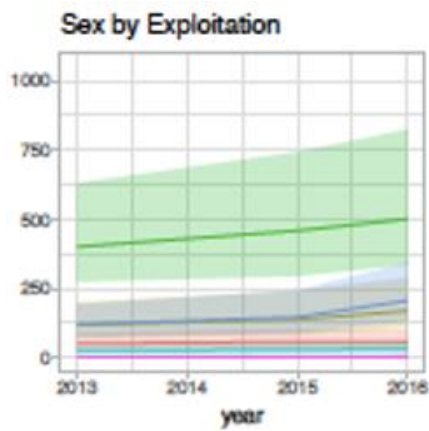
UNODC (2017), *Monitoring Target 16.2 of the United Nations Sustainable Development Goals; A multiple systems estimation of the numbers of presumed human trafficking victims in the Netherlands in 2010-2015 by year, age, gender, form of exploitation and nationality*; Research Brief. Vienna: UNODC.

Van der Heijden, P.G.M., M. Cruyff & G.H.C. van Gils (2015), *Schattingen illegaal in Nederland verblijvende vreemdelingen 2012-2013*. WODC. (Estimations of illegal residents in the Netherlands 2012-2013).

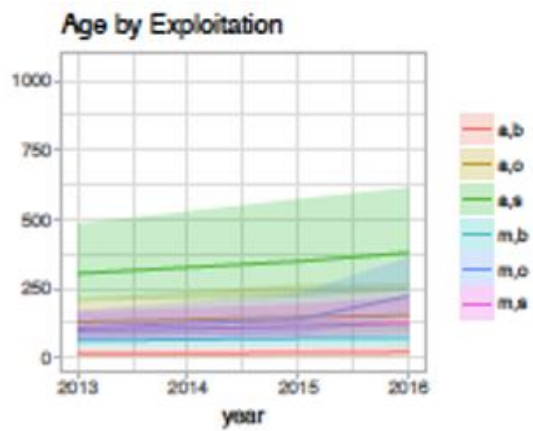
Van Dijk, J.J.M. and P.G.M. van der Heijden (2016), *Research Brief. Multiple Systems Estimation for Estimating the number of victims of human trafficking across the world*. Vienna: UNODC.



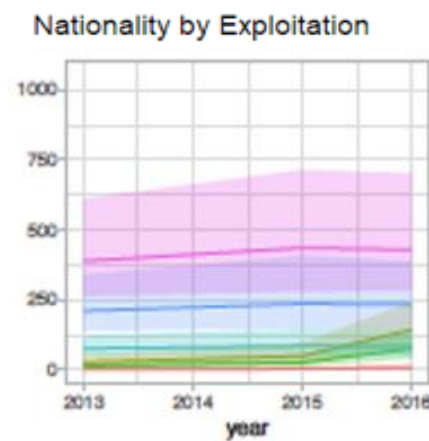
**I A: Two-dimensional plots of disaggregated findings**



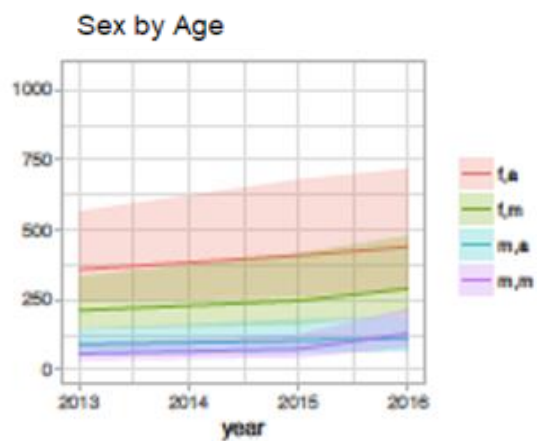
Legend: f=female; m=male; b=begging; s=sexual exploitation; o=other forms of exploitation.



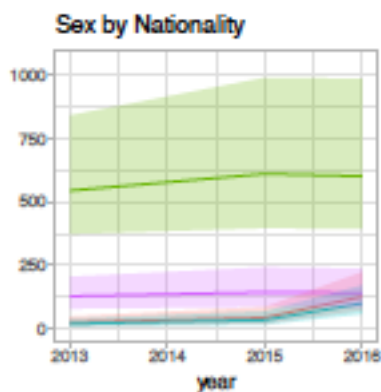
Legend: a=adult; m=minor; b=begging s=sexual exploitation; o=other forms of exploitation.



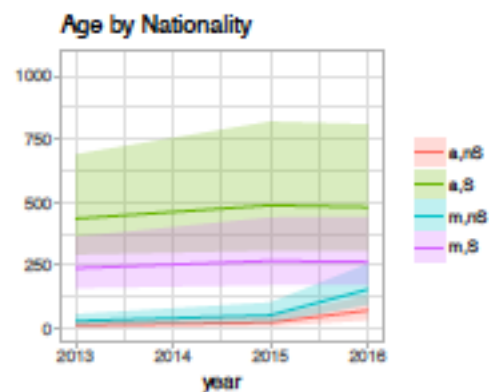
Legend: S=Serbian; nS=other citizenships (not Serbian); b=begging; s=sexual exploitation; o=other, non-sexual forms of exploitation.



Legend: f=female; m(1<sup>st</sup> column)=male; a=adult; m(2<sup>nd</sup> column)=minor.



Legend: f=female; m=male; I=Irish; nI=other citizenships (not Irish).



Legend: a=adult; m=minor; I=Irish; nI=other citizenships (not Irish).

**I B: Observed, estimated, min and max of 95% confidence interval and ratio estimated/observed**

Y		obs	est	min95%CI	max95%CI	ratio
2013		164	717	504	1103	4.4
2015		96	832	559	1360	8.7
2016		146	970	672	1563	6.6
Y	S	obs	est	min95%CI	max95%CI	ratio
2013	f	125	570	397	884	4.6
2015	f	84	655	435	1081	7.8
2016	f	102	729	498	1178	7.1
2013	m	39	147	95	237	3.8
2015	m	12	178	112	299	14.8
2016	m	44	241	161	399	5.5
Y	A	obs	est	min95%CI	max95%CI	ratio
2013	a	84	448	304	699	5.3
2015	a	53	512	329	856	9.7
2016	a	65	551	367	924	8.5
2013	m	80	268	183	424	3.4
2015	m	43	320	215	539	7.5
2016	m	81	418	290	689	5.2
Y	E	obs	est	min95%CI	max95%CI	ratio
2013	b	27	77	47	126	2.8
2015	b	13	87	53	149	6.7
2016	b	7	90	54	158	12.9
2013	o	65	238	159	382	3.7
2015	o	23	285	186	475	12.4
2016	o	66	376	257	615	5.7
2013	s	72	402	277	639	5.6
2015	s	60	461	298	753	7.7
2016	s	73	504	341	841	6.9

Y	N		obs	est	min95%CI	max95%CI	ratio
2013	nS		12	43	19	83	3.6
2015	nS		13	77.0	37	147	5.9
2016	nS		44	226.0	144	392	5.1
2013	S		152	673.0	471	1053	4.4
2015	S		83	756.0	499	1259	9.1
2016	S		102	744.0	499	1241	7.3

Y	S	E	obs	est	min95%CI	max95%CI	ratio
2013	f	b	17	52	31	89	3
2015	f	b	9	58	33	103	6.5
2016	f	b	6	59	34	105	9.8
2013	m	b	10	25	12	47	2.5
2015	m	b	4	29	13	56	7.2
2016	m	b	1	32	14	60	31.8
2013	f	o	37	117	77	197	3.2
2015	f	o	15	138	88	239	9.2
2016	f	o	23	169	112	281	7.4
2013	m	o	28	120	76	194	4.3
2015	m	o	8	147	93	249	18.3
2016	m	o	43	206	135	351	4.8
2013	f	s	71	401	276	634	5.6
2015	f	s	60	459	297	751	7.6
2016	f	s	73	501	338	837	6.9
2013	m	s	1	2	0	6	1.8
2015	m	s	0	2	0	8	Inf
2016	m	s	0	3	0	10	Inf

Y	A	E	obs	est	min95%CI	max95%CI	ratio
2013	a	b	7	15	4	31	2.1
2015	a	b	0	17	5	36	Inf
2016	a	b	0	20	6	41	Inf
2013	m	b	20	62	38	108	3.1
2015	m	b	13	70	42	122	5.4
2016	m	b	7	71	42	125	10.1

2013	a	o	33	129	82	211	3.9
2015	a	o	11	147	89	258	13.3
2016	a	o	13	153	94	270	11.8
2013	m	o	32	108	70	178	3.4
2015	m	o	12	138	86	234	11.5
2016	m	o	53	223	148	366	4.2
2013	a	s	44	304	206	484	6.9
2015	a	s	42	348	222	573	8.3
2016	a	s	52	379	247	634	7.3
2013	m	s	28	98	63	164	3.5
2015	m	s	18	113	71	191	6.3
2016	m	s	21	125	79	215	5.9

Y	N	E	obs	est	min95%CI	max95%CI	ratio
2013	nS	b	1	1	0	4	1.4
2015	nS	b	1	2	0	7	2.4
2016	nS	b	0	7	0	21	Inf
2013	S	b	26	75	45	124	2.9
2015	S	b	12	85	51	146	7
2016	S	b	7	83	50	150	11.9
2013	nS	o	8	27	12	55	3.4
2015	nS	o	3	49	23	94	16.3
2016	nS	o	36	144	88	246	4
2013	S	o	57	210	139	339	3.7
2015	S	o	20	236	148	405	11.8
2016	S	o	30	232	153	394	7.7
2013	nS	s	3	14	6	29	4.8
2015	nS	s	9	26	10	52	2.8
2016	nS	s	8	75	40	140	9.4
2013	S	s	69	388	264	615	5.6
2015	S	s	51	435	279	716	8.5
2016	S	s	65	429	284	712	6.6

Y	S	A	obs	est	min95%CI	max95%CI	ratio
2013	f	a	56	358	244	558	6.4

2015	f	a	49	408	261	675	8.3
2016	f	a	56	439	291	742	7.8
2013	m	a	28	91	53	145	3.2
2015	m	a	4	104	60	183	25.9
2016	m	a	9	112	66	196	12.5
2013	f	m	69	212	144	340	3.1
2015	f	m	35	246	164	409	7
2016	f	m	46	290	195	479	6.3
2013	m	m	11	56	35	98	5.1
2015	m	m	8	74	44	130	9.2
2016	m	m	35	129	82	223	3.7

Y	S	N	obs	est	min95%CI	max95%CI	ratio
2013	f	nS	10	24	10	48	2.4
2015	f	nS	11	43	20	84	3.9
2016	f	nS	16	126	76	229	7.9
2013	m	nS	2	19	8	39	9.5
2015	m	nS	2	34	15	69	17
2016	m	nS	28	100	58	180	3.6
2013	f	S	115	545	379	847	4.7
2015	f	S	73	612	401	1018	8.4
2016	f	S	86	602	397	1015	7
2013	m	S	37	128	80	204	3.5
2015	m	S	10	144	87	247	14.4
2016	m	S	16	141	88	239	8.8

Y	A	N	obs	est	min95%CI	max95%CI	ratio
2013	a	nS	4	14	5	27	3.4
2015	a	nS	3	24	9	49	8.1
2016	a	nS	10	71	33	136	7.1
2013	m	nS	8	30	13	58	3.7
2015	m	nS	10	53	24	102	5.3
2016	m	nS	34	155	96	267	4.6
2013	a	S	80	435	292	677	5.4

2015	a	S	50	488	309	812	9.8
2016	a	S	55	480	317	813	8.7
2013	m	S	72	239	162	375	3.3
2015	m	S	33	268	175	449	8.1
2016	m	S	47	264	175	447	5.6

Annex II: Past MSE studies - United Kingdom

In the United Kingdom, the obligation to identify presumed victims of human trafficking is discharged by the NRM, a framework for identifying victims and ensuring they receive appropriate protection and support. Its datasets are managed by the United Kingdom Human Trafficking Centre (UKHTC) of the Home Office. The National Crime Agency (NCA) of the Home Office collates data from various sources to produce Strategic Assessments of presumed victims. In 2013, 2,744 unique presumed trafficking victims were identified. The information about presumed victims came from a large number of separate source organizations. This information can be summarized into five lists based on the source type:

- LA: Local Authority
- NG: Non-governmental organization
- PF: Police force/National Crime Agency
- GO: Government Organization (mostly Home Office agencies e.g. UK Border Force, Gangmasters Licensing Authority)
- GP: The general public, through various routes

Of the 2,744 victims included in the 2013 database some appeared on two and a few on three or four of the five lists. Table 1 shows the distribution of the identified victims over the five lists.

Table 1: Contingency table for the National Crime Agency Strategic Assessment data, 2013\*

LA	X					X	X	X							X	X	
NG		X				X			X	X	X				X	X	X
PF			X				X		X			X	X		X	X	
GO				X				X		X		X		X	X		X
GP					X						X		X	X			

Source: Silverman (2014).

\*Each column shows the number of cases which fall in the combination of lists indicated by the cells marked.

Columns corresponding to patterns which do not occur in the observed data are omitted. The bottom row of Table 1 gives the numbers of presumed victims falling under each of the possible categories. MSE allows an estimation of the number of individuals not appearing on any of the lists, given the distribution of individuals in the contingency table. This is done by assuming that each of the counts is derived from a Poisson distribution, a distribution for the occurrence of rare events. A restrictive Poisson log-linear model is estimated for each of the cells and the parameter estimates are projected on the cell with the non-appearing (or hidden) individuals. With log-linear modeling, it is possible to assess how much being on one particular list affects a person’s chances of being on another. Possible interactions between lists can be detected, and controlled for in the estimates. The condition of independence can therefore be relaxed.

Bales, Hesketh and Silverman (2015) fitted a log-linear model to the data presented in Table 1 which allows for individual list effects, and also for interaction between lists. The estimated number of victims was 11,304. The 95 per cent confidence interval for the actual population size was estimated between 10,000 to 13,000, including the 2,744 victims already known.

This suggests that the Strategic Assessment was aware of roughly 20 per cent to 30 per cent of all possible victims in the UK in 2013. In round numbers, therefore, the dark figure is around 7,000 to 10,000.

There is a positive correlation between list LA and each of lists NG and PF, so that being known to the local authority apparently increases the chance of being known to NGOs or the police. This may reflect the existence of referral pathways for potential victims between these agencies, in particular in relation to minors who, unlike adults, do not need to consent to referral to the NRM, or joint operations between the local authorities and other agencies. The upshot of the exploratory MSE carried out on the lists of the National Crime Agency is that the true number of victims during 2013 is estimated at 11,300, or four times the numbers of detected victims (2,744).



Annex III: Past MSE studies - Netherlands

A multiple systems estimation (MSE) was carried out using the statistics on possible victims identified by different groups of organizations reporting to CoMensha1 on behalf of the Dutch National Rapporteur on Trafficking in Human Beings and Sexual Violence against Children over a period of six consecutive years (2010 - 2015) (UNODC, 2017). In total six different groups of organizations (lists) reported to CoMensha, among which the Border Police. The presumed victims reported by the Border Police concern presumed victims of a particular type of trafficking that is not informed by the Palermo Protocol. Moreover, this type of trafficking is no longer upheld as human trafficking by the Supreme Court in the Netherlands. For these reasons, two log-linear models were fitted: one including those reported by the Border Police (based on six lists, concerning 8,234 presumed victims between 2010 and 2015), and one excluding those exclusively reported by the Border Police (based on five lists, concerning 6,935 presumed victims between 2010 and 2015). To enhance the robustness of the estimates, they were stratified by four covariates, namely age (minor/adult), gender (female/male), form of exploitation (sexual/non-sexual) and nationality (Dutch/non-Dutch).

A model search was carried out using the stepwise selection procedure of the R-package STEP. This procedure is similar to well-known stepwise regression analyses, that is, it starts with a simple model and includes significant and deletes non-significant interaction terms between the lists until the fit of the model to the data is deemed adequate. The criteria for model selection are the Aikake Information Criterion (AIC) and/or the Bayesian Information Criterion (BIC); the model with the lowest AIC and/or BIC is selected. In the context of MSE models, we prefer the BIC because it offers better protection against overfitting.

The key finding of the analysis is that in 2014 and 2015, the most recent years for which records are available, the total number of presumed victims of human trafficking in the Netherlands was approximately 6,500 (six lists) / 6,250 (five lists) per year. This means that the estimated numbers are four to five times higher than the recorded numbers of victims that come to the attention of the authorities.

Figure 1 shows in black the trend in the total presumed victims recorded by CoMensha and in red the total estimated numbers of victims. The 95 per cent confidence interval around the estimates is depicted in shaded red.

Figure 1: Trends in observed presumed victims and estimated totals of presumed victims in the Netherlands, 2010-2015 (a: based on model with six lists, b: model with five lists)

