Modern slavery in the UK

How many victims?

Victims of modern slavery are often hidden from view, making it difficult to estimate how many there are. Multiple systems estimation helped **Kevin Bales**, **Olivia Hesketh** and **Bernard Silverman** provide an answer

Sarita sold bean cakes by the side of the road in Nigeria before she came to Europe. She was promised a better life if she left her home and family, finding work as a waitress perhaps or a nanny. The man who brought her here – first to Germany, then to the UK – knew Sarita and her mother well. He had been buying their roadside snacks for five years. It was only when she arrived in Germany with four other girls that the man turned aggressive, telling the new arrivals that they would have to work as prostitutes to repay their travel costs.

Sarita is not her real name, but she is a real victim of modern slavery. Her story forms part of a Home Office report that highlights the tragedy and injustice of the crime – a crime that largely remains hidden from view. Without knowing the size of the modern slavery problem, it is difficult to frame appropriate policies or to allocate resources effectively.

But a statistical approach known as multiple systems estimation can help. This technique uses lists of known cases to estimate the number of unknown victims. In doing so, we are able to provide a reasonably reliable measurement of slavery crime – one that has not been previously available.

The scale of the problem

Slavery in the twenty-first century is challenging to both law-makers and law enforcement. The crime variously known as involuntary servitude, human trafficking, and modern slavery comes in many forms, but is essentially the complete control of one person by another based on coercion, deception, violence or the threat of violence, usually with the aim of economic exploitation.

The human impact of slavery is severe. Assault, rape, torture, sleep and food deprivation, dangerous and demeaning work, and psychological coercion are common experiences for slaves. The misery of these individuals is thought to generate $150 billion annually for slaveholders – a small but significant proportion of the global economy. Around the world, governments are building new policies and developing new research agendas to address the problem.

Forms of slavery are thought to exist in most countries, but estimating the extent of modern slavery faces numerous difficulties. Most estimates rely on second-hand information for which no measures of reliability or validity exist. Other estimates combine secondary sources with random sample victimisation surveys. For example, the 2014 *Global Slavery Index*,[1] which does include some representative sample surveys, estimates there are 35.8 million slaves across the world, while in 2012 the International Labour Organization[2] estimated there were 20.9 million people in "forced labour".

Estimates based on counts of victims known to the authorities are likely to underestimate the scale of the problem as modern slavery is a hidden crime that is often not reported or identified. The result is that while most countries acknowledge the presence of modern slavery, they have been unable to determine the true extent of this crime.

A better estimate

The research discussed in this article was carried out in the context of the UK government's Modern Slavery Strategy.[3] It is relevant to note that the *Global Slavery Index* estimate for the number of people in slavery in the UK was calculated using secondary sources combined with extrapolation from some eastern European countries where random sample surveys had been accomplished.[4] This extrapolation yielded an estimate of slavery in the UK of 0.013% of the national population, or approximately 8300 individuals.

While representative random sample surveys have been used to measure slavery in developing countries, there are three key reasons for supposing "rich" countries are less able to do so. The first is that very few individuals living in wealthier countries are likely to be vulnerable to human trafficking or slavery, and so are unlikely to have cases to report.

The second reason is that when law enforcement is strong, criminals – including slaveholders – go to great lengths to conceal both their crime and their victims, making them much less visible to surveys. The third reason is the assumption that the number of enslaved persons and/or their families in "rich" countries is such a small fraction of the total population that, even if they were not being concealed, they would rarely be found and selected for interview.

It is possible to uncover slavery cases in well-off countries through surveys carried out in other, less well-off, developing nations. Some victims of slavery, like Sarita, arrive in developed countries through a process known as human trafficking. Trafficking does not always occur between countries and across borders, but when it does, surveys in origin countries can help to uncover information about slaves in destination countries.

However, the information derived from these surveys is typically insufficient to provide wholly reliable estimates. It is therefore the aim of this research to provide a method of estimation appropriate to developed countries, drawing on the application of multiple systems estimation (MSE).

Table 1. Incidence table for the NCA Strategic Assessment data. Each row of the table corresponds to a possible combination of lists on which cases can appear

LA	NG	PF	GO	GP	NCA	Count
×						54
	×					463
		×				907
			×			695
				×		316
					×	57
×	×					15
×		×				19
×			×			3
	×	×				56
	×		×			19
	×			×		1
	×				×	3
		×	×			69
		×		×		10
		×			×	31
			×	×		8
			×		×	6
				×	×	1
×	×	×				1
×	×		×			1
	×	×	×			4
	×	×			×	3
	×		×		×	1
×	×	×	×			1
Grand total						2744

Uncovering the victims

MSE is the generalisation to multiple lists of the classical mark–recapture method for estimating a population size.[5,6] In classical mark–recapture, two lists or samples (A and B) are drawn from a population of unknown size. We observe the number on each list as well as the overlap (AB) between them and apply probability theory to work out the total population size.

In MSE, the calculations are more complicated. If there are six lists – A, B, C, D, E and F – then there are 64 possible combinations of presence or absence from these lists (AB, AC, ABC, …); the only variant we do not observe are those individuals who are not on any list, which in this context is the "dark figure".

The multiple systems approach has proved robust when applied to other types of human rights violations

While MSE has previously been used to investigate other human rights violations, such as civilian deaths in armed conflict (see "Documents of war", *Significance*, April 2015), this is the first time it has been applied in the context of modern slavery.

The lists used to estimate the scale of modern slavery in the UK were derived from the UK National Crime Agency (NCA) Strategic Assessment[7] which identified 2744 unique potential victims of human trafficking in 2013 using data and information from a wide range of sources.

Despite all efforts, the Strategic Assessment can only present a partial picture of the scale of modern slavery in the UK. Some victims may still be in servitude, and others may not come forward because of feelings of fear and shame. It is also known that some individuals are not identified as victims by professionals who encounter them, and that some victims may not view themselves as victims of exploitation. Additionally, the NCA's coverage is not complete, as only a limited number of agencies respond to the NCA's intelligence requirement request, so other agencies may be aware of potential victims who are unknown to the Strategic Assessment.

The following steps were required to collate the Strategic Assessment data into different lists to construct the multiple systems estimate:

1. *Anonymisation.* Give each potential victim a unique identifier number, based on identifiers such as name and date of birth, where this information was available. Given the sensitivities of this personal information, this stage was undertaken by NCA analysts on secure computer systems.
2. *Identification and grouping of source organisation types.* In 2013, information about potential victims came from over 100 separate source organisations: for example, all 43 police forces in England and Wales and around 20 different non-governmental organisations (NGOs). These organisations were grouped into the following six lists, constructed on the basis of the different roles and responsibilities of these organisation types in relation to modern slavery in the United Kingdom: local authorities (LA); non-governmental or voluntary organisations and charities (NG); police forces (PF); the NCA; government organisations other than the police or NCA (GO); and the general public (GP).
3. *Identification of overlap between different lists.* The data about potential victims were cross-tabulated to create an incidence table of the combinations of lists on which individuals appeared. Of the 2744 potential victims in the Strategic Assessment, some appeared on two, three or four of the lists; the details are given in Table 1. Of the 63 possible incidence patterns we could observe, only 25 actually occur in the data, and the count for the other 38 is zero. The 64th incidence pattern, cases which do not occur on any list, is the dark figure which is to be estimated.

Findings

A number of analyses were carried out, as described in detail in the box on page 20. In particular, analysis was carried out using all six lists, and also combining PF and NCA into a single list (given the similarity between the police and NCA). The overall results were essentially the same, so it was simpler to combine those two lists. The results of this analysis can be summarised as follows:

- The estimated confidence interval for the actual population size of potential victims of modern slavery in the UK (including the 2744 cases already known to the NCA) is from 10 000 to 13 000, suggesting that the Strategic Assessment is aware of roughly 20–30% of all the potential victims in the United Kingdom in 2013. In round numbers, therefore, the dark figure is around 7000 to 10 000.
- There is positive interaction between the LA list and the NG and PF lists. Being known to the local authority increases the chance of a victim being known to NGOs or the police. This may reflect the practice of potential victims being referred between these agencies, especially in the case of children who, unlike adults, do not need to consent to referral via the National Referral Mechanism – a framework for identifying and supporting victims of human trafficking – or to joint operations of local authorities and other agencies.
- There is negative interaction between the GP list and the NG, PF and GO lists. Cases arising from reports by the general public are less likely to be known to agencies (other than local authorities), and often lack the detailed information contained in referrals from public authorities. As an additional check, the analysis was repeated with the GP list omitted.
- There is some negative interaction between the NG and GO lists, so there is some propensity for cases known to NGOs not to be known to government agencies. This may reflect reluctance of some NGOs to share information with public authorities or the unwillingness of some potential victims to engage with authorities.

These results, and the estimate of 10 000 to 13 000 potential victims of modern slavery in the UK, must be regarded as tentative conclusions, because the model is based on assumptions that (while sensible) cannot be

Data analysis

Table 2. The various models fitted, showing the estimates and confidence intervals for the total population size, and the interactions fitted within each model

Model	Source data	Estimate of total population	Standard error	Lower confidence limit	Upper confidence limit	Two-factor interactions fitted
A	Six lists	11 418	809	9982	13 181	PF×NCA, LA×NG, NG×GP, LA×PF, PF×GP, GO×GP, NG×GO
B	Combine NCA into PF	11 313	802	9889	13 063	LA×NG, NG×GP, PF×GP, LA×PF, GO×GP, NG×GO
C	Combine NCA into PF; omit GP	11 015	805	9587	12 771	LA×NG, LA×PF, NG×GO
D	Combine NCA into PF; omit GP, LA	10 951	807	9520	12 714	NG×GO
E	Omit GP	11 048	808	9615	12 810	PF×NCA, LA×NG, LA×PF, NG×GO
F	Omit GP, LA	10 951	808	9547	12 697	PF×NCA, NG×GO

The model fitted to the data was a Poisson log-linear model for the number of cases occurring on any particular combination of lists, as implemented and described in the R package `Rcapture`. For any collection A of lists, let N_A be the number of cases that appear on the lists in A and no others. We then model N_A as Poisson(λ_A), where

$$\log(\lambda_A) = \mu + \sum \alpha_i + \sum \beta_{ij}$$

For example, the number of cases only on list 2 has expected number $\exp(\mu + \alpha_2)$ and the number on lists 3 and 4 but no others has expectation $\exp(\mu + \alpha_3 + \alpha_4 + \beta_{34})$. The expected value of the dark figure is $\exp(\mu)$, since this corresponds to the case where the collection A is empty, so the estimate and profile likelihood of μ gives the estimate and confidence interval for the dark figure.

The routine `closedp.Mx` was used to fit this model, adding terms stepwise as follows:

- Initially a model with all main effects α_i is fitted.
- Interaction effects β_{ij} are added stepwise, at each stage fitting the interaction which makes the biggest improvement in the Akaike information criterion (AIC), a measure of the relative quality of a statistical model for a given set of data.
- The stepwise addition of terms is stopped if the AIC cannot be improved by adding an interaction or if the interaction which most improves the AIC does not have a statistically significant estimated coefficient.

The resulting model yields an overall estimate of the size of the total population (including both the observed data and the dark figure) together with a standard error and a 95% confidence interval, found from the profile likelihood μ using the routine `closedpCI.t`. The sign of the parameter β_{ij} for each of the fitted two-factor interactions demonstrates whether the factors interact positively or negatively.

This procedure was applied to a number of models, as given in Table 2. Model A is the full six-list data, while model B is a five-list version which does not distinguish cases that come directly to NCA attention (a relatively small number) from those notified by the police. Models C, D, E and F omit part of the data, partly to investigate any concern that cases notified by the general public through some route may not have the information that allows data matching with other sources. Models D and F also omit the fairly small number of cases notified by local authorities. The overall estimates within the various models are notably consistent, and (taking account of the various lists merged and/or omitted) exactly the same interactions are fitted throughout, and in the same order, with the single exception of the two interactions PF×GP and LA×NG in the first two models. Table 3 shows the complete fit for model B.

Table 3. Coefficient estimates in the fitted model for the five-list data. The residual deviance is 16.35 on 19 degrees of freedom. The deviance residuals had minimum −1.96 and maximum 1.34, with median −0.06 and quartiles −0.40 and 0.15, showing that the model fits well

Parameter		Estimate	Standard error
Intercept μ		9.06	0.09
Main effects α	LA	−5.09	0.15
	NG	−2.91	0.10
	PF	−2.15	0.09
	GO	−2.52	0.09
	GP	−3.31	0.11
Interactions β	LA×NG	1.52	0.28
	NG×GP	−2.92	1.01
	PF×GP	−1.25	0.32
	LA×PF	0.92	0.26
	GO×GP	−1.19	0.37
	NG×GO	−0.55	0.22

easily verified, and it inevitably uses data that has some limitations. Care was taken to try to collate all the individuals between lists, but some individuals may still be incorrectly counted separately. Considerations of this kind may have the effect that the overall figure is slightly overestimated, though the checks carried out within the analysis suggest that this is not necessarily a concern. It should be stressed that the conclusions of this paper in no way contradict the Strategic Assessment: the 2744 cases are those known about, while the estimate in this paper makes use of the ways in which cases come to attention to build from the known cases to those that are not known.

We believe the importance of using multiple systems estimation is threefold. Firstly, this is currently the only method of estimating modern slavery crime in developed countries that relies not on extrapolation from secondary sources, but on actual reports of suspected or verified slavery cases. Secondly, the multiple systems approach has proved to be robust when applied to other types of human rights violations, and we suggest it may prove equally fruitful with modern slavery crime. And, thirdly, if multiple systems estimation is tested in other countries and can be verified and found to be useful, then public and policy responses to this crime might be placed on a firmer footing and more reliable estimation can aid in the development of appropriate and commensurate policies and the effective allocation of resources to the control or eradication of modern slavery.

Acknowledgements

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