Measuring Modern Slavery: Law, Human Rights, and New Forms of Data

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ABSTRACT

This article argues that many of the lessons learned and achievements made in the measurement of human rights over the past four decades are equally applicable to the measurement of modern slavery. It shows that modern slavery encompasses a significant subset of human rights found in international law, the parameters of which can be delineated and operationalized in ways that make the phenomenon amenable to measurement across a wide range of different data. These include events-based data, standards-based data, survey-based data, and new forms of data made possible through machine learning and artificial intelligence (AI) applications. The article shows that the measurement of modern slavery needs to overcome many of the same challenges that confront efforts at measuring human rights, including the fundamental problem of unobservability, inherent bias through the use of convenience reporting, and the specification of the concept of modern slavery itself. Overcoming these challenges opens up new possibilities to make what many claim to be an intractable problem of development *tractable* and helps contribute to the Sustainable Development Goal target to end modern slavery by 2030.[1]

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I. INTRODUCTION

The phenomenon of modern slavery has emerged over the last twenty years as a significant subset of human rights that has garnered increasing international attention. Long thought to be a thing of the past, scholars and practitioners variously working on forced labor, human trafficking, sexual exploitation, and forced marriage, have drawn together common themes and attributes under the overall rubric of "modern slavery."[2] The United Nations has embraced this agenda, which has been articulated through the promulgation of Sustainable Development Goal (SDG) 8.7, which demands that states "[t]ake immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms."[3] SDG 8.7 can be seen as the culmination of many different efforts in line with the idea of what Jack Donnelly calls the "social construction of human rights," where a history of consensus building since the advent of the 1926 Slavery Convention has sought to develop the core content of human rights instruments that address the problem of modern slavery.[4] Evidence submitted to the UN Special Rapporteur on Contemporary Forms of Slavery, Its Causes and Consequences shows that between 62 percent and 90 percent of countries in the world have ratified the core international instruments on slavery and forced labor, while 47 percent of countries have "no provisions criminalising slavery or the slave trade."[5]

Alongside these normative developments, the anti-slavery movement has endeavored to provide measures of modern slavery, an effort that has much to learn from many other efforts in the measurement of human rights that have developed over many years. There have been significant measurement achievements across different *categories* and *dimensions* of human rights using different kinds of measurement strategies.[6] These strategies provide dif-

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1. UN Global Compact, Transforming Our World: The 2030 Agenda for Sustainable Development, A/RES/70/1, Goal 8.7 (2015).
2. Kevin Bales, Disposable People: New Slavery in the Global Economy (1999); Kevin Bales, Understanding Global Slavery: A Reader (2005); Kevin Bales, Ending Slavery: How We Free Today's Slaves (2007); Kevin Bales & Ron Soodalter, The Slave Next Door: Human Trafficking and Slavery in America Today (2009); Kevin Bales, Zoe Trodd & Alex Kent Williamson, Modern Slavery: The Secret World of 27 Million People (2009); Austin Choi–Fitzpatrick, What Slaveholders Think: How Contemporary Perpetrators Rationalize What They Do (2017).
3. UN Global Compact, *supra* note 1.
4. Jack Donnelly, *The Social Construction of International Human Rights, in* Human Rights in Global Politics 71 (Tim Dunne & Nicholas J. Wheeler eds. 1999).
5. OHCHR, *Delta 8.7 Consultation: Addressing Tomorrow's Slavery Today* 5, https://www.ohchr.org/Documents/Issues/Slavery/SR/AddressingTomorrowSlaveryToday/RightsLab.pdf.
6. Todd Landman, *Measuring Human Rights: Principle, Practice, and Policy*, 26 Hum. Rts. Q. 906 (2004); Todd Landman, Studying Human Rights (2006); Todd Landman, Human Rights and Democracy: The Precarious Triumph of Ideals (2013); Todd Landman & Edzia Carvalho, Measuring Human Rights (2009).

ferent kinds of measures at different levels of analysis and achieve the *direct* and *indirect* quantitative representation of human rights. This article argues that these strategies of human rights measurement are equally applicable to the measurement of modern slavery, which has all the hallmark features, attributes, and challenges associated with other kinds of human rights problems. There are many lessons that travel from these human rights efforts generally to the current attempts to measure modern slavery specifically, and there is a great need for an ongoing conversation between and among human rights scholars and practitioners, statisticians, data scientists, and modern slavery experts and advocates. Much like the debates that have been ongoing since 2000 between statisticians and human rights experts,[7] the movement to end modern slavery is now having similar debates centered around estimating the prevalence of modern slavery and using new tools to track the sites and conditions of vulnerability that can lead to modern slavery.[8]

In order to understand the possibilities for measuring modern slavery, this article first outlines the conceptions of modern slavery as found in extant international law and norms ranging from the 1926 Slavery Convention to the Bellagio-Harvard Guidelines on the Legal Parameters of Slavery.[9] The next section of the article examines the many challenges associated with the measurement of modern slavery. These include the hidden nature of the phenomenon, the inherent biases in reporting and the problem of "convenience" samples and how modern slavery can be operationalized using standard measurement frameworks found in the social sciences, and formal advice and guidance published by the United Nations Office of the High Commissioner for Human Rights.[10] The next section discusses differ-

7. *See* Todd Landman & Julia Häusermann, *Map-Making and Analysis of the Main International Initiatives on Developing Indicators of Democracy and Good Governance* (2003), https://ec.europa.eu/eurostat/documents/46346/48072/Map-Making-Analysi-Main-International-Initiative.pdf/29a35b02–3429–4700–8ddc-ba064ad090ae.
8. For example, in February 2019, Delta 8.7, a global platform for sharing developments in the measurement and analysis of modern slavery based at the United Nations University in New York hosted an event entitled Code 8.7 that featured panels on the use of computational social science and artificial intelligence to help the fight against modern slavery. *See* Delta 8.7, *Code 8.7: Using Computational Science and AI to End Modern Slavery*, United Nations University, https://delta87.org/code87/. In June 2019, Freedom Fund, an anti-slavery NGO, held an event in London on the costs and benefits of measuring slavery prevalence. *See* The Freedom Fund, *What We Do*, https://freedomfund.org/. Both these events, like many human rights events over the past twenty years where I have been a participant, brought together anti-slavery scholars, NGOs, donors, private sector companies, and practitioners, where it was evident debates of the past have re-emerged, and perennial questions about the importance and feasibility of measuring modern slavery have been raised.
9. League of Nations, The Convention to Suppress the Slave Trade and Slavery, *signed* 25 Sept. 1926, (*entered into force* 9 Mar. 1927) [hereinafter 1926 Slavery Convention]; Research Network on the Legal Parameters of Slavery; *The Bellagio-Harvard Guidelines on the Legal Parameters of Slavery* (2012) [hereinafter *Bellagio-Harvard Guidelines*].
10. OHCHR, Human Rights Indicators: A Guide to Measurement and Implementation (2012); OHCHR, A Human Rights-Based Approach to Data: Leaving No One Behind in the 2030 Agenda for Sustainable Development (2018).

ent modes of direct and indirect measurement of modern slavery, including events-based data, standards-based data, survey-based data, and new forms of data made possible with the advent of machine learning and artificial intelligence. The final section summarizes these approaches to measurement and discusses their implications for theories of change, impact assessment, advocacy, and the contribution that measurement can make to ending modern slavery by 2030.

II. CONCEPTIONS OF MODERN SLAVERY

Slavery has existed for nearly 4000 years as a common practice across many different societies and systems of government.[11] In addition to the commonality of slavery among ancient civilizations, transatlantic and imperial forms of slavery are the most commonly known, which were formally abolished when Brazil declared the end to slavery in May 1888.[12] Less than forty years after the Brazilian abolition of slavery, the world sees the first purportedly universal treaty prohibiting slavery (and the slave trade) emerge with the 1926 Slavery Convention.[13] The Convention defines slavery as "the status or condition of a person over whom any or all of the powers attaching to the right of ownership are exercised."[14] This convention, characterized as the "first true international human rights treaty,"[15] gives primacy to the ideas of *ownership* and *property*. Further developments in international human rights law and international humanitarian law have more fully articulated the definition of slavery.[16]

Provisions on slavery and other related forms of exploitation are also set out in other international instruments and norms, such as the International Covenant on Civil and Political Rights and the Rome Statute of the

11. *See* 1 Fernand Braudel, Civilization and Capitalism, 15th–18th Century: The Structure of Everyday Life (1981); 2 Fernand Braudel, Civilization and Capitalism, 15th–18th Century: The Wheels of Commerce (1982); 3 Fernand Braudel, Civilization and Capitalism, 15th–18th Century: The Perspective of the World (1982); 1 S.E. Finer, The History of Government: Ancient Monarchies and Empires (1997).
12. Robert Edgar Conrad, Children of God's Fire: A Documentary History of Black Slavery in Brazil 480 (1983); Peter Winn, Americas: The Changing Face of Latin America and the Caribbean 293 (3d ed. 2006).
13. 1926 Slavery Convention, s*upra* note 9.
14. *Id.* art. 1(1).
15. Paul Sieghart, The International Law of Human Rights 13 (1983).
16. Further developments include: Supplementary Convention on the Abolition of Slavery, Slave Trade and Institutions of Similar Practices, *adopted* 7 Sept. 1956, art. 7 (a), 226 U.N.T.S. 3 (*entered into force* 30 Apr.1957); Convention on Action against Trafficking in Human Beings, Council of Europe, Eur. T.S. No. 197 (*entered into force* 19 May 2005); Protocol to Prevent, Suppress and Punish Trafficking in Persons, Especially Women and Children, Supplementing the United Nations Convention Against Transnational Organized Crime, *adopted* 15 Nov. 2000, U.N. Doc. A/RES/55/25, 2237 U.N.T.S 319 (*entered into force* 25 Dec. 2003).

International Criminal Court (ICC).[17] Slavery is part of the 1945 Charter of the International Military Tribunal and in the Statute of the International Criminal Tribunal for the Former Yugoslavia, where enslavement in qualifying circumstances is defined as a crime against humanity.[18] The International Labour Organisation (ILO) has provisions in its 1930 Forced Labour Convention, 1957 Forced Labour Convention, 1999 Worst Forms of Child Labour Convention, and 2014 Forced Labour Protocol addressing forced or compulsory labor, and slavery and related exploitation of children.[19] "The various regional human rights instruments for Europe, the Americas, Africa, and the Arab region all have provisions addressing the problem of slavery," servitude, forced labor, and traffic in women, "as well as dignity, respect, and free choice of work."[20] Table 1 shows these main instruments and their relevant clauses that address slavery and related forms of exploitation.

Table 1. International Legal Instruments on Slavery, Related Forms of Exploitation and Trafficking[21]

International Instruments	*Article*	*Text*
Slavery Convention (1926)	Article 1	"For the purpose of the present Convention, the following definitions are agreed upon: (1) **Slavery** is the status or condition of a person over whom any or all of the powers attaching to the right of ownership are exercised. (2) The **slave trade** includes all acts involved in the capture, acquisition or disposal of a person with intent to reduce him to slavery; all acts involved

17. International Covenant on Civil and Political Rights, *adopted* 16 Dec. 1966, G.A. Res. 2200 (XXI), U.N. GAOR, 21st Sess., U.N. Doc. A/6316 (1966), 999 U.N.T.S. 171 (*entered into force* 23 Mar. 1976); Rome Statute of the International Criminal Court, *adopted* 17 July 1998, U.N. Doc. A/CONF.183/9 (1998), 2187 U.N.T.S. 90 (*entered into force* 1 July 2002).
18. United Kingdom of Great Britain and Northern Ireland, United States of America, France, Union of Soviet Socialist Republics, *Agreement for the Prosecution and Punishment of the Major War Criminals of the European Axis: "Charter of the International Military Tribunal (IMT)", signed* 8 August 1945, U.N.T.S. 251; Statute of the International Tribunal for the Former Yugoslavia, *adopted* 25 May 1993, S.C. Res. 827, U.N. SCOR, 3217th mtg., U.N. Doc. S/25704 annex (1993).
19. Convention Concerning the Forced Labour or Compulsory Labour (ILO No. 29), *adopted* 18 June 1930 (*entered into force* 1 May 1932); Abolition of Forced Labour Convention (ILO No. 105) *adopted* 5 June 1957 (*entered into force* 25 June 1957); Convention on Worst Forms of Child Labour (ILO No. 182) *adopted* 17 June 1999 (*entered into force* 19 Nov. 2000) [hereinafter Worst Forms of Child Labour]; Protocol of 2014 to the Forced Labour Convention (P029), *adopted* 11 June 2014, (*entered into force* 9 Nov. 2016).
20. Todd Landman, *Out of the Shadows: Trans-disciplinary Research on Modern Slavery*, 2 Peace Hum. Rts. Governance 143, 148 (2018).
21. *Id.* at 1–15.

Table 1., cont.

International Instruments	*Article*	*Text*
		in the acquisition of a slave with a view to selling or exchanging him; all acts of disposal by sale or exchange of a slave acquired with a view to being sold or exchanged, and, in general, every act of trade or transport in slaves."
Charter of the International Military Tribunal (1945)	Article 6 (c)	'Crimes against humanity.- ' namely, murder, extermination, enslavement, deportation, and other inhumane acts committed against any civilian population, before or during the war, or persecutions on political, racial or religious grounds in execution of or in connection with any crime within the jurisdiction of the Tribunal, whether or not in violation of the domestic law of the country where perpetrated.
Supplementary Convention on the Abolition of Slavery, the Slave Trade, and Institutions and Practices Similar to Slavery (1956)	Article 1 (a)-(d)	Defines **debt bondage**, **serfdom**, **forced marriage**, **child slavery**
	Article 7(a)	"Slavery" means, as defined in the Slavery Convention of 1926, the status or condition of a person over whom any or all of the powers attaching to the right of ownership are exercised, and "slave" means a person in such condition or status;
International Convention on Civil and Political Rights (1966)	Article 8	"1. No one shall be held in slavery; slavery and the slave-trade in all their forms shall be prohibited. 2. No one shall be held in servitude. 3. (a) No one shall be required to perform forced or compulsory labour" (excepting criminal punishment, military service and civil obligations)
Rome Statute of the International Criminal Court (1998)	Article 7	1(g) defines 'crimes against humanity' as including slavery. 2(c) '**Enslavement'** means the exercise of any or all of the powers attaching to the right of ownership over a person and includes the exercise of such power in the course of trafficking in persons, in particular women and children;
Statute of the International Tribunal for the Former Yugoslavia	Article 5(c)	Lists enslavement as a crime against humanity.
Protocol to Prevent, Suppress and Punish Trafficking in Persons Especially Women and Children (2000) – 'Palermo Protocol'	Article 3(a)	"Trafficking in persons" shall mean the recruitment, transportation, transfer, harbouring or receipt of persons, by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of

Table 1., cont.

International Instruments	*Article*	*Text*
		power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labour or services, slavery or practices similar to slavery, servitude or the removal of organs.
International Convention on the Protection of the Rights of All Migrant Workers and Members of their Families (1990)	Article 11	"No migrant worker or member of his or her family shall be held in slavery or servitude. 2. No migrant worker or member of his or her family shall be required to perform forced or compulsory labour."
International Labour Organisation Forced Labour Convention (No. 29) (1930)		Forced or compulsory labour is: "all work or service which is exacted from any person under the threat of a penalty and for which the person has not offered himself or herself voluntarily."
ILO Abolition of Forced Labour Convention (No. 105) (1957) Worst Forms of Child Labour Convention (1999)	Article 3 (a)	(a) all forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including forced or compulsory recruitment of children for use in armed conflict;
Forced Labour Protocol (P029) (2014)	Article 1(3)	

Participation in this international legal regime on human rights with specific reference to slavery has varied considerably across the different core instruments. As we shall see below, coding the ratification of international instruments is now common in human rights scholarship, where scores are given for ratification alone, as well as for ratification alongside the reservations that states file upon ratification.[22] In similar fashion, it is possible to code country participation in international instruments specifically promulgated to address slavery, or international instruments that have significant provisions

22. *See, e.g.*, Oona A. Hathaway, *Do Human Rights Treaties Make a Difference?*, 111 Yale L.J. 1935 (2002); Todd Landman, Protecting Human Rights: A Comparative Study (2005); Eric Neumayer, *Do International Human Rights Treaties Improve Respect for Human Rights?*, 49 J. Conflict Resol. 925 (2005); Beth A. Simmons, Mobilizing For Human Rights: International Law in Domestic Politics (2009); Heather Smith-Cannoy, Insincere Commitments: Human Rights Treaties, Abusive States, and Citizen Activism (2012).

for slavery or related practices as set out in Table 1. A simple tabulation of participation in core instruments is shown in Table 2, where it is clear that some instruments enjoy stronger commitment than other instruments. The 1999 Worst Forms of Child Labour Convention enjoys 94 percent participation, a similar ratification record to the 1989 Convention on the Rights of the Child (98.4 percent).[23] In contrast, the 1926 Slavery Convention enjoys only 62 percent participation even though it is the first core instrument established after the wave of nineteenth-century abolitionism.[24]

Table 2. States party membership in core international instruments[25]

Core Instrument	*Membership[†] (% of 193 countries)*
1926 Slavery Convention	62%
1930 Forced Labour Convention	92%
1956 Supplementary Slavery Convention	64%
1957 Forced Labour Convention	89%
1966 International Covenant on Civil and Political Rights	89%
1999 Worst Forms of Child Labour	94%
2000 Palermo Protocol	90%

[†]Membership includes only those countries that have signed and ratified the instruments.

Alongside these legal definitions of and norms about slavery, scholars and practitioners working on modern slavery have developed through consensus the Bellagio-Harvard Guidelines on the Legal Parameters of Slavery,[26] which focus on the right to ownership, the powers attached to the right of ownership, and the notion of possession. In focusing on these elements as foundational to slavery, the guidelines emphasize the notion of control and lack of agency for victims of slavery, where different forms of coercion maintain power over individuals.[27] The key phrase from the guidelines with respect to ownership, also at the heart of the concept of modern slavery, asserts that it constitutes "control over a person in such a way as to significantly deprive that person of his or her individual liberty, with the intent of exploitation through the use, management, profit, transfer or disposal of that person."[28] This notion of ownership is then linked to possession, which

23. *See* Landman, Protecting Human Rights, *supra* note 22, at 61.
24. OHCHR, *supra* note 5.
25. *Id.* at 5 (table "*Membership in Core International Instruments*").
26. *Bellagio-Harvard Guidelines*, *supra* note 9.
27. James Cockayne, Nick Grono & Kari Panaccione, *Slavery and the Limits of International Criminal Justice*, 14 J. Int'l Crim. Just. 253 (2016); Choi-Fitzpatrick, *supra* note 2.
28. *Bellagio-Harvard Guidelines*, *supra* note 9, at 16.

is an extreme form of control that goes far beyond any understanding of reasonable labor relations and management of workers.[29]

III. CHALLENGES OF MEASUREMENT

Modern slavery shares many of the same attributes and characteristics of other human rights violations that render its measurement problematic. First, like arbitrary detention, torture, disappearance, and extra-judicial killing, much of the practice of modern slavery is hidden from direct observation. Individuals involved may be working in plain sight, but the conditions of that work and whether they are being coerced, unpaid, and are free to leave their place of work can remain opaque to the observer. Low-wage and low-skilled sectors, such as mining and other extractive industries, textiles, garments, and "fast fashion"; fisheries; charcoal production; brick making; agriculture, harvesting and food production; and small-scale service industries, such as car washes and nail bars, all have the possibility (and higher probability) of the presence of modern slavery.

Second, the sources of data available to develop measures of modern slavery are inherently biased, where it is typical for such sources to rely on individual reporting, referral into victim support and assistance programs (e.g. the National Referral Mechanism in the United Kingdom) or collated through police and other relevant institutions and organizations. In statistical terms, such reporting constitutes a "convenience" sample, which is a non-probabilistic sample of individuals from which there are significant, but not insurmountable challenges, to making secure inferences. Kenneth Bollen argues that there are degrees of reporting of human rights violations that affect our ability to measure political rights and political liberties.[30] He argues there is in the abstract, a universe of all possible violations that have occurred, and then a continually decreasing probability of these violations ever being recorded to then be used for measurement.[31] The same is true for modern slavery reporting.

Third, given the hidden and unobservable nature of modern slavery, there are many strategies available to provide proxy or indirect measures that capture individuals vulnerable to falling into conditions of modern slavery or that capture physical sites (and distinct identifiable objects) where there is a high probability of modern slavery. However, there are also sites and objects that are not yet visible, limiting the ability for complete measures of this hidden population of people.

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29. *Id.*
30. *See, e.g.*, Kenneth A. Bollen, *Political Rights and Political Liberties in Nations: An Evaluation of Rights Measures, 1950 to 1984, in* Human Rights and Statistics: Getting the Record Straight 188 (Thomas B. Jabine & Richard P. Claude eds., 1992).
31. *Id.*

Finally, any modern slavery measurement strategy can draw on systematic frameworks developed in the social sciences and the United Nations system for measuring concepts in general and for measuring human rights in particular. Ever since the "behavioral revolution" in the social sciences, there has been an increase in the desire and ability to measure different aspects of the social, political, and economic world. Measurement strategies have been developed for different levels of analysis that range from the micro to the macro.[32] In a seminal piece published in the *American Political Science Review*, Robert Adcock and David Collier set out a framework for operationalizing concepts to produce quantitative measures. Their framework includes four main steps.[33] First, they start with the 'background concept' itself, which for them is the broad constellation of meanings and understandings associated with a given concept to be measured.[34] Modern slavery is a background concept for which there is a broad (but not uncontested) constellation of meanings and understandings. While modern slavery is a complex and variegated set of phenomena, it is possible to delineate categories and dimensions that can be measured.[35] Second, Adcock and Collier move to the idea of a systematized concept, which is the specific formulation of the concept that may be used by scholars, NGOs, international agencies, and other stakeholders.[36] The previous section of this article has shown the evolution in the conceptual definitions of modern slavery and the primacy of possession of people "as if" they are property and the *intentional denial of agency* that sits at the heart of what constitutes a modern slave.[37] Third, Adcock and Collier move to the specification of indicators, where the systematized concept is operationalized into a set of measurable attributes, characteristics, and dimensions using different forms of data.[38] Their final step is the provision of what Adcock and Collier call scores on units, or the actual numerical expression of these indicators for different units of analysis, including individuals, groups of individuals, subnational units, nations, and regions.[39]

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32. Heinz Eulau, Micro-Macro Dilemmas in Political Science: Personal Pathways through Complexity (1996); Peter Mair, *Comparative Politics: An Overview, in* A New Handbook of Political Science 309 (Robert E. Goodin & Hans-Dieter Klingemann eds., 1996); Landman & Carvalho, *supra* note 6.
33. Robert Adcock & David Collier, *Measurement Validity: A Shared Standard for Qualitative and Quantitative Research*, 95 Am Pol. Sci. Rev. 529 (2001).
34. *Id.*
35. For example, the United Kingdom Home Office has published a typology of modern slavery that contains seventeen different categories of slavery. *See* Christine Cooper, Olivia Hesketh, Nicola Ellis, & Adam Fair, A Typology of Modern Slavery Offences in the UK (2017), https://www.gov.uk/government/publications/a-typology-of-modern-slavery-offences-in-the-uk.
36. Adcock & Collier, *supra* note 33, at 531.
37. Landman, *Out of the Shadows, supra* note 20, at 147.
38. Adcock & Collier, *supra* note 33, at 531.
39. *Id.* at 531.; *See* Landman, Studying Human Rights, *supra* note 6, at 76–78; Landman & Carvalho, *supra* note 6, at 32–34.

In similar fashion, the Office of the United Nations High Commissioner of Human Rights (OHCHR) engaged in a multi-year project to develop a systematic framework for the development of human rights indicators.[40] The OHCHR framework is based on what it calls structural, process, and outcome indicators that operationalize the panoply of human rights found in the 1948 Universal Declaration of Human Rights and subsequent international human rights instruments.[41] Structural indicators "reflect the ratification and adoption of legal instruments and the existence as well as the creation of basic institutional mechanisms deemed necessary for the promotion and protection of human rights." [42] They are thus legal-institutional protections of human rights formally codified in international and domestic law, or "rights-in-principle."[43] Process indicators "measure duty bearers' ongoing efforts to transform their human rights commitments into the desired results,"[44] efforts that fit squarely into the state obligation approach to respect, protect, and fulfill human rights.[45] Outcome indicators "capture individual and collective attainments that reflect the state of enjoyment of human rights in a given context,"[46] or "rights-in-practice."[47] These three levels of indicators are then further broken down into the different attributes of separate types of human rights, and for relevance to this article, forced labor under the general area of the right to work.[48]

IV. MODES OF MEASUREMENT

At the micro level, there are measurement strategies and data available for a range of dimensions relevant to slavery. These include individual acts, violations, events, perceptions, attitudes, experiences, and feelings. At the macro level, there are also strategies and data available, including on state violence, economic structures, demographics, third party violations, political institutions, communal groups, regions, and states and state performance. In the field of human rights, these micro and macro data strategies are grouped into four main categories: (1) events-based data, (2) standards-based data, (3) survey-based data, and (4) new forms of data that have emerged with the

40. OHCHR, Human Rights Indicators, *supra* note 10, at 34.
41. *Id.*
42. *Id.*
43. Joe Foweraker & Todd Landman, Citizenship Rights and Social Movements: A Comparative and Statistical Analysis 50–52, 70–85 (1997).
44. OHCHR, Human Rights Indicators, *supra* note 10, at 36.
45. *See* Landman & Carvalho, *supra* note 6, at 25–26.
46. OHCHR, Human Rights Indicators, *supra* note 10, at 37.
47. Foweraker & Landman, *supra* note 43, at 52–56, 85–103.
48. OHCHR, Human Rights Indicators, *supra* note 10, at 95.

advent of 'big data' and the use of computational social science, machine learning, and artificial intelligence.[49]

A. Event-Based Data

As the name of this category suggests, events-based data involve discrete and time-bound occurrences in the social, political, and economic world that can be enumerated. For research and advocacy on modern slavery, such work typically focuses on enumerating the number of people in modern slavery. In *Mapping the Nation*, Susan Schulten (2012) shows that in the nineteenth century, there were attempts to produce slavery prevalence maps for the Southern United States in the 1860s, which demonstrate banded frequency counts of slaves by state, producing some initial understanding of the spatial distribution of enslaved persons.[50] Michael Tadman shows that between 1790 and 1859, forced migration in the Southern states of America affected a total of 845,720 enslaved persons, which is an average of more than 12,000 a year.[51] William Reynolds published the Political Map of the United States to compare free and slave states in the United States, and included statistical tables using the 1850 census.[52] These early mapping exercises are now manifested in the provision of online databases on the system of transatlantic enslavement, which provide a rich resource for understanding the dynamics

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49. *See* Todd Landman & Larissa C. S. K. Kersten, *Measuring and Monitoring Human Rights, in* Human Rights: Politics and Practice 127 (Michael Goodhart ed., 3d ed. 2016); Computational Social Science: Discovery and Prediction (R. Michael Alvarez ed., 2016).
50. *See* Susan Schulten, Mapping the Nation: History and Cartography in Nineteenth-Century America (2012); Edwin Hergensheimer, *Map Showing the Distribution of the Slave Population of the Southern States of the United States: Compiled from the census 1860* (1861) (on file with Libr. Cong.), https://www.loc.gov/item/99447026. Arguably the first social scientific attempt to raise awareness about the nature and extent of the slave issue in the United States is found in Thomas Clarkson, The Substance of The Evidence of Sundry Persons on the Slave Trade: Collected in the Course of a Tour Made in the Autumn of the Year 1788 (1788).
51. Michael Tadman, Speculators and Slaves: Masters, Traders, and Slaves in the Old South 12 (1989), *cited in* Edward E. Baptist, The Half Has Never Been Told: Slavery and the Making of American Capitalism 3 (2016). The importing states (net number of slaves in parentheses) include Alabama (213,460), Arkansas (82,303), Florida (26,967), Georgia (68,763), Kentucky (-4,173), Louisiana (124,001), Mississippi (234,229), Missouri (57,571), South Carolina (-158,366), Tennessee (73,154), and Texas (127,812).
52. William C. Reynolds, *Reynolds's Political Map of the United States, Designed to Exhibit the Comparative Area of the Free Slave States and the Territory Open to Slavery or Freedom by the Repeal of the Missouri Compromise* (1856) (on file with Libr. Cong.), https://www.loc.gov/item/2003627003. Counting historical slaves was much easier since slaves were their own legal category of person. The National Archives in the United Kingdom have some records of registered slave trade companies and plantations, which provide a partial quantitative picture of the nature and extent of transatlantic slavery. *See* The National Archives, Slavery and the British Transatlantic Slave Trade, http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/british-transatlantic-slave-trade-records/.

of the trade, [53] such as Henry Lovejoy's analysis of the Oyo kingdom and its role in supplying slaves for the transatlantic trade.[54] Another early example of using statistics to enumerate gross human rights violations using events-based data is found in Donald Greer's study of the patterns over time and space in the use of state executions (n >15,000) during the period of the Reign of Terror in France between March 1793 and August 1794.[55] Such mapping is now common (see the section below on new forms of data), where a new study carried out by the Buffet-McCain Institute Initiative at Arizona State University has mapped the prevalence of human trafficking across the state of Texas.[56]

In the contemporary human rights field, the American Association for the Advancement of Science (AAAS) and now the Human Data Analysis Group (HRDAG) have developed the "who did what to whom model" for documenting, deconstructing, and coding gross human rights violations for countries involved in long periods of civil conflict, authoritarian rule, or foreign occupation.[57] Initially relying on single convenience samples, this approach is now using multiple-samples and a nineteenth-century statistical technique called "capture- recapture" to estimate the number of people killed in ways that can also provide inferences on perpetrators and characteristics of the victims.[58] One of the best examples of this approach, also known as "multiple systems estimation" (MSE), comes from the statistical analysis conducted on the violence that took place between 1980 and 2000 in Peru, published as part of the work of the Peruvian Truth and Reconciliation Commission (*Comisión de Verdad y Reconciliación*, or CVR).[59] In this analysis, the data team for the CVR identified a total of 22,000 unique (and named) dead or disappeared victims of the conflict reported across three main sources of data, from which they estimated between 61,007 and 77,552 people died (95 percent confidence interval), where the likely number was estimated to

53. For example, see *Slave Voyages,* https://www.slavevoyages.org/.
54. Henry B. Lovejoy, *Mapping Uncertainty: The Collapse of Oyo and the Trans-Atlantic Slave Trade, 1816–1836,* 4 J. Glob. Slavery 127 (2019).
55. Donald Greer, The Incidence of Terror During the French Revolution: A Statistical Interpretation 143–45, 146–51, 162. (1935); *see also* Landman, Studying Human Rights, *supra* note 6, at 82–84
56. Sarah Southey, Delta 8.7, *Mapping Agricultural Labour Trafficking in Texas,* United Nations University (2019), https://delta87.org/2019/06/mapping-agricultural-labour-trafficking-texas/.
57. Patrick Ball, Human Rights Data Analysis Group (HRDAG), *Who Did What to Whom?,* https://hrdag.org/whodidwhattowhom/contents.html.
58. *See* Yvonne M. M. Bishop, Stephen E. Fienberg & Paul W. Holland, Discrete Multivariate Analysis: Theory and Practice 231–36 (1975).
59. *See* Patrick Ball, Jana Asher, David Sulmont & Daniel Manrique, American Association For The Advancement of Science, How Many Peruvians Have Died?: An Estimate of the Total Number of Victims Killed or Disappeared in the Armed Internal Conflict Between 1980 and 2000 (2003), https://www.aaas.org/sites/default/files/s3fs-public/Peru2003.pdf.

be 69,280 people.[60] The data revealed that the state was responsible for 30 percent of the killings and *Sendero Luminoso* (the Shining Path rebel group) was responsible for 46 percent of the killings, the distribution of which varied considerably between the highlands areas and the coastal regions.[61]

Using the same analytical technique, Kevin Bales, Olivia Hesketh, and Bernard Silverman estimated that the total number of people in conditions of modern slavery in the United Kingdom in 2013 was between 10,000 and 13,000.[62] Their analysis was based on six different lists of people that had been reported as experiencing modern slavery, including the government's own National Referral Mechanism (NRM).[63] They used different sets of lists and fit a series of models across them to make the best estimate possible, given the sparse coverage of data across the different sources.[64] Jan Van Dijk, Peter G.M. Van Der Heijden, and Suzanne L.J. Kragten-Heerdink conducted MSE across six different lists of victims of trafficking in the Netherlands, where their different models estimate that there were between 10,542 and 17,812 victims in the period from 2010 to 2015.[65] Kevin Bales, Laura Murphy, and Bernard Silverman carried out the same kind of estimations for the City of New Orleans for 2016, where they find that the estimated total number of slaves is somewhere between 650 and 1,600.[66] Like the Peruvian case, the use of multiple sources and using the probability of victims being captured by one or more lists versus the ratio of the probability of not being captured by these lists allowed them to provide their estimate. In the Peruvian, UK, Netherlands, and New Orleans cases, it is the relative overlap of sources and the ratio of probabilities of appearing in these sources that allows for the estimation of the total number of victims (known and unknown victims).[67] Single source data projects suffer from not having this overlap, or the ability to compare the probabilities of being captured, and thus limit the security of the statistical inferences that are drawn. For example, Polaris,

60. *Id.* at 6.
61. *Id.*
62. Bernard W. Silverman, *Modern Slavery: An Application of Multiple Systems Estimation* 1 (2014), https://www.gov.uk/government/publications/modern-slavery-an-application-of-multiple-systems-estimation.
63. *Id.* at 4.
64. *Id.*; Kevin Bales, Olivia Hesketh, & Bernard W. Silverman, *Modern Slavery in the UK: How Many Victims?* 12 Significance 16 (2015); Bernard W. Silverman, *Multiple Systems Analysis for the Quantification of Modern Slavery: Classical and Bayesian Approaches,* Royal Society of Statistics Discussion Paper (2019). *See also,* Kevin Bales, *Unlocking the Statistics of Slavery*, 30 Chance 4 (2017).
65. Jan Van Dijk, Peter G.M. Van Der Heijden, & Suzanne L.J. Kragten-Heerdink, *Multiple Systems Estimation for Estimating the Number of Victims of Human Trafficking Across the World*, University of Southampton Institutional Repository 23 (2016), https://eprints.soton.ac.uk/399731/.
66. Kevin Bales, Laura T. Murphy, Bernard W. Silverman*, How Many Trafficked People Are There in Greater New Orleans? Lessons in Measurement*, 1 J. Hum. Trafficking 7 (2019).
67. Ball, et al., *supra* note 59; Silverman, *supra* note 62; Van Dijk, Van Der Heijden, & Kragten-Heerdink, *supra* note 65; Bales, Murphy, Silverman, *supra* note 66.

an anti-trafficking charity based in the United States, collects data from its hotline, which averages about 30,000 reports of trafficked people per year, is susceptible to the "who did what to whom" model developed by AAAS and HRDAG, but the absence of multiple sources means that an estimation of true number of trafficked people is not possible.[68] The Counter Trafficking Data Collaborative operated by The International Organisation for Migration has a collection of data on 91,416 cases of trafficked people across the world, but it too uses a convenience sample from which very limited inferences are currently possible.[69] In similar fashion, Amy Farrell et al., have examined how crime reporting can be used as the basis for capturing human trafficking victimization.[70]

B. Standards-Based

In the field of human rights measurement, there has been a lot of development on the provision of data that draw heavily on the international law of human rights, or frameworks for standardized coding of human rights information into scales that provide comparable measures on human rights performance over time and space.[71] The work of Michael Stohl in the early 1980s started this approach, with the advent of the "political terror scale," a five-point scale, which is coded using the annual country reports from Amnesty International and the US State Department.[72] The scales are coded "5" for the worst performance and "1" for the best performance and now uses two coding teams per scale.[73] The relative agreement between these teams is subjected to inter-coder reliability tests with any remaining differences adjudicated by the research leadership team.[74] The Cingranelli and Richards Human Rights Data (CIRI and CI) project takes a similar approach and expands the number of rights beyond civil and political rights to cover some social and economic rights, including worker rights, a measure, which includes an assessment of

68. Polaris, *Our Work,* https://polarisproject.org/our-work.
69. The Counter Trafficking Data Collaborative (CTDC) can be found here: https://www.ctdatacollaborative.org/; The International Organisation for Migration (IOM) can be found here: https://www.iom.int/.
70. Amy Farrell, Meredith Dank, Matthew Kafafian, Sarah Lockwood, Rebecca Pfeffer, Andrea Hughes, Kyle Vincent, US Dept. Justice, *Capturing Human Trafficking Victimization Through Crime Reporting* (2019), https://www.ncjrs.gov/pdffiles1/nij/grants/252520.pdf.
71. *See* Landman, Studying Human Rights, *supra* note 6; Landman & Carvalho, *supra* note 6, at 64–90.
72. The Political Terror Scale, *History*, http://www.politicalterrorscale.org/About/History/.
73. The Political Terror Scale, *Documentation: Coding Rules*, http://www.politicalterrorscale.org/Data/Documentation.html.
74. This approach is similar to that employed by Freedom House, which generates annual political rights and civil liberties scores, but without discernible source material or inter-rater reliability tests.

the degree to which forced labor is present in any given country-year.[75] The political terror scale features widely in a range of political science articles and socio-legal studies on the explanation of variation in human rights practice on the one hand, or assessing the importance of human rights protection in explaining the variation in other variables of interest.[76]

With respect to modern slavery, there have been some new developments that see the application of standards-based data approaches that begin to map dimensions crucial to ending it by 2030. For a number of years, Jean Allain and Katarina Schwarz have been collecting and collating data on anti-slavery legislation for all 193 UN member states.[77] Much like other work on human rights treaty ratification, their work has looked at the degree to which countries participate in relevant international legal instruments, and the implementation of these obligations in states' domestic legislation prohibiting and criminalizing slavery and related practices.[78] One should not underestimate this task, as much of the domestic legislation is only in the local language of the member states. While slavery has been abolished worldwide, Table 2, compiled from their work, shows that there are varying degrees of participation in the core international instruments, while their analysis shows that there is much work to be done at the domestic level to make slavery (as well as related practices) a criminal offence in all countries.[79] They argue that anti-slavery groups, activists, scholars, and practitioners have wrongly assumed that slavery was illegal everywhere, when in fact it is only criminalized formally in 53 percent of countries in the world.[80] Like the extant research on the importance of human rights law for the protection of human rights in practice, there is a strong argument that an important step in the fight to end slavery must include strong domestic legislation that criminalizes the practice and empowers law enforcement agencies to address the problem.[81]

Alongside this coding of rights-in-principle, two efforts code country performance for workers' rights, the right to work, and forced labor. As described above, the collection of seventeen different rights in the Cingranelli

75. David L. Cingranelli, David L. Richards & K. Chad Clay, CIRI Human Rights Data Project: The Cingranelli-Richards (CIRI) Human Rights Data Project Coding Manual 65 (2014).
76. *See* Steven C. Poe & C. Neal Tate, *Repression of Human Rights to Personal Integrity in the 1980s: A Global Analysis*, 88 Am. Pol. Sci. Rev. 853 (1994); Foweraker & Landman, *supra* note 43; Steven C. Poe, C. Neal Tate & Linda Camp Keith, *Repression of the Human Right to Personal Integrity Revisited: A Global Cross-National Study Covering the Years 1976–1993*, 43 Int'l Stud. Q. 291 (1999); Hathaway, *supra* note 22; Todd Landman, *Quantitative Analysis, in* Research Methods in Human Rights 94 (Lee McConnell & Rhona Smith eds., 2018).
77. OHCHR, *supra* note 5.
78. *Id.*
79. *Id.*
80. *Id.*
81. *See* Landman, Protecting Human Rights, *supra* note 22; Simmons, *supra* note 22; Christopher J. Fariss, *The Changing Standard of Accountability and the Positive Relationship Between Human Rights Treaty Ratification and Compliance*, 48 British J. Pol. Sci. 239 (2018).

and Richards Human Rights Data Project include variables on worker rights.[82] The coding for this variable includes: (1) the right of association; (2) the right to organize and bargain collectively; (3) a prohibition on the use of any form of forced or compulsive labor; (4) a minimum age for the employment of children; and (5) acceptable conditions of work with respect to minimum wages, hours of work, occupational health and safety.[83] These data have been used, for example, in studies on structural adjustment, trade, and direct foreign investment and range from 0 (no worker rights protection) to 2 (full worker rights protection).[84] Figure 1 shows the mean worker rights protection score for all countries (n = 160) by year for the period 1980 to 2015. It is clear from the figure that globally, worker rights protection shows increasing improvement up to the late 1990s, after which it declines markedly until the end of the period.[85]

The Human Rights Measurement Initiative (HRMI) includes data coded on the general category of the right to work.[86] Using a standards-based framework, the HRMI uses country and regional experts to code civil and political rights protection.[87] For economic and social rights (of which the right to work is one), the HRMI uses publicly available aggregate statistics to measure "how well each country is doing relative to what is feasible for a country with that level of economic resources."[88] This idea of *relative* performance comes from the work led by Sakiko Fukuda-Parr, Terra Randolph and Susan Lawson-Renner on the Social and Economic Rights Fulfillment Index (SERF Index).[89] The data is not coded on an interval scale, *per se*, but are standardized across all countries in what is called the "achievement possibility frontier" and range from 0 (no fulfillment of the right to work) to 100 (full fulfillment of the right to work).[90] Figure 2 is a bar chart of the HRMI right to work score for the period 2006 to 2015, which shows a relative score that dips for the period 2010 to 2014 and then recovers to the level observed in 2006.[91] While not a measure of slavery, *per se*, the score captures the relative ability of the population to access paid employment

82. Cingranelli, et. al., *supra* note 75.
83. *Id.*
84. *See* M. Rodwan Abouharb & David L. Cingranelli, Human Rights and Structural Adjustment (2007); Eric Neumayer & Indra De Soysa, *Globalisation, Women's Rights and Forced Labour*, 30 World Econ. 1510 (2007).
85. Cingranelli, et. al., *supra* note 75.
86. Human Rights Measurement Initiative (HRMI), *Measuring Economic and Social Human Rights*, https://humanrightsmeasurement.org/methodology/measuring-economic-social-rights/.
87. *Id.*
88. *Id.*
89. *See* Economic and Social Rights Empowerment Initiative, *About Us*, https://serfindex.uconn.edu/about-us/.
90. Sakiko Fukuda-Parr, Terra Lawson-Remer, & Susan Randolph, Fulfilling Social and Economic Rights 43 (2015).
91. Human Rights Measurement Initiative, *Measuring Civil and Political Human Rights*, https://rightstracker.org/en/metric/work.

given the overall economic capacity.[92] If these right to work data from the HRMI are broken down across low and high income countries, it is clear that even after controlling for the relative economic capacity of countries, high income countries have a greater fulfillment of the right to work (see Figure 3).

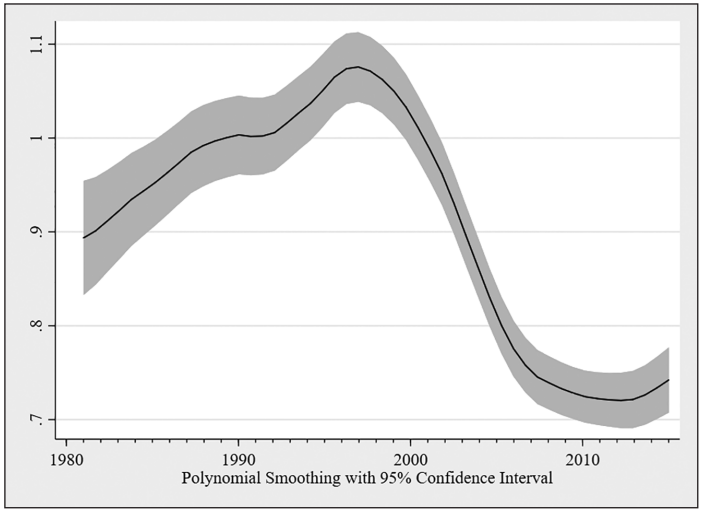

Figure 1. Worker Rights Protection, 1980–2015[93]

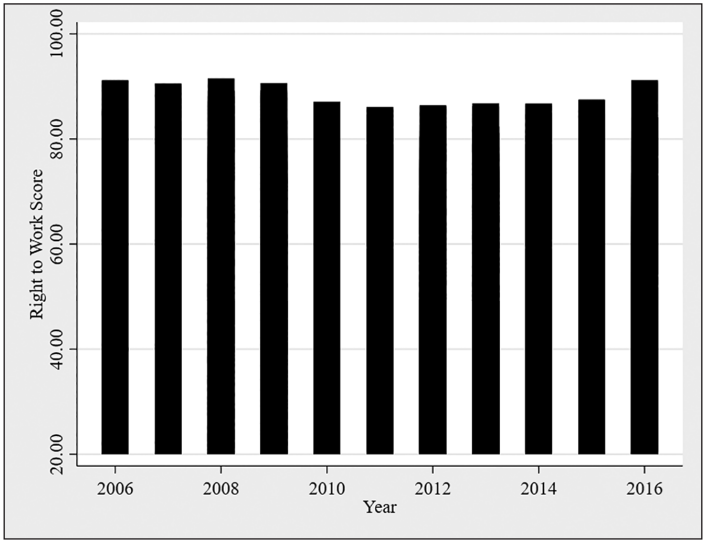

Figure 2. Right to Work Score, 2006–2015[94]

92. *Id.*
93. Cingranelli, et al., *supra* note 74.
94. HRMI, *supra* note 86.

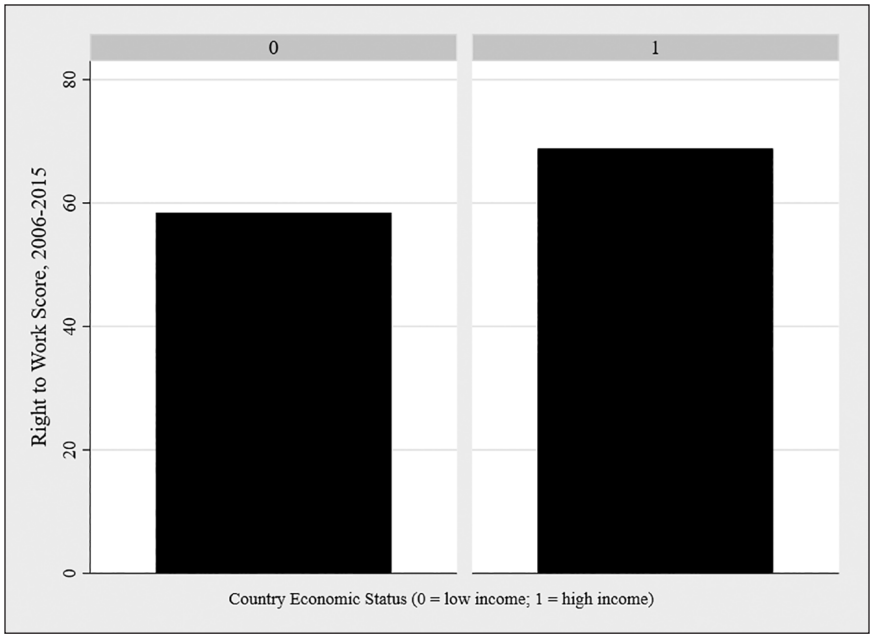

Figure 3. Right to Work Score, mean by country economic status, 2006–2015[95]

C. Survey Based

Random sample surveys with well-designed instruments have been a mainstay tool of the social sciences and, in public opinion, research organizations more generally. These approaches use structured, semi-structured, and open survey tools to uncover perceptions, attitudes, and real life experiences of individuals. They are based on specific research objectives, a sampling frame, a sample, data collection, and descriptive and second-order data analysis. The approach can be used for revealing human rights abuses and has been adopted in work estimating the prevalence of modern slavery. Large-scale surveys, such as the World Values Survey (WVS) and the Eurobarometer (and other regionally-based 'barometer' studies), as well as surveys conducted by polling organizations such as Pew, Gallup, and YouGov, have carried out research on public opinion, attitudes, and perceptions on human rights conditions, which can be aggregated for cross-national comparative analysis.[96] For an actual estimation of human rights abuses, which are sparse and

95. *Id.*
96. The World Values Survey has questions on civil rights and freedom from oppression and a question about the general state of human rights. *See* http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp

affect very small numbers of individuals, organizations such as Physicians for Human Rights (PHR) have focused their attention on sampling frames that comprise those parts of the national population that would most likely be affected by human rights abuse or repression.[97] For example, PHR has focused on internally displaced people (IDP) during periods of conflict in Sierra Leone to determine the degree to people suffered from sexual violence.[98] Truth Commissions, such as the one held for East Timor, used retrospective mortality surveys to uncover human rights abuses carried out by the Indonesian army, which can then be triangulated with other sources of data collected through different means.[99]

The ILO has spent years developing principles and standards for collecting national level measures on data. One of the main motivations for developing their approach is to ensure a higher level of compliance with internationally-agreed concepts, standards, definitions and classifications, favouring the harmonization and comparability of data across countries and over time.[100] Rather than implementing ILO-led survey approaches to measuring different dimensions of labor, the organization has moved to the idea of providing principles, frameworks, and guidelines for national statistical offices to collect data on the labor force in the same way to meet the ILO's compliance requirements and international statistical standards. Their work is important for capturing the nature, extent, and conditions of work across a wide range of occupations and sectors. Their guidance on decent work is aligned with Sustainable Development Goal 8, which commits states to "[p]romote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all."[101] Their SDG indicators of relevance to this article include "the situation of youth in the labour market and the eradication of forced labour and the worst forms of child labour."[102] In 2005, the ILO presented the first set of global estimates of forced labor and in 2012 published their guidelines on how to conduct national level surveys on forced labor and child labor, which was fortified further through a Resolution at the 2013 International Conference of Labour Statisticians (ICLS).[103] Their 2017 Global Estimates of Modern Slavery, delivered in col-

97. Physicians for Human Rights, War-Related Sexual Violence in Sierra Leone: A Population-Based Assessment (2002), https://s3.amazonaws.com/PHR_Reports/sierra-leone-sexual-violence-2002.pdf.
98. *Id.* at 1.
99. The statistical methods are found in: Annex on Data and Statistical Methods, § 12 (2005), http://www.etan.org/etanpdf/2006/CAVR/12-Annexe2-Data-and-Statistical-Methods.pdf.
100. ILO, Decent Work and the Sustainable Development Goals: A Guidebook on SDG Labour Market Indicators (2018), https://www.ilo.org/stat/Publications/WCMS_647109/lang--en/index.htm.
101. *Id.* at 2.
102. *Id.* at 3.
103. *See* ILO, Report II: 19th International Conference of Labour Statisticians (2013), https://www.ilo.org/wcmsp5/groups/public/---dgreports/---stat/documents/publication/wcms_220535.pdf

laboration with the Walk Free Initiative and the International Organisation for Migration (IOM), show that 24.9 million people were in some form of forced labor in 2016, and an additional 15.4 million people were in a forced marriage. Of the total 40.3 million people in modern slavery, 71 percent were female, 50 percent were in debt bondage, and 25 percent were children.[104] The figures for forced labor are further broken down into state-imposed forced labor, forced labor exploitation, forced sexual exploitation of adults, and commercial exploitation of children.[105] These totals vary across regions with the total population considered to be in conditions of modern slavery (forced labor and forced marriage) estimated at 9.24 million in Africa, 1.95 million in the Americas, 520,000 in the Arab States, 24.99 million in Asia and the Pacific, and 3.59 million in Europe and Central Asia.[106]

In addition to, and ultimately in partnership with, the ILO, Walk Free—an anti-slavery NGO and part of the Minderoo Foundation[107]—has used surveys administered by Gallup to collect data on individual vulnerability to modern slavery across an increasing number of high prevalence countries. Through their *Global Slavery Index (GSI)*, Walk Free estimated that in 2013 there were 29 million people in modern slavery, followed by 36 million in 2014, and 45.8 million in 2016.[108] The ILO and Walk Free joined in a partnership in 2017 and estimated the number of people in modern slavery to be 40.3 million. In its 2018 GSI, Walk Free then moved beyond the global and regional estimates of slavery provided with the ILO in 2017, by taking the prevalence estimates from countries in which Gallup administered surveys to provide country level prevalence estimates (n = 48) using hierarchical Bayes models of estimation.[109] In this method, respondent-level survey data and country-level predictions were used to provide estimates of modern slavery prevalence across 167 countries in the world. They used individual and country level variables that have a significant relationship with forced labor and forced marriage to develop a base model that achieved a balance between its predictive capacity and its geographic coverage.[110] They then used this base model to extrapolate beyond the original forty-eight countries.[111] Using just the prevalence estimates for those countries in which

104. ILO & Walk Free Foundation, Methodology of the Global Estimates of Modern Slavery: Forced Labour and Forced Marriage 9–10 (2017).
105. *Id.* at 17.
106. *Id.* at 19.
107. See Minderoo Foundation, *Walk Free*, https://www.minderoo.com.au/.
108. ILO & Walk Free Initiative Global Slavery Index 2016 (2016) [hereinafter Global Slavery Index 2016], https://www.globalslaveryindex.org/resources/downloads/.
109. ILO & Walk Free Initiative Global Slavery Index 2018 (2018) [hereinafter Global Slavery Index 2018], https://www.globalslaveryindex.org/resources/downloads/.
110. *Id.*
111. This method is not without its risks, the results of which should report, like events-based data, the confidence intervals around the prevalence figures that have been estimated. For further discussion from Bernard Silverman, Delta 8.7, *Symposium: Demonstrating Risks*

surveys were carried out for the 2016 and 2018 editions of the GSI, it is possible to provide basic descriptive statistics. Figure 4 shows a histogram for the prevalence measure for seventy data points for the raw estimation of the percentage of total population that is considered to be in a condition of modern slavery. The histogram for the raw figures shows that there are a large number of countries with a fairly low prevalence of slavery and a very small number of countries with a high prevalence of slavery. Plotting across regions, Figure 5 shows that there is higher prevalence in Asia and lower prevalence in Europe and the Americas.[112]

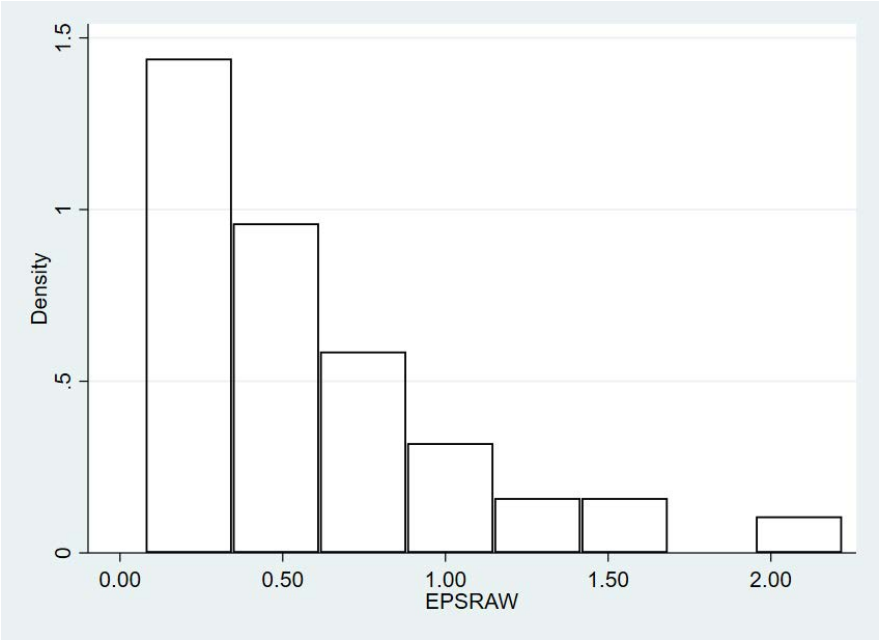

Figure 4. Histogram of slavery prevalence (n = 70)[113]

is not the Same as Estimating Prevalence (12 Dec. 2018), https://delta87.org/2018/12/demonstrating-risk-not-same-estimating-prevalence/.

112. *See* Todd Landman & Bernard W. Silverman, *Globalization and Modern Slavery,* 7 Pol. & Governance (2019). This article uses non-random sampling methods ("network scale up" and "respondent-driven sampling") as a means to estimate prevalence more quickly and less expensively than random methods. For more information on the sampling methods, see https://delta87.org/2018/10/actionable-cost-effective-prevalence-measurement-end-modern-slavery/; *see also* https://www.gfems.org/portfolio.

113. Global Slavery Index 2016, *supra* note 108; Global Slavery Index 2018, *supra* note 109.

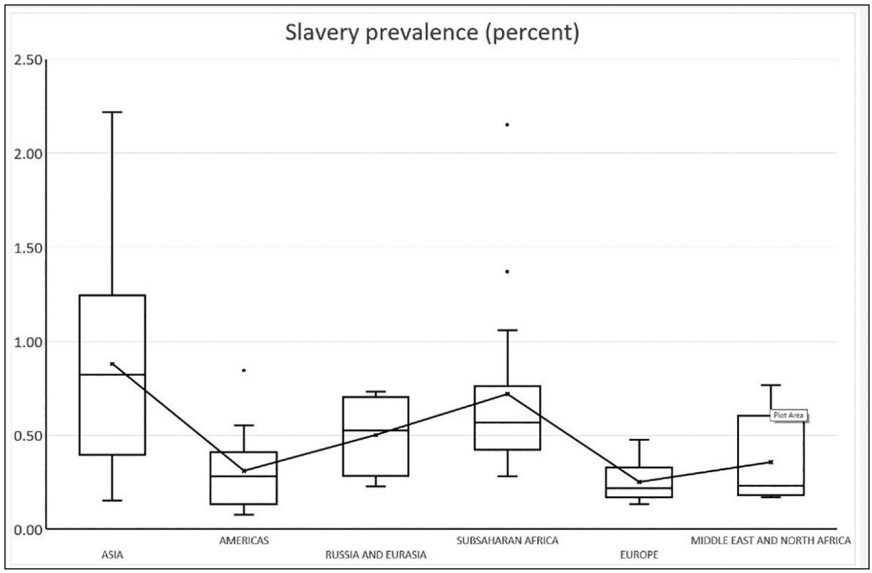

Figure 5. Box plot for slavery prevalence by region (n = 70)[114]

Other survey-based approaches to estimating prevalence include cases of trafficking in San Diego,[115] forced marriage and child bearing of Myanmar women in China,[116] and minors exploited in the adult entertainment sector in Kathmandu, Nepal.[117] In these cases, the methodologies combine qualitative in-depth interview data with quantitative household survey data. The China study finds that 39.8 percent of respondents experienced forced marriage, where respondents answered yes to at least one question relating to them being trafficked.[118] The Nepal study finds that 1650 minors (±23) are working

114. Global Slavery Index 2016, *supra* note 108; Global Slavery Index 2018, *supra* note 109; Landman & Silverman, *supra* note 112.
115. Sheldon X. Zhang, Michael W. Spiller, Brian Karl Finch, & Yang Qin, *Estimating Labour Trafficking Among Unauthorized Migrant Workers in San Diego*, 653 Annals Am. Academy Pol. Sci. 65 (2014) [hereinafter *Estimating Labour*]; Sheldon X. Zhang & Li Cai, *Counting Labour Trafficking Activities: An Empirical Attempt at Standardized Measurement*, 8 Forum on Crime & Soc'y 37 (2015) [hereinafter *Empirical Attempt*]; Wayne J. Pitts, Kelle Barrick, Sheldon X. Zhang & Pamela K. Lattimore, *Estimating Labour Trafficking Among Farmworkers: An Inverse Sampling Strategy Based on Reliable Housing Predictions*, 1 J. Hum. Trafficking 117 (2015).
116. W. Courtland Robinson & Casey Branchini, Johns Hopkins Bloomberg School of Public Health, Estimating Trafficking of Myanmar Women for Forced Marriage and Childbearing in China (2018) [hereinafter Robinson & Branchini 2018 Report].
117. Meredith Dank, Kyle Vincent, Andrea Hughes, Niranjan Dhungel, Sunita Gurung & Orla Jackson, Research Prevalence of Minors in Kathmandu's Adult Entertainment Sector (2019), https://d1r4g0yjvcc7lx.cloudfront.net/uploads/20190612195109/Prevalence-of-minors-in-Kathmandus-adult-entertainment-sector-FINAL-print.pdf.
118. Robinson & Branchini 2018 Report, *supra* note 116, at 3. The criteria are: (1) Did not cross the border on own free will and the decision was made by someone else (excluding

in adult entertainment venues in Kathmandu, an estimation based on fifty in-depth interviews and surveys from a sample size of 600 workers.[119] The data collection for the Nepal study uses the content from Article 3 of the 1999 Worst Forms of Child Labour Convention.[120] The age breakdown comprises 55 percent 18–21 years of age, 36 percent 15–17 years, and 9 percent 14 years and under.[121] 91 percent of the sample were female.[122] The data also reveals that 20 percent of the sample experienced restrictions of freedom at work, and 72 percent experienced violence at work.[123] The research on trafficking among migrant workers in San Diego adopts a similar methodology in developing a legally and theoretically grounded survey instrument,[124] GPS enabled sampling strategies of households,[125] and systematic data collection to estimate trafficking prevalence.[126]

D. New Forms of Data

In following Moore's Law on the rapid growth in computing technology,[127] the last few years has seen an explosion of both data and the means with which to analyze it. The advent of the internet has made increasingly complex forms of data more readily available, while the expansion and use of social media and other sharing platforms have created new forms of data. These so-called big data include text and words from users across the world, images from users and satellites, and other kinds of data that are increasingly available in the public domain.[128] Alongside this growth in available data, tools for analyzing it have evolved in ways that now make it possible to provide new insights into the nature and extent of modern slavery. Computational science and artificial intelligence (AI) allow for new kinds of statistical inference to be carried out on large and complex forms of data. The Human Rights Data Analysis Group (HRDAG) has developed

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family members), (2) Decided to leave based on the advice of someone else (excluding family members), (3) Spent most of their travel journey to China with a recruiter or broker, (4) Travelled with a recruiter or broker to reach final destination in China, and/or (5) Their marriage was arranged by an unrelated adult.

119. Dank et al., *supra* note 117, at ii.
120. Worst Forms of Child Labor, *supra* note 19, art. 3.
121. Dank et al., *supra* note 117, at 7.
122. *Id.* at 8.
123. *Id.* at 20–21.
124. Zhang & Cai, *Empirical Attempt*, *supra* note 115.
125. Pitts et al., *supra* note 115.
126. Zhang et al., *Estimating Labour*, *supra* note 115.
127. Arnold Thackray, David C. Brock & Rachel Jones, Moore's Law: The Life of Gordon Moore, Silicon Valley's Quiet Revolutionary (2015).
128. *See* Megan Price, Anita Gohdes & Patrick Ball, *Updated Statistical Analysis of Documentation of Killings in the Syrian Arab Republic,* OHCHR & HRDAG (Aug. 2014), https://hrdag.org/wp-content/uploads/2014/08/HRDAG-SY-UpdatedReportAug2014.pdf.

human supervised machine learning techniques to estimate the number of people who have died in the conflict in Syria between March 2011 and April 2014,[129] the location of mass graves in Mexico,[130] and the patterns of discourse among and between human rights perpetrators.[131] For Syria, their analysis combined an initial automated review of records of deaths in the conflict with other sources, to find that there were 191,369 unique killings for the period under consideration.[132] For Mexico, they used a "random forest" model of known and unknown sites across Mexican municipalities to provide an estimate of the total number and location of graves for the whole country.[133] With regards to the perpetrators in Mexico, they apply machine learning and AI to large volumes of text messages among perpetrators to tease out those that are related to the abuse of human rights.

These techniques are equally applicable to providing new data and insights into modern slavery. One way to use these techniques to measure modern slavery is to identify objects and potential sites that have a high probability of the presence of modern slavery and then use machine learning and AI on "training sets" to make estimates for larger geographical areas. The "Slavery from Space" research program at the University of Nottingham's Rights Lab[134] has engaged in such techniques on fisheries, mines, brick kilns, quarries, and charcoal production farms.[135] Google Earth is a platform for imagery captured by satellites owned by DigitalGlobe and Airbus, which produce a large number of images of the surface of the earth with varying degrees of resolution on a regular basis.[136] Such images have been the mainstay data source for the field of "earth observation" (EO) and geospatial analysis, which can be used to identify and count sites known for the presence of modern slavery. In the brick making industry, for example, NGOs and anti-slavery activists estimate that up to 96 percent of the labor force is engaged in some form of bonded labor or modern slavery in India, where the identification and enumeration of brick kilns can assist organizations with their work in addressing the problem of slavery in this industry.[137]

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129. *Id.* at 1.
130. Monica Meltis *New Results For The Identification Of Municipalities With Clandestine Graves in Mexico,* HRDAG (23 Nov. 2017), https://hrdag.org/2017/11/23/new-clandestine-graves-mexico/.
131. Price et al., *supra* note 128, at 10–12.
132. *Id.* at 1, 3.
133. *Id.*
134. University of Nottingham, *Fighting Slavery from Space,* https://www.nottingham.ac.uk/vision/in-focus/2018/summer/slavery-space.aspx.
135. *See e.g.,* Giles M. Foody, Feng Ling, Doreen S. Boyd, Xiaodong Li, & Jessica Wardlaw, *Earth Observation and Machine Learning to Meet Sustainable Development Goal 8.7: Mapping Sites Associated with Slavery From Space,* 11 Remote Sensing 266 (2019).
136. For example, Planet takes a picture of the entire surface of the earth every twenty four hours.
137. Anti-Slavery International, Slavery in India's Brick Kilns & the Payments System 3 (2017), https://www.antislavery.org/wp-content/uploads/2017/09/Slavery-In-Indias-Brick-Kilns-The-Payment-System.pdf.

Brick production, in the so-called "brick belt" of South Asia (India, Pakistan, Bangladesh, and Nepal), involves brick kilns, which have a unique shape that is discernible from space. They are elliptical with a tall chimney and area of cleared land surrounding them. Using early crowdsourced and human-coded training sets, the Rights Lab project then used machine learning and AI to search large volumes of images to identify brick kilns across the brick belt. The challenges for this kind of analysis, much like other probabilistic statistical models, is to reduce the number of Type I and Type II errors, which is to say, reduce the number of false positives (identifying something as brick kiln that is not a brick kiln) and false negatives (not identifying something that is a brick kiln). NGOs had originally believed that the brick belt had roughly 10,000 such kilns, but new analysis using this technique shows that the number is 55,387.[138] Like the estimation of killings in Peru during the period of conflict, the brick kiln work has changed the conversation and awareness about the industry, which is larger and more widespread than originally thought. While the analysis does not measure modern slavery, *per se*, it does provide a mapping of sites that have a very high probability of the presence of modern slavery, which can be used by NGOs on the ground to undertake carefully designed interventions.[139]

Table 3 summarizes these different examples of events-based, standards-based, survey-based, and new forms of data on modern slavery and human trafficking. The table shows that across different types of data and units of analysis there is a growing evidence base for modern slavery prevalence in specific geographical locations and most of the world. There are many limitations to these data sets including inherent biases in source material, sparse coverage across and between sources, and temporal and spatial coverage. These limitations, however, do not suggest that such efforts should be abandoned. Like other human rights data projects, incremental gains in knowledge through the development of greater specificity of concepts, better developed frameworks and guidelines, methodological innovations such as MSE, machine learning, and AI, as well as the increasing availability of new forms of data all suggest that measuring modern slavery is a fruitful and significant research enterprise.

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138. Doreen S. Boyd, Bethany Jackson, Jessica Wrdlaw, Giles M. Foody, Stuart Marsh & Kevin Bales, *Slavery From Space: Demonstrating the Role for Satellite Remote Sensing to Inform Evidence-Based Action Related to UN SDG Number 8,* 142 ISPRS J. Photogrammetry & Remote Sensing 380 (2018); Foody et al., *supra* note 135.
139. The Slavery from Space research program estimates that roughly a third of slavery may be detectible from space. *See* Observatory of Public Sector Innovation (OPSI), *Slavery from Space* (2018), https://oecd-opsi.org/innovations/slavery-from-space/.

Table 3. Examples of data sources for measuring modern slavery

Type of Data	*Units of Analysis*	*Geographical Coverage*	*References*
Events-based	Individuals	UK, New Orleans, Netherlands	Bales, Hesketh and Silverman (2015) Bales, Murphy, and Silverman (2019) Silverman (2019) Van Dijk, Van der Heijden, and Kragten-Heerdink (2016) Farell et al. (2018)
Standards-based	Country-year	Global ($160 \leq n \leq 218$)	Allain and Schwarz (n.d.) Cingranelli and Richards (2014)
Survey-based	Individuals	Global ($48 \leq n \leq 167$) San Diego China Nepal	Walk Free (2016, 2018) ILO (2018) Zhang et al. (2014) Zhang and Cai (2015) Pitts et al. 2015 Robinson (2018) Dank et al. (2019)
New Forms of Data	Objects/Sites	Bangladesh, India, Nepal, Pakistan	Boyd et al 2018 Foody et al 2019

IV. SUMMARY AND IMPLICATIONS

This article has demonstrated that efforts to measure modern slavery have made great strides and that many of the achievements in the measurement of human rights are equally applicable to modern slavery. Modern slavery encompasses a significant subset of human rights with express legal articulation, codification, and prohibition. It remains a complex and contested concept, rendering its measurement challenging. However, there has been much clarification of the definition of slavery since its first articulation in the 1926 Slavery Convention. The desire to measure slavery dates to the abolitionist movements of the eighteenth and nineteenth centuries, and these efforts developed alongside those that have sought to measure human rights. Like other human rights, the practice of modern slavery remains elusive, hidden, and difficult to observe. The article has shown that data techniques and measurement strategies have been devised to provide direct and indirect measures of slavery that are proving useful to the movement to end it by 2030 in line with the aspirations of SDG 8.7. Events-based data, standards-based data, survey-based data, and the analysis of new forms of

data provide a variety of different ways to measure a social, political, and economic phenomenon that remains largely unobservable.

There are a number of common themes across all of these different measurement strategies that are also common to other human rights measurement efforts. First, all modern slavery measurement strategies rely on raw data sources. Second, a coding or counting step gives numerical expression to different categories and dimensions of slavery, converting the raw source information into some form of quantitative data (or scores on units). Third, there is an analytical step that yields descriptive statistics or more complex bivariate and multivariate second-order analyses that combine or compare the data across different categories, variables, and dimensions. Finally, there is a step that allows for the production of useful outputs that help us understand different aspects of modern slavery, including: (1) prevalence counts or objects and sites significantly related to modern slavery prevalence; (2) explanations and modeling of prevalence; and (3) predictions and estimations of prevalence. Figure 6 depicts this modern slavery measurement data generating model and its various components.

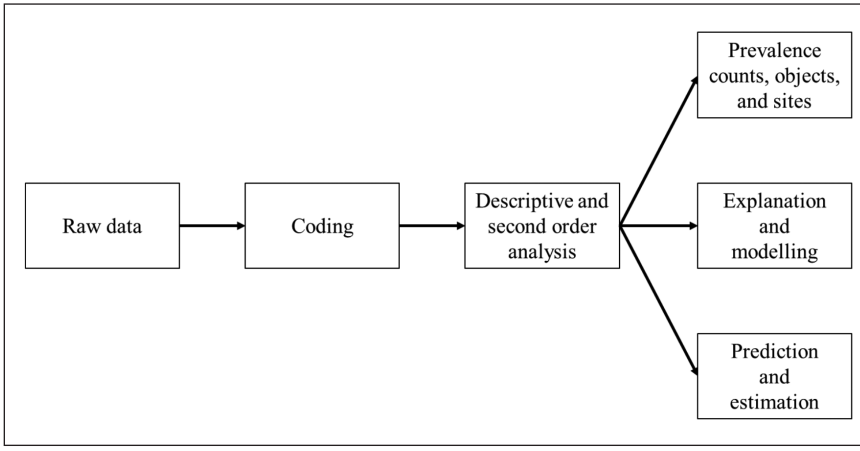

Figure 6. modern slavery data generating model

Measuring modern slavery is not an end in itself. Rather, it is crucial for a wide range of other uses. First, robust measurement of modern slavery over time can be used for mapping change in prevalence over time and space. While this is not yet possible, it should be a goal of the measurement community. Second, modern slavery measurement allows for monitoring, evaluation, and impact assessment of direct and indirect interventions to

reduce.[140] It provides baseline and ongoing assessments to determine the degree to which anti-slavery interventions make a difference to reducing slavery, through either contribution or direct attribution.[141] Third, modern slavery measurement provides an evidence base for concerted advocacy efforts aimed to raise awareness about the problem across a variety of policy communities. Finally, measuring modern slavery is a vital component to the overall strategy to end it by 2030. There continues to be much work needed conceptually and methodologically, but the lessons of human rights measurement provide a useful contribution to this ongoing and much needed area of work.

140. Katharine Bryant & Todd Landman, *Combatting Modern Slavery Since Palermo: What do we Know About What Works?* J. Hum. Trafficking (2019).

141. Pauline Oosterhoff, Danny Burns, Sowmyaa Bharadwaj, Rituu B. Nanda, Participatory Statistics to Measure Prevalence in Bonded Labour Hotspots in Uttar Pradesh and Bihar: Findings of the Baseline Study (2017), https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/13294/Participatory_statistics_to_measure_prevalence_bonded_labour_hotspots_Uttar_Pradesh_Bihar-Updated.pdf;jsessionid=A9317C95EEA3913A4B24E29D1FFA353C?sequence=3. *See also* Pauline Oosterhoff & Danny Burns, *Participatory Statistics to Measure Prevalence in Bonded Labour Hotspots in Uttar Pradesh and Bihar: Report of Preliminary Findings of the Baseline Study* (2017) https://www.ids.ac.uk/publications/participatory-statistics-to-measure-prevalence-in-bonded-labour-hotspots-in-uttar-pradesh-and-bihar-report-of-preliminary-findings-of-the-baseline-study/.