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Agency and social constraint among victims of domestic minor sex trafficking: A method for measuring free will

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ABSTRACT

Human agency has been a focus of philosophical and sociological concern from early debates about "free will" to recent themes in poststructuralism. Debates over the proper understanding of structure, agency, and constraint are hindered by the fact that few if any empirical measures of these concepts have been proposed. As sociologists have long recognized, the total results of the decisions of a group's members can be viewed as a distribution, and parameters can be fit to obtain a description of observed distributions. Here we propose the use of negative binomial curve to model population survival outcomes, and suggest that the parameters of such a curve represent reasonable surrogates for measures of agency, opportunity, and constraint when the decision process can be thought of as akin to a Bernoulli process. To provide an illustration of this approach, we discuss participation of legal minors in commercial sex (commonly referred to as victims of domestic minor sex trafficking (VDMST) or commercially sexually exploited children (CSEC)). In popular and advocacy-based accounts, considerable focus has been placed on the relative powerlessness of female VDMST. Using the proposed modeling technique, we test the extent to which male versus female VDMST appear to possess greater agency (or function under more limiting constraint) when deciding whether to remain in sex work or "leave the life". Contrary to existing literature, our results indicate that male and female underage sex workers are experiencing similar levels of agency, and differ mainly in opportunity, and constraint. Other individual circumstances are shown to contribute to varying levels of agency and constraint among sex workers, including street work status, community trouble, drug use, and the availability of an alternative income.

1. Introduction

The concept of human agency has been discussed at regular intervals within the social sciences for more than a century (Sztompka, 2014), peaking in the so-called "structure versus agency debates" in the 1960–80s (Alexander, 1988). The roots of the debate are much older, of course, arising in theology and philosophical circles in their earliest days and providing current philosophical debates with concepts such as compatibilism, libertarianism, and anti-determinism (Dennett, 1984). Differences between philosophical and social science approaches are significant, however. Sociologist James Coleman (1986) sees much of the debate on individual action by philosophers from the 1600s to the 1900s as continuing a much older debate on "free will". He notes that for the period leading up to the modern social sciences "individuals were viewed as purposeful and goal directed" (p.1310) with considerable emphasis given to natural and religious constraints. Social science approaches have somewhat different roots, however, with much

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greater emphasis on the conditions of early industrial modernity, urbanism and secularization (Dupré, 1995; Pfau, 2013). Since Durkheim (Pope, 1973) and Mead (Mead, 1913, 1934), a notion of social structure has emerged that qualifies agency and individuality by paying greater attention to its social (rather than divine) limits. Here individual action is read as "social action", meaning activity and decisions that, though carried out by an individual, necessarily reflect the embeddedness of those decisions in the mores, values and understandings of the group (Coser et al., 1995). Indeed, one can read much of the intellectual history of sociology from Talcott Parsons onward as an attempt to specify and define a concept of social action, and understand how it comes to pass that so much of what we think of as our own decisions are actually made for us by the conditions of our lives (Parsons et al., 1965).

By the end of the 20th century, questions of social action reached an extreme with the emergence of theories of post-structuralism. Writers in this genre questioned the validity of the concept of individuality itself, finding virtually all action as embedded in linguistic and technological fields whose determinism dwarfed even that envisioned by Mead or Durkheim (e.f. Foucault, 1982; Haraway, 2013). Throughout sociology, by the late 20th century individual agency was examined by social scientists largely to the extent that it could be understood within the larger processes of language, labor, or state governance (Sewell, 1992). As Hays notes, for late 20th social science agency "can be understood as human social action involving choices among the alternatives made available by the enabling features of social structure, and made possible by a solid grounding in structural constraints" (1994, p. 64).

This shift was by not without dissent, however. As Sewell (1992) argued, not *all* individual choices are pre-determined for social actors, regardless of social position. Even under extreme constraint, individuals continue to make choices which, regardless of how limited in scope, must still be thought of as an exercise in agency outside of structure. Pushback against totalizing theories of structure were advanced by Emirbayer and Mische as well, who provided a concept of human decision making that invokes an individual's consideration of her past, present, and possible futures (Emirbayer and Mische, 1998). Anthropologist Gerald Sider advanced a similar theory of individuals that are at once "within and against" the social structures they occupy, with an ability to exist outside of structure that is rooted in their capacity to recognize and resist structure itself. Highlighting the centrality and ubiquity of the human faculty for forethought and reflection, Sider points out that people everywhere think about the future—and more so, think about the relationship between their current means and conditions and the likelihood of seeing a future they hope for. This faculty necessarily restores a measure of "agency" to individuals, regardless of their structural position (Dombrowski, 2014; Sider, 2003).

The vigor of the debate over structure, free will, agency, and constraint masks (or is perhaps aided by) the fact that few empirical measures of agency or constraint have been proposed by any of the social scientists involved (Lavazza and Inglese, 2015). Numerous measures have been proposed for the belief in free will/agency, e.g. (Nadelhoffer et al., 2014), measures of self-control (Baumeister, 2014), and neuroscience evidence of pre-disposition (Libet, 1985, 1999). While there is considerable prior work in psychology on the *sense* of agency (Haggard and Eitam, 2015; J. W. Moore, 2016) and its measurement (Tapal et al., 2017), in these investigations, the emphasis has been on quantifying the extent to which individuals report the registration that they are the initiator of their own actions, and on analyzing factors impacting such perceptions (or lack thereof). In this paper, we will not explore the subjective experience of free will, and will instead focus on objective measures of its varied manifestations. In political science and economics, on the other hand, the "agency problem" is postulated as a dynamic between *two* autonomous individuals, the principal and the agent (Eisenhardt, 1989). Here the agent is to contractually perform a task on behalf of the principal, and a problem arises due to incentives and the presence of discretion in task completion, which can cause the agent to be motivated to act in a manner that is not favorable for the principal (Ross, 1973). While it may be possible to reformulate this theoretical framework to settings in which the principal and the agent coincide, i.e. where the principal represents stasis and the agent represents transformation, we are unaware of any such reformulation and will not attempt to achieve this here.

The focus and contribution of this research is methodological, with VDMST being a means to illustrate the application of new statistical techniques. We refer the reader to considerable research literature exploring issues surrounding VDMST (Choi, 2015; Kotrla, 2010) and gender in the context of VDMST (J. L. Moore, Houck, Hirway, Barron and Goldberg, 2017; Okech et al., 2018), which are substantives areas worth investigating, and extending far beyond the methodological frame we adopt here. We choose to follow historical norms in referring to our VDMST subjects as "victims", though we note that this article seeks to explore the complex issues of agency and constraint in the context of youth sex work.

In the course of our work, we follow the lead of Sider, Emirbayer and Mische, and others by invoking a notion of human reflection in the initiation of social action. In simplified form, we model the human capacity as a periodic exercise of stochastic contemplation, the actual execution of which is limited by a range of external factors. In an abstract sense, such a process is represented as periodically flipping a biased coin, and performing actions based on the accumulated results of those tosses. While such a model may sound overly simplistic (and it is), it is actually in line with "compatibilist" doctrines such as "deliberative indeterminism" (Dennett, 1981, 2014), and evolutionary models of "smart consciousness" emerging from neuro-cognitive approaches (Banja, 2015, and comments) where "critique and upgrade" cognitive functions are seen as intrinsic to human consciousness (2015, p. 7). These approaches can be seen as "compatibilist" in the sense that they do not see free will and social constraint as strict alternatives, but instead see determinism and choice/responsibility as elements of all human action, though the levels of these elements can vary considerably depending on circumstances. Our approach also seeks to reconcile the problematic relationship between "chance" and "freewill" identified by Ebert and Wegner (2011), whereby chance outcomes of both the subject and those she perceives are interpreted as freewill under experimental conditions. Here chance and free will are not seen as alternatives. Rather, we root choice in conditioned, repeated random outcomes such that those perceiving "free will" in the outcomes of this process would, in fact, be correct.

Neither are such simplifications very different from ordinary sociological depictions of social outcomes. When individual factors such as race or gender are used to model specific social data, this is not because these factors are seen to directly "cause" those

outcomes. Rather, the assumption is that the outcomes are caused by a host of recurring, stochastic actions that take place across a population, whose recognition or contemplation of the respective factor influences their own action. The result is that the final distribution varies according to the variable in question (i.e. race, or gender); but it would be a logical fallacy to see those attributes as "causing" the distribution to do so. The actions that underlie the final distribution are assumed to take into account the respective variable, but the specific mechanism of that influence is not seen directly. Rather, the influence of "race" or "gender" or any other social variable on the stochastic outcomes of myriad social actions are discoverable mainly in their cumulative effects, and only in the aggregate.

With respect to considerations of objective single-actor phenomena, significant effort has already been devoted to developing theoretical frameworks for evaluating *empowerment* (Kabeer, 1999) in terms of resources, processes of decision-making, and attainment of outcomes. These frameworks typically assess empowerment by considering (1) Existence of choice: whether an opportunity to make a choice exists; (2) Use of choice: whether a person actually uses the opportunity to choose; (3) Achievement of choice: whether the choice resulted in the desired outcome (Alsop and Heinsohn, 2005, p.7). These three axes have served to guide the design of numerous measures of empowerment, across a very broad range of contexts (Narayan-Parker, 2005), including international development (Ibrahim and Alkire, 2007), poverty (Narayan et al., 2009), and gender (Alkire et al., 2013; Elliott, 2007). The application of empowerment frameworks is wide-ranging; the World Bank's report on "Measuring Empowerment in Practice: Structuring Analysis and Framing Indicators" provides one example:

"To illustrate, if a team were trying to assess the degree of political empowerment of women, it would need to gather information on (1) whether opportunities for political participation exist, such as whether elections are held, and, if so, (2) whether women attempt to vote; and (3) whether they actually vote" (Alsop and Heinsohn, 2005, p.10, p.10).

Where others have used the tripartite rendering of empowerment to guide the *a priori* design comprehensive surveys from which to draw defensible conclusions about empowerment, we use these same three axes to define a 3-parameter model of agent self-transformation. Once established, the model will be used to carry out *a posteriori* inference on the varied nature of self-transformation processes among different subsets of a population of interest. Where previous research on structure and agency has to date been largely abstract and conceptual, our model-based approach provides a new quantitative framework through which hypotheses about relative agency, opportunity, and constraint can be empirically verified or refuted.

In what follows, our method builds on prior work by Ackerman and Khan fitting formal curves to social science data normally treated by survival analysis (Ackerman and Khan, 2012). Such an approach represents a subtle but significant departure from the ordinary method of demography. Survival analysis, like many sociological approaches, aims primarily at predicting aggregate *social outcomes* from a list of individual characteristics. In contrast, the approach undertaken here seeks to return to the question of *social action*—one that is rooted in a human capacity for reflection, forethought, and consideration of one's circumstances. While survival analysis aims to identify those factors that shape social outcomes, the current method seeks to understand how some of these same factors seem to influence a process of stochastic contemplation—contemplation aimed at undertaking a specific social action. Although social action was once a main object of sociological inquiry (Coleman, 1986), recent sociology has seen it replaced by model building aimed at ever greater and more rigorous predictive capacity for aggregate social outcomes. The results of these models hold obvious actuarial significance, but they seldom pose or answer questions of social action, and as such, provide only a limited advance in our understanding of human social being. Our approach seeks to restore a notion of subjectivity to what have increasingly become the pure objects of sociological inquiry, even while retaining the formalism and rigor found in current sociology.

We view social action as rooted in stochastic contemplation, a simplified understanding of individual decision making that sees the contemplative act as repeatedly tossing a biased coin. Each contemplation (i.e. toss of the coin) contributes to the final impetus to act, providing suggestions to action ("success/heads/yes"), or the lack of such a suggestion ("failure/tails/no"). When sufficient impetus has been accumulated and exceeds a threshold, the individual acts. In such a Bernoulli system, the existence of choice (1) is reflected in the number of coin tosses; the use of choice (2) is reflected in the probability of success, and the achievement of choice (3) is reflected in the threshold of impetus. The time required for an individual to execute a decision in such a system necessarily follows a negative binomial distribution. Such distributions are governed by three parameters: (1) the maximum number of tosses in the game (needed to tie a potentially infinite series to a set of finite, empirical data). (2) the bias of the coin, and (3) the cumulative number of successful throws necessary to "end the game" (i.e. commit the social act under consideration).

In what follows, the frequency with which individuals (in the population of interest) flip coins is taken as a measure of their agency or will (with more frequent tosses being taken to be more frequent contemplation of committing the act); the bias of the coin being used is taken as a measure of their opportunity to act (or freedom of action); finally, the cumulative successes needed to exercise the decision (in effect, "to act") is taken as a measure of the external constraint placed on the decisions of the individual even where both will and opportunity are present. These three parameters N (number of tosses), P (the bias in coin), and R (the number of "successful tosses" required to execute the action) offer a potential scaffolding for questions of action, agency, and structural constraint. They also offer possible interpretations well-suited to a compatibilist understanding of free will that separates *freedom of will* from *freedom of action* (Albritton, 1985; Watson, 1987). In this view, all persons are free in their desire for difference, but are not necessarily free to pursue every desire, or every aspect of their desire. Action, in this sense, is limited by circumstances, but deliberation on even unachievable actions goes on.

One immediate advantage of this approach is that the three axes N, P, and R provide a means to quantify a wide range of subjective positions, from highly constrained individuals with low agency and opportunity, to others whose positions are characterized by high agency, low opportunity, and altogether different levels of social constraint. This represents an advance over current modeling approaches that place considerable emphasis on population means rather than the total distribution of population outcomes. A three-parameter formulation is thus an advance on what has often been seen as an either/or proposition in the social

sciences, whereby agency is presented as the inverse of constraint. When all three measures can vary independently, and indeed must do so in order to fit different aggregate outcomes, a strict opposition between agency and constraint can be avoided, allowing far greater descriptive and analytic power. In the examples that follow, we show clear evidence that differences across distinct classes of actors requires, and gains much from, the freedom to vary across three independent axes (agency, opportunity, and constraint).

To provide an illustration of this approach, this paper discusses the participation of legal minors in commercial sex (commonly referred to as victims of domestic minor sex trafficking (VDMST) or commercially sexually exploited children (CSEC)). In popular and advocacy-based accounts, considerable focus has been placed on the relative powerlessness of VDMST (Marcus et al., 2011; Weitzer, 2007; Weitzer et al., 2014a,b). This includes firsthand accounts of personal domination (Lloyd, 2012) that mark sex workers as "passive and disempowered victims exploited and coerced into sex work" (Minichiello et al., 2013, p. 264). Academic research on (frequently unmarked) female sex workers often echoes this approach. It is common in this literature to read of coercion into sex work by male partners or "pimps" (Norton-Hawk, 2004; Tyler and Johnson, 2006; Williamson and Cluse-Tolar, 2002) who facilitate females into sex work through a number of techniques, including drug addiction, violence, and affection/love (Kennedy et al., 2007), often leading to conditions of complete powerlessness for their victims.

This view is underwritten by an unstated assumption that the powerlessness of VDMST is related to gender differences between victims and their controllers/clients. Most research on sex workers makes use of feminine pronouns and nearly eighty-five of the articles reviewed by Dennis (2008) focused on female sex workers only, though only seventeen percent noted that fact or provided any rationale behind that decision. In contrast, seemingly different assumptions about agency and constraint apply when researchers focus on underage *male* sex workers (Romesburg, 2009). Those few studies that focus on males report mixed evidence for exploitation and individual agency (Minichiello et al., 2013). Studies of male VDMST tend to focus on HIV/AIDS risk to the larger population rather than domination and entrapment (Mimiaga et al., 2009; Simon et al., 1994; Timpson et al., 2007). This focus is closely related to the fact that research on male sex workers often focuses on their sexual orientation. Dennis (2008) found that only one article about female sex workers discusses their sexual orientation, while every article on male sex workers reports on their sexuality (see also Bimbi, 2007).

In what follows, we use empirical data on lifetime participation rates of VDMST to ask whether and to what extent male versus female participants appear to possess greater agency, or function under more limiting constraint, when deciding whether to remain in sex work or, by contrast, deciding to "leave the life". While our method does not propose an absolute measure of agency, opportunity, or constraint, it does allow us to compare the extent to which different values for each of these parameters describe the differential outcomes of one sub-population versus another.

1.1. Approach

Our method will be illustrated by way of a specific example. Suppose we want to answer the question of whether VDMST who have alternative means of income experience different levels of agency, opportunity, and constraint compared to those for whom sex work is their exclusive means of financial support. Answering such a question requires us to first (1) collect data from a sample of VDMST who have alternate incomes ("yes"), and from another sample of those who do not ("no"). Next, we (2) model the observed data from each of these two samples, under the hypothesis that the data arose from an underlying process of "stochastic contemplation". As described previously, our models will contain 3 free parameters related to the underlying distribution of the model: N (number of tosses), P (the bias in coin), and R (the number of "successes" required to act). We add a time-scale constant T (the total amount of time in years over which the process of contemplation is seen to take place in the sample). Modeling the data involves (2a) finding the best parameter settings (N, P, R values) for each of the two sets of observations. This optimization is done relative to (2b) a concrete measure by which we compare how well a particular set of parameter values explains the observed data. With two models in hand (one for each of the two samples), we will (3) assess the extent to which each model fits its data (a scenario in which the model fits well signals a world that is consistent with our hypothesis) and (4) compare the parameter values of the two fitted models. Such a comparison (where well-fit models can be found) allows us to reflect on the "stochastic contemplation" processes of the two populations in comparison to one another. To illustrate the technique by way of a concrete example, we apply this 4-step sequence to quantify the difference *in decision-making* of those who have alternative means of income, versus those for whom sex work is an exclusive means of support, specifically with respect to the *processes by which individuals come to commit the act* of leaving "the life".

(1) Data collecting and processing: In seeking to measure the impact of individual characteristics on the amount of agency and constraint experienced by individuals of a given class, we partition the population according to that class (e.g. those "with alternative income" versus those with "no alternative income"). We ask all individuals, irrespective of class membership, to disclose the amount of time they have spent "in the life", to date. Each individual's answer is then doubled and used as proxy to how long they will have been in the life at the moment when they commit to the act of quitting. This doubling is justified by appealing to Lindy's Law which, informally stated, asserts that, for certain kinds of entities, expected remaining lifetimes increase as they grow older. The law is observed to hold in diverse contexts such as the lifetimes of institutions, technology, books, music, art, and ideas (Mandelbrot, 1982), which exhibit a kind of anti-fragility (Taleb, 2012). Both observed that Pareto's Law implies Lindy's Law (Reed and Jorgensen, 2006), and that the former manifests in power-law statistics of large samples, as are frequently encountered across the sciences (Gott, 1993), including in economics (Chatterjee et al., 2005), demography [(Krugman, 1996), linguistics (Serrà et al., 2012), scientific productivity (Lotka, 1926), networks (Albert and Barabási, 2002). Although human lifespans, by virtue of their finiteness, clearly do not follow Lindy's Law, here we will be considering only a small initial segment of lifetimes of individuals, and within that segment, the contiguous duration of time that they engage in sex

work. As a consequence, in what follows, we disregard truncation effects due to human lifespans, and assume that "duration of engagement in sex work" satisfies a power law distribution, and hence Lindy's Law. Under this assumption, when arrivals and departures are governed by a stochastic process, a randomly selected individual will be discovered, on average, at the mid-point of their participation period. While doubling the time period has the consequence that some participants are inferred to continue sex work beyond the age of minor, this does not impede our modeling the decision process by which individuals end involvement with sex work—more specifically, their opportunities, their use of said opportunities, whether their use of the opportunities brings about a transformational change. The net result of this step is that we obtain two distributions O^{yes} and O^{no} which describe the *observed* distributions of expected decision-making time, for those who do and do not have alternate means of income, respectively.

(2) Model building and curve-fitting: In this step, we model observed data from each of these two classes under the hypothesis that they arose from an underlying process of "stochastic contemplation". For each observed sequence, we find the best-fit parameter settings by computing its Shannon-Jensen distance (D).

(2a) To discover best fit curves, our approach is to compare the distribution of observed data collected in Step (1) against theoretical parameterized distributions, seeking optimal parameter values that yield the closest correspondence. The theoretical distribution we use is a revised negative binomial distribution (BIN) having three free parameters: the maximum number of tosses (N), the bias of the coin where the probability of a successful toss is constant (P), and the number of successful tosses (R) that must be reached for the game to be over. The classical negative binomial distribution is revised by assigning the residual likelihood that an individual departs after $>$ N tosses equally amongst the events of departing at tosses 1, …, N. The parameter N thus reflects a hard upper bound on the total number of tosses permissible. In addition, we add a fixed parameter (T) representing the time in which the N tosses must take place. This was a practical consideration to allow this approach to be applied to decision-making under conditions of actual observed data (which do indeed take place across a fixed amount of time). We set T to a constant value that is twice the maximum observed duration of participation in years. Note that N and T are positive integers, and P and R are real numbers. Each concrete choice of concrete values N, P, R, T produces a distinct distribution BIN(N,P,R; T).

(2b) At the core of the optimization process of (2a) we are required to quantify the alignment between two distributions. For this we use a measure referred to here as D (referred to here as the Shannon Jensen distance). The metric D quantifies the difference between two probability distributions by building on the concept of information radius (IRAD), a symmetrized and smoothed version of the Kullback-Leibler divergence (Briët and Harremoës, 2009; Taneja, 1989). Given two distributions P and Q, the Kullback-Leibler divergence between them is defined as:

$$KL(P||Q) = \sum_i P(i)\, log \frac{P(i)}{Q(i)},$$

and the information radius between P and Q is then:

$$IRAD\ (P||Q) = \frac{1}{2} KL(P||M) + \frac{1}{2} KL(Q||M),\ \ where\ M = \frac{1}{2}\ (P + Q)$$

The square root of IRAD is a metric is referred to here as Shannon-Jensen distance (D) (Endres and Schindelin, 2003; Österreicher and Vajda, 2003). When D between two distributions is close to zero, they are very similar, and when it is close to 1, they are very different; D has many desirable properties, including the fact that it defines a metric space on distributions.

By computing the Shannon-Jensen distance D between the observed distributions (O^{yes} and O^{no}, respectively) against each possible BIN(N,P,R; T) in the universe of all negative binomial distributions, we find the parameter values that yield the closest fit. An iterative search process is employed to scan the space of parameter settings by way of stepwise, nested loops across a range of settings for each of N, P, and R. The outcome of this step is that we obtain the two *fitted* distributions F^{yes} and F^{no} which most closely approximate the observed distributions O^{yes} and O^{no}. The formal description of the curve-fitting process is given in the appendix, as Algorithms 1, 2, and 3. The results of the search process for our two classes (alternative income "yes" versus "no") are seen in Fig. 1, where heat maps show the distance between the observed distribution O^{yes} and $O^{no}$and each point in P-R space. Darker regions show a closer fit, while lighter regions indicate larger distance. It is clear from the images that the two classes show quite different patterns of distance across P-R space. The best fitting parameter set for those with alternative income ("yes") is P = 0.21, R = 4, and for the other ("no") group, the minimum occurs at P = 0.07, R = 2.1. Note that the figures present a 2D projection of what is in fact a 3D optimization across three parameters N, P, and R.

(3) Model evaluation: After the second step, we have produced a parameter set (N, P, R) that yields the minimum Shannon-Jensen distance for each observed sequence. Fig. 2 shows the observed and fitted distributions for the "yes" and "no" classes associated with alternative income. Fig. 2a shows the observed sample distribution, while Fig. 2b shows the fitted negative binomial distributions whose parameters have been selected by the optimization process described in step (2). A visual representation of the observed and fitted distributions for each sample is seen in Fig. 2c ("yes") and Fig. 2d ("no"). From these figures, we can qualitatively check that the fitted distributions we obtained align well with the distributions in our observed data. We can render this alignment more precisely via the Shannon-Jensen distance between the observed distributions and the corresponding fitted distribution; this is 0.0990 for those with alternative income and 0.0552 for those without). We can also use Shannon-Jensen distance to quantify the difference between the "yes" and "no" classes; this is 0.1955 between the observed distribution, and 0.1900 between the fitted distributions). These four values are shown in Fig. 3, which depicts the relationships between the inputs and outputs to the fitting process.

To evaluate the accuracy of the model, we look first at the measure of D between fitted and observed distributions ($D(F,\ O)$) for

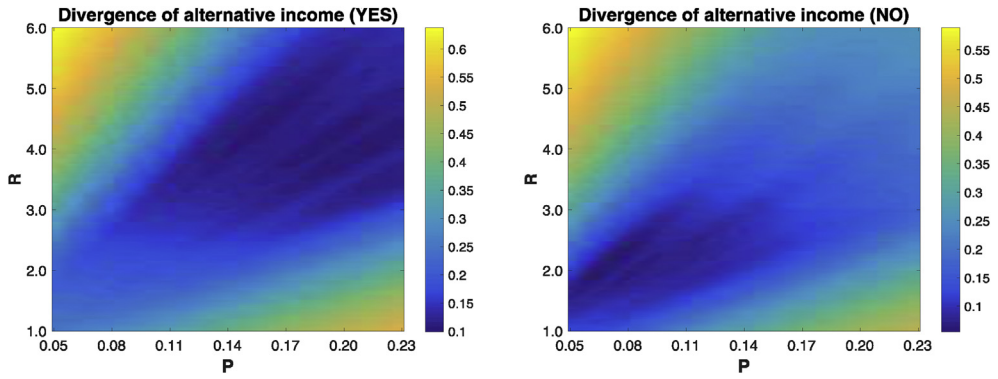

Fig. 1. Heat maps of the minimum Shannon-Jensen distance for the curve-fitting process plotted in the P-R coordinate system. We loop over N, P, and R spaces and color code D (BIN(N,P,R), O^{yes}) in the left panel; D (BIN(N,P,R), O^{no}) is similarly depicted on the right panels, respectively. Small D values represent a good fit and appear as dark regions of the parameter space. The best fitting parameter sets are seen to be $F^{yes}\sim$ BIN(50, 0.21, 4) for with alternative income group (left), and $F^{no}\sim$BIN(75, 0.07, 2.1) for the group with no alternative income (right). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

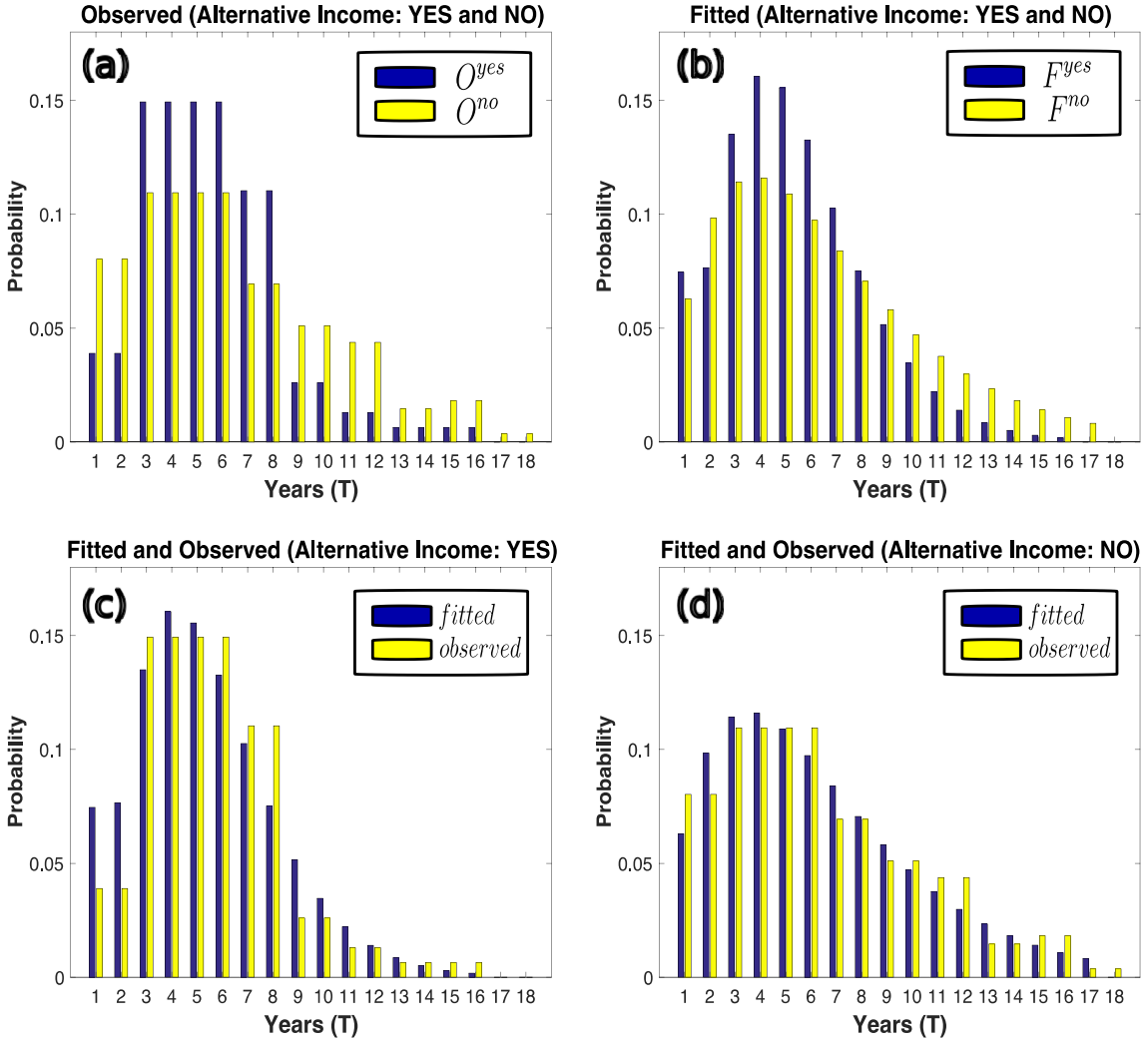

Fig. 2. For the variable "alternative income", we perform the maximum-likelihood-fit to "yes" and "no" classes. (a) shows the processed sample of the two groups; (b) shows the best-fit distributions from the two samples. (c) and (d) are the comparison of the best fit distribution and sample of "yes" and "no" groups, respectively.

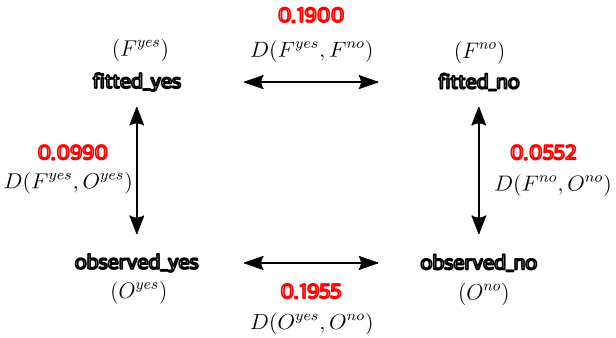

Fig. 3. Diagram of Shannon-Jensen distance (D) of the four alternative income distributions. The F^{yes} and F^{no} are the best fit revised negative binomial distributions for the O^{yes} and O^{no} distributions. Here we can see the distance for the observed versus fitted (optimal) (vertical arrows) are much smaller than the interclass differences in either the observed or fitted distributions (horizontal arrows).

each class of response. In Fig. 3, these are the vertical arrows, whose values represents the amount of error introduced to each class distribution in the fitting process. Where these values are small, we consider the fitted distribution to be a good representative of the observed data.

In addition, to evaluate the overall effect of the fitting process on the difference between the two classes, we can compare the values of D between the respective classes $D(F^{yes}, F^{no})$, $D(O^{yes}, O^{no})$, in the observed and fitted distributions (i.e. the difference in the values of the horizontal arrows in Fig. 3). To the extent that these values are similar, we interpret this to mean that the fitting process did not introduce any new/artificial distance between the classes. Where this value is large, we have reason to suspect that the differences between the parameter sets for the two classes may reflect error introduced in the curve fitting process, and not actual differences in the observed data. In the example, we can see from Fig. 3 that the $D(F^{yes}, F^{no})$ is smaller than the $D(O^{yes}, O^{no})$, and that $D(F^{yes}, O^{yes})$, $D(F^{no}, O^{no})$ are small compared to the first two distances. These findings indicate that the distance between the fitted representations is a lower bound on the actual differences between those who answer "yes" and those who answered "no" to the question of alternative income.

Interpreting the Shannon-Jensen distance can be difficult as the metric is uncommon and the model fitting described above is not amenable to conventional statistical error estimation. To provide a means for assessing the distances discussed in this example (and in the following analyses), we can make use of a perturbation example that provides an intuitive interpretation of the fit between the fitted distribution and the observed distribution it represents. The perturbation technique begins with a discrete, uniform distribution over 18 years, which we denote as UNIF. Then, we increase the probabilities of half of the sample by ρ% and decrease the other half by –ρ%; we denote this perturbed distribution as ρ*UNIF. Table 1 shows the Shannon-Jensen distance D (UNIF, ρ*UNIF) between the uniform distribution and its perturbation as ρ is varied from 5 to 50% The ρ value serves as an equivalent by which one can get an intuitive sense of the scale of Shannon-Jensen distances.

Using Table 1, we can evaluate the extent to which the *fitted* rendering of the distance between the "yes" and "no" classes retained the distance between these two classes in the *observed* distribution. The difference between $D(O^{yes}, O^{no})$ and $D(F^{yes}, F^{no})$ is 0.1955–0.1900 = 0.0055, which is equivalent to a perturbation ρ < 5%. This indicates that the process of rendering the distributions in fitted form retained the essential information about the differences between the classes relative to the observed data. In the results show below, we use this interpretive metric to provide an intuitive understanding of the overall alignment between the observed and fitted distributions. This value, $|\, D(O^{yes}, O^{no}) - D(F^{yes}, F^{no}) \,|$, is referred to in the following tables as the model's *distortion perturbation equivalent*. Where it is low, it indicates that very little information was lost in the curve fitting process (and thus the interclass differences we see in the final parameter sets are a good representation of the differences that exist between the classes in the observed data). Where this value is large, we have reason to be concerned about the overall error introduced by the fitting process.

(4) Interpreting the results: The same metric can be used to show the overall differences between the classes in the final results. The Shannon-Jensen distance between the fitted models of the yes and no classes from the alternative income example is $D(F^{yes}, F^{no})$ = 0.1900, which is equivalent to a perturbation of 51.8%. This indicates a significant difference in the subjective processes of stochastic contemplation experienced by those who have alternate means of income, and those who do not. Given this, we may

Table 1
Shannon-Jensen distances between a uniform distribution and its +ρ% / -ρ% perturbation.

ρ	D(UNIF, ρ∗UNIF)	ρ	D(UNIF, ρ∗UNIF)
5%	0.0177	30%	0.108
10%	0.0354	35%	0.126
15%	0.0532	40%	0.145
20%	0.0711	45%	0.164
25%	0.0892	50%	0.184

now attempt to interpret the differences in the best-fit parameters (N,P,R) for the two classes. These were computed in Step (2) as (N = 50, P = 0.21, R = 4) for those with alternative income group, and (N = 75, P = 0.07, R = 2.1) for those without.

It is important to note that these parameter values do not provide absolute measures of agency, opportunity, or constraint. They do, however, provide a means for comparison across the classes. In this case, the ratio of "yes" to "no" values for N/T, P, or R can be examined and conclusions about the impact of particular factors on each of the three interpretive axes can be drawn. Where similar values of N/T are found, this indicates that individuals are exercising similar rates of contemplating the act in question. In other cases where one class of individuals is showing higher rates of N/T, we consider this to be a reflection of greater agency—a more frequent rate of considering whether or not to perform a particular action. Similarly, for P: where large differences in the bias of the coin can be detected, this is interpreted by us to indicate differences in opportunity to act for members of that class. And finally, given that R is the number of successful throws against probability P for a given class, we interpret a greater value of R to indicate a higher level of overall external constraint acting to prevent the individual from acting on the most recent opportunity. In the event where R = 1, individuals would be free to act the first time the act of contemplation coincided with an opportunity to do so. In the case of R > 1, the individual is not free to act at the first opportunity, but must instead postpone that action due to aggregate external constraints. The more times an individual is forced to forgo the opportunity to act, the greater the constraint that class is said to experience.

1.2. Data

In the analysis that follows, a model curve is mapped to a set of empirical values from data on the participation of VDMST from the CSEC-NYC data set collected in New York City in 2006–7 (Curtis et al., 2008). These data include various individual characteristics such as gender, law enforcement histories, drug use habits, and so on that allow the population to be partitioned into non-overlapping classes, as well as reports of the amount of time each individual in that class has spent "in the life" (as study participants referred to it—meaning the amount of time each individual engaged in commercial or transactional sex as significant means for survival at the time of the interview). The CSEC-NYC study was funded by the National Institute of Justice and included interviews with self-identified male, female, and transgender youth who were currently employed in the commercial sex economy. Respondent Driven Sampling (RDS) was employed to recruit a sample of underage sex workers in New York City (Heckathorn and Cameron, 2017; Johnston et al., 2016). A total of 255 respondents were included in the original study. Data and documentation of the study data are available at the ICPSR data repository (ICPSR 34657). We note that the ICPSR public data contains only those records for which complete data was available, this study used the full original data set and listwise deletion for missing data.

Respondents in the study self-identified as male, female, or transgender. The original sample included interviews with 119 females, 111 males, and 19 transgender youth. Due to the small number of self-identified transgender VDMST, however, they were not included in the first analysis. The number of years that underage sex workers have been employed in the commercial sex economy ("time in the life") was created using three open-ended questions. The first two questions asked respondents, "How old were you when you first started having sex for money or in exchange for other things?" and "For how long have you been in the life?" Respondents provided the age at which they first exchanged sex (ranged from 9 to 19) and the age at which they "entered the life" (ranged from 11 to 19). The third question asked respondents their current age at the time of the interview (which ranged from 14 to 25). The age at which a respondent first exchanged sex and the age at which they entered the life were then each subtracted from their current age to obtain two numbers representing the number of years that a person has been a participant in the commercial sex economy. These two numbers were then averaged to create an estimate of the number of years that respondents have participated in the commercial sex economy (ranged from 0 to 9).

Responses were recoded into nine categories ranging from "$x \leq 1$ year in the life" to "$8 < x \leq 9$ years in the life." One male and one female respondent were excluded from the analysis of the classes related to gender because "time in the life" estimates could not be calculated based on their responses to interview questions. As a result, the gender analysis contains 226 respondents, 108 males and 118 females. The data for respondents in the analytic sample are presented in Table 1 ($n_{gender} = 226$). We note that both male and female respondents have similar distributions for time spent in the life, with a large number of both males and females clustered at the lower end of the spectrum and a small number clustered at the higher end. The average time spent in the commercial sex economy for males is 3.09 years and for females is 2.75 years.

Additional variables were also identified for their potential impact on overall levels of agency. Listwise deletion for missing data resulted in different analytic sample sizes (214–249 respondents) for these variables. They include *homeless* (replied Shelter, Squat/Abandoned Building, and/or Streets when asked "Where do you currently live?"), *working the streets* (yes/no to "Do you currently work the streets?", e.g. in contrast to those that recruit clients via indirect methods such as internet advertising), *street troubles* (yes/no to "Have you had any trouble with people in the neighborhood where you work?"), several forms of drug use including *marijuana* (replied yes to "What drugs do you take/use? – Marijuana) and *cocaine* (replied yes to "What drugs do you take/use? – Cocaine), and *alternative income* (yes/no "Do you have another source of income?"). Distributions of these data by years in the life (doubled) can also be found in Table 2.

2. Results

Table 3 presents the curve fitting results for the variable gender, containing the classes males and females. The curve that best corresponds to the distribution of time in the life for male VDMST is: $N = 73$, $P = 0.11$, and $R = 3.2$. According to the analogy presented above, male sex workers are flipping a coin that comes up heads roughly one in every ten time, 73 times in an 16-year

Table 2
Descriptive statistics of additional analyses.

Time in the Life (years)	Gender		Homeless		Working Streets		Street Troubles		Marijuana Use		Cocaine Use		Alternative Income	
	Female	Male	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
	Variable													
$0 \leq x \leq 1$	12	14	17	14	13	18	15	15	14	17	7	24	6	22
$1 < x \leq 2$	22	34	22	38	30	30	17	41	33	27	14	46	23	30
$2 < x \leq 3$	32	24	25	36	37	24	27	32	36	25	16	45	23	30
$3 < x \leq 4$	16	25	24	21	30	15	19	26	21	24	14	31	17	19
$4 < x \leq 5$	8	12	8	12	10	10	12	8	11	9	4	16	4	14
$5 < x \leq 6$	10	4	9	6	10	5	11	4	9	6	4	11	2	12
$6 < x \leq 7$	4	2	3	3	3	3	4	2	4	2	3	3	1	4
$7 < x \leq 8$	3	3	2	4	2	4	4	2	4	2	1	5	1	5
$8 < x \leq 9$	1	0	1	0	1	0	0	1	1	0	1	0	0	1
Total	108	118	111	134	136	109	109	131	133	112	64	181	77	137

Table 3
Curve fitting results for gender.

Variable	T	N	N/T	P	R	$D(O,\ F)$	Difference between $D(F^{male}, F^{female})$ and $D(O^{male}, O^{female})$	Distortion perturbation equivalent
Gender								
Male	16	73	4.56	0.11	3.2	0.103	0.0371	9.5%
Female	18	75	4.17	0.09	2.7	0.0828		
Ratio M/F		1.10	1.22	1.19	–			

period to decide whether to leave the life. This amounts to 4.56 coin flips every year. To commit the act of leaving, they must obtain 3.2 successful tosses cumulatively. The curve that best represents the distribution of time in the life for female sex workers is $N = 75$, $P = 0.09$, and $R = 2.7$. Using the same metaphor, female VDMST are flipping the coin with similar probability of success 75 times in an 18-year period to determine if they are able to leave the life, and this amounts to 4.17 coin flips every year. Females who receive 2.7 successful tosses then act to leave the life. According to these results, male and female VDMST are experiencing roughly the same levels of agency, but experiencing different levels of opportunity and constraint. Looking to the ratios for P and R, we see that males have moderately higher opportunity to leave the life, while females have somewhat lower levels of constraint (but probabilistically fewer opportunities).

Other variables also show varying differentiation among classes. The interclass ratios of N/T, P, and R for each variable are found in Table 4. The main results may be summarized as follows:

1) Street solicitation centric analyses indicate that those VDMST who are working the streets are experiencing 2.278 the agency of those not working the streets (in the sense that they "contemplated" leaving more than twice as often as the latter), but slightly smaller levels of opportunity (0.733) and greater overall constraint (1.789).
2) Results for street troubles (verbal or physical altercations with people encountered on the streets) indicated that those who reported altercations on the streets experienced 4.056 the agency of those who did not, and similar levels of constraint (0.867). This group also showed very low relative levels of opportunity (0.174).
3) Marijuana and cocaine use were examined separately to determine if substance use was associated with individual levels of agency, constraint and opportunity. The results indicate that marijuana users experienced lower agency (0.693) than non-users,

Table 4
Comparison results for additional analyses.

Variable	Relative Agency (N/T)	Relative Opportunity (P)	Relative Constraint (R)	Difference between $D(F^{yes}, F^{no})$ and $D(O^{yes}, O^{no})$	Distortion perturbation equivalent
Homeless/Not Homeless	0.755	1	0.813	0.0358	10.1%
Working Streets/Not Working Streets	2.278	0.733	1.789	0.0256	7.2%
Street Troubles/No Street Troubles	4.056	0.174	0.867	0.0522	14.7%
Marijuana Use/No Marijuana Use	0.693	1.385	1.038	0.00190	0.3%
Cocaine Use/No Cocaine Use	0.622	1.444	0.966	0.0423	11.9%
Alt. Income/No Alt. Income	0.750	3	1.905	0.00553	1.4%

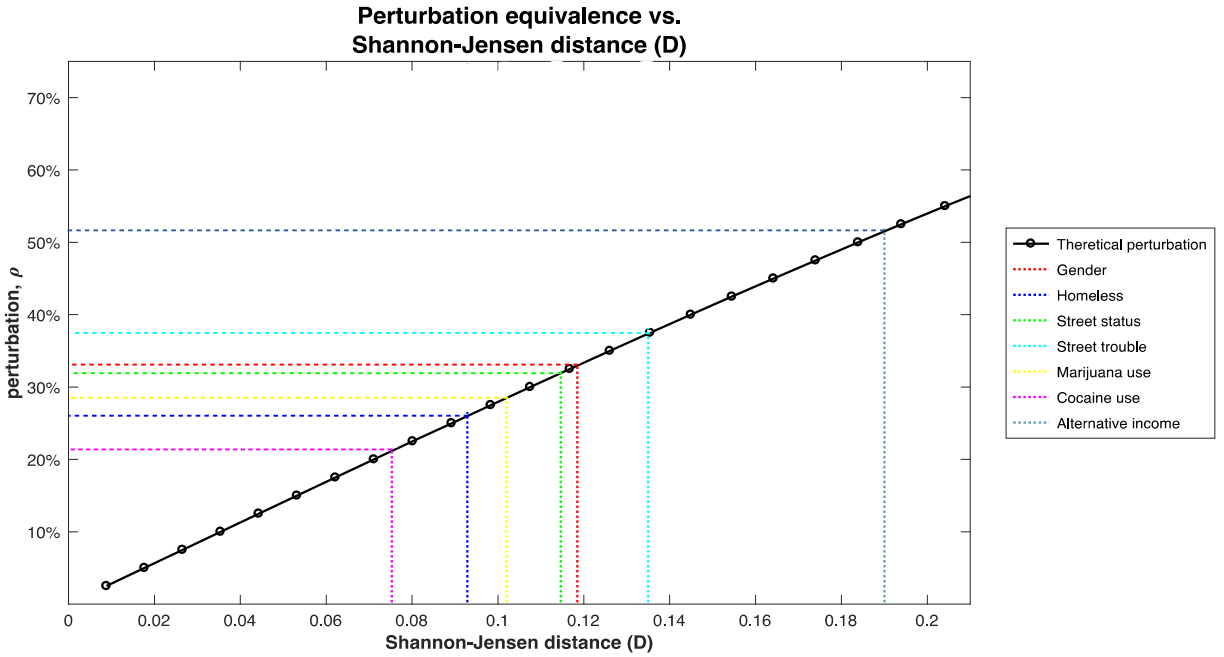

Fig. 4. Distortion perturbation equivalent versus Shannon-Jensen distance (D). We plot the $D(F^{yes}, F^{no})$ between the two fitted distributions and versus $D(UNIF,\ \rho{*}UNIF)$ the equivalent percentage perturbation from uniform—to help interpret the magnitude of interclass differences.

but overall had greater opportunity. The pattern was similar among cocaine users who demonstrated 0.622 the agency of non-users, and higher opportunity.

4) Homeless individuals are experiencing 0.755 the agency, the same opportunity, and 0.813 the constraint that individuals who are not homeless are experiencing.
5) And finally, those individuals with alternative sources of income experience 0.750 the agency, 3 times the opportunity, and 1.905 the constraint experienced by those who have no alternative income source.

The distortion values for each variable provide a sense of the overall fit of the modeling process. Here we see that in the group Marijuana Use, the distortion perturbation equivalent of the difference between the fitted and observed interclass Shannon-Jensen distance is very small, indicating that our best-fit distributions capture the underlying behavior very well. On the other hand, for the models associated with Street Troubles and Cocaine Use, the curve fitting process has introduced a perturbation equivalent difference of more than 10% to the underlying interclass distance. For these variables, any interpretation of the results may be questioned.

As a final point of comparison across variables, the perturbation equivalent of the interclass distance in the fitted model for each of the variables can be found in Fig. 4. This figure shows the extent to which each of the variables discussed here divides the total sample into distinct subjective positions with respect to agency and constraint. Here we see that cocaine use is among the least differentiated divisions (21.7%), while alternative income is among the highest differentiators (51.8%). Put another way, the latter seem to make the most difference in altering individuals' experience of agency, constraint, and opportunity away from an imagined baseline.

3. Discussion

The results of the empirical example are informative in two senses. In the first sense, these results suggest a different understanding of the levels of agency, opportunity and constraint experienced by VDMST. Existing literature on VDMST depicts males and females in very different ways. When discussing female VDMST, researchers often assume that female VDMST have very little agency in their decision to leave the world of commercial sex. Males are assumed to have agency by virtue of fewer structural constraints that force them to remain in the life. The latter are rarely portrayed as victims in the same manner as female VDMST. In contrast to existing literature, our results indicate that male and female underage participants in commercial sex are experiencing similar levels of agency, and generally small differences in opportunity, and constraint. This finding supports those researchers that see different portrayals of female versus male VDMST as rooted in interpretive bias rather than the actual circumstances of those involved (Bimbi, 2007; Dennis, 2008).

Apart from gender, other characteristics/circumstances seem to contribute much more clearly to varying levels of agency and constraint among VDMST, including street status, experience with street troubles, drug use, and the presence of an alternative income. Focusing mainly on those results with low levels of error introduced in the fitting process, we see that street status and having alternative sources of income provide the greatest differentiation between classes across agency, opportunity, and constraint.

Those working the streets think about leaving the life more often, but have lower levels of opportunity and higher levels of constraint than those who find customers through other means. These results can draw support from prior studies that describe street work as a more difficult survival strategy (Weitzer, 2005; Weitzer et al., 2014a,b). In contrast, those with alternative sources of income exercise less overall agency, but have much greater opportunity; yet they experience greater overall constraint. We hypothesize that alternative sources of income make it harder to move or relocate, even while they provide greater means to do so (Tyler, 2009).

In each of these cases, the ability of the method to capture three distinct aspects of individual agency/constraint can itself raise new sorts of questions. To the extent that alternative income seems to offer both greater opportunity *and* greater constraint, future research would do well to pose these questions directly—rather than simply assuming that greater financial options necessarily lead to greater freedom. Similarly, where both forms of drug use seem to indicate lower levels of agency but little difference in overall constraint, researchers may wish to reconsider the prevailing view that drug use contributes to ongoing reliance on sex work mainly due to issues of dependence on drug sources, rather than a reliance on sex work income to support a drug habit (Dalla, 2002).

In a second way, these results open the possibility of a new social scientific approach to the question of agency, opportunity and constraint. In contrast to survival analysis (Miller Jr, 2011)—which in this case would seek to explain variation in time "in the life" via a range of individual factors—our goal here is not to explain when or even why individuals leave. Rather, our purpose is to use survival data to inform models of social action. The main rationale for the essay—an attempt to create rigorous, plausible models for the relative quantification of agency and constraint—showed flexibility when applied across a range of variables. As importantly, and perhaps not immediately obvious initially, the approach found that our three parameters (agency, opportunity, and constraint) varied independently. Under these conditions, it is possible to talk about classes of individuals who have both high levels of agency and high levels of constraint (or other combinations). In the conventional sociological and philosophical literature agency and constraint are normally taken as alternatives. Here a more nuanced appraisal is possible.

4. Limitations

While this analysis provides novel means for examining these questions, it is not without limitations. First, the data used in the example analysis was collected through respondent-driven sampling. Respondent-driven sampling is a complex sampling method for studying hidden and hard-to-reach populations for whom traditional sampling methods are infeasible or unreliable. However, respondent-driven sampling does not necessarily result in representative samples. Therefore, the sample of underage sex workers utilized in this analysis may not be representative of all underage sex workers. Second, the study was conducted in New York City and it is plausible that the findings generated by this analysis are not generalizable to underage sex workers employed in other cities or areas of the United States. Underage sex workers in smaller cities may not experience the same levels of agency, opportunity, and constraint as those working and residing in a large metropolis, like New York City. Third, the variable created to measure "time in the life" was based on responses to two questions: one addressing the age at which respondents first reported engaging in sex work and the second addressing the age at which respondents perceived that they had "entered the life". This is potentially problematic given the possibility that sex workers can have multiple entries into and exits out of sex work. However, these measures were based on survey data that was collected at one time point and does not allow for longitudinal analysis of multiple entries and/or exits. Fourth, the variables used in additional analyses can also vary across time, which cannot be measured with the data available. Finally, the model used in this analysis has never been employed in this manner. Replication of these analyses with other data sources would allow for a better understanding of whether and how the model is able to capture meaning measures of agency, opportunity, and constraint.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ssresearch.2018.06.007.

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