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Reproductive decision-making under uncertainty: exploring the relationship of economic preferences and reproductive health

By

Deborah Karasek

A dissertation submitted in partial satisfaction of the

requirements for the degree of

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in

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of

The University of California, Berkeley

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Abstract

Reproductive decision-making under uncertainty: exploring the relationship of economic preferences and reproductive health

by

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Little research has examined how economic uncertainty and preferences affect decision-making surrounding fertility intention, contraceptive behavior and pregnancy outcomes – an area where intention-behavior inconsistencies are widely acknowledged. Risk preference are defined as a person's willingness to assume risk, and time preference as a person's degree of present bias. Measures of risk and time preferences that underlie decision-making have been linked to health behaviors, especially substance use. There is a long history in social science of examining how these preferences correlate with financial decision-making and behavior, and measures have therefore been included in population surveys to examine economic behavior. Far less frequent are analyses that examine how economic preferences may extend beyond financial behavior to explain behavior in other domains, such as health behavior. Sexual and contraceptive behaviors are influenced by uncertainty surrounding pregnancy risk, pregnancy intention, access to methods, sexual and reproductive control, as well as perception of STI risk. Decision-making theory may therefore be especially helpful to shed light on disparities in unintended pregnancy and contraceptive use.

Drawing on behavioral economics, this dissertation expands understanding of uncertainty and reproductive health decision-making in several steps. My three papers examine if there are general decision-making constructs, including risk-taking propensity and degree of present bias that may extend beyond financial decisions to health behavior and ultimately reproductive health outcomes. In the first paper, I review the state of the literature on temporal and risk preferences and sexual and reproductive health. Next, I examine how risk preferences are related to sexual behavior and contraceptive use in the National Longitudinal of Youth (NLSY97). Finally, I examine the relationship between national economic uncertainty and pregnancy intentions and outcomes in the National Survey of Family Growth (NSFG). This work draws on economics, psychology, and social epidemiology.

The goal of this research is to contribute to understanding the context of reproductive decision-making and behavior. This work deepens our understanding of the mechanisms underlying choices that drive health behavior. This is an important step towards predicting who will be at highest risk of adverse outcomes and develop models for intervention.

For my husband, Ben, and my son, Oscar, whose love, support and constant laughter got me through this dissertation.

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Chapter 1. Introduction

The way that people make decisions is of fundamental importance to epidemiologists seeking to understand health behavior. Eating, substance use, physical activity and sexual behavior result in differential health trajectories over the life course. The fact that unhealthy behaviors persist despite knowledge of risk has perplexed public health practitioners and led them to consider whether insights might be gleaned from behavioral economics – a field committed to explaining why humans act in ways inconsistent with rational self interest [1]. Sexual and reproductive behaviors are particularly relevant to study in the context of behavioral economics because the results of risky sex have delayed and uncertain consequences to health, such as pregnancies or STI acquisitions. Additionally, reproductive health researchers have long noted that sexual and contraceptive behavior may deviate from women’s stated intentions about pregnancy.

The field of behavioral economics is rising in popularity and quickly expanding into public health and social epidemiology [1, 2]. At the intersection of economics and psychology, research in this area attempts to explain human behavior [3, 4]. In particular, behavioral economics arose out of acknowledgement that standard economic utility maximization models poorly explain observed behavior, as people often deviate from purely “rational” choices [3]. If people act differently than we would predict from their apparent preferences, does that make them irrational? These systematic deviations offer a window into drivers of health behavior and potential points of intervention.

My dissertation applies decision-making constructs from behavioral economics to reproductive health outcomes. Specifically, I examine the tradeoffs between risk and reward and between now and later. These preferences are fundamental characteristics of decision-making. Risk tolerance and temporal discounting have been demonstrated to be drivers of financial behavior, and these same concepts have now been extended to the study of health behavior [9, 10]. Sexual behavior and pregnancy decision-making are an understudied and, as I demonstrate, particularly relevant area for exploration.

National and international public health priorities include reduction of unintended pregnancy [11]. Defined as pregnancies that are mistimed or unwanted, unintended pregnancies comprised 45% of all pregnancies to women aged 15-44 in the United States (US) in 2011. Half of those pregnancies ended in abortion [12]. Reproductive health literature reports inconsistencies between intention and behavior regarding contraceptive use and pregnancy. Nonuse or inconsistent use of contraception is common among women at risk of unintended pregnancy, meaning those sexually active with a stated desire not to get pregnant [13-17]. Misperception of pregnancy risk may also result in reduced contraceptive use and subsequent unintended pregnancy, regardless of knowledge of available methods [18, 19].

In my second chapter, I conduct a systematic scoping review of the literature on temporal and risk preferences, and sexual and reproductive health behavior. Temporal discounting is the rate at which people devalue delayed rewards in comparison to more temporally present rewards [5, 6]. Higher discount rates indicate less willingness to exchange current consumption for future consumption. Individual decision-making is also shaped by

perception of risk. Prospect theory describes decision-making in the context of risk [7]. Risk preferences are generally measured as willingness to take gambles with income [8]. People willing to take fewer gambles are generally deemed risk averse and those more willing to take gambles risk tolerant. I examine the consistency of findings from 20 studies identified to meet my inclusion criteria. Mapping the literature can identify common themes and gaps in current knowledge. While the majority of studies concern sexual risk behavior, I draw comparisons to outcomes of unintended pregnancy and contraceptive use. Finally, I make recommendations for future avenues of research based on the existing literature.

I expand the empirical research on economic preferences and reproductive behavior in my third chapter, which examines risk preferences and sexual and contraceptive behavior in the 1997 cohort of the National Longitudinal Survey of Youth (NLSY). I test the hypothesis that the propensity to take risk manifests not only in the financial decisions commonly studied by decision theorists, but also in less-well studied choices that affect reproductive health. I investigate the association of risk tolerance with several proximate determinants of unintended pregnancy, including high-risk sexual behavior, contraceptive non-use, inconsistent contraceptive use, and the effectiveness of contraceptive method type.

In addition to risk preferences and discounting, uncertainty affects reproductive decision-making and behavior. Variation in economic context may influence contraceptive and sexual behavior, thereby altering risk of unintended pregnancy and decision-making once a pregnancy has occurred. My fourth chapter examines how the recent Great Recession and economic uncertainty affect unintended pregnancy and pregnancy decision-making. I use the National Survey of Family Growth (NSFG), a nationally representative sample of reproductive aged women. Understanding how the economy affects pregnancy intention and decision-making brings insight to the discussion of decision-making and reproductive outcomes as well economic drivers of fertility.

The goal of this dissertation is to improve understanding of behavioral drivers of reproductive health. The incorporation of concepts from behavioral economics into reproductive health frameworks may improve our predictions of distributions of disease and also generate hypotheses of pathways between social environment and health [1]. It may be especially useful for behaviors that offer benefits, or “rewards”, in the present that offset future negative consequences, or “costs”, to health later. The chapters show that economic preferences and measures of uncertainty have implications for our understanding of mechanisms underlying choices that drive reproductive health. This is an important step towards predicting who will be at highest risk of adverse outcomes and potentially develop models for intervention.

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Chapter 2: The relationship of temporal and risk preferences with sexual and reproductive health: a systematic scoping review

Introduction

Although sexually transmitted infections (STIs) and unintended pregnancy have long been major public health concerns worldwide, unprotected sex and ineffective contraceptive use persist [1, 2]. Much literature shows that decisions affecting sexual behavior and fertility result from a complex process that involves norms, resources, knowledge, power, and individual tolerance for risk and propensity to make impulsive choices.

The fact that unhealthy behaviors persist despite knowledge of risk has perplexed public health practitioners and led them to consider whether insights might be gleaned from behavioral economics – a field committed to explaining why humans act in ways inconsistent with rational self interest [3]. Economists have theorized that individual behavior results from a desire to maximize utility, which varies based on individual preferences. These preferences, elaborated by behavioral economics, include the tradeoffs between risk and reward and between now and later, and are fundamental characteristics of decision-making. Risk and temporal preferences have been demonstrated to be drivers of financial behavior, and these same concepts have now been extended to the study of health behavior. Sexual and reproductive behaviors are particularly relevant to study in the context of behavioral economics because the results of risky sex have delayed and uncertain consequences to health, in the form of pregnancy or STI acquisition, and so risk and temporal preferences are particularly salient.

This review summarizes the scope of the literature relating temporal and risk preferences to sexual and reproductive behavior, to determine if discounting or risk tolerance are reliable correlates of choice relating to sex, pregnancy and STI risk.

I first describe background literature on sexual and reproductive health that is relevant to the application of temporal discounting and risk tolerance. Next, I briefly define temporal discounting and risk preferences and discuss relevant literature in other health domains. This background motivates the systematic scoping review of the literature on temporal discounting or risk tolerance and sexual and reproductive outcomes, which follows.

Background on sexual and reproductive health behavior

Nearly half of pregnancies to women aged 15-44 in the United States (US) are unintended [4]. These unintended pregnancies are associated with negative outcomes for mothers and children, including delayed prenatal care, maternal depression, lower quality of maternal-child relationship, and higher rates of preterm birth [5-9].

Unintended pregnancies, like many public health problems, concentrate among low-income women and women from minority racial/ethnic groups [10-12]. Young age, low education, previous pregnancies, non-married status, and urbanicity explain much but not all of the concentration of unintended pregnancy among poor and minority women in

developed contexts [10]. The consequences of unintended pregnancy are more severe in the developing world, and lead to excess maternal mortality, morbidity from births, and unsafe abortions [13].

Research reports inconsistencies in behavior and intention regarding contraceptive use and pregnancy. Nonuse or inconsistent use of contraception is common among sexually active women with a stated desire to avoid pregnancy [1, 14, 15]. Lack of information about method availability, especially long acting methods, appears more common among women reporting unintended pregnancy [16-19] [20].

Contraceptive use is influenced by a variety of system level factors, such as access and cost, as well as individual decision-making [21]. Research on attitudes toward contraceptives has, moreover, reported that fear of side effects or differences between desired and available method features also affect use [22-24].

Misperception of risk may also result in reduced contraceptive use and subsequent unintended pregnancy regardless of knowledge of available methods. A study of family planning patients found, for example, that nearly 46% of women who engaged in unprotected intercourse in the past 3 months underestimated the risk of conception and that underestimation predicted unprotected sex [25]. Similarly, a study of women seeking abortion services found that the majority of women thought themselves to have an inaccurate risk of pregnancy prior to conception [26]. A California study following young women who initiated a new method of contraception and who reported not wanting to be pregnant within a year found high rates of discontinuation over the year [27, 28].

Similarly in the field of sexual risk behavior, risk reduction strategies including condom distribution, increasing HIV/AIDS risk perception, and education have proven successful strategies at reducing some but not all sexual risk behavior [29]. A strong body of literature shows that sexual decision-making is often spontaneous and unplanned, especially in the context of alcohol or substance use [30].

The intuitive connection between individual decision-making and unintended pregnancy and STI risk behavior has lead reproductive health researchers to explore the field of behavioral economics. In a white paper, the Behavioral Economics in Reproductive Health Initiative (BERI) noted the opportunity to apply behavioral economics to global reproductive health concerns. They describe the importance of trade-offs between today versus tomorrow and of beliefs about probability in individual calculation of pregnancy or STI risk in reproductive decision-making [31]. These notions apply to earlier cited literature showing that people misestimate the risks of pregnancy and STIs and make impulsive decisions relating to sex.

Research into health decision-making more broadly has already borrowed from behavioral economics [3, 32-34]. Given the importance and persistence of sexual risk behavior and the gap between contraceptive use and intention, behavioral economics concepts would seem particularly useful for research concerned with reproductive health [21, 31].

Temporal discounting

Temporal discounting is the rate at which people devalue delayed rewards in comparison to more temporally present rewards [35, 36]. Higher discount rates indicate less willingness to exchange current consumption for future consumption. Delay discounting is typically assessed with hypothetical questions about different monetary amounts in the present or in the future. Most people would choose a higher amount of money over a lower amount if both were offered at the same time. However as the higher amount is delayed, individuals may switch to preferring the lower but sooner amount to the higher but later amount. The amount and delay at which the switch occurs is called the indifference point and can be used to calculate individual discount rates. Those with very high discount rates discount the future value of a reward steeply as the delay increases and, therefore, show a present bias. Those with lower discount rates seem to value the future more similarly to the present. The preference for smaller pleasures in the present to larger benefits in the future can explain certain behaviors like smoking again one day after you quit.

Probability discounting is similar to delay discounting, except that it measures a person's sensitivity to uncertainty rather than delay of rewards. While delay discounting assesses the tradeoff between an immediate and delayed reward, probability discounting assesses the tradeoff between a certain and probabilistic reward. In discounting tasks, if both larger and smaller rewards are certain, most people would prefer a larger amount. However as the probability of the larger amount decreases, there is a shift to the smaller, certain amount. Similar to delay discounting, the point at which a person switches from a larger less probable reward to a smaller certain reward is considered the indifference point of probability discounting. Probability discounting is closely tied to the concept of risk tolerance, as it is a measure of the degree of monetary risk someone is willing to assume.

Behavioral economists have posited that discount function is nonlinear over time and instead fits a hyperbolic shape, meaning that there is attenuation in the rate of devaluation with increasing delays [37]. Hyperbolic discounting reflects inconsistencies between long term goals and short-term rewards, and explains "impulsive" decisions as the value is discounted more steeply with shorter delays [36]. Present biased individuals make far-sighted plans when rewards are distant but often reverse their choices in favor of short-term rewards as the decision-point is reached.

Literature linking temporal discounting to health behavior has emerged. Researchers have proposed that temporal discounting relates to unhealthy behavior and explains inconsistencies between exhibited behavior and stated intention [38]. Health behaviors, including sexual risk behavior, often involve the present/future tradeoffs that are central to the concept of discounting. Unhealthy behaviors also typically have a delayed effect on health, such that one might not immediately experience loss of health or functioning. Indeed, the immediate rewards of the behavior often are so strong that they overpower the risk of future negative outcomes (e.g. unprotected sex and pregnancy risk). This has led researchers to propose that unhealthy choices may be related to an individual's temporal discount rate, or the degree to which they value present rewards versus future

outcomes [38]. Time preferences are related to health investment and health status [39] and self-reported health [40].

Several studies characterize addictive behaviors, including cigarette smoking, alcohol consumption and illicit drug use, as a special case of discounting [41-43]. A review of gambling and substance use studies found consistent evidence that high rates of discounting are associated with a range of addictive behaviors with adverse health consequences [44]. Discount rates are higher in smokers compared to non-smokers and also correlate with smoking frequency [45, 46]. Discount rates have also been linked to alcohol dependence [46], alcohol abuse disorder [47], and moderate levels of alcohol use, including heavy social drinking [48, 49]. These effects are seen early in life, as discounting is positively correlated with age of first alcohol use and number of passed out episodes among adolescents [50, 51]. Illicit drug use also shows a consistent relationship, with higher discount rates among heroin and opioid-dependent individuals compared to non-drug users [52, 53].

Discount rates have also been studied in relationship to eating behavior and obesity, and may be closely related to food rewards among children [54]. There are mixed results of monetary discounting and BMI in adults [55-58]

The tradeoffs between longer-term goals and immediate rewards of unprotected sex fit a discounting framework. A qualitative study exploring determinants of inconsistent contraceptive use found that eroticism of unprotected sex and misunderstanding the risk of conception was a powerful explanatory factor [59]. In one of the only articles to propose the connection between contraceptive use and behavioral economic interventions, Stevens and Berland note the connection of present-biased preferences to long acting reversible contraceptive (LARC) use [21]. They suggest that present bias in use of LARC could be leveraged by reducing the actual or perceived costs of obtaining LARC methods, such as higher cost if insurance is unavailable and discomfort of the procedure, in favor of long term benefits (highly effective at pregnancy prevention). While these types of changes to clinical encounters make intuitive sense based on behavioral economics, no research directly links delay discounting to contraceptive method choice. However, literature about other reproductive and sexual decisions may offer insight into the connection with contraceptive use.

Risk tolerance

Individual decision-making is also shaped by perception of risk. Prospect theory describes decision-making in the context of risk [60]. The theory posits that people take greater risks to avoid loss than to realize gain even if the loss and gain are equal. It has gained credibility in the arena of health decision-making in comparison to the standard economic model, which assumes people are rational agents who make choices to maximize utility. Risk preferences are frequently studied in social science and are established as strong determinants of financial decision-making, including investment and savings. Risk preferences are generally measured as willingness to take gambles with income [61]. People willing to take fewer gambles are generally deemed risk averse and those more willing to take gambles risk tolerant. Prospect theory also described loss

averse behavior in the context of risk, where individuals are more sensitive to potential losses than gains [62].

A few studies have examined risk preferences and health behaviors. Anderson found that an experimental measure of risk aversion was negatively associated with several health behaviors, including smoking, heavy drinking, obesity, and non-use of a seat belt [63]. A seminal study in the Health and Retirement Study (HRS) found that an economic measure of risk tolerance predicted risk behavior including smoking and drinking [61, 64, 65]. Loss aversion has also been linked to reduced cancer screening behavior among those with chronic disease who would be most sensitive to health losses [66].

Willingness to accept risk has intuitive connection to sexual and reproductive health behaviors. The consequences of sexual and reproductive behavior, including unintended pregnancy to STI transmission, are probabilistic rather than certain. Thus an individual's tolerance for risk may affect their willingness to engage in unprotected sex.

Although it is clear that individual decision-making affects sexual and reproductive health behaviors, including contraceptive method choice, consistency of condom use, number of sexual partners, and use of substances while engaging in sex, literature exploring the connection of discounting and risk tolerance has emerged only recently. This systematic scoping review examines the literature suggesting how two decisional preferences from behavioral economics, temporal discounting and risk tolerance, may influence sexual and reproductive behavior. The review seeks to contribute to the literature on sexual and reproductive health by assessing the state of the evidence available and offering suggestions for future work.

Methods

I conducted a search of medical, public health, and social science journal abstracts catalogued in PubMed and POPLINE databases. Searches included a combination of key words relevant to both economic preferences and sexual and reproductive health outcomes: 1) temporal discounting (discounting, delay discounting, temporal discounting, or temporal position) or 2) risk preferences (risk preferences, monetary gambles, risk tolerance, risk aversion, behavioral economics, or risk attitudes), and 3) sexual and reproductive health outcomes (sexual risk taking, reproductive health, condom use, sexually transmitted diseases, risky sex, fertility, childbearing, contraception, contraceptive, unintended pregnancy, pregnancy, or sexual behavior). Searches were not restricted by the date of publication or study design. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram aided in the reporting of this scoping review.

I downloaded all titles and abstracts of records from the databases into Endnote and screened all titles for relevance. Remaining articles were read in full for inclusion based on the following criteria: 1) research on humans, 2) published in English, 3) presented findings from analysis of primary or secondary data, 4) include a survey measure of time or risk preference, 5) include a primary measure of a sexual or reproductive health behavior or outcome variables, and 6) proposed to assess the direct or indirect

relationship of economic preference measures with sexual and reproductive health outcome measures. Papers that focused on prenatal screening were excluded as beyond the scope of this review. Manual searches of bibliographies were performed to identify any articles not identified from the database search.

I developed a data abstraction spreadsheet to assess inclusion criteria and comparison studies on several dimensions. I abstracted the following information from each full text article reviewed: author(s) and year of publication, title, country of data collection, sample size, study population, study design, sexual and reproductive health outcome measure, time or risk preference measure, other mediating or moderating variables of interest, and study results.

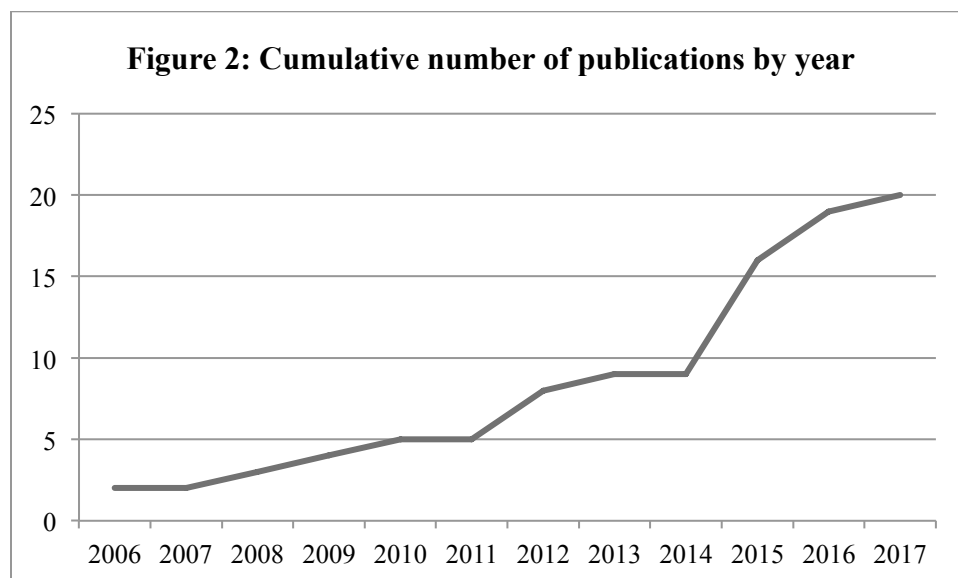
Results

Study characteristics

Figure 1 shows the study ascertainment and screening process. A total of 241 articles were identified from the PubMed and POPLINE searches, and 3 additional articles were identified through bibliography review. Of these, 121 were excluded after title review. Following review of 122 structured abstracts, 33 articles proceeded to full text review, and 13 were excluded for not meeting inclusion criteria. This left a final set of 20 articles for qualitative scoping review.

Seventeen of the articles included study samples from the United States, while one was based in South Africa, one in Switzerland, and one among MTurk workers without specifying a geographic location.

Figure 2 shows the cumulative number of publications on risk or temporal preferences and sexual and reproductive health outcomes by year. It demonstrates an increase in the publication rate in the past 2 years. Since 2015, the all 10 of the studies focused on measures of sexual delay discounting.



Descriptions from the 20 included articles are displayed in Table 1. Sixteen studies utilized cross-sectional designs, three were longitudinal, and one embedded within a randomized trial. Four of the studies tested correlations between the preference measure of interest and one or more health behaviors and did not control for confounding variables, making causal assessment of findings difficult.

Participants were recruited from university courses or psychology labs [67-73], general populations [74] or subgroups of the general population [73, 75-78] clinical samples [79-83], Facebook [84, 85], or MTurk [86].

Overall 10 studies focused on adolescents or young adults. These studies noted that adolescents are a particularly important subgroup to study in the context of sexual risk behavior, as they have heightened risk of STI and also unintended pregnancy. Five papers focused on college students above 18 [68] [67, 69] [70] [72]. Three studies included general samples of young people including 16-24 year old Swiss young adults [75], 18-24 year olds from urban centers [76], and 14-30 year olds from medical and STI clinics [81]. Two studies included even younger samples of Appalachian youth aged 10-17 at recruitment [78], and 10-12 year olds in Philadelphia [73].

Three studies focused on sexual risk behavior among men who have sex with men (MSM) [85] [84, 86]. One study included only male heterosexual college students, 21-32 [71], and another only heterosexual women from the PSID [74]. Four studies required hazardous alcohol or substance use dependence for eligibility [77, 79, 80, 82].

Measures of discounting and risk tolerance

The dependent and independent variables of interest as well as the results are summarized in Table 2. The majority of the articles examined delay or probability discounting while only three assessed a measure of risk tolerance [74, 75, 83].

Earlier studies of discounting and sexual behavior used survey measures of monetary discounting: a tradeoff between present and future monetary rewards. More recently, in recognition of domain specific preferences, discounting measures have been developed for discounting relating to sexual rewards [77, 87]. There is a further distinction between delay discounting and probability discounting, of both money and sex. Probability discounting tasks entail choices between smaller sooner rewards and delayed uncertain rewards.

The reviewed articles can be divided into those that use measures of monetary discounting, sexual discounting, or both. Studies that assessed monetary discounting most often used the Monetary Choice Questionnaire (MCQ), a 27-item measure involving choices between smaller immediate rewards and larger delayed rewards developed by Kirby [37] [78-80, 82, 84, 85]. One study used the MCQ but added a time perspective measure to assess future uncertainty [68]. Chesson used a three-item hypothetical payoff measure [81]. One study included probability discounting of money in addition to delay discounting [82].

Sexual delay discounting tasks (SDDT) [77] were used in several studies. Participants were asked to consider 60 photographs of people and to rank who they most want to have sex with, least want to have sex with, who is most likely to have an STI and least likely to have an STI. The chosen photos were then shown to participants to assess willingness to wait for condom-protected sex with a higher ranked partner versus immediate unprotected sex as a form of sexual delay discounting [67, 76]. Both studies found that sexual discounting differed as a function of the stated partner characteristics. Darioitis found that youth discounted (preferred immediate condomless sex) significantly more with partners they ‘most want to have sex with’ and partners whom they thought were ‘least likely to have an STI.’ The sexual probability discounting tasks extend this same logic as the delay tasks, but instead of a delay they use varying chances of engaging in sex with the preferred partner [69, 87]. One study modified the SDDT for use with MSM [86]. Two studies included both measures of monetary and sexual discounting [69, 77]. Johnson and Bruner were the first to find evidence of sexual domain specificity, as they not find evidence of monetary discounting with HBRS measure [77]. Lawyer [87] proposed another specification of the sexual discounting task. This task did not use hypothetical partner images, but instead asked participants about a tradeoff between more minutes of the sexual activity with some delay or fewer minutes immediately. The study used several scales that are validated in sexuality research and correlated with behavior. Sexual delay and probability discounting were associated with the measure of sexual excitability, but not with other non-sexual measures. Additionally monetary discounting was not associated with sexual outcomes, lending support to the domain specificity of sexual discounting [70].

In the three articles focusing on risk tolerance, each used a different measure. Brobdeck used a risk preference and hedonism scale from the Trier Integrated Personality Inventory developed by Becker (Becker, 2003)[75]. Schmidt used a measure of hypothetical gambles over lifetime income that is modeled after the Health and Retirement Study (HRS) in the PSID [74]. Szrek et al employed four risk-taking propensity measures, including the (1) a general measure of risk-taking propensity derived from a one-item survey question (Dohmen et al., 2011), (2) a risk aversion index calculated from a set of incentivized monetary gambles (Holt & Laury, 2002), (3) a measure of risk taking derived from an incentive compatible behavioral task—the Balloon Analog Risk Task (Lejuez et al., 2002), and (4) a composite score of risk-taking likelihood in the health domain from the Domain-Specific Risk Taking (DOSPERT) scale (Weber et al., 2002) [83].

Are discounting and risk tolerance associated with sexual and reproductive health outcomes?

For synthesis, I grouped the studies into three general categories based on the outcomes examined 1) sexual risk behavior as main effect, 2) sexual behavior among adolescents, 3) sexual risk behavior in the context of substance use, 4) pregnancy history or fertility

Sexual behavior

Seventeen of the 20 articles evaluated the effect of discounting or risk tolerance on sexual behavior and outcomes. Of these, seven examine these relationships in the context of substance use.

The sexual discounting task was repeatedly associated with sexual behavior. All studies assessed self-report of sexual risk behavior, and Chesson also included laboratory measures of STIs [81]. Daugherty and Base, included a measure of sociosexual orientation (SOI, Simpson & Gangestad, 1991), a measure of degree to which individual is more comfortable engaging in sexual behaviors without mental or emotional commitment [68]. Lawyer examined sexual excitability rather than self reported behavior [70]. Johnson and Bruner examined HIV risk behaviors, finding a significant relationship between greater discounting (or preference for smaller immediate rewards) and history of high-risk sex [77]. Dariotis and Johnson extended these findings from older high-risk sample to a sample of youth, finding that the four components of the SDT were negatively correlated with several reported sexual behaviors, including number of lifetime risky sexual partners. In addition, they found that less favorable attitudes towards risk were correlated with lower discounting, or preference for postponed protected sex under the 'most want to have sex with' and 'least likely to have an STI' components. [76]. Jarmolowicz applied the SDT task to promiscuity, finding that number of sexual partners selected on discounting task was related to higher rates of delay discounting, which was predictive of sexual behavior [69]. Collado et al. examined sexual delay discounting and self-reported STI risk sex behaviors, HIV knowledge and STI risk perception among college students [67]. They found that higher values of each of the four SDT measures were associated with self-reported risk behaviors. Hermann et al. extended the SDT to men who have sex with men (MSM) and found discounting of condom protected anal intercourse (CPAI) to be hyperbolic, meaning that participants discounted using condoms as delays to CPAI increased. Steeper discounting of CPAI was associated with unprotected anal intercourse, substance use, not having been tested for HIV, sex under the influence of substances [86].

One study examined risk tolerance, and argued that risk taking is domain specific, comparing four risk propensity measures with health risk behavior including sexual risk behavior. They found the Dohmen measure of general risk propensity was positively correlated with sexual risk behavior along with problem drinking and seat belt use. A risk aversion index calculated from a set of incentivized monetary gambles and the BART), and the DOSPERT scale were each uncorrelated with sexual risk behavior [83].

Sexual behavior among adolescents

Adolescence is a critical period for sexual behavior, as risk behavior emerges and peaks during the period (CITE). In one of the few studies to have self-reported data along with laboratory measures of STIs, higher discount rates were associated with ever having sexual intercourse, sexual intercourse before age 16, and ever having gonorrhea or chlamydia, controlling for demographics among a sample of adolescents and young adults [81]. They did not find significant association of discount rates with unprotected sex or HSV-2 testing or infection [81]. Khurana enrolled 10-12 year olds and examined the role working memory on adolescent early sexual initiation two years later [73] and

potential meditational pathways of impulsivity. The protective relationship of working memory on sexual initiation was mediated through acting-without thinking and temporal discounting. Kahn [78] also found the meditational effects of discounting on relationship between adolescent-parent relationship quality and risk behavior, which were moderated by self-control. Higher delay discounting was related to higher levels of risky sexual behavior for the low self-control group but not the high self-control group. The indirect effect of parent-adolescent relationship quality on risky sexual behavior was significant for the low self-control group [78]. Jones and Sullivan found some evidence of a developmental period of importance in the relationship of discounting to sexual risk behavior. Among MSM between aged 18-24, but not older men, higher monetary discounting was associated with more reports of condomless anal intercourse [85].

Sexual behavior in the context of substance use

Many of the studies investigated discounting and sexual behavior in the context of substance use. Alcohol and other substance use are reliable predictors of high-risk sexual behavior, and often interact with other factors to increase risk. There is also a strong relationship between substance use and discounting [38](could also cite: (George and Stoner, 2000; Shuper et al., 2009)), leading researchers to explore discounting among substance users and also as a potential mediating variable between substance use and sexual risk behavior.

Studies that examined drug and alcohol users as a subgroup of interest found largely consistent relationships between discounting and sexual behavior. Finding included that discounting was associated with HIV risk behaviors among high-risk drug users [79], history of high-risk sex among cocaine users [77], and percentage of alcohol-related condomless sex [80]. Celio found differential effects of alcohol expectancies based on the degree to which individuals discount delayed rewards, meaning that those who believed they would engage in sex while drinking were more likely to have done so in the past [80].” In another study among heavy or problem drinkers, monetary delay discounting, but not probability discounting, was associated with increased frequency of unprotected sex with a non-steady partner while drinking [82]. Higher discounting of condom-protected sex in the SDT was associated with substance use and sex under the influence of substances among MSM [86] and interacted with overvaluation of alcohol, to account for both increased sexual risk behavior and alcohol consumption among sexually active college drinkers [72]. Brodbeck et al. was the only study to examine cannabis use, testing whether the connection between sexual behavior and cannabis use was causal or could be attributed to an underlying risk propensity making people predisposed to both risk behaviors. They found a weak meditational relationship between the measure of risk preference/hedonism and the relationship of cannabis use and unprotected sex [75]. Not all studies found evidence of effect. In an experimental study that randomized college students to drink alcohol or placebo, Wray et al. found no relationship between intoxication and change in experiential discounting task (EDT) scores, or between EDT and sexual arousal or intention to have unprotected intercourse.

Pregnancy history and fertility

The literature focusing on pregnancy was smaller. None of the studies directly examined unintended pregnancy. Chesson et al. included history of pregnancy among the surveyed outcomes. They found that higher discount rates were associated with being pregnant before or at the time of the study, or impregnating someone. Jarmolowicz assessed sexual risk behavior with 23-items that included history of pregnancy [69]. Using estimates for indifference points for delay of both sex and money, they found significant correlations between area under the curve (AUC) for sexual discounting and the number of times both men and women reported having a pregnancy scare. In contrast to the other work, Schmidt's study focused on fertility and timing of first birth. She hypothesized effect modification by age on the relationship between risk tolerance and fertility timing, noting that more risk tolerant young women may experience earlier birth than do less risk tolerant young women, as risk tolerance would be related to ineffective use of contraception. Conversely, later in life, risk tolerance may be associated with delayed fertility. Women who are more tolerant to risks may be comfortable postponing childbearing until later ages when risks of infertility rise. She found evidence of the positive relationship between fertility timing and risk tolerance among married and unmarried women under 20. She also found that among unmarried, college educated women, risk tolerance appears to delay first births at the end of the fertile period [74].

Gender differences

Several studies focused on men only, or women only [74]. Others reported stratified results that indicated these relationships may be different among men and women. Jarmolowicz, for example, found that delay discounting was associated with number of pregnancy scares for both genders, but the relationship of discounting with total number of lifetime sexual partners, number of instances of having sex while under the influence of alcohol and/or drugs was only significant for women. Their work suggests women may devalue delayed sex less rapidly than men [69]. Johnson and Bruner note that a trend of gender differences in the relationship of sexual discounting and sexual behavior, but do not have the power to examine differences [77]. Collado specifically focused on gender, where males showed higher sexual delay discounting relative to females [67].

Discounting as a mediator

In addition to the articles mentioned above, two examined the mediational role of discounting between social factors and outcomes. Khurana also found that the effects of socioeconomic status and Black racial identity on sexual initiation were mediated through discounting. Twenty one percent of the effect of race operated through discounting and 43% of the SES effect [73]. Kahn noted that environmental factors that affect discounting are less well explored in the discounting literature, and evidence of a mediational relationship between parent-child relationship quality and sexual initiation [78].

Discussion

The studies in this review revealed consistent associations between economic preference measures and sexual and reproductive behavior. In particular, the literature on temporal preferences suggests that high rates of discounting serve as an important marker of sexual

risk behavior. Preferences shifted from condom protected sex to unprotected sex as the delay to sexual behavior increased, suggesting that discounting may relate to willingness to engage in unprotected sex despite overall preference for condoms [69, 77, 86]. This is a similar preference shift from long-term health and disease avoidance to short-term reward as the delay horizon increases, as seen in other discounting and health literature [38]. The review also supports the conclusion that discounting interacts with substance use, particularly alcohol use, to produce heightened risk for impulsive sexual behavior.

Another consistency across studies was the finding that domain specific discounting (i.e., using the sexual discounting task) better predicted sexual behavior than the monetary discounting measure [70, 77]. The relationship of the SDT to sexual behavior was confirmed in several of the other studies reviewed here [67, 69, 76, 86]. This commodity specific discounting has also been seen in substance use [44], indicating that domain specific measures are more proximal and relevant. While the SDT attempts to model complex situations, it is limited to hypothetical sexual partners and decisions. The literature that uses hypothetical delays states that they are comparable to real rewards in producing estimates of individual differences in outcomes [88]. Future research should expand on this work to model complex choice environments.

The literature on pregnancy, while smaller, also suggests an association between risk and temporal preferences and younger age at first birth and number of pregnancy scares [69, 74, 81]. This indicates that HIV and pregnancy risk behavior may share proximate pathways from discounting and risk tolerance to sexual behavior. Further, the literature on sexual behavior provides insight into possible connections with reproductive health that should be further explored. Alcohol and drug use are risk factors for unintended pregnancy as they lead to higher risk sexual behavior [89, 90]. Thus the relationship between substance use and discounting may inform unintended pregnancy interventions.

Probability discounting can apply to the literature showing that the perception of pregnancy risk influences behavior and risk of unintended pregnancy [26]. If substantial uncertainty exists surrounding the risk of pregnancy, women may be more likely to prefer current rewards when future consequences from pregnancy. The concept could also interact with individual risk tolerance, as described in the Schmidt article [74], to produce heterogeneity in pregnancy risk behavior even within groups with the same pregnancy intention and access to resources. Studies that attempted to unpack the relative importance of delay and uncertainty (delay discounting versus probability discounting) could be expanded to include pregnancy related attitudes.

Inclusion criteria for the review required that the study assess a sexual health behavior or outcome directly. As a result, several studies that included only sexual delay discounting as an outcome and not a direct measure of behavior were excluded. For example, one study examined sexual delay discounting among opioid dependent women, compared to control. Opioid dependent women discounted condom protected sex more steeply than controls in each of the four partnership conditions [91].

This review finds that while there are consistent associations between economic preference measures and sexual and reproductive health behaviors, there is little evidence

to establish a causal effect. Many of the studies were correlational in nature and did not include sufficient control of potential confounding variables. As Brodbeck noted, it is unclear whether an underlying risk propensity is a common cause for both sexual risk behavior preference measures, or if preferences could be manipulated to reduce risky behavior. This work shows that heterogeneity in the way people make choices about temporal tradeoffs and perceptions of risk and uncertainty may provide insight into their reproductive behavior. More work is needed to establish mechanisms.

Implications

Given that there is a relationship with monetary discounting, as well as sexual discounting, it should be considered that there is a generalized temporal tradeoff process in sexual behavior. This apparent preference–behavior incongruence is not only explanatory but also offers potential targets of intervention.

The results of the SDT papers imply that condoms should be made readily available, as people are more likely to prefer immediate condomless sex under heightened arousal or when using substances. This same conclusion could be applied to contraceptive use, with similar implications for easily available methods or long acting methods among people more likely to discount sex. Contraceptive use that requires daily maintenance (e.g. birth control pills) or use at the time of sex (e.g. condoms, withdrawal, or diaphragms) may be more challenging for high discounters.

The discounting and risk tolerance measures could potentially be applied in a clinical context, to identify those at highest risk of engaging in unprotected sex. While the SDT consistently showed a relationship with sexual behavior in the experimental studies, the task may have less utility in a screening setting. It requires more time to administer than other tools, and the hypothetical partner and choice experiments may be less relevant for women making a contraceptive decision. More work is needed to establish if these tools have utility for screening and prevention.

While excluded from this review because it did not include a preference assessment measure, a study by Hiel and colleagues gives a potential framework for interventions leveraging discounting [92]. They provided a decision making tool and financial incentives to reduce barriers to contraceptive uptake and continuation among a population at high risk of unintended pregnancy. Their experiment showed marked differences in contraceptive use and continuation, and trends in pregnancy rates, even in a small sample.

Even people who are clear on their stated intentions may make different decisions in different settings. Risk reduction interventions may prove difficult because of a disconnect between intentions and what individuals would do in contexts where contraception is unavailable. Understanding how decision-making could be influenced by these other contextual factors would be very important in tailoring intervention strategies. Indeed the studies in this review suggest that situational factors, such as attraction or partners, alcohol and drug use, and may alter preferences and biases.

Unintended pregnancy, contraceptive use and pregnancy decision-making result from a multidimensional set of economic, cultural, social, psychological and demographic determinants. I believe that there is rich potential to include risk and temporal preference constructs into social epidemiologic models. The differences in STI incidence, unintended pregnancy, and contraceptive use by race, class and social environment are well established. Yet the pathways through which these structural factors exert influence are less explored. Two of the articles reviewed include a discussion of the contextual factors that produce differences in discounting [73, 78]. They discuss discounting as a potential mediator between social environment and sexual risk behavior. The environmental risk factors that influence discounting and risk behavior are not well explored. Indeed, there is a debate among scholars as to the stability of these preferences and whether they constitute trait or state characteristics. Odum argues that delay discounting is a personality trait that is influenced through environmental circumstances [93]. The findings for parent-child relationship quality, also imply that discounting is responsive to social environment [78]

The review leads to several considerations for future research. Pregnancy risk should be explicitly included in research, so that we may understand how the behavioral processes may be different from those involved in STI risk. Certainly, among young adults, the dual risks of STI and pregnancy that are associated with unprotected sex should be further explored.

Conclusion

The literature on discounting and risk tolerance indicates a relationship with sexual risk behavior and STI risk. Future work that controls for confounders and assesses multiple time points would be useful to establish a causal relationship. More research is needed to expand these topics to models of pregnancy risk and contraceptive use. If discounting proves to be a reliable marker of impulsive decision making it may be a useful tool for screening in the context of contraceptive decision making or identifying those at risk of unintended pregnancy. There is evidence that adolescents and substance users may be especially prone to tradeoffs between present and future rewards, and should be the subject of continued research. If these relationships hold, preferences may offer insight into pathways between structural risk factors and reproductive outcomes.

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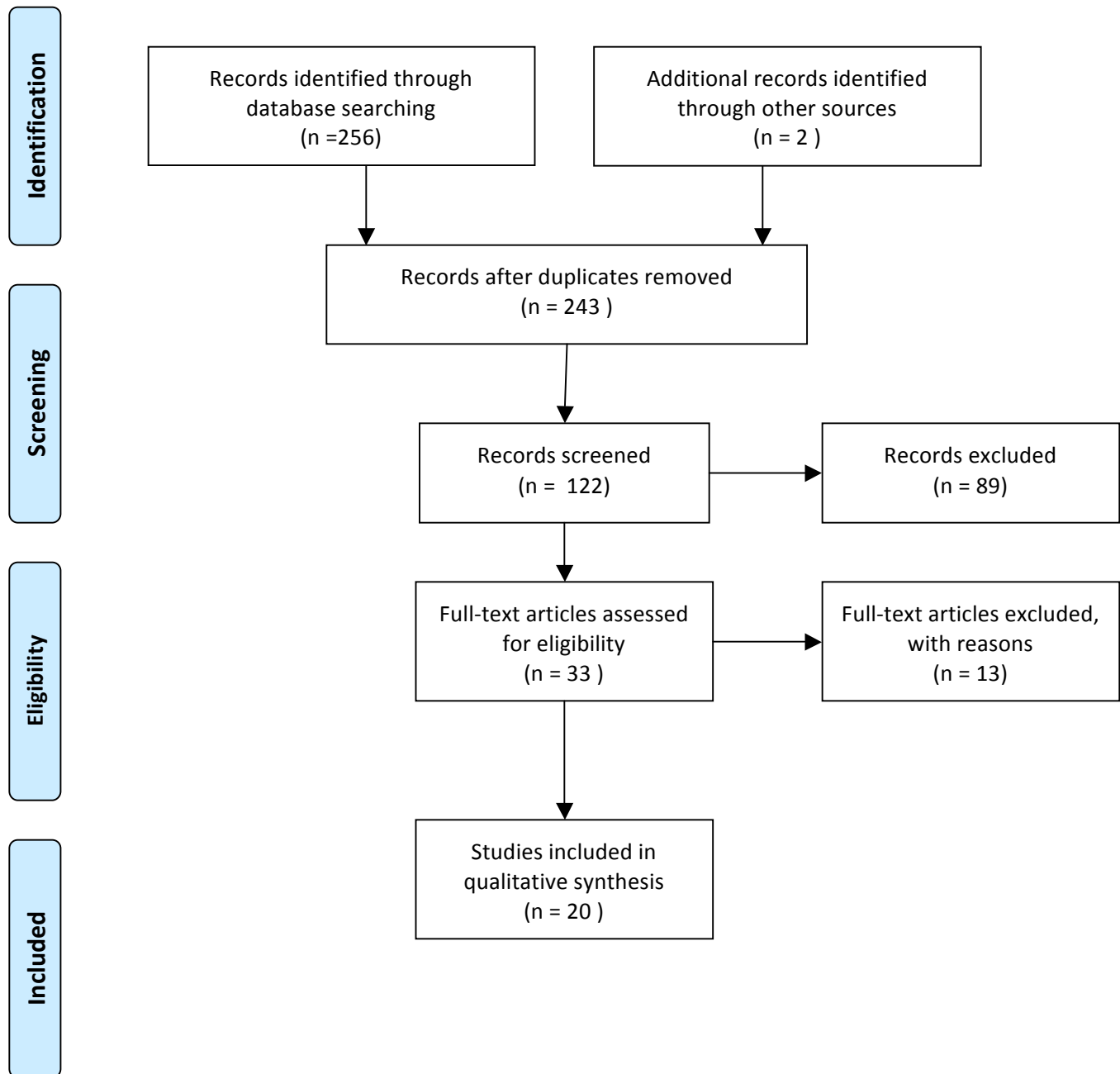
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Figure 1: PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Table 1: Descriptions on studies included in systematic scoping review

Author (Year)	Title	Country	Sample Size (N)	Study Population	Study Design
Black et al. (2009)	Associations between Impulsivity and High Risk Sexual Behaviors in Dually Diagnosed Outpatients	US	51	Dually diagnosed: substance use and psychiatric disorders. Recruited from a community mental health center to participate in a clinical trial targeting substance abuse.	Cross-sectional - Path model with impulsivity and cocaine use as the exogenous variables and HIV risk behavior as the endogenous variable.
Brodbeck, J., Matter, M., & Moggi, F. (2006).	Association between cannabis use and sexual risk behavior among young heterosexual adults.	Switzerland	2790	16–24-year-old urban Swiss men and women was selected based on the official registers of the Residents' Administration Offices of the Swiss cities of Basel, Bern, and Zurich	Cross-sectional - Meditational model controlling for age
Celio, M. A., MacKillop, J., Caswell, A. J., Mastroleo, N. R., Kahler, C. W., Barnett, N. P., et al. (2016).	Interactive Relationships Between Sex-Related Alcohol Expectancies and Delay Discounting on Risky Sex.	US	126	Emergency Department patients who reported high-risk alcohol use and sexual behavior during the past 3 months.	Cross-sectional. Used data from RCT for alcohol intervention.

Author (Year)	Title	Country	Sample Size (N)	Study Population	Study Design
Chesson, H. W., Leichliter, J. S., Zimet, G. D., Rosenthal, S. L., Bernstein, D. I., & Fife, K. H. (2006).	Discount rates and risky sexual behaviors among teenagers and young adults	US	1042	Clients of a public STD clinic, clients of adolescent health clinic, clients of two general medical clinics, and students at a large, public university campus. Aged 14–30 years	Cross-sectional
Collado, A., Johnson, P. S., Loya, J. M., Johnson, M. W., & Yi, R. (2016).	Discounting of Condom-Protected Sex as a Measure of High Risk for Sexually Transmitted Infection Among College Students	US	262	College students from a large Mid-Atlantic public university participated in the study. Recruited from Psychology dept. 18+	Cross-sectional. Correlations that controlled for sex.
Dariotis, J. K., & Johnson, M. W. (2015)	Sexual discounting among high-risk youth ages 18-24: implications for sexual and substance use risk behaviors.	US	126	126 HIV-negative, never married 18–24 year old women and men who provided informed consent living within an urban city characterized by high STI and HIV prevalence rates, drug use, and crime as well as surrounding counties marked by fewer risk outcomes.	Cross-sectional

Author (Year)	Title	Country	Sample Size (N)	Study Population	Study Design
Daugherty, J. R., & Brase, G. L. (2010).	Taking time to be healthy: Predicting health behaviors with delay discounting and time perspective	US	467	Undergraduates from into to psychology course	Cross-sectional
Herrmann, E. S., Johnson, P. S., & Johnson, M. W. (2015).	Examining Delay Discounting of Condom-Protected Sex Among Men Who Have Sex with Men Using Crowdsourcing Technology	Global	108	Mturk workers were eligible to participate in the study if they identified as male, reported having AI with a male partner during the previous 6 months, and were willing to provide sensitive personal information.	Cross-sectional
Jarmolowicz, D. P., Lemley, S. M., Asmussen, L., & Reed, D. D. (2015).	Mr. right versus Mr. right now: A discounting-based approach to promiscuity.	US	66	Heterosexual college students recruited from behavioral science classes at a large Midwestern university.	Cross-sectional
Johnson, M. W., & Bruner, N. R. (2012).	The Sexual Discounting Task: HIV risk behavior and the discounting of delayed sexual rewards in cocaine dependence.	US	62	Cocaine dependent. Mostly men.	Cross-sectional, No adjustment
Jones J. & Sullivan P. (2016)	Age-dependent effects in the association between monetary delay discounting and risky sexual behavior	US	1332	MSM 18 and older recruited through Facebook	Cross-sectional - effect modification by age

Author (Year)	Title	Country	Sample Size (N)	Study Population	Study Design
Jones, J., & Sullivan, P. S. (2015).	Impulsivity as a risk factor for HIV transmission in men who have sex with men: a delay discounting approach.	US	1042	MSM Facebook recruited aged ≥ 18 years, resided in the United States, and reported being interested in men in their profile and reported oral or anal sex with at least one man in the past 12 months.	Cross-sectional - multivariable logistic regression controlling for education and drug use in one model and high discounting only income and drug use
Kahn, R. E., Holmes, C., Farley, J. P., & Kim-Spoon, J. (2015).	Delay Discounting Mediates Parent-Adolescent Relationship Quality and Risky Sexual Behavior for Low Self-Control Adolescents.	US	219	Longitudinal study conducting research on youth's healthy development and were recruited from an understudied Appalachian population	Longitudinal
Khurana, A., Romer, D., Betancourt, L. M., Brodsky, N. L., Giannetta, J. M., & Hurt, H. (2012).	Early adolescent sexual debut: The mediating role of working memory ability, sensation seeking, and impulsivity.	US	347	Longitudinal survey of a community sample of preadolescents residing in the Philadelphia, Pennsylvania, area, aged 10–12 years at the time of the study's inception.	Longitudinal

Author (Year)	Title	Country	Sample Size (N)	Study Population	Study Design
Lawyer, S. R., & Schoepflin, F. J. (2013).	Predicting domain-specific outcomes using delay and probability discounting for sexual versus monetary outcomes	US	103	Participants were sexually active undergraduate students (n = 103) recruited from psychology courses at Idaho State University. T	Cross-sectional
Lemley, S. M., Fleming, W. A., & Jarmolowicz, D. P. (2017).	Behavioral Economic Predictors of Alcohol and Sexual Risk Behavior in College Drinkers	US	85	College students who provided complete data and reported that they drank alcohol and had consumed alcohol during the past month.	Cross-sectional
MacKillop, J., Celio, M. A., Mastroleo, N. R., Kahler, C. W., Operario, D., Colby, S. M., et al. (2015)	Behavioral economic decision making and alcohol-related sexual risk behavior	US	127	Emergency department sample of hazardous drinkers who engage in risky sexual behavior. English-speaking patients ages 18–65 who received medical care in the ED. Eligibility: drinkers who engaged in some form of risky sex.	Cross-sectional
Schmidt, L. (2008)	Risk preferences and the timing of marriage and childbearing.	US	4470	PSID family in any wave, beginning with 1985	Longitudinal

Author (Year)	Title	Country	Sample Size (N)	Study Population	Study Design
Szrek, H., Chao, L. W., Ramlagan, S., & Peltzer, K. (2012)	Predicting (un)healthy behavior: A comparison of risk-taking propensity measures.	South Africa	351	351 clients of health centers around Witbank, South Africa. 40% HIV positive	Cross-sectional - logistic regression with covariate control
Wray, T. B., Simons, J. S., & Maisto, S. A. (2015). A	Effects of alcohol intoxication and autonomic arousal on delay discounting and risky sex in young adult heterosexual men.	US	113	Undergraduate men, ages 21–32	Randomized experiment

Table 2: Summary of measures and results from studies included in systematic scoping review

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior and substance use	Black et al. (2009)	High-risk sexual behavior (HRSB)- HIV risk behaviors in the last month: number of sexual partners, frequency of condom use with regular and casual partners, frequency of condom use while prostituting, and frequency of anal sex.	The DDQ is designed to assess the extent to which a participant discounts money if the person has to endure a delay before receiving it	Alternative impulsivity measures	HRSBs were moderately correlated with cocaine use, and were less strongly associated with a preference for immediate rewards. The DDQ-HRBS path approached significance, while the Cocaine→HRBS path was significant the path between the BIS and the HRBS, and between the WCST-64 “failure to maintain set” variable and HRBS were not significant.
Sexual behavior and substance use	Brodbeck, J., Matter, M., & Moggi, F. (2006).	Sexual risk behavior was defined as sexual intercourse without condom use, with a casual partner, or/and sexual intercourse with a new main partner without condoms or without HIV test for those partners who had ever had intercourse.	Risk preference and hedonism scale from the Trier Integrated Personality Inventory developed by Becker (Becker, 2003).	Cannabis use	Risk preference/hedonism and psychosocial stress among women were less important predictors of sexual risk behavior than cannabis use and HIV protection intention but still significant. Lower HIV-self-efficacy and higher risk preference/hedonism were only partial mediators for the association between cannabis use and sexual risk behavior.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior and substance use	Celio, M. A., MacKillop, J., Caswell, A. J., Mastroleo, N. R., Kahler, C. W., Barnett, N. P., et al. (2016).	(1) Frequency of alcohol-related condomless sex; and (2) Percentage of alcohol-related condomless sex, which was calculated by dividing the number of nonsteady sex events that were condomless and involved alcohol by the total number of nonsteady sex events.	Money choice questionnaires (MCQ Kirby & Marakovic 1996), which proposed 27 hypothetical choices between smaller immediate rewards and larger delayed rewards.	Sex-related alcohol expectancies were assessed using Leigh's 13- item questionnaire (Leigh, 1990).	No results for frequency of condomless sex. The associations between percentage of alcohol-related condomless sex and both expectancies for alcohol-induced risk taking and the enhancement of sexuality were significantly stronger in individuals who exhibited steeper delay discounting.
Sexual behavior and pregnancy status	Chesson, H. W., Leichliter, J. S., Zimet, G. D., Rosenthal, S. L., Bernstein, D. I., & Fife, K. H. (2006).	Ever having sexual intercourse, having sexual intercourse before age 16, having a history of gonorrhea and/or chlamydia infection, having more than 1 sex partner in the previous six months, having at least one unprotected sex act in the previous six months, pregnancy status, presence of HSV-2 antibody	Monetary discounting- three hypothetical questions about the possible payoff of a prize.		Higher discount rates were significantly associated with a range of risky sexual behaviors and health outcomes, including having sex before age 16, having gonorrhea or chlamydia, and pregnancy status

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior	Collado, A., Johnson, P. S., Loya, J. M., Johnson, M. W., & Yi, R. (2016).	CDC Sexual Behavior Questionnaire (CSBQ; CDC, 2011)	Sexual Delay Discounting Task (SDDT; Johnson & Bruner, 2012)	HIV knowledge, STI risk perception	Greater sexual delay discounting was significantly associated with higher engagement in self-reported risky sexual behaviors across all partner conditions.
Sexual behavior	Dariotis, J. K., & Johnson, M. W. (2015)	HIV sexual risk-taking behaviors—A composite variable of lifetime risky sexual partners was calculated by summing: (1) ever having sex with another male, (2) ever have sex with a prostitute or ever received money/drugs/ something else in exchange for sex, (3) ever have sex with an intravenous drug user, (4) ever have sex with someone who is HIV+, and (5) ever have sex with someone only once (one-time partners).	The Sexual Discounting Task (SDT)		Number of lifetime risky partners was significantly negatively related to discounting in the ‘most want to have sex with’ partner condition. The greater the number of substances used was significantly negatively related to both the 'most want to have sex with' and 'least likely to have an STI' conditions. Overall, less favorable attitudes toward risk were related to greater postponement of immediate unprotected sex under two conditions: ‘most want to have sex with’ and ‘least likely to have an STI’ partners.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior	Daugherty, J. R., & Brase, G. L. (2010).	Examined health behaviors, including sociosexual orientation (SOI, Simpson & Gangestad, 1991). Degree to which individual is more comfortable engaging in sexual behaviors without mental or emotional commitment compared to restricted individual. Marker of unsafe sexual activity more likely have unprotected sex and more sexual partners.	Money choice questionnaires (MCQ Kirby & Marakovic 1996). Also include these 2 measures of time perspective. The ZPTI fatalism score higher values reflect tendency to focus on present because future believed to be uncertain	Time perspective. And other health behaviors	show that when controlling for sex and big five personality traits the inclusion of the time discounting and time perspective examined additional variation in SOI. Looking at regression coefficients, only future and fatalistic ZPTI significant, but that is also super correlated with MCQ, so seems weird to have all in model.
Sexual behavior among MSM	Herrmann, E. S., Johnson, P. S., & Johnson, M. W. (2015).	unprotected anal intercourse (UAI)	SDT modified for use with MSM.	Drug use	First, MSM discounted the value of delayed CPAI in a manner that was orderly and well fit by hyperbolic functions. Second, discounting of CPAI was sensitive to partner characteristics likely to influence decisions to use condoms (e.g., partner desirability, perceived STI risk). Third, participants' choices on the SDT were significantly associated with several variables associated with sexual HIV risk among MSM.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior and pregnancy history	Jarmolowicz, D. P., Lemley, S. M., Asmussen, L., & Reed, D. D. (2015).	A 23-item sexual risk survey (Turchik and Garske, 2009) assessed sexual activities occurring in the past six months, including substance use before sex, birth control and contraceptive use, and number of sex partners. The 13 items included at the end of the survey evaluated lifetime numbers of sexual partners, age of first sexual experiences, and lifetime number of instances of sexually transmitted infections and pregnancies.	Novel sexual discounting task for promiscuity. First completed a preference assessment based on photos. Then presented choices between sex with a less preferred partner today and sex with the participant's most preferred partner after a delay. Monetary discounting task consisting of a random-adjusting amount titration procedure (Richards et al., 1999)	Gender	AUC for sex was significantly correlated with total number of lifetime sexual partners. For women, AUC for sex was significantly correlated with total number of lifetime sexual partners, number of instances of having sex while under the influence of alcohol and/or drugs in the past six months, and the lifetime number of times she thought she might be pregnant. For men, AUC for sex was significantly correlated with the number of times there was a concern of pregnancy. Measures of sexual risk behavior did not significantly differ between genders.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior and substance use	Johnson, M. W., & Bruner, N. R. (2012).	Sexual risk behavior HRBS	Sexual discounting and monetary delay discounting (from Johnson and Bickel 2002). Monetary discounting had a real reward		Negative correlations between the HRBS scores and each sexual discounting task. Greater sexual risk associated with greater discounting. Not significant in the most want to have sex measure, which was associated with the greatest preference for immediate unprotected sex. Monetary discounting not associated with HRBS score. correlation not monetary discounting with sexual discounting, which found significant associations with the most likely to have an STI condition
Sexual behavior	Jones J. & Sullivan P. (2016)	Condomless anal (CAI) intercourse in last 12 months	Monetary discounting monetary choice questionnaire (MCQ; Kirby et al. 1999) categorized as high and low	Age	Among 18–24 18 % higher prevalence discounting among CAI in 12 months, controlling for education. no association men age 25 and older.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior among MSM	Jones, J., & Sullivan, P. S. (2015).	Participants were classified as having any UAI if they reported having anal sex with at least one male partner within the past 12 months without a condom; similarly, participants were classified as having >2 UAI partners if they reported at least three male sex partners with whom they had sex without a condom in the previous 12 months.	The Kirby DD questionnaire is a 27-item survey tool (Kirby et al., 1999)	Drug use in the past 12 months	Above-median DD was not significantly associated with reporting UAI controlling for education and drug use. High DD was significantly associated with reporting >2 UAI partners in the past 12 months compared to ≤ 2 UAI partners in the past 12 months, controlling for income and drug use.
Sexual behavior in adolescence	Kahn, R. E., Holmes, C., Farley, J. P., & Kim-Spoon, J. (2015).	Youth Risk Behavior Survey (CDC 2012a) regarding: condom use at last intercourse and age of sexual debut or initiation with response choices	The Monetary Choice Questionnaire (MCQ: Kirby et al. 1999) was used to measure impulsive decision making in the form of delay discounting	Inventory of Parent and Peer Attachment 12-item short version (IPPA; Raja et al. 1992); self control	Findings revealed that delay discounting served as a mediator in the association between parent–adolescent relationship quality and later risky sexual behavior but only for those adolescents who demonstrated low levels of self-control. For the low self-control group, higher delay discounting was related to higher levels of risky sexual behavior whereas for the high self-control group, there was no association between delay discounting and risky sexual behavior.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior in adolescence	Khurana, A., Romer, D., Betancourt, L. M., Brodsky, N. L., Giannetta, J. M., & Hurt, H. (2012).	Sexual initiation— Respondents were asked at baseline and at 1-year follow-up if they had ever engaged in vaginal intercourse during their lifetime. Twenty-five adolescents (7.2% of the sample) had initiated sexual intercourse at baseline, and a total of 55 adolescents (15.9%) reported being sexually experienced by follow-up.	A monetary choice procedure adapted from Green et al. (1994) was used to assess adolescents' preference for immediate reward	working memory; acting-without-thinking	Statistically significant correlations were observed between sexual initiation temporal discounting. The net indirect effect: 21% of the effect of Black racial identity on sexual initiation was channeled through temporal discounting. For socioeconomic background, 53% of the effect on sexual initiation was transmitted through temporal discounting.
Sexual behavior	Lawyer, S. R., & Schoepflin, F. J. (2013).	Sexual excitability and sexual inhibition from latent variable analysis of several sexuality measures	Monetary delay and probability discounting. Delay and probability discounting for sexual activity was measured using a modified version of the task used by Lawyer et al. (2010). In both tasks, the large sexual activity was set at 30 min.	Alcohol use and abuse, gambling, nicotine dependence, poly drug use	When gender was considered as a covariate, the only significant monetary discounting relationship was between probability discounting and sexual inhibition such that higher AUC scores (indicating a preference for probabilistic outcomes) predicted higher sexual inhibition scores. There were consistently significant relationships between the sexual excitability factor and delay and probability discounting for sexual activity, with gender included in the model.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior and substance use	Lemley, S. M., Fleming, W. A., & Jarmolowicz, D. P. (2017).	Computerized version of the 23-item Sexual Risk Survey (SRS) assessed sexual risk amongst college students and includes five subscales: sexual risk taking with uncommitted partners, risky sex acts, impulsive sexual behaviors, intent to engage in risky sexual behaviors, and risky anal sex acts. An additional 11 questions about sexual history	Sexual delay and probability discounting, MCQ, modified alcohol CQ	Alcohol discounting and use	Behavioral economic measures of sexual discounting, alcohol intensity, and money and alcohol discounting were significant predictors of the sexual risk (i.e., the total sexual risk score and/or three sexual risk subscales). Additionally, the interaction of intensity and sex discounting was a significant predictor of sexual risk in two of these models. Specifically, intensity was associated with increased sexual risk in individuals with higher rates of sexual partners discounting (i.e., low AUC), but not those with lower sexual partners discounting rates (i.e., high AUC).
Sexual behavior and substance use	MacKillop, J., Celio, M. A., Mastroleo, N. R., Kahler, C. W., Operario, D., Colby, S. M., et al. (2015)	(1) Frequency of unprotected sexual intercourse (vaginal or anal); (2) frequency of consuming alcohol before or during sex; and (3) frequency of using any drug before or during sex.	Monetary choice questionnaire (MCQ). Probability discounting used the probabilistic choice questionnaire (PCQ), which is a 30-item measure of decision-making under conditions of risk.	Alcohol use	Delay discounting was significantly associated with unprotected sex with co-occurring alcohol use. Impulsive delay discounting for money was significantly associated with frequency of unprotected sex with a non-steady partner when drinking. Found probability discounting was generally not associated with risky sexual behavior.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Pregnancy	Schmidt, L. (2008)	Marriage timing and age at first birth	Risk preference (Barsky)	Stratified by marital status and education	Risk preferences play a role in fertility timing that varies by age, marital status, and education. Among both unmarried and married women, greater tolerance for risk led to earlier births at young ages. As college-educated unmarried women near the end of their fertile period, women who have a high tolerance for risk were likely to delay childbearing relative to their more risk-averse counterparts.
Sexual behavior; health risk behavior	Szrek, H., Chao, L. W., Ramlagan, S., & Peltzer, K. (2012)	Sexual behavior defined risky if the respondent did not have a regular partner and did not use a condom the last time the respondent had sex or if the respondent was married/ cohabitating and had more than one partner in the last 12 months.	(1) A general measure of risk-taking propensity (2) a risk aversion index- incentivized monetary gambles (3) a measure of risk taking - the Balloon Analog Risk Task, and (4) a composite score of risk-taking likelihood in the health domain from the Domain-Specific Risk Taking scale.	Other self reported risky health behaviors considered: smoking, problem drinking (alcohol), seat belt non-use,	The Dohmen measure (1) is a statistically significant predictor of problem drinking and seat belt non-use, and almost predicts smoking and risky sexual behavior. None of the other measures predicted risky sexual behavior.

Outcome Area	Author (Year)	Specific Outcome	Preference measure	Other variables of interest	Results
Sexual behavior and substance use	Wray, T. B., Simons, J. S., & Maisto, S. A. (2015). A	Intent to engage in unprotected vaginal sex	Experiential discounting task (EDT)- computerized measure of experiential discounting (Reynolds & Schiffbauer, 2004)	Alcohol use	Did not find evidence for EDT mediating the relationship of alcohol use and intent to engage in unprotected sex

Chapter 3: Risk preferences and reproductive behavior: evidence from the National Longitudinal Survey of Youth

Introduction

Reproductive health researchers and practitioners have documented that perceptions of the risk of pregnancy and of STIs shape sexual and reproductive behavior in addition to pregnancy intention and access to contraceptive methods. These perceptions and behaviors are partly the result of individual tolerance for risk and uncertainty. Tversky and Kahneman instigated a robust area of inquiry by first describing how risk preferences shape choices and behavior [1, 2]. These same theories of how humans make decisions under uncertainty may shed light on differences in reproductive outcomes.

Economists concerned with explaining behavior, including wealth accumulation, focus on measures of economic preferences that govern differences in decision-making. These preferences, including the willingness to assume risk, strongly predict financial behavior and outcomes [3, 4]. Analyses that examine how risk preferences may extend beyond financial behavior to explain behavior in other domains, including health, appear less frequently in the literature [5, 6]. A particularly unexplored area of research concerns how risk preferences affect decision-making surrounding reproduction, contraceptive behavior, and sexual risk taking, where intention-behavior inconsistencies are widely acknowledged.

This paper tests the hypothesis that the propensity to take risk manifests not only in the financial decisions commonly studied by decision theorists, but also in less-well studied choices that affect reproductive health. I explore whether individual measures of financial risk tolerance predict important reproductive outcomes of sexual and contraceptive behavior using data from the 1997 cohort of the National Longitudinal Survey of Youth (NLSY).

National and international public health priorities include reduction of unintended pregnancy [7]. Defined as pregnancies that are mistimed or unwanted, unintended pregnancies comprised 45% of all pregnancies to women aged 15-44 in the United States (US) in 2011. Half of those pregnancies ended in abortion [8]. Epidemiologic literature, moreover, reports associations between unintended pregnancy and negative health and mental health outcomes for mothers and children [9-12]. Women who experience unintended pregnancies also are more likely to report perceived stress, low social support, and depressive feelings [13]. Evidence further suggests a connection between unintended pregnancy and risk behaviors during pregnancy, such as smoking and alcohol drinking [12, 14]. It is estimated that unintended pregnancies cost the US more than \$20 billion per year in expenses for births, abortions and miscarriages [15, 16].

Unintended pregnancies, like many health outcomes, are differentially experienced in the population. They concentrate among women of color and low-income women [17-19]. Young age, low education, previous pregnancies, non-married status, and living in an urban neighborhood, explain some but not all of the concentration of unintended pregnancy among poor and minority women [17].

Nonuse or inconsistent use of contraception is common among women at risk of unintended pregnancy, meaning those sexually active with a stated desire not to get pregnant [20-22]. Reproductive health literature reports inconsistencies between intention and behavior regarding contraceptive use and pregnancy. A California study following young women who initiated a new method of contraception and who reported not wanting to be pregnant within a year found high rates of discontinuation over the year [23, 24]. An analysis of a nationally representative dataset found that 25% of non-Hispanic black women, 16% of Hispanic women, and 14% of non-Hispanic white women did not use contraception despite risk of unintended pregnancy [21]. Additional studies have shown disparities in contraception use for non-Hispanic black and Hispanic women [25-28].

These differences may result, at least in part, from lack of information about method availability, especially long acting methods [27, 29-31]. Research on contraceptive attitudes has reported fear of side effects and mismatches of desired method features to selected method features to be a reason for nonuse [32-34]. Other research suggests that provider biases may also lead to disparities in information: in one such study, providers of contraceptive counseling recommended IUDs to low-income women of color more often than to white women [35]. Misperception of pregnancy risk may also result in reduced contraceptive use and subsequent unintended pregnancy regardless of knowledge of available methods. A study of family planning patients found, for example, that underestimation of the likelihood of conception predicted unprotected sex [36]. Foster et al. found that nearly 46% of women engaged in unprotected intercourse in the past three months underestimated the risk of conception [36]. A study of women seeking abortion services found that the majority of women had an inaccurately estimated the risk of pregnancy prior to conception [37].

Structural and psychosocial factors also affect unintended pregnancy risk. Relationship factors, including reproductive coercion, drive contraceptive decision-making and ability to use contraception even in contexts where pregnancy is not desired [38-40]. A qualitative study exploring determinants of inconsistent use found that eroticism of unprotected sex and the risk of conception was a powerful explanatory factor [41]. Additionally many women, particularly young, poor, and uninsured women, lack access to reproductive healthcare [42].

Micro economists have long attempted to explain differences in choices given equal information. Much of this work falls under the rubric of “behavioral economics,” the study of decisional biases and preferences. Primary questions in the field include: what leads people to behave in ways inconsistent with intentions? Given that differences in information alone unlikely explain differences among groups in unintended pregnancy, looking to behavioral economics for suggestions of other determinants seems warranted.

Risk preferences literature

Risk preferences, frequently studied in social science, are strong determinants of financial decision-making, including investment and savings. While elicitation methods vary, a common approach to assess preferences includes a series of questions assessing

willingness to take gambles with lifetime income [6]. People willing to take fewer gambles are generally deemed risk averse and those more willing to take gambles are risk tolerant.

Behavioral economists have argued that risk preferences in humans arise from loss aversion or the tendency to risk more to avoid a loss than to realize a gain even if the prospective losses and gains are equal [1]. The argument has garnered credibility in comparison to a standard economic model, which assumes “rational agents” who make choices to maximize utility and who would, therefore, exhibit indifference (i.e., take the same risk) in choices between equal loss and gain.

A small literature explores the association of risk preferences with health behaviors. One seminal study found that a measure of financial risk tolerance predicted risk behavior including smoking and drinking [6]. Barky validated the now widely used measure of risk preferences in a nationally representative sample in the Health and Retirement Study (HRS). Risk aversion has also been linked to cancer screening behavior [43], smoking, heavy drinking, obesity, and non-use of a seat belt [5].

Despite results from the above studies, and the widely-held belief that loss aversion and risk preferences affect choices under uncertainty, surprisingly little attention has been paid to these measures as determinants of sexual and reproductive behavior. In the best example of this limited literature, Schmidt hypothesized that when the risk of pregnancy appears highly uncertain, risk preferences help explain variability in timing of childbearing [44]. She found risk tolerance correlated with earlier childbearing at young ages and earlier timing of marriage [44]. She suggested that the association between early childbearing and increased risk tolerance may be a product of less contraceptive use, although she did not directly test this connection.

With exception [45], much work argues that risk preferences vary with age, income and gender [6, 46, 47]. Gender differences in risk aversion, with females expressing greater aversion, have been hypothesized to arise from different reproductive investment strategies [48]. A few studies have shown that risk tolerant women more likely delay marriage, indicating the apparent importance of risk tolerance to demographic behavior [45, 49]. Schmidt found that the effect of risk tolerance on fertility timing varied by marital status, such that for both married and unmarried women, higher risk tolerance predicted early birth at young ages. Among married women it was also associated with delayed fertility later in life [44].

In this paper, I ask whether propensity to risk-taking in financial decisions affects reproductive behavior. Using data from the 1997 cohort of the National Longitudinal Survey of Youth (NLSY), I examine several outcomes relevant to reproductive health: sex with high-risk partners, number of sex partners, consistency of contraceptive use, and effectiveness of contraceptive method. I conduct stratified analyses for contraceptive consistency and effective method use among unmarried and non-cohabitating women and among married or cohabitating women.

Methods

Data

This paper uses data from the 1997 cohort of the National Longitudinal Survey of Youth (NLSY97), a study funded primarily by the Bureau of Statistics (BLS) to describe entry to the labor market. NLSY97 is an ongoing prospective cohort that included 8,984 respondents aged 12-17 when first interviewed in 1997. The original sample included 4,599 (51%) men and 4,385 (49%) women. This cohort was comprised of both a nationally representative sample of 6,748 youths and an oversampled group of 2,236 Non-Hispanic blacks and Hispanics [50]. Sixteen waves of the longitudinal survey have been conducted to date. Data are publically available from the NLSY website and contain no personal identifiers. Sexual behavior and pregnancy items are derived from the self-administered questionnaire completed by youth. An interviewer administered the remainder of the survey items, including risk preferences.

Measures

Risk preference. Wave 14 of the survey, conducted in 2010, included attitudinal risk measures asked of all participating respondents. Few papers have used the discrete choice risk preference measures from either the 1979 or 1997 cohort [45, 51]. Respondents not able to participate in the 2010 wave were asked the risk attitude items in the 2011 wave. The questions, similar to those validated in the Health and Retirement Study (HRS) for their association with health behavior [6, 52], measure risk aversion based on hypothetical questions about lotteries. Risk tolerance is assessed through the following gamble questions (gamble 1):

Suppose you are the only income earner in the family, but that your current job is ending. You have to choose between two new jobs. The first job would guarantee your current family income for life. The second job is also guaranteed for life and possibly better paying, but the income is less certain. There is a 50-50 chance that the second job will double your current family income for life and a 50-50 chance that it will cut your current family income by a third for life. Which job would you take: the first job or the second job?

Depending on this first response, the respondent was asked an additional question which varied percent of income loss. If the respondent answered “first job”, they were then asked the following (gamble 2):

Suppose the chances were 50-50 that the second job would double your current family income and 50-50 that it would only cut it by 20 percent. Would you take the first job or the second job?

If the respondent answered, “second job” to gamble 1, they were then asked the following (gamble 3):

Suppose the chances were 50-50 that the second job would double your current family income and 50-50 that it would cut it in half. Would you take the first job or the second job?

These three gamble questions allow categorization into four groups along the risk aversion continuum. Respondents who preferred the first (more secure) job in both questions were classified as “very strongly risk averse.” Respondents who answered the first job to gamble 1 and the second job to gamble 2 were classified as “strongly risk averse.” Respondents who answered second job to gamble 1 and first job to gamble 3 were classified as “moderately risk averse.” Finally, those that responded second job to both gambles 1 and 3 were classified as “weakly risk averse.”

According to expected utility theory [6], a utility maximizer will choose the 50-50 gamble of doubling income as opposed to having it fall by $1-\lambda$ as long as the expected utility of the gamble exceeds the expected utility of the certain income:

$$\frac{1}{2}U(2c) + \frac{1}{2}U(\lambda c) \geq 2c$$

Only the fourth category, or weakly risk averse, would accept all gambles.

The construct of risk aversion serves as the inverse of risk tolerance, such that the fourth group noted above is the most risk tolerant and the first group the least. The 4-category variable that ranges from very strongly risk averse to weakly risk averse. The very strongly risk averse category serves as the referent.

Respondents who gave “don’t know” or “refuse” responses to the first gamble question then skipped gamble 2 and 3 and were coded as missing. Women who answered the first job to gamble 1 but “don’t know” to gamble 2 were recoded as strongly risk averse (category 2). Women who responded the second job in gamble 1 but ‘don’t know’ to gamble 3 were recoded to “somewhat risk averse” (category 3).

Reproductive Health Behaviors

Outcomes for this analysis included sex with a high-risk partner, number of sexual partners, consistency of contraceptive use, contraceptive method type, and effectiveness of chosen method. Any participant reporting sexual activity with a person of the opposite sex in the last year was asked a series of questions relating to sexual risk behavior, condom use frequency, contraception use frequency and contraceptive method type. I selected the reproductive health outcome variables from the same wave in which the risk preference questions were collected. The majority of responses come from 2010 (n=3,602), with a few from 2011 (n=101).

High-risk sex partner. Respondents were asked if they had sex with a stranger or with an “an I-V drug user - a person who takes/shoots street drugs using a needle”. If a respondent answered yes to either question, I classified them as having sex with a high-risk partner.

Number of sexual partners. Respondents were asked the number of partners they had sexual intercourse with since the last interview. As this variable was highly right-skewed, I truncated responses above five to greater than or equal to five partners.

Consistent contraceptive use. I derived a measure of consistency of contraceptive use from several questions in the survey. Respondents are first asked the number of times they had sex and then the number of times they used a condom or other birth control. If they could not recall the number, they were asked the proportion of the time that they used a method. Combining the frequency of intercourse and condom or birth control use questions allowed me to create a percent condom or birth control variable. This is variable categorized into nonuse (0% of the time), inconsistent use (1%-99% of the time), and perfect consistent use (100% of the time). I recoded anyone that reported sterilization as a consistent user even if they reported a lower birth control usage percent.

Contraceptive method type. Respondents were asked: “ thinking of all the times that you have had sexual intercourse since the last interview, how many of those times did you or your sexual partner or partners use a condom or female condom?” if they replied 1 or greater, I coded them as using condoms. The following question assessed additional contraceptive use asking which “one of these methods did you or your partner use most often, either with or without a condom or female condom?” Respondents could select one of the following: withdrawal (pulling out), rhythm (safe time), spermicide (foam, gel, crème, sponge or suppositories), diaphragm (with or without gel), IUD (Intrauterine device), morning after pill (emergency contraception), birth control pills, Depo-Provera or injectables, Norplant, patch (Ortho Evra) or ring (Nuva Ring), cap (Femcap) or shield (Lea’s Shield), had vasectomy or tubal ligation, or no other method. Since the questions were asked separately, condom use could be in addition to or in absence of other contraception use.

Contraceptive method effectiveness. I grouped contraceptive methods together based on typical use pregnancy prevention effectiveness rates [53] using categories of low effectiveness (withdrawal, diaphragm, rhythm, cap, or spermicide), medium effectiveness (condoms or emergency contraception), and high effectiveness (IUD, Depo-Provera or injectable, Norplant, Birth Control Pills, patch or ring, or sterilization). Participants were coded as medium effectiveness with condoms only if condoms were reported as the only method.

Covariates

Confounding variables were selected a priori based on literature as characteristics that would affect both risk aversion and sexual behavior and included: age, race/ethnicity, education, religion, marital status, parity, insurance, poverty.

Age serves as an important control variable, as both risk aversion and fertility intention and contraceptive behavior change with age [27, 54]. Age was assigned at year of risk preference measurement and ranges from 26-32. Race/ethnicity information was recorded at entry into the cohort in 1997. Respondents self-reported race ethnicity, which I divided into Hispanic, non-Hispanic white, non-Hispanic black, and mixed race/other. For

multivariable models, I dropped the mixed race/other respondents (N=32) due to positivity concerns.

Education influences risk perception as well as fertility timing and method choice. Risk aversion has been shown to decrease with later schooling and age [54]. I categorize educational attainment into the following categories: some high school, high school degree, some college, and college degree or higher.

In addition to age, reproductive history is an important predictor of current reproductive behavior. I therefore include a control for parity (0,1,2,3 or more biologic children).

Unintended pregnancy may carry different meaning in the context of being partnered and not partnered. While there is evidence that partnership may affect risk preference and also sexual behavior, I would not expect a different relationship of risk preferences to high-risk sex by partnership status. Partnership status can be thought of as an effect modifier to the relationship between risk preferences and contraceptive behavior. Additionally relationship context and power may influence ability to use contraception. Marital status is categorized as: never married/not cohabitating, never married/cohabitating, currently married, and widowed, separated or divorced.

While each wave of NLSY97 contains detailed information on contraceptive method use and type, no wave measures pregnancy intention. I cannot, therefore, attribute nonuse to wanting pregnancy or use to wanting to avoid pregnancy. I attempt to indirectly assess intention through fertility expectations. First I include a measure of fertility expectations assessed with the following question: “In five years, what is the percent chance that you will have (a/another) child?” Respondents report a range of 0-100%. I code ‘don’t know’ responses as 50%. While expectations may differ from intention, they have been shown to access the same construct (Hayford, 2009). The low expectation group could be driven by not wanting to have a child or experience of infertility. However, among people who reported having problems getting pregnant, the expected fertility variable had a higher mean than among those who did not report it. This implies that the expectation measure is largely capturing pregnancy intention.

Income and wealth are highly correlated with risk preferences. Although much literature in economics assumes, *a priori*, that risk preferences precede income, empirical research reports evidence for both causal directions [55]. I, therefore, exclude poverty as a control in the main models because it may be on the causal pathway between risk preferences and sexual and reproductive behavior. I, however, include a measure of poverty in the sensitivity analyses. Poverty is coded as household income relative to the federal poverty line.

Demand for insurance is correlated with risk tolerance, and at times itself used as a measure of risk tolerance (Friedman, 1973; Szpiro 1986). Therefore, I treat insurance status in the same manner as poverty, excluding it from the main models and including it for sensitivity analyses. Insurance status is coded as any insurance versus no insurance at the time of interview.

Analytic sample

By wave 14 in 2010, 7,479 participants remained in the cohort, constituting 83.2% retention. My analytic samples included 3,045 women who were not missing data on risk preference, sexual behavior, and contraceptive measures from 2010 and 2011. Women were only asked questions regarding contraceptive use if they reported having any sex in the 12 months prior to interview. This analysis uses custom survey weights from the 2010 and 2011 waves in accordance with the risk perception and fertility measures. These weights account for both the initial sample strategy and sample attrition prior to assessment.

Analyses

I assessed the relationship between covariates and risk aversion as well as behavioral outcomes using weighted regression models for each outcome: 1) sex with high-risk partner, 2) number of sexual partners, 3) consistency of contraceptive use, 4) effectiveness of birth control method, and 5) type of method. I used a Generalized Linear Model (GLM) with a log link to model the relative risk (RR) for sex with a high-risk partner. Given the skewed count of number of partners, I used a Poisson model with log link. I used multinomial logistic regression for the three-part consistency outcome, comparing inconsistent and nonuse to consistent use (referent). I also used multinomial logistic regression to compare use of highly and medium effective methods to those with low effectiveness (referent). As non-use of contraception is captured in the contraceptive consistency outcome, the multivariable models of effectiveness include only women who were using a contraceptive method. Exclusion of non-use also removed women who may be trying to become pregnant. For consistency of use and method effectiveness, I examined models stratified by partnership status. For the stratified models the groups are never married/not cohabitating combined with widowed, separated or divorced compared to never married/cohabitating combined with currently married. Finally, I used GLM regression with a log link to model the RR of individual method type compared to other methods, adjusting for race, parity and education. All analyses were adjusted for confounding variables and conducted using the survey function of Stata SE version 14.

Sensitivity analyses

I specified several sensitivity analyses *a priori* to explore robustness of findings. First, according to economic theory, risk aversion may not have a linear relationship with these outcomes across demographic groups. Barsky suggests conversion to a risk tolerance measure that controls for heterogeneity within the categorical responses. I therefore conduct analyses with this linear transformation of risk the tolerance measure (Barsky, 1997[52]).

To further examine different associations of risk preferences and reproductive behaviors by fertility intention, I conduct an analysis limited to women who expect a less than 10% chance of having a child in 5 years. This would further isolate those that do not want a pregnancy

Second, the strong correlation between wealth, health insurance and risk tolerance leads to a dilemma about whether it should be included as a control, or serves as a proxy for risk measures. My main effect models therefore exclude the poverty and health insurance as control variables. As a sensitivity analysis I explore how inclusion of poverty and health insurance affects the results.

Finally I examine whether there is evidence of effect modification by educational attainment.

Results

The risk preference measure was missing in 3.1% of 3,821 women interviewed in 2010 or 2011. Of the 118 missing responses, 103 answered don't know to the first gamble question. Of the 3,703 women with risk preferences measures, 530 were excluded due to reporting no sexual behavior with a member of the opposite sex in the preceding year. An additional 4% of the 3,173 responses were excluded from the analyses due to missing all of the sexual and contraceptive behavior outcomes, leaving a final analytic sample of 3,045 women.

The distribution of risk tolerance for the study sample included 56.6% in the very strongly risk averse category, 23.0% in the strongly risk averse category, 10.0% in the moderately risk averse category and 10.4% is the weakly risk averse category. These estimates parallel those reported in the literature, with one third to one half of participants falling into the most risk averse category [6, 45].

Table 1a shows the distribution of risk aversion by covariates in the sample. Measures of risk aversion appear similar across non-Hispanic white, non-Hispanic black and Hispanic respondents, with non-Hispanic blacks displaying slightly more responses in both risk averse and risk tolerant categories. The low numbers in the mixed/other racial group prevent any meaningful comparisons. The age range in the study sample included 25 to 31 year olds at the time of interview. With the exclusion of these 25 and 31 year olds that had low numbers of respondents, the risk preference measures appear largely stable over the age range. Higher education corresponded to decreased risk aversion and increased risk tolerance in this sample (very strongly risk averse as education increases from less than high school, high school/GED, some college, Bachelors degree and above: 68%, 67%, 59%, 46%), as is consistent with the literature.

As expected, risk aversion differed by marital/partnership status, with the never married/not cohabitating group showing lowest risk aversion and highest risk tolerance. Cohabitating but not married respondents also have higher risk tolerance and lower risk aversion than their married counterparts, with separated/divorces/and widowed in between. Respondents with no children ranked higher on risk tolerance and lower on risk aversion, than those with 1, 2, or 3 plus children. Insurance status, a marker for access to contraception and also SES, differed by risk aversion. Examining poverty and risk aversion also revealed expected differences. Those with lower income to poverty ratios displayed the highest degree of risk tolerance, and the wealthiest showed the highest degrees of risk aversion. Finally, risk preferences varied by expectation of future children

with those that 100% expect children in the next five years, and those that 0% expect children in the next five years exhibited stronger risk aversion.

I evaluated sexual and reproductive health behaviors through several dependent variables: sex with high risk partner, number of sexual partners in the past year, contraceptive method type, consistency of contraceptive method use, and effectiveness of method. Overall only 3.1% of the sample engaged in sex with a stranger or IVDU. Mean number of sexual partners was 2.4 and 79% of the sample had one sexual partner in the preceding year. 27.7% reported no method of birth control, 2.5% a low effectiveness method alone, 20.4% a medium effective method, and 49.3% a high effectiveness method. 40.6% of the sample reported some condom use, which could be either alone or in combination with another form of birth control. The mean condom use was 29.3%. Women reported using condoms in a mean of 29.3% of sexual acts and birth control in a mean 59.8% of acts. The percent of time women used birth control was 28.6% using a method none of the time, 47.6% reporting consistent use and 23.8% reporting inconsistent use.

Table 1b describes outcomes and covariate distributions in the sample. Consistency of contraceptive use appeared to differ by most covariates. Non-Hispanic black women appear more likely to report inconsistent use of contraception than non-Hispanic Whites and Hispanics, while Hispanics are more likely to report nonuse. Nonuse increased with age, while inconsistent use remained relatively stable. Consistently using a method increased with more education and non-use decreased.

Finally, table 1c shows demographic differences in contraceptive method type. Of note, non-Hispanic blacks were more likely to report condom use, withdrawal, Depo-Provera and emergency contraception and less likely to report birth control pills or the IUD. Condom use decreased with increasing age, as did use of the pill and IUD, perhaps around anticipated childbearing. Increased education correlated to increased pill and condom use, but a decrease in Depo-Provera use. Never married/ not cohabitating used withdrawal and condoms over other methods more than other groups and to used IUDs less. Increasing parity was associated with less condom and birth control use. The poorest respondents used more condoms and withdrawal over hormonal methods.

Risk preference and outcomes

Table 2 displays the distributions of risk preferences across outcome variables in both the full sample. The small number of women who reported a high-risk sex partner (n=89) appeared more risk tolerant than those who did not. Higher number of sexual partners was associated with lower risk aversion.

In the full sample, those that report contraceptive nonuse display higher levels of risk aversion. Inconsistent contraceptive users appear slightly less risk averse. This relationship is particularly apparent among the never married/not cohabitating group (44% vs. 60% very strongly risk averse for nonuse) (table not shown).

Proportions of very strongly risk averse were lower among those that used low effectiveness methods (44%) as compared to medium (55%) and highly effective (55%)

methods as well as among those that didn't use a method (62%). The difference persisted among never married and not cohabitating and divorced, separated, or widowed women, but not among cohabitating or married women (table not shown).

Risk preference and contraceptive methods

Examining each method type by risk preference reveals some trends (table not shown). Women who reported emergency contraception use in the last year are less risk averse (25% in weakly risk averse category). IUD (61%), Depo-Provera (63%), spermicide (82%) and sterilization (64%) all appear above the group mean for being very strongly risk averse.

Multivariable models

Tables 3 and 4 show adjusted models for sexual behavior and tables 5-7 show those for contraceptive use. Table 3 shows the association of risk preference with high-risk sexual behavior, in which the 95% confidence interval contained the null. Poisson regression of the number of sexual partners revealed an increased relative risk for the lowest level of risk aversion compared to the highest in adjusted [RR=1.10, 95% CI (1.002, 1.208)] models (Table 4).

Tables 5a and 5b show the association between risk preferences and consistency of contraceptive use. Stratification by partnership status reveals evidence of effect modification. Within the group of unmarried/non-cohabitating/separated, the risk of inconsistent versus consistent contraceptive use was elevated for the highest risk tolerance group [RR=1.65, 95% CI (1.00, 2.71)]. The married/cohabitating group saw a slightly decreased risk of inconsistent use with a one-category increase in risk tolerance, and a decreased risk of nonuse with a 2 unit increase in risk tolerance (from very strong to strong or moderately strong risk aversion), although the confidence interval crossed the null [RR=0.749, 95% CI (0.52, 1.06)]. Additionally, there was indication of a negative effect of increasing risk tolerance with nonuse of contraception among married and cohabitating women, although each of the three categories crossed the null.

Multinomial models of method effectiveness (table 6a and 6b) once again revealed associations among the unmarried/separated group but not the married/cohabitating group. Among unmarried women, each decreasing category of risk aversion was associated with a decreased relative risk of using a method with medium effectiveness [category 4 vs. 1 RR=0.28, 95% CI (0.08, 0.95)] or high effectiveness [category 4 vs. 1 RR=0.21, 95% CI (0.06, 0.71)] compared to a method of low effectiveness. For married or cohabitating women the lowest levels of risk aversion were associated with increased risk of using a method of medium effectiveness [RR=10.74, 95%CI (1.37, 84.15)] or high effectiveness [RR=11.04, 95% CI (1.46, 83.73)].

Finally, individual method types are shown in table 7. In models adjusted by race, parity and education, weak risk aversion was associated with decreased risk of sterilization [RR=0.44, 95% CI (0.20, 0.96)], increased use of the patch or ring [RR=2.08, 95%CI (1.08, 4.02)]. Comparing strong risk aversion to very strong risk aversion was associated

with decreased IUD use [RR=0.69, 95% CI (0.49, 0.96)], and decreased use of spermicide [RR=0.12, 95% CI (0.01, 0.95)]. The model for withdrawal did not converge due to low cell sizes.

Sensitivity analyses

Sensitivity analyses are shown in the appendices. First, I confirmed that the choice to code the second order “don’t know” responses to the middle categories of risk aversion did not alter results. All measures of effect remained unchanged.

Categorizing risk preference as a linear measure of tolerance according to the adjusted mean values reported in Barsky [6], led to similar results (Appendix 1). An increase in risk tolerance was associated with number of partners [RR= 1.25, 95% CI (1.02, 1.54)], but not with likelihood of having a high-risk sexual partner. Consistency of use results persisted for unmarried/not cohabitating women: the linear risk tolerance measure was associated with increased relative risk of inconsistent contraceptive use [RR= 3.20, 95% CI (1.03, 9.91)]. The results with nonuse were attenuated from the categorical measure from the measures for the married group. Finally, for effectiveness, a one-unit increase in the linear risk tolerance measure was associated with decreased risk of using a medium effectiveness [RR=0.06, 95% CI (0.007, 0.50)] or high effectiveness [RR=0.03, 95% CI (0.004, 0.26)] method use versus low effectiveness methods among the unmarried/not cohabitating group. The confidence intervals for an increased relative risk of medium and highly effective method use among the married or cohabitating group contained the null. For individual methods, only the relationship with the patch or ring and sterilization persisted with the continuous risk tolerance measure.

Models including the natural log of poverty and health insurance as covariates attenuated results for number of sexual partners (Appendix 2). The consistency of contraception and effectiveness of method relationships remained similar in magnitude.

I conducted a final sensitivity analyses for the contraceptive consistency and contraceptive effectiveness outcomes limited to those that did not expect to have a child in the next 5 years (results not shown). These models yielded similar results. Among unmarried/not cohabitating women, inconsistent use increased in relative magnitude across the three risk categories.

Finally, I tested if the relationships between risk preference and contraceptive outcomes was modified by educational attainment and did not see evidence of effect modification (results not shown).

Discussion

To my knowledge, this is the first paper to report a relationship between risk preferences and contraceptive use, an important determinant of unintended pregnancy. In a nationally representative sample of women aged 25-31, I found that among unmarried and not cohabitating or separated women, greater risk tolerance was associated with inconsistent contraceptive use, as well as decreased use of more effective methods of contraception. Among married and cohabitating women, the highest level of risk tolerance is associated

with an increased likelihood of using a more effective method of contraception. This likely indicates distinct pathways through which propensity to risk may operate in regard to reproductive behavior.

I further found evidence of risk tolerance and sexual behavior, as reported number of sexual partners increased with risk tolerance. The unadjusted relationship between risk tolerance and sex with a high-risk partner did not remain after covariate adjustment. As only three percent of the sample engaged in this behavior, it may be measuring a greater level of risk taking than is captured by the four categories of risk preferences measures by the lottery question.

Despite extensive research into reproductive decisions, little attention has been paid to risk preferences. Standard economic models generally view women as rational actors who adjust fertility behavior to maximize utility [56]. This view is inconsistent with the work from reproductive epidemiology that shows a complex set of factors influence reproductive decision making, and that women's stated pregnancy intentions and behavior do not always converge [22, 57-59]. This paper uses a well-studied measure from economics to explain variation in reproductive risk taking. The results suggest that the propensity to assume financial risk may imply a more general risk-taking that extends to reproductive behavior.

I found that partnership status modified the relationship of risk preference and contraceptive use. These results are consistent with previous work finding earlier marriage and divorce propensity are related to risk preferences [44, 45, 49]. Among unpartnered women, decreasing risk aversion was associated with increased inconsistent method use. This result supports the hypothesis that more risk tolerant unmarried or separated women may accept a greater risk of pregnancy versus potential negative cost of consistently using contraception. Also less likely to use more effective methods, this risk tolerant group may serve as a potential target of intervention.

The stratified models for married or cohabitating women paint a different picture of the risk preference relationship with contraceptive use, showing that the most risk tolerant women had less use of medium and highly effective methods. This direction was the opposite of that I hypothesized. This apparent increase in method effectiveness with increasing risk tolerance may be explained by unmeasured confounding by pregnancy intention. Previous work has noted that risk tolerant women may be more likely to use less effective contraception early in life but also may be most likely to delay childbearing until later in life, despite reductions in fecundity [44]. This latter theory may be at work in this married and cohabitating sample.

The effect modification by partnership status suggests that partnership status may serve as a source of differentiation of pregnancy intention as well relationship context. If a true relationship exists between risk preferences and contraceptive behavior it may be moderated by fertility intention. Undoubtedly, inconsistent or nonuse of contraception is capturing both those women trying to become pregnant, those ambivalent to pregnancy, and those trying to avoid pregnancy. My hypothesis would operate in a different direction in the latter two groups than the former. In the absence of any measure of pregnancy

planning or intention, the expectation measure may serve as a proxy for this construct. However, examining the relationship among those with low expectations of a child in 5 years did not change the results.

The results by individual contraceptive methods reveal some compelling differences. The most risk averse appeared more likely to use IUDs, the most effective reversible form of contraception. Patch and ring use was higher among the most risk tolerant women, while sterilization was associated high-risk aversion. While more work on method types is needed, these results suggest that assessing women's risk propensity may be an important determinant of appropriate contraceptive counseling. There has been a substantial push towards long acting reversible contraception for women in the US. A patient centered decision-making process could involve a discussion on only of risks of each particular method but of women's tolerance of such risks [60]. Indeed women may value particular features of contraceptive methods over others according to their risk preferences [33, 34].

The temporal ordering of measures of risk preference and sexual and contraceptive behavior is a strength of this analysis. Economic models frequently assume that preferences are trait characteristics, and can therefore be studied at any point in time with validity [61, 62]. Conversely, other literature has noted fluctuation of preferences with demographic changes and life events [47]. There is mixed evidence around potential alteration of risk preferences following childbearing [63]. Temporal ordering may not be an issue for this analysis, however additional measures of risk preference would be beneficial to establish the preference consistency and look at contraception and pregnancy outcomes over time.

Limitations

The age at which risk preferences were elicited poses a substantial limitation to the theory connecting risk tolerance to fertility and contraceptive behavior. The women in this analysis were in their late twenties at the time of elicitation of risk preferences. In order to rule out problematic temporal ordering, I chose to examine only proximate contraceptive use and sexual risk behavior. However, the hypothesized relationship between risk tolerance and sexual and reproductive behavior may operate differently for women at younger and older ages than I was able to explore in this sample of 25-31 year olds. Much work in adolescent development and neuroscience shows different adaptive responses to risk [64]. As adolescents exhibit more high-risk sexual behaviors and higher rates of unintended pregnancy [23, 65, 66], this age group would serve as a particularly important focus of further study of risk preferences and reproductive decision-making. The relationship of risk tolerance and fertility may be nonlinear with age, as Schmidt suggests. Early in fertility risk tolerant women may be less likely to use contraception while later they may be more likely to delay childbearing. Schmidt postulated that her finding that highly risk tolerant women experienced earlier first birth, was due to increased sexual risk behavior and reduced contraceptive use [44]. While I saw no relationship with age in this sample, I may not have had enough variability in age in this time period to notice an effect. Schmidt also notes that at high education levels, risk tolerance may lead to a postponement of childbearing. While I did not see any evidence

of interaction by education in this sample, additional analyses to explore subgroup differences are warranted.

Over half of the sample fell into the most risk averse category. While consistent with other representative studies, this measure may miss levels of granularity in risk preference that would be important to reproductive behavior. Other questions have attempted to improve the measure to capture more heterogeneity in risk response, however, those questions were not available in the NLSY97 [52]. The literature varies in its characterization of the risk preference variable, even with the same discrete choice questions [44, 45, 52, 67]. My results are similar whether including the full 4-category variable or the linear adjusted risk tolerance measure.

Misclassification of contraceptive consistency as well as contraceptive method could be a concern. There were some discrepancies between women's reported percent of contraceptive usage and their method type. For example, there were 13 people who reported 0% use of birth control methods and also reported IUD use. This may result from misinterpretation of the question specifically for women using long acting methods. Or those women may have recently switch to IUDs, or use IUDs for other medical issues [68]. It is challenging to determine if this is an error or an accurate response. There may be similar but less outwardly apparent misclassification across all contraceptive groups.

The characterization of sexual behavior is limited in NLSY. Notably, respondents were not asked about sexual activity with a same sex partner in the last year. While the results of number of sexual partners are suggestive, future research on risk preference and sexual risk behavior should include a more comprehensive battery of questions.

Future directions and conclusions

Potential intention-behavior incongruence may lead to the outcome of unintended pregnancy. Novel epidemiologic studies that include models of decision-making could identify antecedents of unintended pregnancy and develop interventions that may be targeted by individual risk preferences. This work provides an initial examination of the relationship between risk preferences and sexual risk behavior and contraceptive use. The findings merit future research with longitudinal samples to explore measure stability over time and in response to life circumstances. If a relationship between risk preferences and reproductive risk behavior, including number of partners and contraceptive use is reinforced, it should inform our models of etiology of unintended pregnancy and also target behavioral interventions.

The goal of this research was to demonstrate the potential contribution of behavioral economics to our understanding of reproductive choices and behavior. Examining people's decision-making can tell us not only about their likelihood of experiencing outcomes of interest, but also give information about their overall orientation. Preferences and biases may explain behavior and could be integrated into work on psychosocial predictors of health [69, 70].

The link between measured risk aversion and sexual and reproductive outcomes signal the importance of these measures beyond explaining financial behavior. They may, it appears, have implications for our understanding mechanisms underlying choices that drive reproductive health. This is an important step towards predicting who will be at highest risk of adverse outcomes and potentially develop models for intervention.

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Table 1a: Survey weighted descriptive statistics by risk aversion

	Risk Aversion				Unweighted N
	Very strongly risk averse	Strongly risk averse	Moderately risk averse	Weakly risk averse	
	Weighted%	Weighted%	Weighted%	Weighted%	
Total	0.566	0.230	0.100	0.104	3045
Race					
NH White	0.563	0.233	0.101	0.103	1,610
NH Black	0.579	0.212	0.096	0.112	756
Hispanic	0.573	0.232	0.111	0.084	647
NH Mixed	0.551	0.246	0.009	0.194	32
AGE					
25	0.549	0.231	0.137	0.082	61
26	0.587	0.24	0.075	0.097	579
27	0.555	0.231	0.089	0.125	592
28	0.577	0.223	0.116	0.085	638
29	0.551	0.232	0.105	0.111	611
30	0.573	0.22	0.112	0.095	541
31	0.246	0.356	0.084	0.314	23
Education					
<HS	0.679	0.173	0.062	0.086	238
HS/GED	0.673	0.155	0.08	0.093	649
Some college	0.586	0.222	0.102	0.09	1,237
BA/BS+	0.463	0.293	0.113	0.131	897
Religion					
Christian	0.585	0.231	0.091	0.093	1,630
Catholic	0.594	0.207	0.101	0.098	613
Other/None	0.505	0.246	0.123	0.125	638
Partnership Status					
Never married, Not Cohabiting	0.495	0.242	0.116	0.147	973
Never married, Cohabiting	0.564	0.22	0.109	0.107	541
Married	0.604	0.233	0.087	0.076	1,272
Separated, Divorced or Widowed	0.597	0.192	0.104	0.107	252

Table 1a continued

Parity						
	0	0.486	0.257	0.125	0.132	1,150
	1	0.598	0.252	0.074	0.076	719
	2	0.647	0.178	0.088	0.086	655
	3	0.634	0.189	0.086	0.09	520
Health Insurance Status						
No insurance		0.585	0.202	0.098	0.115	717
Insurance		0.561	0.238	0.101	0.1	2,324
Percent of FP						
<100		0.621	0.194	0.081	0.104	426
100-200		0.618	0.191	0.098	0.094	544
200-300		0.603	0.205	0.11	0.082	471
300-400		0.545	0.268	0.111	0.076	370
>400		0.506	0.271	0.102	0.121	864
Expected chance have a child in 5 years						
100%		0.6	0.221	0.093	0.085	586
51-99%		0.454	0.324	0.133	0.089	477
11-50%		0.55	0.22	0.108	0.122	867
1-10%		0.447	0.267	0.117	0.169	194
0%		0.653	0.183	0.073	0.091	921

Table 1b: Survey weighted descriptive statistics for outcome measures

	Consistency of contraceptive use			Method effectiveness				Sex with stranger or IVDU		Number of sexual partners				
	Always	Inconsistent	Nonuse	No method	Low	Medium	High	No	Yes	1	2	3	4	5+
Race														
NH White	0.491	0.224	0.285	0.278	0.022	0.186	0.514	0.971	0.029	0.81	0.09	0.043	0.018	0.04
NH Black	0.45	0.304	0.246	0.232	0.037	0.303	0.429	0.966	0.034	0.725	0.127	0.087	0.023	0.037
Hispanic	0.427	0.239	0.334	0.318	0.035	0.206	0.441	0.968	0.032	0.78	0.11	0.032	0.021	0.057
NH Mixed	0.307	0.323	0.370	0.352	0.035	0.202	0.411	0.966	0.034	0.658	0.205	0.091	0.009	0.037
AGE														
25	0.533	0.327	0.139	0.108	0.045	0.143	0.703	0.961	0.039	0.678	0.185	0.055	0.022	0.061
26	0.484	0.266	0.251	0.245	0.014	0.261	0.479	0.967	0.033	0.752	0.119	0.06	0.021	0.048
27	0.528	0.21	0.262	0.247	0.02	0.208	0.524	0.972	0.028	0.772	0.109	0.066	0.019	0.034
28	0.474	0.247	0.279	0.272	0.038	0.187	0.503	0.966	0.034	0.82	0.076	0.049	0.022	0.034
29	0.462	0.228	0.310	0.308	0.028	0.186	0.477	0.979	0.021	0.825	0.091	0.027	0.015	0.042
30	0.431	0.227	0.342	0.324	0.026	0.189	0.462	0.966	0.034	0.813	0.091	0.034	0.017	0.044
31	0.363	0.178	0.459	0.444	0	0.111	0.445	0.94	0.06	0.62	0.105	0.107	0	0.168
Education														
<HS	0.363	0.194	0.443	0.414	0.021	0.19	0.376	0.965	0.035	0.747	0.135	0.051	0.014	0.054
HS/GED	0.445	0.17	0.385	0.385	0.019	0.183	0.412	0.976	0.024	0.777	0.117	0.045	0.02	0.041
Some college	0.447	0.252	0.301	0.291	0.027	0.195	0.488	0.969	0.031	0.789	0.098	0.05	0.023	0.039
BA/BS+	0.545	0.271	0.185	0.173	0.028	0.232	0.567	0.968	0.032	0.814	0.081	0.048	0.014	0.042
Religion														
Christian	0.466	0.233	0.301	0.294	0.026	0.199	0.481	0.975	0.025	0.804	0.105	0.041	0.018	0.031
Catholic	0.497	0.213	0.290	0.283	0.024	0.206	0.487	0.978	0.022	0.824	0.092	0.028	0.008	0.049

Table 1b continued

Other/None	0.487	0.25	0.263	0.252	0.026	0.219	0.504	0.947	0.053	0.759	0.09	0.074	0.025	0.052
Partnership Status														
Never married, Not Cohabiting	0.587	0.28	0.133	0.123	0.032	0.326	0.518	0.931	0.069	0.559	0.205	0.121	0.042	0.073
Never married, Cohabiting	0.462	0.204	0.334	0.321	0.024	0.161	0.493	0.977	0.023	0.859	0.075	0.023	0.009	0.034
Married	0.409	0.24	0.351	0.346	0.022	0.164	0.468	0.991	0.009	0.934	0.03	0.009	0.006	0.02
Separated, Divorced or Widowed	0.52	0.166	0.314	0.301	0.022	0.132	0.545	0.963	0.037	0.636	0.178	0.076	0.032	0.078
Parity														
0	0.542	0.25	0.208	0.199	0.029	0.23	0.543	0.953	0.047	0.74	0.114	0.062	0.024	0.059
1	0.413	0.281	0.306	0.293	0.029	0.217	0.461	0.98	0.02	0.829	0.082	0.049	0.02	0.019
2	0.452	0.203	0.345	0.334	0.023	0.159	0.483	0.985	0.015	0.858	0.068	0.027	0.011	0.037
3	0.422	0.179	0.399	0.398	0.012	0.172	0.418	0.979	0.021	0.796	0.124	0.033	0.011	0.036
Health Insurance Status														
No insurance	0.447	0.247	0.306	0.297	0.027	0.29	0.386	0.946	0.054	0.714	0.132	0.059	0.023	0.072
Insurance	0.484	0.235	0.281	0.272	0.025	0.18	0.523	0.976	0.024	0.815	0.089	0.045	0.017	0.034
Percent of FP														
<100	0.422	0.245	0.333	0.333	0.024	0.256	0.387	0.979	0.021	0.735	0.138	0.069	0.007	0.051
100-200	0.467	0.211	0.322	0.305	0.027	0.207	0.461	0.954	0.046	0.73	0.133	0.059	0.022	0.056
200-300	0.503	0.236	0.261	0.256	0.02	0.2	0.525	0.966	0.034	0.825	0.082	0.045	0.013	0.036
300-400	0.469	0.233	0.298	0.292	0.029	0.185	0.495	0.982	0.018	0.846	0.068	0.037	0.025	0.024
>400	0.495	0.249	0.256	0.248	0.02	0.196	0.536	0.976	0.024	0.838	0.072	0.034	0.016	0.04

Table 1b continued

Expect child in 5 years														
100%	0.279	0.315	0.405	0.392	0.021	0.178	0.409	0.993	0.007	0.912	0.034	0.028	0.003	0.022
51-99	0.429	0.284	0.286	0.274	0.027	0.187	0.511	0.967	0.033	0.822	0.083	0.041	0.009	0.045
11-50	0.563	0.242	0.195	0.179	0.03	0.255	0.535	0.964	0.036	0.755	0.109	0.058	0.021	0.057
1-10	0.609	0.267	0.124	0.119	0.038	0.254	0.589	0.958	0.042	0.685	0.132	0.102	0.036	0.047
0%	0.523	0.142	0.335	0.337	0.02	0.167	0.476	0.963	0.037	0.753	0.136	0.044	0.029	0.037

Table 1c: Survey weighted descriptive statistics for contraceptive method type

	Spermicide	Withdrawal	Diaphragm	Rhythm	Birth control pills	IUD	Depo	Norplant	EC	Patch or ring	Cap or shield	MF sterilization	Condoms
Race													
NH White	0.011	0.125	0.000	0.013	0.424	0.121	0.040	0.003	0.006	0.039	0.001	0.080	0.388
NH Black	0.004	0.233	0.000	0.010	0.265	0.106	0.082	0.010	0.021	0.033	0.003	0.076	0.537
Hispanic	0.006	0.191	0.000	0.013	0.335	0.178	0.039	0.010	0.011	0.036	0.005	0.048	0.374
NH Mixed	0.052	0.171	0.000	0.000	0.185	0.166	0.059	0.055	0.000	0.000	0.000	0.171	0.345
AGE													
25	0.000	0.154	0.000	0.000	0.564	0.091	0.062	0.000	0.000	0.033	0.000	0.046	0.544
26	0.006	0.193	0.000	0.005	0.358	0.136	0.062	0.006	0.007	0.042	0.000	0.037	0.495
27	0.015	0.146	0.000	0.008	0.419	0.136	0.040	0.009	0.011	0.045	0.000	0.046	0.435
28	0.013	0.136	0.000	0.018	0.389	0.135	0.034	0.001	0.017	0.041	0.004	0.089	0.371
29	0.010	0.118	0.000	0.013	0.391	0.105	0.051	0.009	0.006	0.035	0.003	0.088	0.376
30	0.005	0.145	0.000	0.020	0.370	0.118	0.037	0.002	0.001	0.021	0.001	0.139	0.340
31	0.000	0.023	0.000	0.000	0.321	0.130	0.119	0.000	0.000	0.094	0.000	0.023	0.337
Education													
<HS	0.012	0.170	0.000	0.010	0.160	0.119	0.142	0.003	0.000	0.011	0.000	0.214	0.340
HS/GED	0.001	0.175	0.000	0.008	0.278	0.164	0.072	0.007	0.013	0.023	0.001	0.127	0.344
Some college	0.009	0.148	0.000	0.010	0.348	0.160	0.044	0.009	0.009	0.030	0.002	0.094	0.384
BA/BS+	0.014	0.132	0.000	0.016	0.508	0.077	0.026	0.000	0.007	0.054	0.001	0.021	0.479
Religion													
Christian	0.010	0.140	0.000	0.013	0.370	0.129	0.046	0.005	0.007	0.036	0.001	0.096	0.386
Catholic	0.007	0.157	0.000	0.015	0.408	0.136	0.034	0.007	0.011	0.038	0.003	0.051	0.400
Other/None	0.009	0.172	0.000	0.012	0.379	0.125	0.056	0.005	0.010	0.038	0.000	0.064	0.439

Table 1c continued

Partnership Status													
Never married, Not Cohabitating	0.004	0.222	0.000	0.009	0.406	0.063	0.060	0.005	0.014	0.031	0.001	0.029	0.656
Never married, Cohabitating	0.007	0.138	0.000	0.001	0.452	0.148	0.049	0.004	0.012	0.047	0.000	0.031	0.364
Married	0.012	0.099	0.000	0.021	0.357	0.156	0.033	0.005	0.003	0.038	0.003	0.120	0.283
Separated, Divorced or Widowed	0.026	0.119	0.000	0.004	0.356	0.168	0.053	0.006	0.005	0.045	0.000	0.146	0.354
Parity													
0	0.010	0.172	0.000	0.010	0.550	0.032	0.032	0.003	0.014	0.045	0.000	0.012	0.499
1	0.010	0.148	0.000	0.008	0.329	0.202	0.054	0.004	0.003	0.047	0.001	0.015	0.376
2	0.011	0.096	0.000	0.027	0.234	0.260	0.051	0.006	0.007	0.023	0.002	0.160	0.306
3	0.005	0.128	0.000	0.009	0.121	0.142	0.077	0.012	0.002	0.016	0.006	0.319	0.322
Health Insurance Status													
No insurance	0.010	0.216	0.000	0.029	0.253	0.114	0.065	0.010	0.011	0.023	0.002	0.087	0.456
Insurance	0.010	0.130	0.000	0.008	0.426	0.129	0.041	0.004	0.008	0.042	0.001	0.074	0.391
Percent of FP													
<100	0.007	0.230	0.000	0.009	0.229	0.107	0.091	0.009	0.018	0.037	0.002	0.112	0.474
100-200	0.006	0.157	0.000	0.017	0.310	0.146	0.042	0.005	0.006	0.027	0.000	0.136	0.400
200-300	0.001	0.128	0.000	0.011	0.314	0.195	0.058	0.004	0.007	0.026	0.005	0.107	0.389
300-400	0.016	0.127	0.000	0.012	0.407	0.131	0.066	0.001	0.005	0.043	0.000	0.047	0.397
>400	0.010	0.126	0.000	0.012	0.497	0.092	0.019	0.006	0.007	0.049	0.002	0.042	0.400

Table 1c continued

Expect child in 5 years													
100%	0.008	0.142	0.000	0.010	0.418	0.147	0.045	0.000	0.001	0.030	0.000	0.030	0.332
51-99	0.016	0.135	0.000	0.012	0.548	0.060	0.028	0.000	0.008	0.064	0.001	0.006	0.403
11-50	0.007	0.167	0.000	0.018	0.422	0.139	0.029	0.002	0.012	0.040	0.000	0.021	0.489
1-10	0.000	0.186	0.000	0.008	0.364	0.125	0.055	0.018	0.006	0.041	0.000	0.072	0.490
0%	0.013	0.122	0.000	0.008	0.230	0.138	0.079	0.012	0.011	0.021	0.005	0.231	0.351

Table 2: Survey weighted descriptive statistics for risk aversion and outcome measures

	Risk Aversion				Unweighted N
	Very strongly risk averse	Strongly risk averse	Moderately risk averse	Weakly risk averse	
	Weighted%	Weighted%	Weighted%	Weighted%	
Consistency of Contraceptive use					
Always	0.549	0.236	0.107	0.107	1,357
Inconsistent	0.539	0.238	0.114	0.109	705
Nonuse	0.62	0.213	0.075	0.093	830
Sex with a high risk partner					
No	0.569	0.227	0.102	0.102	2,952
Yes	0.476	0.338	0.041	0.145	89
Effectiveness of method					
No method	0.617	0.212	0.081	0.09	825
Low effectiveness	0.437	0.303	0.181	0.08	82
Medium effectiveness	0.547	0.235	0.095	0.124	665
High effectiveness	0.55	0.236	0.108	0.106	1,417
Condom use					
No	0.578	0.226	0.098	0.098	1,722
Yes	0.546	0.238	0.103	0.113	1,271
Number of sexual partners					
1	0.585	0.229	0.098	0.087	2,364
2	0.507	0.209	0.107	0.177	317
3	0.487	0.263	0.09	0.16	157
4	0.447	0.3	0.104	0.149	59
5+	0.487	0.225	0.125	0.164	125

Table 3: Adjusted RR for risk aversion and sex with a high risk partner

	Sex with high risk partner		
	RR	95% CI	
Risk Categories			
Very Strongly Risk Averse	1.00		
Strongly Risk Averse	1.521	(0.926	2.497)
Moderately Risk Averse	0.385	(0.129	1.149)
Weakly Risk Averse	1.071	(0.535	2.143)
Race/Ethnicity			
NH White	1.00		
NH Black	0.701	(0.389	1.264)
Hispanic	1.123	(0.597	2.114)
AGE	1.094	(0.929	1.290)
Education			
<HS	2.042	(0.866	4.812)
HS/GED	1.307	(0.636	2.684)
Some college	1.358	(0.792	2.327)
BA/BS+	1.00		
Religion			
Christian	0.619	(0.376	1.019)
Catholic	0.471	(0.219	1.012)
None/Other	1.00		
Marital Status			
Never married/ Not Cohabiting	6.923	(3.631	13.20)
Never married/Cohabiting	1.924	(0.760	4.870)
Married	1.00		
Separated/Divorced/Widowed	3.25	(1.170	9.024)
Parity	0.744	(0.564	0.980)

Table 4: Adjusted RR for risk aversion and number of sexual partners

	Number of Sexual Partners		
	RR	95% CI	
Risk Categories			
Very Strongly Risk Averse	1.00		
Strongly Risk Averse	1.03	(0.967	1.097)
Moderately Risk Averse	1.04	(0.949	1.139)
Weakly Risk Averse	1.1	(1.002	1.208)
Race/Ethnicity			
NH White	1.00		
NH Black	0.957	(0.893	1.025)
Hispanic	1.022	(0.945	1.104)
AGE	0.996	(0.977	1.015)
Education			
<HS	1.088	(0.965	1.226)
HS/GED	1.093	(1.005	1.189)
Some college	1.051	(0.984	1.122)
BA/BS+	1.00		
Religion			
Christian	0.941	(0.882	1.004)
Catholic	0.928	(0.851	1.013)
None/Other	1.00		
Marital Status			
Never married/ Not Cohabiting	1.59	(1.489	1.698)
Never married/Cohabiting	1.058	(0.986	1.135)
Married	1.00		
Separated/Divorced/Widowed	1.445	(1.295	1.613)
Parity	0.975	(0.947	1.003)

Table 5a: Adjusted RR for risk aversion and inconsistent contraceptive use compared to consistent contraceptive use, stratified by partnership status

Inconsistent Contraceptive Use						
	Never Married/Not Cohabitating/Separated			Cohabitating/Married		
	OR	95% CI		OR	95% CI	
Risk Categories						
Very Strongly Risk Averse	1.00			1.00		
Strongly Risk Averse	1.329	(0.872	2.024)	0.749	(0.526	1.066)
Moderately Risk Averse	1.18	(0.683	2.041)	1.012	(0.635	1.612)
Weakly Risk Averse	1.647	(1.001	2.710)	0.777	(0.447	1.348)
Race/Ethnicity						
NH White	1.00			1.00		
NH Black	2.068	(1.414	3.026)	1.511	(1.008	2.265)
Hispanic	1.766	(1.086	2.870)	1.117	(0.756	1.652)
AGE	1.031	(0.919	1.157)	0.997	(0.899	1.106)
Education						
<HS	1.094	(0.496	2.411)	1.739	(0.840	3.601)
HS/GED	1.415	(0.835	2.398)	0.878	(0.556	1.388)
Some college	1.63	(1.075	2.472)	1.15	(0.813	1.627)
BA/BS+	1.00			1.00		
Religion						
Christian	0.590	(0.387	0.899)	1.00	(0.696	1.437)
Catholic	0.536	(0.312	0.921)	0.889	(0.566	1.396)
None/Other	1.00			1.00		
Parity	0.99	(0.822	1.192)	1.051	(0.901	1.225)
Expectation of children	1.006	(1.001	1.011)	1.017	(1.012	1.021)

Table 5b: Adjusted RR for risk aversion and non-use of contraceptives compared to consistent contraceptive use, stratified by partnership status

	Contraceptive Nonuse					
	Never Married/Not Cohabiting/Separated			Cohabiting/Married		
	OR	95% CI		OR	95% CI	
Risk Categories						
Very Strongly Risk Averse	1.00			1.00		
Strongly Risk Averse	0.986	(0.591	1.645)	0.849	(0.626	1.152)
Moderately Risk Averse	1.077	(0.556	2.087)	0.649	(0.416	1.015)
Weakly Risk Averse	1.587	(0.883	2.851)	0.791	(0.483	1.294)
Race/Ethnicity						
NH White	1.00			1.00		
NH Black	0.675	(0.431	1.058)	1.294	(0.900	1.859)
Hispanic	1.273	(0.746	2.173)	1.269	(0.908	1.776)
AGE	1.115	(0.978	1.272)	1.162	(1.063	1.271)
Education						
<HS	3.771	(1.740	8.174)	4.827	(2.658	8.764)
HS/GED	2.753	(1.394	5.437)	3.022	(2.064	4.424)
Some college	2.702	(1.488	4.908)	1.919	(1.402	2.628)
BA/BS+	1.00			1.00		
Religion						
Christian	1.232	(0.734	2.069)	0.971	(0.710	1.329)
Catholic	0.803	(0.407	1.584)	0.895	(0.602	1.331)
None/Other	1.00			1.00		
Parity	1.598	(1.307	1.954)	1.041	(0.911	1.190)
Expectation of children	1.009	(1.004	1.015)	1.013	(1.009	1.016)

Table 6a: Adjusted RR for risk aversion and using a medium effectiveness contraceptive method compared to a low effectiveness contraceptive method, stratified by partnership status

Medium Effectiveness						
	Never Married/Not Cohabiting/Separated			Cohabiting/Married		
	RR	95%CI		RR	95%CI	
Risk Categories						
Very Strongly Risk Averse	1.00			1.00		
Strongly Risk Averse	0.323	(0.113	0.925)	0.681	(0.291	1.594)
Moderately Risk Averse	0.129	(0.0419	0.395)	0.756	(0.225	2.540)
Weakly Risk Averse	0.277	(0.0810	0.950)	10.74	(1.371	84.14)
Race/Ethnicity						
NH White	1.00			1.00		
NH Black	0.869	(0.329	2.292)	0.797	(0.295	2.153)
Hispanic	1.191	(0.340	4.179)	0.521	(0.195	1.392)
AGE	0.927	(0.722	1.189)	0.838	(0.647	1.087)
Education						
<HS	0.338	(0.0608	1.880)	1.137	(0.101	12.83)
HS/GED	0.619	(0.157	2.436)	1.18	(0.339	4.109)
Some college	0.672	(0.234	1.933)	0.839	(0.341	2.067)
BA/BS+	1.00			1.00		
Religion						
Christian	0.744	(0.235	2.358)	0.89	(0.380	2.089)
Catholic	0.535	(0.143	1.997)	1.458	(0.447	4.751)
None/Other	1.00			1.00		
Parity	0.995	(0.673	1.473)	1.553	(1.014	2.379)
Expectation of children	0.992	(0.981	1.004)	1.008	(0.997	1.018)

Table 6b: Adjusted RR for risk aversion and using a high effectiveness contraceptive method compared to a low effectiveness contraceptive method, stratified by partnership status

	High Effectiveness					
	Never Married/Not Cohabiting/Separated			Cohabiting/Married		
	RR	95%CI		RR	95%CI	
Risk Categories						
Very Strongly Risk Averse	1.00			1.00		
Strongly Risk Averse	0.275	(0.0978	0.776)	0.804	(0.359	1.800)
Moderately Risk Averse	0.141	(0.0480	0.415)	1.059	(0.338	3.323)
Weakly Risk Averse	0.209	(0.0615	0.713)	11.04	(1.456	83.73)
Race/Ethnicity						
NH White	1.00			1.00		
NH Black	0.337	(0.130	0.873)	0.786	(0.303	2.037)
Hispanic	0.782	(0.226	2.704)	0.501	(0.194	1.289)
AGE	0.934	(0.731	1.193)	0.848	(0.662	1.085)
Education						
<HS	0.24	(0.0432	1.334)	0.961	(0.0897	10.30)
HS/GED	0.442	(0.115	1.705)	1.015	(0.304	3.390)
Some college	0.566	(0.200	1.606)	0.958	(0.408	2.251)
BA/BS+	1.00			1.00		
Religion						
Christian	0.922	(0.295	2.881)	0.946	(0.422	2.119)
Catholic	0.663	(0.181	2.430)	1.321	(0.425	4.101)
None/Other	1.00			1.00		
Parity	1.319	(0.899	1.936)	1.378	(0.917	2.070)
Expectation of children	0.994	(0.983	1.006)	1.002	(0.991	1.012)

Table 7: Adjusted RR for risk aversion and using each type of contraceptive method.

	Risk Aversion									
	Very strongly risk averse		Strongly risk averse		Moderately risk averse		Weakly risk averse			
	RR*	RR*	95% CI		RR*	95% CI		RR*	95% CI	
Condom only	1.00	1.028	(0.766	1.379)	0.791	(0.499	1.255)	1.094	(0.747	1.602)
Spermicide	1.00	0.118	(0.015	0.947)	0.489	(0.064	3.723)	0.363	(0.048	2.742)
Birth control pills	1.00	0.970	(0.848	1.110)	1.015	(0.856	1.204)	0.937	(0.780	1.127)
IUD	1.00	0.686	(0.491	0.958)	1.093	(0.736	1.624)	0.971	(0.648	1.454)
Depo	1.00	1.099	(0.692	1.745)	0.472	(0.177	1.260)	0.613	(0.265	1.417)
Norplant	1.00	1.779	(0.363	8.704)	1.00	(1.00	1.00)	2.629	(0.487	14.19)
Emergency contraception	1.00	0.702	(0.188	2.627)	1.45	(0.335	6.266)	2.440	(0.814	7.317)
Patch or ring	1.00	1.390	(0.779	2.481)	1.193	(0.541	2.632)	2.081	(1.078	4.016)
Male or female sterilization	1.00	1.196	(0.854	1.675)	0.97	(0.551	1.709)	0.438	(0.200	0.957)

* Models adjusted for Race, parity and education

Chapter 4: The role of the economic environment in unintended pregnancy and pregnancy decision-making

Introduction

The economic recession in the U.S. prompted increased interest in economic drivers of fertility. Variation in economic conditions may influence pregnancy intentions as well as contraceptive and sexual behavior, thereby altering risk of pregnancy. Additionally, the economic environment may impact individual decision-making on whether to continue a pregnancy. Understanding how economic uncertainty affects fertility intention and decision-making offers insight into the determinants of unintended pregnancy, spontaneous and induced abortion.

Unintended pregnancy reduction is a stated national and international public health priority [1]. Nearly half of pregnancies to women aged 15-44 in the United States (US) are unintended, and 40% of those pregnancies end in abortion [2]. Literature links unintended pregnancy to negative health outcomes for mothers and children, making it a significant public health concern and the target of prevention efforts as part of Healthy People 2020 [3-6].

Unintended pregnancy and pregnancy decision-making result from a multidimensional set of economic, cultural, social, psychological and demographic determinants. While risk of unintended pregnancy extends to the majority of women through their reproductive years, age, income, race/ethnicity, and psychosocial factors are associated with occurrence [7-10]. There is an educational gradient in unintended pregnancy, with higher incidence among women with lower levels of education [11]. Women who experience unintended pregnancies are more likely have riskier psychosocial profiles prior to pregnancy, including depression, perceived stress, and low social support [12].

Consequences of unintended pregnancy are substantial. There is some evidence of increased maternal risk behavior during pregnancy among those pregnancies that are unintended, including smoking and drinking [6, 13]. Consequences of unintended births include depression, preterm birth and delays in child development [5]. It is estimated that unintended pregnancies cost the US more than \$20 billion per year in expenses for births, abortions and miscarriages [14, 15].

Traditional measures of pregnancy intention measure the degree to which a pregnancy was planned or correctly timed. Unintended pregnancies are defined as pregnancies that are mistimed (occurring too soon) or unwanted at the time of conception. Intended pregnancies include pregnancies that are wanted at the time of conception or happen later than desired. Literature has critiqued this measure as one-dimensional, while asserting that people may feel a complex and multidimensional set of emotions surrounding pregnancy. [16, 17]. In addition pregnancy intentions are dynamic and can change prior to and over the course of a pregnancy [18]. Pregnancy intentions are often retrospectively recalled at the time of conception. This can be problematic as participant's responses of intentions and desires can change depending on when they are assessed. Despite critiques

that standard unintended pregnancy measures may not capture there this nuance, they are useful to identify time trends and risk factors.

Research on the economy and pregnancy

Researchers have long examined the relationship of the economy to fertility. Most studies find evidence for pro-cyclical effects [19-21], meaning slowing fertility in an economic downturn. The literature posits several mechanisms through which a worsening economy could affect fertility. First, an income effect from individual economic hardship causes individuals to rationally postpone or revise fertility plans. Becker (Becker, 1974), for example, suggests that the income effect leads to a quantity-quality tradeoff in childbearing decisions. Temporary income decreases may cause delays in childbearing whereas more persistent periods of unemployment may reduce the underlying desire to have children [22].

The economic environment can affect perception of risk in a population, not only among those directly affected by the experience of, for example, unemployment. Uncertainties in the labor market may affect fertility through anticipation of hardship, making fertility planning more challenging. These mechanisms would also yield a pro-cyclical association between the performance of the economy and fertility.

Few studies show evidence of counter-cyclical effects [23], which assume that as employment opportunities decrease, the opportunity costs of time spent raising children decrease as well. This would promote substitution effects of fertility for employment. The recent economic recession in the United States provides opportunity for understanding mechanisms relating the economy and fertility.

The Great Recession in the United States officially began in December 2007 and ended in June 2009. Unemployment and foreclosures rapidly increased as consumer confidence declined nationwide. During the Great Recession, the fertility rate decreased from 69.6 births per thousand women in 2007 to 66.4 births per thousand women in 2009, and has continued to decline [24]. Several studies have documented a fertility decline in the United States and Europe from 2007-2011 [25, 26]. During that time, state level economic indicators were linked to general fertility declines, as well as heterogeneity within subgroups [27, 28]. Schneider found strongest fertility effects of the economic downturn among women aged 20-24, who experienced lower rates of live birth than expected. Decreases in fertility were attributed to increased economic hardship and economic uncertainty which may have affected changes in contraceptive use, increases in abortion, miscarriage, or shifts in pregnancy intentions [28]. Cherlin attributed a greater decline in fertility for young women to postponement rather than elimination of childbearing [26]. Ananat et al. found birthrate declines among black but not white teens following country level job losses [29]. They inferred that changes could be attributed to abortion or pregnancy avoidance based on the timing in gestation at which point the job losses occur. They hypothesized that black teens may be more vulnerable to job loss or uncertainty than white youth and found that the reductions in black teen births may be due to increased pregnancy terminations, reductions in sexual activity and increased contraceptive use.

Much of the above work theorizes that fertility decline is due to rational choice to postpone or abstain from childbearing, however the ratio of intended and to unintended births during the Great Recession has rarely been examined. There is limited research on how the economic environment may serve as a determinant of unintended pregnancy and pregnancy outcome. Economic uncertainty or income effects may influence decision making prior to pregnancy, including pregnancy planning, sexual behavior and contraceptive use, and decision-making once a pregnancy has occurred, including the decision to abort. A study of institutional and individual economic measures found perception of job and income insecurity as well as aggregate unemployment rates to be associated with decreases short term childbearing intentions [30]. A recent study by Percheski and Kimbo used the National Survey of Family Growth to investigate the risk of unintended pregnancy among women in the great recession [31]. They exploited statewide indicators of unemployment, foreclosure and consumer sentiment and find reductions in both intended and unintended pregnancy among non-college educated women. They investigated the determinants of the decline, but found little evidence that economic indicators reduced sexual activity or increased contraceptive use [31].

Reductions in births observed during the economic downturn may also have resulted from changes in pregnancy outcomes. While challenging to observe given high rates of fetal loss prior to pregnancy recognition, changes in the proportion of pregnancies that are not carried to term can alter fertility rates. A related body of literature establishes the increase of spontaneous abortion, following economic shocks [32, 33]. Additionally, work demonstrating the shared correlation of spontaneous abortion and induced abortion suggests a positive relationship in response to economic events [34]. Ananat et al.'s finding that teen fertility decreases following job loss that occurs during the first trimester could be explained by either mechanism [29]. Research on abortion patients finds that economic insecurity is often cited as a reason for the decision [35].

In the current investigation, I focus on two primary research questions: i.) Is national economic uncertainty associated with ratio of pregnancies reported as mistimed or unwanted relative to intended pregnancies; and ii) Is national economic uncertainty associated with the ratio of pregnancies ending in abortions or miscarriages relative to live births?

Economic uncertainty, measured by changes in national monthly measures of the economy, captures contextual effects beyond effects among individuals who have experienced job loss or economic change. To investigate the relationship of economic uncertainty and reproductive health outcomes, I use data from the National Survey of Family Growth (NSFG), combined with and monthly national unemployment data from the National Bureau of Labor statistics (NLBS) and the national consumer sentiment index from the Conference Board.

Methods

The National Survey of Family Growth (NSFG) is a cross sectional, nationally representative survey administered by the National Center for Health Statistics. The Survey, initiated in 1973, collects data on fertility in the United States and contains

detailed questions about sexual behavior, contraceptive use, relationship status and pregnancy. Data are collected on a rolling basis through in-person interviews and released every two years.

The survey collects data on each pregnancy, retrospectively recalled by participants. It is one of the only national surveys to include questions about pregnancy intention and contraception use at the time that the pregnancy occurred, as well as report of pregnancy resolution. This allows for examination of multiple pregnancies. NSFG includes inverse probability selection weighting based on of PSU, segment, housing unit, and person within selected household sampling procedures

My analysis uses the 2006-2010 wave, which includes a national sample of 12,279 women and 10,403 men age 15-44 years living in households in the United States. In-person interviews were conducted for a total sample size of 22,682. The interviews averaged 80 minutes in length for women. The response rate was 77% overall—78% for women, 75% for men [36].

To investigate women's reproductive health outcomes, I use the pregnancy data file from the 2006-2010 survey of women across the US. The pregnancy file contains information on all of the participants' past and current pregnancies, including date of conception, 'wantedness' at the time of conception, and pregnancy outcome. Therefore pregnancy is the unit of analysis.

Fertility outcome Measures

NSFG assessed pregnancy intention assessed from recall of whether respondent wanted a child at that time or in the future for the period prior to each pregnancy. If a respondent said that her pregnancy occurred at the 'right time', was 'later, or overdue' or that she 'didn't care, indifferent', that pregnancy was classified as intended. Pregnancies that occurred 'too soon, mistimed' were classified as mistimed, and those that were 'unwanted' were classified as such. Both mistimed and unwanted pregnancies were classified as unintended.

Pregnancy outcome was assessed from self-report of the resolution of each pregnancy and categorized as either ending in live birth, induced abortion, or miscarriage.

Economic exposure measures

National economic uncertainty was measured in three ways:

- 1.) National Bureau of Labor Statistics adjusted national unemployment rate
- 2.) University of Michigan Consumer Sentiment Index (ICS)
- 3.) An indicator of date after fall of 2008, compared with before

The National Bureau of Labor Statistics calculates a monthly, seasonally adjusted unemployment rate for the United States. The ICS is a national consumer confidence index published each month by the University of Michigan. It is an index generated from a survey of a random sample of 500 Americans who are asked five questions comprising

consumer expectations and report of economic conditions. Higher values correspond with less confidence in the economy in this analysis. The consumer sentiment measure may be a better approximation of cognitive risk aversion, as it measures willingness to make purchases and is responsive to general feelings about the economy rather than gross measures of economic conditions.

Many analyses of the great recession use a fixed effect for the nadir of the recession in November 2008. I also explored this characterization of the economy, which compares the period before the recession to the period of the recession, as a simple characterization of the economic environment.

Monthly aggregate values of the unemployment rate and ICS measures were assigned to month of conception from each pregnancy reported in the NSFG between January 1990 and March 2010. I merged pregnancies with economic measures by month of conception, based on the theory that the economic conditions may have influenced pregnancy intentions, contraceptive behavior as well as decision making regarding whether to continue the pregnancy.

Analysis

I constructed multivariate generalized estimating equation (GEE) models to estimate the association of the economic environment with fertility outcomes. Given that there are multiple pregnancies per woman in the dataset, GEE was used to account for clustering by woman. I estimated associations of economic uncertainty with (1) unintended compared to intended pregnancy, (2) mistimed compared to wanted pregnancy (3) unwanted compared to wanted pregnancy, (4) abortion compared to birth, and (5) miscarriage compared to birth.

All analyses controlled for age at the time of conception, race, and education. Age was modeled as a categorical variable, adolescents (15-19), early adults (20-24), and adults (25-44). Race was classified as non-Hispanic White, non-Hispanic Black, Hispanic, and other. I collapsed education at the time of interview into a dichotomous variable for less than high school education compared to those that completed high school or beyond. While this completed education measure does not capture education level at the time of pregnancy, it could be considered a measure of SES at the time of survey. All analyses were completed in Stata SE 14.0.

Results

The sample included 18,091 pregnancies, among 7,211 women, reported between 1990 and 2010. Sixty-six pregnancies were coded as “don’t know” when asked about intention at the time of conception and changed to missing. The mean unemployment rate across this period was 5.4%, with a minimum of 3.8% in June of 2000 and a maximum of 10.0% in October 2010. The fluctuation in the monthly unemployment rate and ICS is displayed in Figure 1. The figure shows a marked increase in unemployment corresponding with the current economic recession and notable increases in unemployment in the early 1990s.

Unintended pregnancy included mistimed and unwanted pregnancies, and was compared to pregnancies that were reported as at the right time, overdue, or those to which the woman was indifferent at the time of conception. The weighted responses to each question and associated groups are listed below:

<i>Intended</i>		<i>Unintended</i>	
Later, overdue	7.6%	Too soon, mistimed	27.2%
Right time	48.4%	Unwanted	15.8%
Didn't care, indifferent	0.8%		

This measure of 'unintended' pregnancy includes 43% of all pregnancies.

Descriptive statistics across strata of pregnancy intention are displayed in Table 1. 'Later' and 'indifferent' were grouped into 'other'. The frequencies presented are unweighted, and the percentages account for survey weighting. Mean unemployment rate is slightly higher for pregnancies classified as mistimed (5.47, SE= .03), compared to unwanted (5.37, SE= .03) and wanted (5.38, SE= .02). Pregnancy intention is not randomly distributed across groups. Women with less than high school education are more likely to report their pregnancies as mistimed or unwanted as compared to wanted. Black women have higher percentages of pregnancies reported as mistimed or unwanted compared to white women. Hispanic show the same trend, but to a lesser degree. Over half of women report pregnancies occurring from 15-19 years of age as being mistimed, 32% of 20-24 year old, and only 15% of 25-44 year olds. Reports of unwanted pregnancies do not differ as dramatically by age, suggesting that the differences in pregnancy intention are largely driven by pregnancies that occur sooner than the woman would have hoped. These observed differences may speak to underlying differences in the incidence of mistimed, unwanted, and wanted pregnancies across racial, SES and age groups. They may also arise from cultural differences in the interpretation of the survey questions and constructs.

Table 2 presents reported pregnancy outcomes across race, education and age. Women are more likely to report a pregnancy as unintended (unwanted and/or mistimed) at times of higher economic uncertainty. Additionally, at times of higher economic uncertainty, pregnancies are more likely to end in abortion and miscarriage as compared to live birth. Differences in reported abortion, miscarriage and birth are apparent. Mean unemployment is highest among pregnancies that ended in abortion, (5.47, SE=.03), as compared to miscarriage (5.39, SE .03) and birth (5.37, SE=.01). Reported abortion is highest among black women, which is consistent with national demographics of abortion. The proportion of reported miscarriage (15.8%) may be explained by the underreporting of abortion, and over reporting of miscarriage by participants. This may occur because miscarriage is significantly less stigmatized in the US than abortion and participants may be more comfortable reporting a terminated pregnancy as a miscarriage. Abortion is known to be underreported in this sample [37].

In adjusted models an increase of 1 standard deviation in the unemployment rate (Table 3) was positively associated with odds of a mistimed as opposed to wanted pregnancy (OR=1.10, 95% CI [1.02, 1.17]) and pregnancy ending abortion (OR=1.12, 95% CI [1.04, 1.25]) or miscarriage (OR=1.25, 95% CI [1.15, 1.37]) as opposed to live birth. The association with unwanted pregnancies was lower in magnitude and the confidence interval included the null. Less confidence in the economy, as measured by the Index of Consumer Sentiment (Table 4) was associated with increased odds of unintended versus intended (OR=1.09, 95% CI [1.05, 1.13]), mistimed (OR=1.10, 95% CI [1.06, 1.15]) and unwanted (OR=1.08, 95% CI [1.03, 1.13]) versus wanted pregnancy, and pregnancy ending abortion (OR=1.19, 95% CI [1.11, 1.28]) or miscarriage (OR=1.20, 95% CI [1.14, 1.27]) as opposed to live birth. A model (Table 5) with an indicator for the Great Recession in fall of 2008 and beyond demonstrated that the period following fall 2008 was positively associated with unintended versus intended (OR=1.29, 95% CI [1.06, 1.58]) mistimed (OR=1.42, 95% CI [1.11, 1.82]) versus wanted pregnancy, and pregnancy ending abortion (OR=4.16, 95% CI [2.98, 5.83]) or miscarriage (OR=3.86, 95% CI [2.99, 4.98]) as opposed to birth.

Discussion

Economic uncertainty, as measured by the unemployment rate, Index of Consumer Sentiment, and timing of recession was associated with increased ratio of unintended compared to intended pregnancy, and abortion and miscarriage compared to live birth. Among unintended pregnancies, the ratio of mistimed pregnancies appeared more strongly and consistently associated with economic indicators than unwanted pregnancies.

These findings describe how unintended pregnancy may change based on the economic environment. This may be measuring fluctuations in prospective intentions that lead to different contraceptive or sexual behavior, or a change in intentions once a pregnancy has occurred. For example, if a woman experiences an unplanned pregnancy in good economic times, she may be more likely to report that pregnancy as wanted, whereas a pregnancy that comes in times of economic uncertainty may be more likely to be classified as mistimed.

This paper does not explore overall risk of pregnancy, but rather the odds of unintended pregnancy relative to intended pregnancy. Risk aversion, through income or uncertainty effects, may reduce sexual behavior or increase contraceptive use in times of economic uncertainty, leading to lower pregnancy rates, as shown in the economic and demographic literature [20, 27, 31]. My findings add to this line of research by showing that women who become pregnant during recessions are less likely to intended to do so than those becoming pregnant at other times. My results can be reconciled with those of Percheski and Kimbo by assuming that the relative composition of pregnancies changed even if the numbers decreased. My results may be produced by an increase in mistimed pregnancies, or a reduction in intended pregnancies.

My findings are consistent with the possibility that reported reductions in fertility during the Great Recession may, in part, arise from increases in the likelihood of abortion and/or

miscarriage. This finding adds to the individual literature on abortion decision-making, which finds financial concerns among the most commonly cited reasons for abortion decisions [35, 38]. The abortion rate in the US gradually declined from 1990 to 2005, leveled off until 2008, and began declining again through 2011 [39, 40]. Jones and Jerman speculate that the economy may contribute to the declines in both the birth and abortion rate between 2008-2011, indicating that fewer women got pregnant in this period [39]. Greater declines in intended pregnancy, as women and couples revise fertility plans, would likely cause a greater decrease in number of births than abortions.

The significant effect for miscarriage could indicate a biological mechanism of increases in spontaneous abortion with stressful economic conditions, as has been suggested by previous work [32, 41, 42]. This work posits that pregnant women non-consciously evaluate the likelihood of success for their offspring under varying environmental conditions. When the environment poses more of a threat [41], in this case through scarce resources, fewer gestations survive to birth. My results of increased odds of miscarriage compared to live births support this argument.

Alternatively, the increase in reported miscarriages may arise, at least in part, from misclassification. It is well documented that the stigma of induced abortion leads some women to instead report spontaneous abortion on surveys, an outcome that does not carry the same stigma in the United States [37]. If stigma is also trending in time, as it is reflective of the political environment, there may be differential misclassification that may bias the result. For example, if anti-abortion policies, which have increased since 2010, were also correlated in time with the economic uncertainty measures, this may have increased stigma about reporting abortion. The fact that all women were interviewed over the same period between 2006-2010 and reported abortions retrospectively makes this issue less of a concern in this analysis. Additionally, research has shown that these restrictions have little impact on the abortion rate [43].

Limitations

There are several limitations to this analysis. As noted, if women failed to report a pregnancy that ended in induced abortion or reported it as a miscarriage instead, my results for the effect on odds of induced abortion would be conservative and odds of miscarriage would be inflated. Secular trends may be a concern of the analysis. I chose to model the economic variables as their absolute value given the hypothesis that it is the absolute rate of uncertainty that would affect decision-making, rather than a deviation from expected. However it is possible that the models captures autocorrelation shared by the independent and dependent variable.

This paper examines measures of the national economy. It is possible that regional data would suggest a different or more complex relationship than I found. It may be that states with high unemployment would be most affected by changes in the unemployment rate, because more people are sensitive to shocks in that region. Conversely, it could be hypothesized that those same states would be less affected, because the relative change in unemployment may be less significant as compared to lower endemic rates. A recent study found that states with the highest income inequality also had the highest rates of

unintended pregnancy, but it is unclear how an economic shock may affect these populations (Kost, 2012). NSFG does not include questions about individual unemployment or economic stress at the time of pregnancy, thus preventing further control or examination of individual circumstances.

It is possible that economic uncertainty would have different effects at different times in a woman's pregnancy. For instance, increases in unemployment several months before pregnancy, may impact contraceptive use and sexual behavior, while unemployment in the first trimester could alter risk of miscarriage or decision to have an abortion. Economic changes at any point during pregnancy could alter women's likelihood of reporting that pregnancy as mistimed or unwanted at conception. I chose to assign economic uncertainty measures during the month of conception to align with the framing of the pregnancy intention questions. Future work could consider if there is a particularly sensitive period in pregnancy to these effects.

These findings add to the literature on the economy and fertility. They also inform public health discussions of the determinants of unintended pregnancy. Income effects from economic downturns may extend to contraceptive use, preventing some women from using methods despite desire not to become pregnant. It would therefore be an especially important time to provide adequate contraceptive access to women.

Conclusion

It is important to understand the context of decision-making in addition to individual determinants, and in particular, how the economic environment may drive observed changes in pregnancy outcomes. The literature on the economy and fertility provides ample theoretical, yet limited empirical evidence for how economic uncertainty affects pregnancy intentions and outcomes. The results described above support the hypothesis that economic uncertainty impacts fertility intention through changes in desired timing of pregnancy. The findings also indicate that women are more likely to terminate or lose a pregnancy in a time of greater economic risk. Understanding how the economy affects pregnancy intention and decision-making will bring insight to the discussion of decision-making and reproductive outcomes as well economic drivers of fertility.

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Figure 1: Crude economic measures over study period

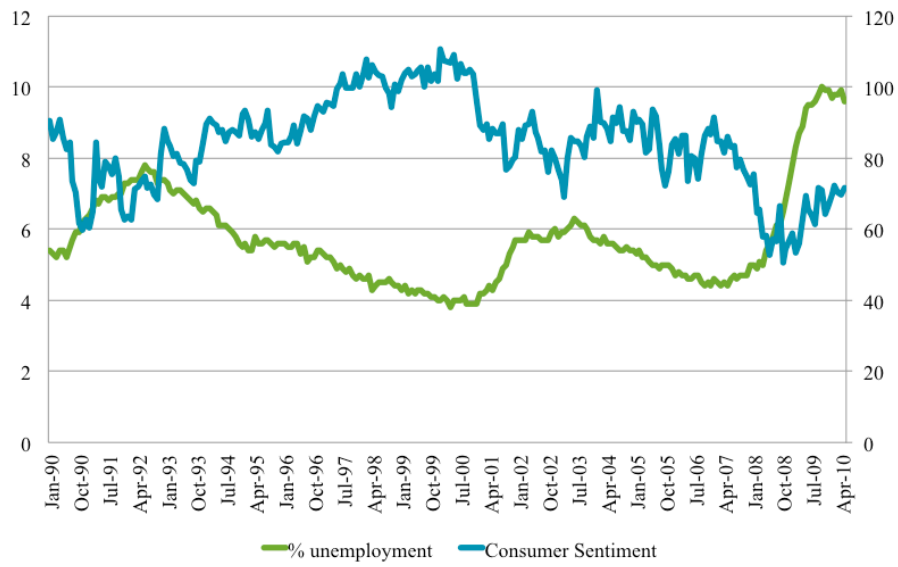


Table 1: Population descriptive statistics for unemployment, education, race and age by pregnancy intention measures. Unweighted frequencies and weighted percentages are presented.

	All		Unintended				Intended			
	%	N	Mistimed		Unwanted		Wanted		Other	
			%	N	%	N	%	N	%	N
Mean national unemployment		5.40	5.47		5.37		5.38		5.34	
Education	49.9	8,046	24.3	2,220	12.1	1,218	52.5	3,829	11.1	779
HS and above										
Less than HS	50.1	10,111	30.1	3,185	19.5	2,227	44.0	4,082	6.3	617
Race	54.9	7,698	25.9	2,165	12.8	1,097	51.7	3,677	10.4	759
White										
Hispanic	20.9	4,805	27.4	1,379	17.3	854	47.5	2,223	7.7	349
Black	15.9	4,373	32.4	1,490	25.9	1,235	37.4	1,456	4.3	192
Other	8.3	1,281	26.0	371	17.4	259	48.2	555	8.4	96
Age	18.8	4,209	53.6	2,224	19.7	918	23.7	935	3.1	132
15-19										
20-24	29.5	5,761	32.0	1,854	16.1	1,168	47.1	2,462	4.8	277
25-44	51.7	8,187	15.0	1,327	14.3	1,359	57.8	4,514	13.0	987
Total		18,157	27.2	5,405	15.8	3,445	48.2	7,911	8.7	1396

Table 2: Population descriptive statistics for unemployment, education, race and age by pregnancy outcome measures. Unweighted frequencies and weighted percentages are presented.

			Abortion		Miscarriage		Birth	
	%	N	%	N	%	N	%	N
Mean national unemployment	5.40		5.47		5.39		5.37	
Education	49.9	7,636	10.1	933	16.0	1,239	73.8	5,464
HS and above								
Less than HS	50.1	9,607	8.9	931	15.5	1,457	75.6	7,219
Race	54.9	7,307	8.7	697	17.5	1,313	73.8	5,279
White								
Hispanic	20.9	4,566	8.2	379	10.9	551	80.9	3,636
Black	15.9	4,138	14.1	666	15.1	601	70.8	2,871
Other	8.3	1,232	9.4	122	17.2	231	72.8	979
Age	18.8	4,088	14.8	601	16.6	603	68.6	2,884
15-19								
20-24	29.5	5,492	10.9	675	13.8	760	75.3	4,057
25-44	51.7	7,663	6.7	558	16.6	1,333	76.7	5,742
Total		17,243	9.5	1,864	15.8	2,696	74.7	12,683

Table 3: Odds Ratios and associated 95% confidence intervals for the association of national unemployment rates (Z-score) with unintended pregnancy, mistimed pregnancy, unwanted pregnancy, abortion, and miscarriage using GEE models to account for clustering by respondent. All models are adjusted for covariates.

	OR	95% CI
Unintended pregnancy	1.05	(0.99, 1.11)
Mistimed pregnancy	1.10	(1.02, 1.17)
Unwanted pregnancy	0.96	(0.88, 1.03)
Abortion	1.12	(1.04, 1.25)
Miscarriage	1.25	(1.15, 1.37)

Table 4: Odds Ratios and associated 95% confidence intervals for the association of Index of Consumer Sentiment (Z-score) with unintended pregnancy, mistimed pregnancy, unwanted pregnancy, abortion, and miscarriage using GEE models to account for clustering by respondent. All models are adjusted for covariates.

	OR	95% CI
Unintended pregnancy	1.09	(1.05, 1.13)
Mistimed pregnancy	1.10	(1.06,1.15)
Unwanted pregnancy	1.08	(1.03, 1.13)
Abortion	1.19	(1.11, 1.28)
Miscarriage	1.20	(1.14, 1.27)

Table 5: Odds Ratios and associated 95% confidence intervals for the association of the Great Recession (Fall 2008) with unintended pregnancy, mistimed pregnancy, unwanted pregnancy, abortion, and miscarriage using GEE models to account for clustering by respondent. All models are adjusted for covariates.

	OR	95% CI
Unintended pregnancy	1.29	(1.06,1.58)
Mistimed pregnancy	1.42	(1.11, 1.82)
Unwanted pregnancy	1.24	(0.97, 1.59)
Abortion	4.16	(2.98, 5.83)
Miscarriage	3.86	(2.99, 4.98)

Chapter 5. Conclusion

The drivers of unintended fertility are complex and multifactorial. As epidemiologists model sexual and reproductive behavior, it is vital that we understand key components of decision-making. As this dissertation demonstrates, borrowing concepts of risk tolerance, temporal discounting, and decision-making under uncertainty from behavioral economics allows insight into these outcomes.

The second chapter described the scope of the literature on temporal discounting and risk preferences in sexual and reproductive health. The review revealed consistent associations between economic preference measures and sexual and reproductive behavior. In particular, the literature on temporal preferences suggests that high rates of discounting serve as an important marker of sexual risk behavior. It shows that people exhibit a shift in preferences from condom-protected sex to unprotected sex as the delay to sexual behavior increases. This is similar to a preference shift from a long-term disease avoidance to short-term rewards of risky behavior seen in other discounting and health literature. The literature on pregnancy, while smaller, also suggests an association with risk and temporal preferences, indicates that HIV and pregnancy risk behavior may share proximate pathways. The review also supports the conclusion that discounting interacts with substance use, particularly alcohol use, to produce heightened risk for impulsive sexual behavior. More research is needed to expand these topics to models of pregnancy risk and contraceptive use. If discounting proves to be a reliable marker of impulsive decision making it may be a useful tool for screening in the context of contraceptive decision making or identifying those at risk of unintended pregnancy.

The third dissertation chapter expands on this literature by testing the relationship of risk tolerance to sexual and contraceptive behavior in the NLSY 1997 cohort. I find that among unmarried and not cohabitating or separated women, greater risk tolerance is associated with inconsistent contraceptive use, as well as decreased use of more effective methods of contraception. Among married and cohabitating women, the highest level of risk tolerance is associated with an increased likelihood of using a more effective method of contraception. I also found evidence for increased numbers of sexual partners among more risk tolerant women. This work, in combination with results of the review, demonstrates that measures of financial risk tolerance may serve as more general marker of propensity to assume risk that extend to reproductive behavior.

Finally, the fourth chapter describes how contexts of economic uncertainty contribute to unintended pregnancy and pregnancy outcomes. I find that economic uncertainty, as measured by the unemployment rate, Index of Consumer Sentiment, and timing of recession is associated with increased ratio of unintended compared to intended pregnancy, and abortion and miscarriage compared to live birth. My results support the hypothesis that economic uncertainty impacts fertility intention through changes in desired timing of pregnancy. This paper fills a gap in the literature by providing empirical evidence for how economic uncertainty affects pregnancy intentions and outcomes.

Taken together this work provides examples of how uncertainty and preferences affect reproductive decision-making. If these relationships hold, preferences may offer insight into pathways between structural risk factors and reproductive outcomes.

Appendix 1

Appendix 1a: Adjusted RRs for linear risk aversion and sexual behavior outcomes

	Sex with stranger or IVDU			Number of sexual partners		
	RR	95% CI		RR	95% CI	
Linear risk tolerance	0.909	(0.191	4.338)	1.251	(1.015	1.543)
NH Black	0.722	(0.412	1.266)	0.956	(0.893	1.025)
Hispanic	1.184	(0.639	2.194)	1.021	(0.945	1.104)
AGE	1.074	(0.916	1.259)	0.996	(0.977	1.015)
<HS	2.11	(0.922	4.827)	1.088	(0.964	1.227)
HS/GED	1.225	(0.591	2.539)	1.093	(1.004	1.189)
Some college	1.311	(0.766	2.245)	1.05	(0.983	1.122)
Christian	0.634	(0.389	1.034)	0.941	(0.882	1.004)
Catholic	0.464	(0.219	0.983)	0.928	(0.852	1.012)
Parity	0.756	(0.580	0.987)	0.975	(0.947	1.003)
Health Insurance Status	6.776	(3.612	12.71)	1.59	(1.489	1.698)
Poverty	1.83	(0.730	4.588)	1.058	(0.986	1.135)
Never married/ Not cohab	2.995	(1.090	8.229)	1.445	(1.295	1.612)
Never married/ cohab	0.909	(0.191	4.338)	1.251	(1.015	1.543)
Separated	0.722	(0.412	1.266)	0.956	(0.893	1.025)

Appendix 1b: Adjusted RRs for linear risk aversion and inconsistent contraceptive use compared to consistent use

	Inconsistent contraceptive use					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Linear risk tolerance	3.197	(1.032	9.907)	0.54	(0.164	1.772)
NH Black	2.058	(1.410	3.005)	1.528	(1.019	2.291)
Hispanic	1.774	(1.089	2.890)	1.111	(0.753	1.640)
AGE	1.026	(0.915	1.149)	0.997	(0.899	1.106)
<HS	1.079	(0.490	2.377)	1.748	(0.844	3.621)
HS/GED	1.39	(0.822	2.352)	0.895	(0.568	1.410)
Some college	1.61	(1.062	2.440)	1.161	(0.821	1.643)
Christian	0.593	(0.390	0.903)	0.996	(0.693	1.431)
Catholic	0.531	(0.309	0.912)	0.886	(0.565	1.391)
Parity	0.992	(0.825	1.193)	1.051	(0.902	1.226)
Expectation of children	1.006	(1.001	1.011)	1.016	(1.012	1.021)

Appendix 1c: Adjusted RRs for linear risk aversion and non-use of contraception compared to consistent use

	Non-use of contraception					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Linear risk tolerance	2.73	(0.691	10.78)	0.433	(0.148	1.264)
NH Black	0.671	(0.428	1.051)	1.295	(0.902	1.859)
Hispanic	1.254	(0.738	2.132)	1.26	(0.902	1.760)
AGE	1.114	(0.977	1.270)	1.161	(1.062	1.269)
<HS	3.82	(1.753	8.326)	4.866	(2.685	8.816)
HS/GED	2.766	(1.397	5.478)	3.071	(2.102	4.485)
Some college	2.706	(1.486	4.927)	1.93	(1.410	2.642)
Christian	1.227	(0.733	2.055)	0.975	(0.713	1.333)
Catholic	0.809	(0.411	1.593)	0.903	(0.608	1.341)
Parity	1.607	(1.315	1.963)	1.04	(0.910	1.188)
Expectation of children	1.009	(1.004	1.015)	1.013	(1.009	1.016)

Appendix 1d: Adjusted RRs for linear risk aversion and use of a medium effectiveness method compared to a low effectiveness method

	Medium effectiveness					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Linear risk tolerance	0.058	(0.007	0.498)	4.627	(0.340	62.94)
NH Black	0.884	(0.351	2.229)	0.816	(0.303	2.198)
Hispanic	1.061	(0.286	3.929)	0.491	(0.185	1.301)
AGE	0.903	(0.703	1.160)	0.834	(0.643	1.082)
<HS	0.368	(0.0695	1.949)	1.221	(0.112	13.32)
HS/GED	0.614	(0.164	2.291)	1.295	(0.378	4.433)
Some college	0.648	(0.219	1.921)	0.86	(0.352	2.103)
Christian	0.798	(0.253	2.514)	0.874	(0.371	2.060)
Catholic	0.585	(0.151	2.264)	1.447	(0.438	4.786)
Parity	1.036	(0.712	1.507)	1.57	(1.030	2.394)
Expectation of children	0.991	(0.980	1.003)	1.007	(0.997	1.018)

Appendix 1e: Adjusted RRs for linear risk aversion and use of a medium effectiveness method compared to a low effectiveness method

	High effectiveness					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Linear risk tolerance	0.0316	(0.004	0.264)	6.896	(0.603	78.91)
NH Black	0.344	(0.139	0.848)	0.802	(0.310	2.072)
Hispanic	0.701	(0.192	2.563)	0.477	(0.186	1.221)
AGE	0.916	(0.715	1.173)	0.844	(0.658	1.083)
<HS	0.264	(0.0493	1.412)	1.013	(0.098	10.47)
HS/GED	0.445	(0.120	1.655)	1.086	(0.331	3.564)
Some college	0.553	(0.189	1.618)	0.974	(0.418	2.272)
Christian	0.981	(0.315	3.052)	0.929	(0.413	2.090)
Catholic	0.727	(0.190	2.776)	1.309	(0.416	4.124)
Parity	1.366	(0.945	1.973)	1.388	(0.928	2.076)
Expectation of children	0.993	(0.982	1.005)	1.001	(0.991	1.011)

Appendix 2

Appendix 2a: Adjusted RRs for risk aversion and sexual behavior outcomes with the addition of health insurance status and poverty as covariates

	Sex with stranger or IVDU			Number of sexual partners		
	RR	95% CI		RR	95% CI	
Strongly Risk Averse	1.328	(0.765	2.305)	1.007	(0.942	1.076)
Moderately Risk Averse	0.444	(0.148	1.331)	1.018	(0.924	1.120)
Weakly Risk Averse	1.12	(0.547	2.296)	1.074	(0.971	1.188)
NH Black	0.714	(0.374	1.363)	0.944	(0.877	1.016)
Hispanic	1.042	(0.551	1.970)	1.016	(0.937	1.103)
AGE	1.114	(0.935	1.327)	0.995	(0.975	1.015)
<HS	1.814	(0.715	4.604)	1.049	(0.921	1.195)
HS/GED	0.988	(0.447	2.185)	1.081	(0.991	1.180)
Some college	1.101	(0.619	1.958)	1.042	(0.972	1.116)
Christian	0.656	(0.375	1.147)	0.918	(0.857	0.984)
Catholic	0.626	(0.293	1.340)	0.912	(0.832	0.999)
Parity	0.754	(0.564	1.007)	0.976	(0.946	1.007)
Health Insurance Status	0.403	(0.231	0.704)	0.913	(0.848	0.983)
Poverty	1.062	(0.868	1.300)	1.001	(0.971	1.033)
Never married/ Not cohab	5.159	(2.601	10.24)	1.577	(1.468	1.694)
Never married/ cohab	1.505	(0.564	4.018)	1.066	(0.992	1.146)
Separated	2.315	(0.741	7.235)	1.431	(1.264	1.621)

Appendix 2b: Adjusted RRs for risk aversion and inconsistent contraceptive use compared to consistent use with the addition of health insurance status and poverty as covariates

	Inconsistent contraceptive use					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Strongly Risk Averse	1.458	(0.926	2.295)	0.745	(0.513	1.082)
Moderately Risk Averse	1.2	(0.660	2.182)	0.956	(0.586	1.559)
Weakly Risk Averse	1.698	(0.996	2.896)	0.854	(0.466	1.566)
NH Black	2.063	(1.365	3.116)	1.312	(0.839	2.050)
Hispanic	1.669	(0.987	2.823)	1.101	(0.722	1.679)
AGE	1.038	(0.915	1.178)	1.013	(0.906	1.132)
<HS	0.877	(0.363	2.118)	1.899	(0.847	4.258)
HS/GED	1.3	(0.721	2.347)	0.781	(0.468	1.305)
Some college	1.484	(0.933	2.358)	1.156	(0.795	1.682)
Christian	0.591	(0.376	0.927)	1.033	(0.700	1.526)
Catholic	0.558	(0.316	0.987)	0.837	(0.518	1.354)
Parity	0.996	(0.811	1.223)	1.009	(0.851	1.196)
Expectation of children	1.007	(1.001	1.012)	1.019	(1.014	1.024)
Health Insurance Status	0.761	(0.498	1.164)	0.703	(0.459	1.075)
Poverty	0.936	(0.815	1.074)	0.9	(0.726	1.116)

Appendix 2c: Adjusted RRs for risk aversion and non-use of contraception compared to consistent use with the addition of health insurance status and poverty as covariates

	Non-use of contraception					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Strongly Risk Averse	1.135	(0.646	1.993)	0.825	(0.599	1.135)
Moderately Risk Averse	1.115	(0.544	2.286)	0.627	(0.395	0.994)
Weakly Risk Averse	1.368	(0.705	2.657)	0.811	(0.472	1.394)
NH Black	0.666	(0.400	1.108)	1.221	(0.826	1.805)
Hispanic	1.162	(0.640	2.110)	1.216	(0.851	1.735)
AGE	1.114	(0.965	1.285)	1.2	(1.092	1.319)
<HS	3.65	(1.454	9.161)	4.267	(2.184	8.336)
HS/GED	2.558	(1.172	5.583)	2.908	(1.924	4.397)
Some coll	2.016	(1.040	3.908)	1.936	(1.385	2.707)
Christian	1.264	(0.715	2.236)	1.016	(0.727	1.420)
Catholic	0.58	(0.266	1.264)	0.923	(0.606	1.406)
Parity	1.662	(1.306	2.116)	0.984	(0.852	1.137)
Expectation of children	1.011	(1.005	1.017)	1.014	(1.010	1.018)
Health Insurance Status	0.642	(0.404	1.021)	0.765	(0.539	1.085)
Poverty	1.048	(0.862	1.275)	0.876	(0.734	1.046)

Appendix 2d: Adjusted RRs for risk aversion and use of a medium effectiveness method compared to a low effectiveness method with the addition of health insurance status and poverty as covariates

	Medium effectiveness					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Strongly Risk Averse	0.202	(0.0668	0.610)	0.629	(0.252	1.570)
Moderately Risk Averse	0.0876	(0.0269	0.285)	1.06	(0.225	4.985)
Weakly Risk Averse	0.186	(0.0494	0.698)	8.736	(1.130	67.54)
NH Black	1.181	(0.408	3.420)	1.142	(0.324	4.028)
Hispanic	1.167	(0.304	4.479)	0.399	(0.145	1.096)
AGE	0.995	(0.759	1.305)	0.857	(0.621	1.182)
<HS	0.147	(0.0188	1.156)	1.301	(0.0964	17.55)
HS/GED	0.281	(0.0540	1.464)	1.189	(0.304	4.655)
Some coll	0.294	(0.0794	1.087)	1.072	(0.375	3.062)
Christian	0.575	(0.147	2.255)	0.537	(0.188	1.530)
Catholic	0.407	(0.0972	1.705)	1.106	(0.277	4.412)
Parity	1.008	(0.645	1.574)	1.416	(0.902	2.224)
Expectation of children	0.995	(0.982	1.007)	1.01	(0.998	1.022)
Health Insurance Status	0.339	(0.113	1.019)	0.733	(0.210	2.557)
Poverty	0.986	(0.754	1.288)	0.911	(0.496	1.674)

Appendix 2e: Adjusted RRs for risk aversion and use of a medium effectiveness method compared to a low effectiveness method with the addition of health insurance status and poverty as covariates

	High effectiveness					
	Never Married/No Cohabiting			Cohabiting/Married		
	RR	95% CI		RR	95% CI	
Strongly Risk Averse	0.165	(0.0562	0.484)	0.806	(0.338	1.922)
Moderately Risk Averse	0.0893	(0.0292	0.274)	1.383	(0.309	6.184)
Weakly Risk Averse	0.137	(0.0370	0.510)	8.493	(1.139	63.32)
NH Black	0.429	(0.151	1.215)	1.327	(0.391	4.508)
Hispanic	0.749	(0.199	2.824)	0.394	(0.151	1.032)
AGE	0.984	(0.756	1.282)	0.818	(0.600	1.116)
<HS	0.143	(0.0186	1.104)	1.113	(0.0849	14.58)
HS/GED	0.267	(0.0535	1.330)	1.502	(0.399	5.653)
Some coll	0.331	(0.0905	1.209)	1.34	(0.492	3.651)
Christian	0.729	(0.190	2.791)	0.576	(0.210	1.580)
Catholic	0.517	(0.127	2.105)	1.077	(0.285	4.067)
Parity	1.257	(0.815	1.939)	1.258	(0.820	1.931)
Expectation of children	0.995	(0.983	1.008)	1.002	(0.991	1.014)
Health Insurance Status	0.906	(0.302	2.717)	1.414	(0.417	4.788)
Poverty	1.09	(0.833	1.425)	0.962	(0.535	1.727)