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Determining the Optimal Number of Interview Waves in the National Crime Victimization Survey: Evaluation and Recommendations

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Abstract

The National Crime Victimization Survey (NCVS) currently uses a seven-wave or time-in-sample (TIS) design. That is, households are asked to participate every six months over a three year period. In an effort to maintain or reduce costs and improve data quality, the Bureau of Justice Statistics commissioned a Panel Design Study to evaluate the effects of changing the NCVS from a 7-TIS design to a 5-TIS, 4-TIS, 3-TIS, or 1-TIS design. Panel surveys need to balance the benefits of repeated measurements (e.g., bounded interview, reduced cost, increased response rates) with the drawbacks that may eventually occur (e.g., respondent fatigue, attrition, nonresponse). The optimal number of interview waves for a panel survey needs to maximize the advantages while minimizing the potential for bias due to incorporating sampling units for too many interview waves. This study used a set of simulations to mimic different panel design options for the NCVS. The simulation assumptions were constructed using NCVS data from 1999 to 2011, and included assumptions about sample sizes, costs, response rates, household replacement, type of interview, demographics, and victimization propensities. Samples were simulated with different panel designs and summary victimization propensities, and standard errors were computed for key estimates. Simulations considered cost models for potential constraints: (1) the need to keep the cost constant and (2) the need to keep the number of interviews constant across the different panel design options. In this paper, we show the impact of changing the number of panel TISs on property and violent victimization rates in terms of point estimates, variability, sample sizes, and costs, by several population characteristics. Simulation results found that a 4-TIS design is optimal for the NCVS.

Contents

List of Tables

Table number Page

List of Figures

Figure number Page

1. Introduction

1.1 Background

The National Crime Victimization Survey (NCVS) is the nation's leading measure of reported and unreported crime victimization rates in the United States. Sponsored by the Department of Justice's Bureau of Justice Statistics (BJS) and conducted by the U.S. Census Bureau, the NCVS is a nationally representative, probability-based household survey that interviews all persons age 12 or older in a selected household. Each year in the NCVS, interviews are conducted in approximately 90,000 households and 160,000 individuals are interviewed (U.S. Census Bureau, 2014; Truman, Langton, & Planty, 2013).

Similar to other national benchmark surveys,[1] the NCVS uses a rotating panel design, where equally sized sets of sampling units (i.e., rotation groups) are brought in and out of the sample in a specified pattern (Kasprzyk et al., 1989; Cantwell, 2008). In the NCVS, samples of about 50,000 households are generated every 6 months and allocated across seven rotation groups with about 7,000 households per group. Once the households rotate in, they remain in the sample for 3.5 years and are interviewed seven times (at 6-month intervals) during that period (Truman, Langton, & Planty, 2013). In other words, seven is the maximum time in sample (TIS) for a household in the NCVS.

Rotating panel designs offer three key benefits to a survey design (Kasprzyk et al., 1989; Kalton & Citro, 1995):

1. *Bounded interviews*. For studies where there is a concern that the outcome of interest may be highly susceptible to recall bias (e.g., telescoping), bounding an interview (i.e., tying a previous interview to a specific point in time) to the sampling unit's previous interview better ensures that events of interest occurring before the

[1] For example, the Current Population Survey (U.S. Department of Labor, 2006) and Consumer Expenditure Survey (U.S. Department of Labor, 2011).

bounding period will not be reported in the current period (Biderman & Cantor, 1984; Gaskell, Wright, & O'Muircheartaigh, 2000).

2. *Cost*. A panel design can reduce survey costs in two ways. First, panel designs often have higher response rates because after the initial contact, participating households are more motivated to remain in the study (Cantwell, 2008). A higher response rate allows fewer sampling units to be initially selected to achieve the desired number of interviews, thereby reducing data collection costs. Second, a panel design allows the study to alter the interview mode to a lower-cost mode after the initial contact is made. For example, in the NCVS, the initial interview with a sampling unit may be conducted in person (i.e., the interviewer goes to the sampled address in person to interview all eligible household members) to better recruit the household into the study and explain the study and its purpose. Follow-up interviews may be conducted by telephone (i.e., the same interviewer calls the household and conducts interviews via the telephone with each eligible household member) to reduce survey costs.

3. *Longitudinal design*. By interviewing a sampling unit multiple times, a rotating panel design allows for longitudinal data analysis in addition to serial cross-sectional analysis. This benefit allows analysts to better take into account the correlation between a sampling unit and the outcome of interest over time.

However, some logistical considerations may reduce the impact of these benefits (Kasprzyk et al., 1989). For instance, because the NCVS includes the initial, unbounded interview, measurement error in the form of recall bias may be introduced. Similarly, mobility in the sample may reduce the benefits of bounding and the longitudinal nature of the data (Addington, 2005). If there is a large amount of household turnover requiring replacement households (i.e., new families that have moved into a selected address), then the cost benefits of changing interview mode may not be realized because the first interview with a new replacement household will be conducted in person and will negate the potential cost savings by switching modes. Also, conducting initial interviews and replacement household interviews in person and other interviews over the telephone operates the potential for a mode effect between in-person

and telephone interviews. In addition, if there is a large amount of panel attrition during the data collection period, the ability to conduct a longitudinal analysis may be reduced due to an increase in bias and a reduction in precision. Furthermore, respondents that remain in the panel may suffer from rotation group bias or panel conditioning (Bailar, 1975; Hart, Rennison, & Gibson, 2005). Although the exact impact of panel conditioning is not consistent in all surveys, it may contribute to changes in respondents' behavior over time (Cantor, 2007). In the NCVS, Berzofsky et al. (forthcoming) found that respondents in later interview waves report fewer victimizations than in earlier waves. Since telescoping in the NCVS is controlled for with a bounding adjustment in the first wave and by prior interviews in subsequent waves, this may indicate respondent fatigue is occurring in the NCVS panel, which could lead to suppressed victimization rates. Also, because BJS conducts most analyses in a cross-sectional or serial cross-sectional manner (Planty et al., 2013; Hardison-Walters et al., 2013), having a larger number of interview waves (referred to here as TISs) may not be helpful analytically. This paper addresses the issue of cost and the longitudinal design. The effect of including unbounded interviews is beyond the scope of this paper.[2]

1.2 Purpose of study

Because a rotating panel design has both benefits and limitations, it is necessary to assess the current NCVS design to see if the number of panel waves (TISs) for a household in the sample is optimal. Therefore, the purpose of this study is to determine the optimal number of TISs for the NCVS while ensuring that study estimates (i.e., crime victimization rates), precision levels, and study costs are not negatively altered.

To understand how changing the number of TISs for sampled households in the NCVS will affect the cost of data collection, four alternative designs were considered in addition to the current 7-TIS design:

- 5-TIS design
- 4-TIS design

[2] Because the adjustment for unbounded cases is not incorporated (published estimates for the NCVS include this adjustment), estimates in this analysis will increase across designs compared to published estimates. BJS is examining bounding adjustment considerations through other lines of research.

- 3-TIS design
- 1-TIS or serial cross-sectional design.

To assess the main study goal, four secondary study questions were considered:

1. Do violent and property victimization estimates differ across different TIS designs, and what would be the impact of reducing the number of TISs on these estimates?

2. To what extent do response rates differ across TIS designs, and what would be the impact of reducing the number of TISs on response rates?

3. Given household turnover and attrition, what are the cost savings associated with keeping households in the sample for 7 TISs compared to 5 TISs, 4 TISs, 3 TISs, and 1 TIS?

4. How would key sample demographic distributions be affected if the NCVS moved from a 7-TIS design to a 5-TIS, 4-TIS, 3-TIS, or 1-TIS design?

2. Methods

Study questions were answered through a three-step process. First, cost models were developed to determine the change in survey costs or the number of interviews that could be conducted under the current and alternative designs. Second, key characteristics related to the probability of reporting a crime were determined. Third, a Monte Carlo simulation was conducted using the cost models and key characteristics to assess the change in the NCVS estimates and precision levels caused by modifying the number of TISs.

2.1 Cost models

To assess the cost of modifying the number of TISs, two types of cost models were developed: 1) keeping the number of interviews constant (KNIC) and 2) keeping the cost constant (KCC). In the KNIC model, the number of interviews is fixed on the basis of the average number of interviews in the 7-TIS (current) design. The model adjusts the cost of each design based on this fixed number of interviews. In the KCC model, the cost of each design is fixed on the basis of the estimated cost of the 7-TIS (current) design. The model adjusts the number of interviews in each design based on the fixed cost. Because both models depend on knowledge about the current 7-TIS design, the first step was to determine, within these model frameworks, the number of interviews and the cost of the survey under the current design.

2.2 Cost model assumptions

Each cost model is based on assumptions grounded in how the NCVS is currently conducted. Two main assumptions were needed for the cost models: 1) the probability of a sampled person participating in a particular TIS and 2) the cost of conducting an interview.

Because the field procedures and analysis of the NCVS have changed over time, the data used to determine the probability of participating were restricted to a period that best reflects current practices. Characteristics that needed to be based on current practices included—

- distribution of interview types (i.e., mode of interview)
- household status in previous TIS[3]
- response rate
- cost per interview type.

Using the data that met the cost assumption study criteria,[4] the following response and participation distributions were determined:

- Household response rate and household status by TIS and the person's previous TIS status **(table 2-1)**
- For households responding in the current TIS, the distribution of person-level response status by TIS for each possible pattern of response in the previous TISs, based on 1) the household's response status (i.e., whether the same household is responding or if it is a replacement household), 2) the person's previous participation status for a household (i.e., whether or not at least one person in the household participated in the survey during the previous TIS), and 3) mode of interview (i.e., in person or telephone) **(table 2-2[5])**.

[3]Either "First TIS," "Same HH [household] interviewed the previous TIS," "Replacement HH since the previous TIS," or "Noninterview in the previous TIS."
[4]For the cost portion of the analysis, data were restricted to the years 2007 to 2011 and included only sample and rotation groups for which all seven TISs were publicly available. Additionally, reinstated cases were excluded from the analysis.
[5]Appendix Table B-1 presents the counts associated with the percentages presented in this table.

Table 2-1. Household response rate and status by time in sample and previous time in sample's response status

TIS	Address responded in previous TIS	Address responded	HH Status					All HHs
			Number in sample	First TIS	Same HH interviewed the previous TIS	Replacement HH since the previous TIS	Noninterview in the previous TIS	
1	—	No	22,346	—	—	—	—	28.4%
		Yes	56,423	100%	—	—	—	71.6%
2	No	No	11,513	—	—	—	—	69.8%
		Yes	4,977	—	0.8%	10.1%	89.1%	30.2%
	Yes	No	4,312	—	—	—	—	8.9%
		Yes	44,297	—	95.6%	4.4%	—	91.1%
3	No	No	9,484	—	—	—	—	71.5%
		Yes	3,780	—	2.3%	31.6%	66.1%	28.5%
	Yes	No	3,735	—	—	—	—	8.8%
		Yes	38,724	—	95.7%	4.3%	—	91.2%
4	No	No	8,111	—	—	—	—	72.2%
		Yes	3,122	—	2.6%	39.1%	58.3%	27.8%
	Yes	No	3,126	—	—	—	—	8.6%
		Yes	33,416	—	95.7%	4.3%	—	91.4%
5	No	No	6,781	—	—	—	—	72.3%
		Yes	2,592	—	2.4%	43.1%	54.6%	27.7%
	Yes	No	2,565	—	—	—	—	8.2%
		Yes	28,628	—	95.6%	4.4%	—	91.8%
6	No	No	5,439	—	—	—	—	72.2%
		Yes	2,093	—	1.4%	46.1%	52.5%	27.8%
	Yes	No	2,073	—	—	—	—	8.1%
		Yes	23,564	—	95.7%	4.3%	—	91.9%
7	No	No	4,108	—	—	—	—	71.2%
		Yes	1,658	—	1.5%	45.8%	52.7%	28.8%
	Yes	No	1,486	—	—	—	—	7.3%
		Yes	22,346	—	95.5%	4.5%	—	92.7%

Note: HH = household, TIS = time in sample, — = not applicable.

Table 2-2. Person response rate and interview type by time in sample, household status, and whether the household responded in a previous time in sample

		First TIS			Same HH interviewed the previous TIS*			Replacement HH since the previous TIS			Non-interview in the previous TIS: HH has responded previously			Non-interview in the previous TIS: HH has not responded previously		
TIS	Person Resp.	IP	Phone	Non-interview	IP	Phone	Non-interview	IP	Phone	Non-interview	IP	Phone	Non-interview	IP	Phone	Non-interview
1	No	—	—	11.3%	—	—	—	—	—	—	—	—	—	—	—	—
	Yes	65.7%	23.0%	—	—	—	—	—	—	—	—	—	—	—	—	—
2	No	—	—	—	—	—	12.5%	—	—	12.9%	—	—	14.3%	—	—	—
	Yes	—	—	—	27.3%	60.3%	—	67.9%	19.2%	—	59.1%	26.6%	—	—	—	—
3	No	—	—	—	—	—	13.0%	—	—	11.7%	—	—	15.1%	—	—	20.8%
	Yes	—	—	—	26.2%	60.8%	—	69.9%	18.4%	—	58.7%	26.2%	—	40.0%	39.2%	—
4	No	—	—	—	—	—	13.0%	—	—	11.7%	—	—	14.6%	—	—	25.1%
	Yes	—	—	—	25.6%	61.4%	—	71.9%	16.4%	—	58.2%	27.2%	—	37.5%	37.4%	—
5	No	—	—	—	—	—	12.9%	—	—	11.3%	—	—	13.4%	—	—	22.2%
	Yes	—	—	—	26.1%	61.0%	—	71.5%	17.2%	—	60.1%	26.5%	—	38.7%	39.0%	—
6	No	—	—	—	—	—	12.7%	—	—	10.0%	—	—	13.2%	—	—	24.7%
	Yes	—	—	—	26.0%	61.3%	—	73.2%	16.8%	—	58.4%	28.4%	—	36.2%	39.1%	—
7	No	—	—	—	—	—	11.7%	—	—	9.2%	—	—	11.6%	—	—	22.8%
	Yes	—	—	—	29.2%	59.1%	—	75.7%	15.1%	—	62.0%	26.4%	—	41.9%	35.3%	—

Note: HH = household, IP = in person, TIS = time in sample, — = not applicable. See Appendix Table B-1 for interview counts for each category.
*Possibly due to coding error, a few households are coded as "Same HH Interviewed in the Previous TIS" and "never previously responded." Those households are not included in the table because there are very few of them (51 cases in this restricted dataset). For these cases, the same interview type distribution as for those households that previously responded was applied, but a cost of $250 is assumed.

With these two pieces of information, a person's probability of participating in the NCVS for a particular TIS by interview mode was determined.

For the cost per interview, this study assumed $250 for an in-person interview and $120 for a telephone interview. BJS provided these cost assumptions, which were based on actual total Census Bureau costs to administer the survey in 2013 and the approximate distribution of in-person and telephone interviews.

2.3 Cost estimates for current design

To make a fair comparison with the simulated samples (for 5, 4, 3, or 1 TISs), the actual sample (of 7 TISs) is not used to calculate the cost of the current design. Instead, a *simulated* sample of seven TISs similar to the current design is generated. Using the simulated sample removes any noise from the actual sample caused by cases that were excluded from the analysis. This allows for an equal comparison between the current design and the alternative designs. Approximately 50,000 households are selected every 6 months and distributed among seven rotation groups (across two samples). This means that a sample of 7,143 households per rotation group by sample number is selected. **Table 2-3** shows a typical rotation pattern for households for the simulation of the current 7-TIS design, with 2 sample numbers and 18 semesters (9 years). When the maximum seven rotation groups are active (see periods 7 to 12 in **table 2-3**), there are 50,000 households for which interviewers are attempting to conduct the survey.

Table 2-3. Number of selected households in a rotation scheme for a 7-time in sample design

	Sample 1						Sample 2					
	Rotation group						Rotation group					
Period	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
1	7,143											
2	7,143	7,143										
3	7,143	7,143	7,143									
4	7,143	7,143	7,143	7,143								
5	7,143	7,143	7,143	7,143	7,143							
6	7,143	7,143	7,143	7,143	7,143	7,143						
7	7,143	7,143	7,143	7,143	7,143	7,143	7,143					
8		7,143	7,143	7,143	7,143	7,143	7,143	7,143				
9			7,143	7,143	7,143	7,143	7,143	7,143	7,143			
10				7,143	7,143	7,143	7,143	7,143	7,143	7,143		
11					7,143	7,143	7,143	7,143	7,143	7,143	7,143	
12						7,143	7,143	7,143	7,143	7,143	7,143	7,143
13							7,143	7,143	7,143	7,143	7,143	7,143
14								7,143	7,143	7,143	7,143	7,143
15									7,143	7,143	7,143	7,143
16										7,143	7,143	7,143
17											7,143	7,143
18												7,143

Given this rotation pattern; the number (n) of sampled households in a rotation group and sample; the response propensity (r) for a person given the TIS, household status, household response status in the previous TIS, and interview type; and the cost (c) of the person interview given the interview type, the total cost (TC) model can be written as

$$TC = \sum_{m=1}^{2} \sum_{l=1}^{6} \sum_{h=1}^{n_{lm}} \sum_{i=1}^{4} \sum_{j=1}^{2} \sum_{p=1}^{P} \left(r_{ijklm} c_{k|p} \right)$$

where h = household; i = household status (1 = first TIS, 2 = household in the previous TIS, 3 = replacement household since the last TIS, 4 = noninterview in the previous TIS); j = household response status in the previous TIS (1 = responded, 2 = nonrespondent); k = interview type (1 = in person or equivalent, 2 = telephone) for person p; l = rotation group; m = sample number; p = person in the given household; P = number of persons in the given household; and n_{lm} = 7,143.

On the basis of the rotation chart for the 7-TIS design, the cost model, and the distribution of the number of persons age 12 or older living in a household (based on the NCVS sample, the average is 2.04 persons per household), the survey cost for a 6-month period is approximately $12,200,000, with about 67,200 interviews conducted.

2.4 Cost model for keeping the number of interviews constant

On the basis of the model for the current 7-TIS design, designs that kept the number of interviews constant fixed the number of interviews for a 6-month period at 67,200 and let the cost vary based on the mixture of in-person and telephone interviews. For each alternative design, a rotation chart (similar to the one in **Table 2-1**) was developed to determine the number of households that would need to be selected per rotation group. The average number of households needed per sample (*m*) and rotation group (*l*) is

$$n_{lm} = \frac{n_p}{\overline{r_{lm}}\bar{p}}$$

Given the number of households sampled, the total cost for the alternative models for a 6-month period is

$$TC = \sum_{m=1}^{M}\sum_{l=1}^{L} TC_{lm} = \sum_{m=1}^{M}\sum_{l=1}^{L}\left\{ n_{lm} \sum_{i=1}^{4}\sum_{j=1}^{2}\sum_{p=1}^{P} r_{ijk} c_{k|p} \right\}$$

2.5 Cost model for keeping the cost constant

On the basis of the model for the current 7-TIS design, designs that kept the cost constant fixed the total cost for a 6-month period at $12,200,000 and let the number of interviews vary based on the mixture of in-person and telephone interviews. For each alternative, when KCC, the number of interviews per sample (*m*) and rotation group (*l*) can be written as

$$n_{lm} = \frac{TC_{lm}}{\sum_{i=1}^{4}\sum_{j=1}^{2}\sum_{p=1}^{P} r_{ijk} c_{k|p}}$$

However, this formula will lead to a sample size that will vary across rotation groups. Therefore, for ease of implementation, the average number of interviews can be written as

$$\overline{n_{lm}} = \frac{\sum_{m=1}^{M}\sum_{l=1}^{L} n_{lm}}{ML}$$

where *M* is the number of samples selected during the 6-month period and *L* is the number of rotation groups per sample.

2.6 Population parameter assumptions for victimization rates

The simulations that were carried out to assess the impact of reducing the number of NCVS interview TISs required a set of population distribution assumptions. Because the sample population is fixed before any data are collected, the population distribution for the simulations needs to be based on attributes about the population that are knowable before data are collected. The assumptions about the population distribution will be applied to all of the samples used throughout the simulation study.

It is not practical, or feasible, to use *all* of the available variables when creating the population for the simulations. Therefore, it is necessary to restrict the variables for simulation to the ones that best predict the outcome of interest: reporting a victimization. Characteristics associated with the propensity to experience property and violent victimization are likely to be different. Additionally, the subjects to which the two types of victimization apply are also different (households vs. persons). Therefore, the population distribution assumptions will be created separately for property and violent victimization.

Once the characteristics that are most strongly associated with experiencing victimization have been identified, they will be used to determine the distribution of characteristics for the simulated samples. The victimization outcome will then be generated on the basis of those characteristics and the victimization propensity for the group to which the household or person belongs.

2.7 Data for determining population assumptions

As crime victimization is relatively rare, especially within groups of interest (e.g., Hispanic males ages 18 to 29), the data used for the cost models were deemed inadequate (too sparse) to determine the most significant population parameters. The cost models dealt with estimating nonresponse patterns and sample sizes across TIS designs, so it was necessary to use a dataset for which the TIS variable could be calculated without error. However, for the population parameters, the most important requirement is for the propensity estimates to be as accurate as possible within propensity groups; therefore, a larger dataset was needed. Thus, to estimate the victimization propensity and to find the most important variables affecting those propensities, the analyses used all of the dataset that contains TIS 1 through TIS 7 responses for survey years 1999 to 2011.

2.8 Population parameters

For property and violent victimizations, the first step is to determine how many distinct victimization propensities exist in the population and the variables that are most strongly associated with experiencing victimization. The subjects (either households or persons) in the NCVS sample will then be split according to differential propensity groups, defined by the most important variables. All of the subjects within a group will have the same victimization propensity, but the propensity will differ across groups.

To identify the characteristics most strongly associated with the propensity to experience a property or violent victimization, respectively, the outcome of interest is defined as whether or not the household was the victim of *at least one* property crime in the reference period or *at least one* violent crime in the reference period. The set of characteristic variables that will be evaluated includes all population characteristics collected in the NCVS. These variables are potentially associated with 1) whether or not a household experienced property victimization or 2) whether a person experienced a violent victimization. For certain variables, some category collapsing was done beforehand due to either small cell counts or preliminary exploratory analyses that revealed that some categories did not differ with respect to the outcome of interest: victimization.

It was then necessary to establish the number of groups to be used for estimating the likelihood of experiencing a violent or property victimization. As mentioned above, the propensity will vary among groups but will be constant within groups. One way to decide how many groups to use is by evaluating the reduction in *deviance* that increasing the number of groups produces. The deviance is a statistical measure of the error associated with a model. For example, in this case the model might specify that the data can be divided into a number of groups (for instance, 10) within which all of the subjects have the same victimization propensity, and across which the propensity to experience victimization differs. Another model might specify that the data are divided into 11 groups (rather than 10), and so on.

Once the reduction in deviance was equal to at least 80% of the total possible reduction, it was clear that the largest reduction in deviance occurred when there were 25 to 27 groups for property victimizations and 12 to 14 groups for violent victimizations. Therefore, the property victimization model will include at least 27 groups and the violent victimization model will include at least 14 groups. For each victimization type, a recursive partitioning tree was used to determine the best set of groups. The partitioning tree for property crime included 12 different household characteristics that were identified as correlated with reporting a property victimization. The partitioning tree for violent crime included nine person and household characteristics identified as correlated with reporting a violent victimization.

In addition to the variables used for predicting the probability of reporting a victimization, other key demographic characteristics that BJS uses for analysis (e.g., sex, age category) were randomly assigned to the sample population based on their marginal distributions in the population (i.e., the probability of being ages 18 to 29 was not conditioned on any other characteristic, such as sex or race). These variables were used for subpopulation analysis.

2.9 Monte Carlo simulation

Once the propensities to respond and the population parameters were determined, a Monte Carlo simulation was conducted to produce victimization estimates by type of crime (TOC). The simulation produced estimates for each detailed TOC. For property crime, estimates were produced for household burglary, theft, and motor vehicle theft. For violent crime, estimates were produced for rape and sexual assault, aggravated assault, robbery, and simple assault.

Because of the complex nature of the NCVS household sample design, it was not feasible to incorporate the actual design into the simulation. Therefore, a simple random sample was used to select households from the population. To get appropriate standard errors, design effects from the population were estimated from the unbounded 1999 to 2011 data. For each design, only responses from the corresponding TISs were used to estimate the design effects. For example, for robbery, the design effect for the 4-TIS design was based only on robbery victims in TIS 1 through TIS 4. **Table 2-4** and **Table 2-5** present the design effects for the property crime and violent crime types, respectively, that were analyzed.

Table 2-4. Design effects for property crime

	Design alternative				
Type of crime	**7-TIS**	**5-TIS**	**4-TIS**	**3-TIS**	**1-TIS**
All property crime	2.51	2.20	2.07	1.90	1.42
Household burglary	1.48	1.39	1.32	1.28	1.29
Motor vehicle theft	1.21	1.12	1.14	1.18	1.11
Theft	2.55	2.27	2.15	2.04	1.54

Note: TIS = time in sample.

Table 2-5. Design effects for violent crime

	Design alternative				
Type of crime	**7-TIS**	**5-TIS**	**4-TIS**	**3-TIS**	**1-TIS**
All violent crime	1.94	1.80	1.78	1.68	1.63
Rape and sexual assault	1.25	1.22	1.21	1.26	1.31
Robbery	1.31	1.27	1.20	1.21	1.30
Aggravated assault	1.41	1.43	1.44	1.40	1.47
Simple assault	1.99	1.80	1.75	1.72	1.47

Note: TIS = time in sample.

Furthermore, because no bounding adjustment (i.e., an adjustment applied to respondents in TIS 1 who report a victimization to account for potential recall bias) can be applied to a 1-TIS (cross-sectional) design, no bounding adjustment was applied to any of the designs.

The simulation of samples was conducted 1,000 times. For each simulation, households are assigned a rotation group and survey characteristics. Within each rotation group, response and participation characteristics are assigned on the basis of the cost model assumptions. Given these characteristics and the simulated TIS for a household, a household (or person) is assigned a victimization status. Among those identified as victims, the number of victimizations reported was simulated on the basis of the simulated household (or person) characteristics.

Estimates were the average victimization rate over the 1,000 simulations. In other words, if the victimization rate for one realization of the simulation for TOC V is V_r. $r = 1,2,\cdots,1000$, then the average victimization rate across all simulations was calculated as

$$\bar{V} = \frac{1}{1000}\sum_{r=1}^{1000} V_r$$

The standard error is the product of the design effect for TOC V ($DEFF_V$) and the standard error under a simple random sample. In other words,

$$\widehat{SE(\bar{V})} = \sqrt{DEFF_V \times \widehat{VAR_{SRS}}(\bar{V})} = \sqrt{DEFF_V \times \frac{1}{1000}\sum_{r=1}^{1000}(V_r - \bar{V})^2}$$

3. Results

3.1 Cost models

Table 3-1 presents the results of the cost models by alternative design when KNIC. The table shows that as the number of TISs decreases, the cost to maintain the same number of interviews increases compared with the current design. For instance, with the 4-TIS design, the cost increases to $12.8 million (a 4.9% increase). The cost increase is 37.7% for the 1-TIS design but the change in cost is less than 10% for all other designs. The total cost grows because as the number of households per sample and rotation group increases, the number of in-person interviews also increases (i.e., there are more first interviews with an address).

Table 3-1. Costs and number of interviews for keeping number of interviews constant by design

Design	Households per sample and RG	Households per 6 months	Interviews per 6 months	Cost per 6 months	Percent change in cost
7-TISs	7,143	50,000	67,200	$12,200,000	
5-TISs	10,108	50,540	67,200	$12,500,000	2.5
4-TISs	12,695	50,780	67,200	$12,800,000	4.9
3-TISs	16,990	50,970	67,200	$13,300,000	9.0
1-TIS	51,470	51,470	67,200	$16,800,000	37.7

Note: RG = rotation group, TIS = time in sample.

Table 3-2 presents the results of the cost models by alternative design when KCC. The table shows that as the number of TISs decreases, the number of interviews per 6-month period decreases. For instance, for the 4-TIS design, only 48,400 interviews can be conducted for the $12.2 million cost of the current design (a 4.8% decrease). The decrease in the number of interviews is 27.4% for the 1-TIS design, but the change is less than 10% for all other designs.

Table 3-2. Costs and number of interviews for keeping costs constant by design

Design	HHs per sample and RG	HHs per 6 months	Interviews per 6 months	Cost per 6 months	Percent change in number of interviews
7-TISs	7,143	50,000	67,200	$12,200,000	
5-TISs	9,860	49,300	65,500	$12,200,000	−2.5
4-TISs	12,100	48,400	64,000	$12,200,000	−4.8
3-TISs	15,567	46,701	61,600	$12,200,000	−8.3
1-TIS	37,370	37,370	48,800	$12,200,000	−27.4

Note: HH = household, RG = rotation group, TIS = time in sample.

3.2 Victimization rates

Two types of analyses were conducted to assess victimization rates: 1) comparing overall victimization rates by design and 2) comparing subpopulation victimization rates by design.

3.3 Comparing overall victimization rates by design

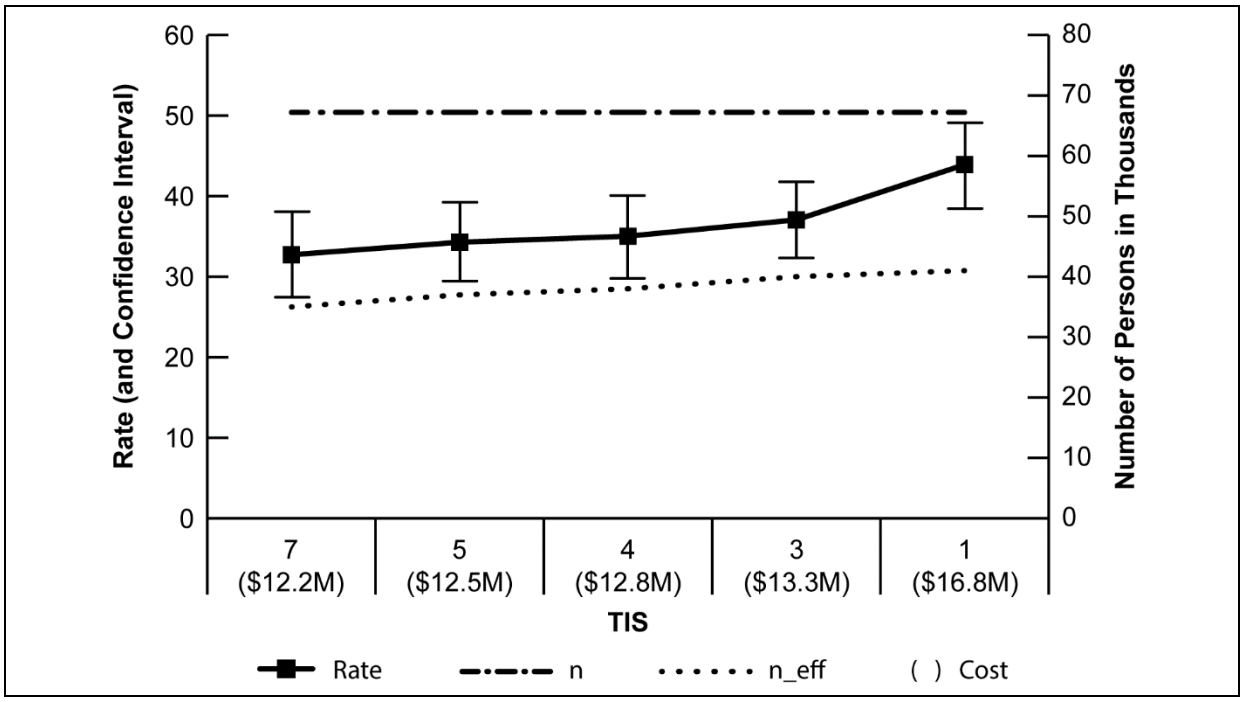
To assess the quality of the estimates under each design, given that no gold standard (i.e., error-free estimate) of crime victimization exists, only relative comparisons to the current design could be made. Therefore, to compare victimization estimates in each design, the following measures were used—

- estimates by type of crime
- statistical difference of estimates
- relative standard errors (RSEs)
- nominal and effective sample sizes.

Figure 3-1 and **Figure 3-2** show (for violent crimes and property crimes, respectively) the victimization rates, nominal and effective sample sizes, and costs for the KNIC designs. In both figures, the victimization rate increases as the number of TISs decreases because as the number of TISs decreases, the influence of the unbounded interview (i.e., the first TIS) is greater. Unbounded interviews have more victimizations reported due to potential recall bias. For violent victimization, the differences in the victimization rates are not significantly different from one another. However, for property victimization, the 1-TIS design has a significantly higher rate than the other designs because the design effects for property crimes decrease more sharply than for violent crimes as the number of TISs decreases (**table 2-4** and **table 2-5**). Violent crimes

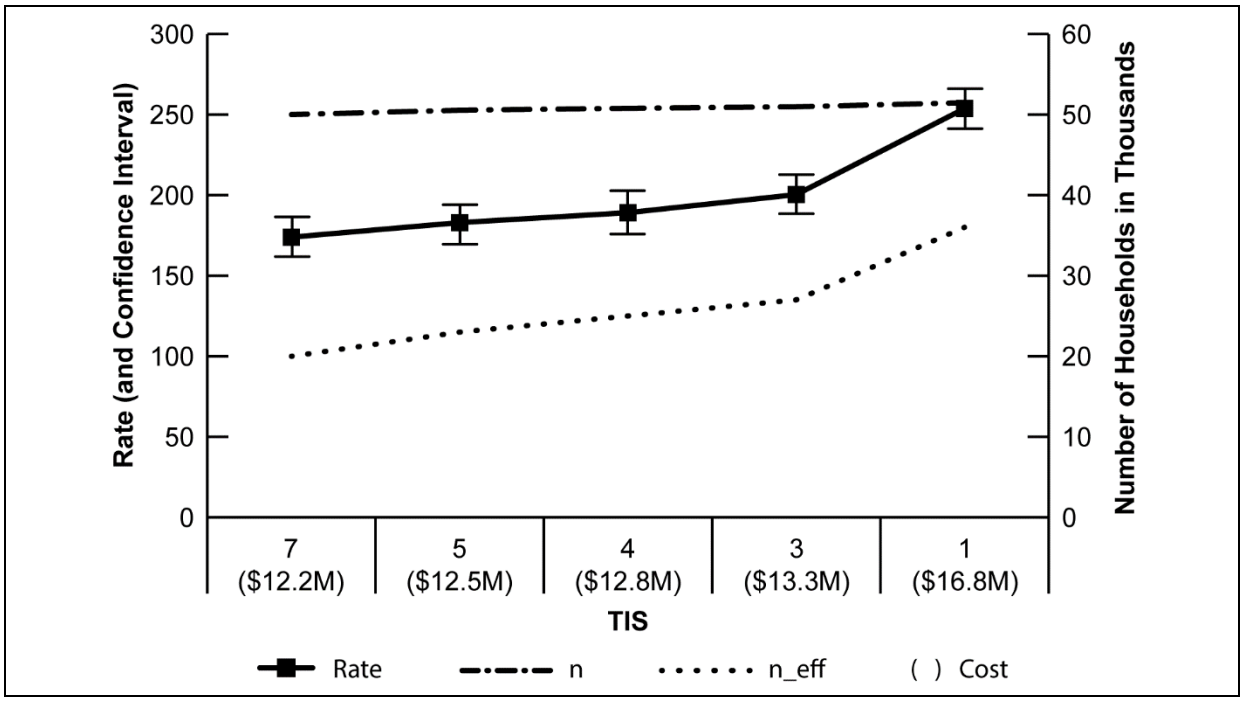
have additional correlation as a result of interviewing all persons age 12 or older in a household. This additional correlation offsets the benefits, in terms of variance reduction, of having fewer repeat interviews over time. These findings are similar when violent crimes are separated into more detailed types of crime (e.g., aggravated assault, household theft). Moreover, although the nominal sample size is intentionally the same for each design, due to the decreasing design effects, the effective sample size increases as the number of TISs decreases for both violent and property crime.

Figure 3-1. Violent victimization rate, nominal and effective alternative sample sizes, and cost when keeping the number of interviews constant by design



Note: TIS = time in sample.

Figure 3-2. Property victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



Note: TIS = time in sample.

Table 3-3 presents the RSEs for violent crime and property crime, respectively, by design when KNIC. In both cases, the RSE decreases as the number of TISs decreases. This is mainly a result of the reduction in design effect as the number of TISs decreases.

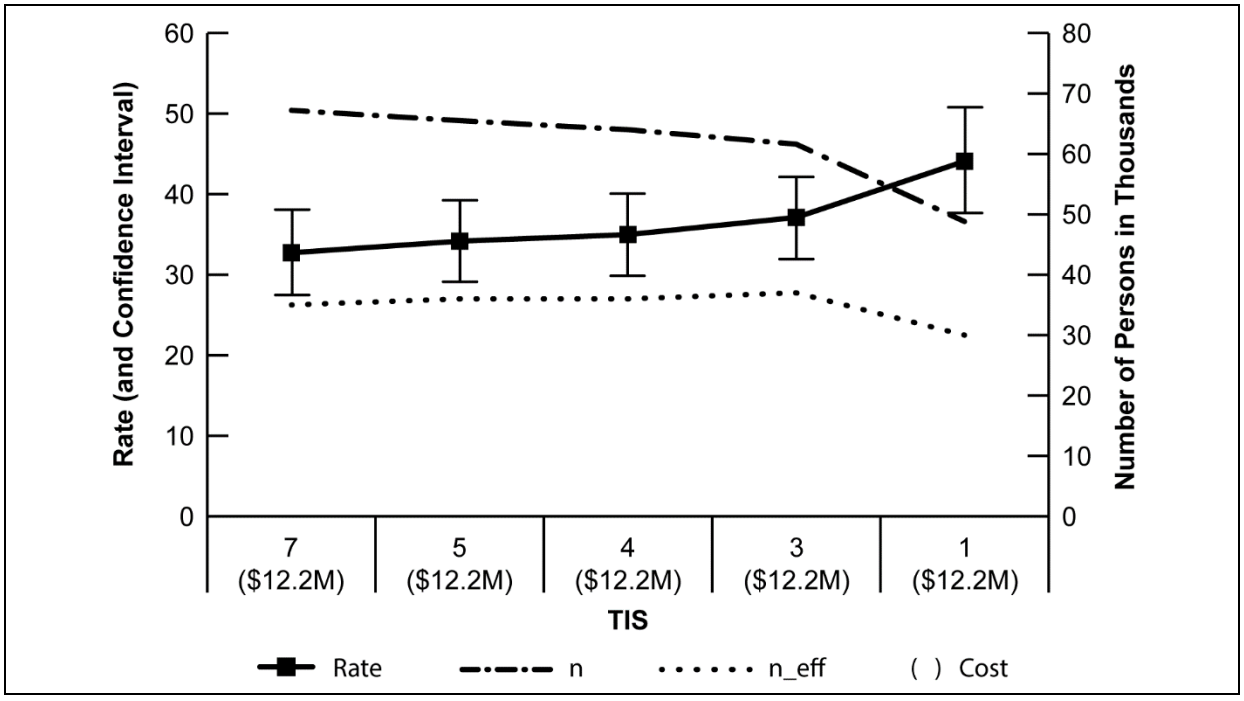
Table 3-3. Victimization rate, standard error, and relative standard error by type of crime and design alternative for keeping the number of interviews constant designs

	Violent crime			Property crime		
Design	Estimated rate per 1,000	Standard error	RSE	Estimated rate per 1,000	Standard error	RSE
7-TIS	33	2.64	8.00	174	6.51	3.74
5-TIS	34	2.55	7.50	183	6.16	3.37
4-TIS	35	2.58	7.37	189	6.29	3.33
3-TIS	37	2.62	7.08	200	5.93	2.97
1-TIS	44	2.94	6.68	254	6.19	2.44

Note: RSE = relative standard error, TIS = time in sample.

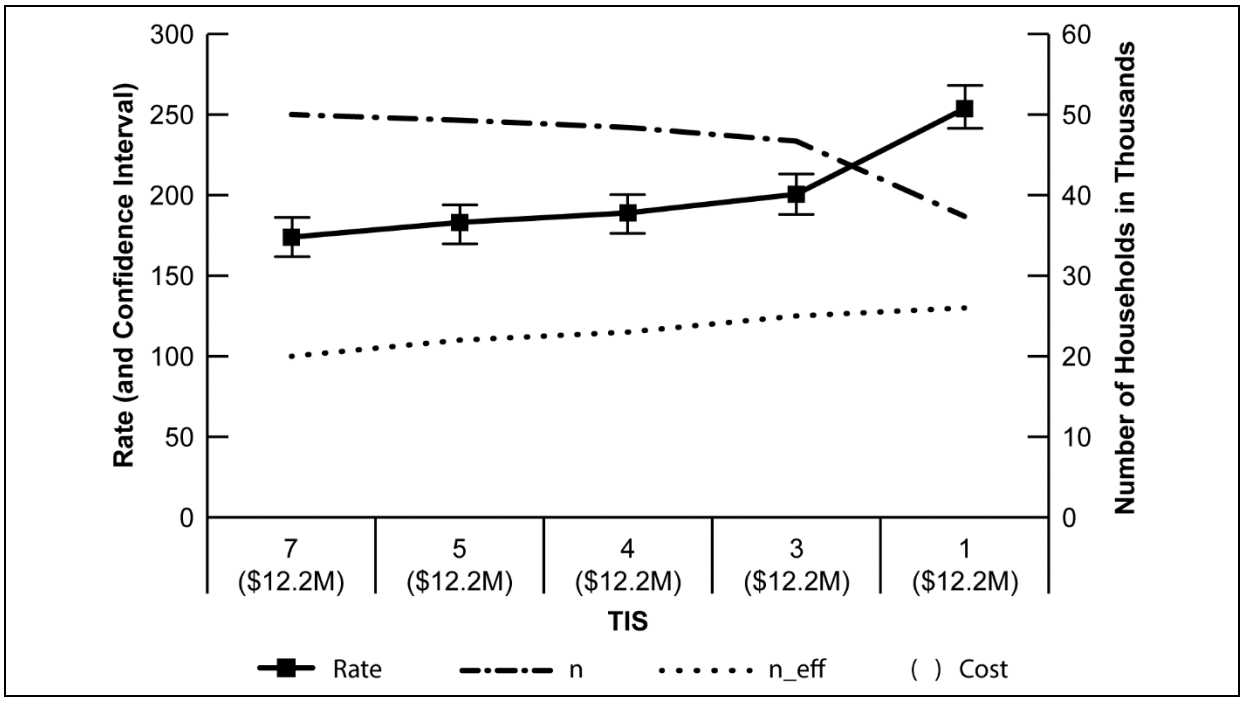
Figure 3-3 and **Figure 3-4** show, for violent crime and property crime, respectively, the victimization rates, nominal and effective sample sizes, and costs for the KCC designs. As with the KNIC designs, the victimization rates increase as the number of TISs decreases. For violent victimization, the differences in the victimization rates are not significantly different from one another. However, for property victimization, the 1-TIS design has a significantly higher rate than the other designs. These findings are similar for more detailed types of crimes (e.g., aggravated assault, household theft). Furthermore, the nominal sample size decreases as the number of TISs decreases in order to keep costs fixed. Nonetheless, for 3-TIS, 4-TIS, and 5-TIS designs, the effective sample size increases relative to the 7-TIS design for both types of crime. However, due to the smaller decrease in the design effect and the large (27.4%) decrease in the nominal sample size for violent crime, the effective sample size is lower for the 1-TIS design than the 7-TIS design. The 1-TIS effective sample size is larger than the 7-TIS design for property crime because the design effect is much smaller for the 1-TIS design than for the 7-TIS design.

Figure 3-3. Violent victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



Note: TIS = time in sample.

Figure 3-4. Property victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



Note: TIS = time in sample.

Table 3-4 presents the RSEs for violent crime and property crime, respectively, by design when KCC. For violent crime, the RSEs (100 × standard error/estimate) remain relatively flat across design options, while for property crime, the RSEs decrease as the number of TISs decreases. In the KCC designs, the nominal sample size must decrease to maintain costs because the number of in-person interviews increases. When the change in the design effect is negligible (as it is with violent crime) the standard errors increase rather than remain flat (i.e., the negative impact of the decrease in sample size on the standard errors is greater than the positive impact of the smaller design effect), thus leading to flat RSEs. However, for property crime, the decrease in the design effect has greater influence on the standard errors than the decrease in nominal sample size, leading to lower RSEs as the number of TISs decreases. These findings were consistent across the more detailed types of crime.

Table 3-4. Victimization rate, standard error, and relative standard error by type of crime and design alternative for keeping the cost constant designs

	Violent crime			Property crime		
Design	Estimated rate per 1,000	Standard error	RSE	Estimated rate per 1,000	Standard error	RSE
7-TIS	33	2.64	8.00	174	6.51	3.74
5-TIS	34	2.62	7.71	183	6.22	3.39
4-TIS	35	2.65	7.58	189	6.33	3.35
3-TIS	37	2.82	7.62	201	6.48	3.23
1-TIS	44	3.65	8.30	254	6.82	2.68

Note: RSE = relative standard error, TIS = time in sample.

3.4 Comparing subpopulation victimization rates by design

In addition to comparing overall victimization rates by design, it is necessary to know whether the alternative designs affect subpopulation estimates. For this comparison, subpopulation estimates for key population characteristics (e.g., age category, income) were computed for each design and statistically compared to the current 7-TIS design.

Table 3-5 and **Table 3-6** present the violent and property victimization rates by gender and race for KNIC and KCC models, respectively, by design alternative. For both the KNIC and KCC models, the only differences (except for whites in the 3-TIS design) between the alternative designs and the current 7-TIS design were in the 1-TIS design. This finding held true for all other characteristics compared.

Table 3-5. Violent crime and property crime victimization rates when keeping the number of interviews constant by selected demographic characteristic and alternative design

	Violent crime victimizations					Property crime victimizations				
Characteristic	**7-TIS**	**5-TIS**	**4-TIS**	**3-TIS**	**1-TIS**	**7-TIS**	**5-TIS**	**4-TIS**	**3-TIS**	**1-TIS**
Sex										
Male	33.3	34.8	35.7	37.8	44.6*	—	—	—	—	—
Female	32.2	33.5	34.4	36.4	43.2*	—	—	—	—	—
Race										
White	30.0	31.2	32.1	34.0	40.5*	162.5	170.9	176.4	186.5*	235.6**
Black	41.9	43.9	44.8	47.1	55.3	191.6	201.2	208.1	222.7	285.4**
Hispanic	38.1	40.0	41.0	43.5	50.5	217.8	228.8	237.7	252.4	319.8**
Other	35.1	36.3	37.1	38.7	46.8	190.5	202.2	209.7	221.3	280.3*
Age										
12–19	56.9	60.0	61.6	65.5	73.9	—	—	—	—	—
20–29	51.0	52.9	53.2	56.2	67.0	—	—	—	—	—
30–39	32.9	34.8	35.4	37.2	45.1	—	—	—	—	—
40–49	29.1	30.5	31.4	33.3	39.8	—	—	—	—	—
50–59	26.9	28.4	29.5	31.0	37.6	—	—	—	—	—
60+	8.1	8.3	8.6	9.2	11.2	—	—	—	—	—
Household income										
Less than $14,999	56.0	57.9	59.2	60.9	78.1	179.9	189.6	199.1	211.7	278.6**
$15,000–24,999	37.3	38.9	39.2	42.2	51.9	177.9	187.2	195.4	209.2	270.9**
$25,000–34,999	33.5	34.8	35.2	37.7	42.8	167.9	176.4	181.6	191.9	243.3**
$35,000–49,999	31.5	33.0	34.0	35.7	41.0	167.2	175.2	179.8	190.4	240.1**
$50,000–74,999	29.2	30.8	31.3	33.3	38.4	169.8	178.5	183.7	194.7	244.2**
$75,000+	26.4	27.9	28.7	30.5	35.7	178.3	188.1	193.6	204.0	252.8**
Region										
Northeast	30.4	31.9	32.9	34.7	41.0	158.9	166.7	171.9	181.9	231.8**
Midwest	32.8	34.3	34.8	37.0	44.1	171.8	181.7	187.9	198.4	251.8**
South	33.0	34.6	35.3	37.5	44.3	174.4	182.9	189.5	201.1	254.5**
West	34.2	35.6	36.5	38.4	45.5	187.5	197.6	203.9	216.1	272.4**
Place size										
Not in a place	27.9	29.3	30.2	32.0	37.8	155.5	163.4	168.8	178.0	222.2**
Under $10,000	31.9	33.3	34.3	36.0	43.3	156.9	163.8	169.4	179.7	227.7**
$10,000–99,999	33.5	35.0	35.6	37.8	44.7	159.4	167.6	172.4	183.5	232.7**
$100,000–249,999	37.3	39.0	39.6	41.8	49.2	200.6	211.3	219.2	231.9	294.4**
$250,000–999,999	38.1	40.0	40.8	43.0	51.3	206.4	218.4	226.7	239.1	305.0**
$1,000,000+	36.5	38.5	38.9	41.3	48.8	200.8	211.5	218.6	233.3	298.3**
Tenure										
Owned or being bought	—	—	—	—	—	162.0	170.5	176.1	185.7*	231.7**
Rented	—	—	—	—	—	198.1	208.1	215.5	230.1*	298.4**

Note: TIS = time in sample, — = not applicable.
*Significantly different from 7-TIS design at the 95% confidence level.
**Significantly different from 7-TIS design at the 99% confidence level.

Table 3-6. Violent crime and property crime victimizations when keeping the cost constant by selected demographic characteristic and design

Characteristic	Violent crime victimizations					Property crime victimizations				
	7-TIS	5-TIS	4-TIS	3-TIS	1-TIS	7-TIS	5-TIS	4-TIS	3-TIS	1-TIS
Sex										
Male	33.3	34.8	35.7	37.8	44.6 *	—	—	—	—	—
Female	32.2	33.5	34.4	36.4	43.2 *	—	—	—	—	—
Race										
White	30.0	31.2	32.1	34.0	40.5 *	162.5	170.9	176.4	186.5 *	235.6 **
Black	41.9	43.9	44.8	47.1	55.3	191.6	201.2	208.1	222.7	285.4 **
Hispanic	38.1	40.0	41.0	43.5	50.5	217.8	228.8	237.7	252.4	319.8 **
Other	35.1	36.3	37.1	38.7	46.8	190.5	202.2	209.7	221.3	280.3 *
Age										
12–19	56.9	60.0	61.6	65.5	73.9	—	—	—	—	—
20–29	51.0	52.9	53.2	56.2	67.0	—	—	—	—	—
30–39	32.9	34.8	35.4	37.2	45.1	—	—	—	—	—
40–49	29.1	30.5	31.4	33.3	39.8	—	—	—	—	—
50–59	26.9	28.4	29.5	31.0	37.6	—	—	—	—	—
60+	8.1	8.3	8.6	9.2	11.2	—	—	—	—	—
Household income										
Less than $14,999	56.0	57.9	59.2	60.9	78.1	179.9	189.6	199.1	211.7	278.6 **
$15,000–24,999	37.3	38.9	39.2	42.2	51.9	177.9	187.2	195.4	209.2	270.9 **
$25,000–34,999	33.5	34.8	35.2	37.7	42.8	167.9	176.4	181.6	191.9	243.3 **
$35,000–49,999	31.5	33.0	34.0	35.7	41.0	167.2	175.2	179.8	190.4	240.1 **
$50,000–74,999	29.2	30.8	31.3	33.3	38.4	169.8	178.5	183.7	194.7	244.2 **
$75,000+	26.4	27.9	28.7	30.5	35.7	178.3	188.1	193.6	204.0	252.8 **
Region										
Northeast	30.4	31.9	32.9	34.7	41.0	158.9	166.7	171.9	181.9	231.8 **
Midwest	32.8	34.3	34.8	37.0	44.1	171.8	181.7	187.9	198.4	251.8 **
South	33.0	34.6	35.3	37.5	44.3	174.4	182.9	189.5	201.1	254.5 **
West	34.2	35.6	36.5	38.4	45.5	187.5	197.6	203.9	216.1	272.4 **
Place size										
Not in a place	27.9	29.3	30.2	32.0	37.8	155.5	163.4	168.8	178.0	222.2 **
Under $10,000	31.9	33.3	34.3	36.0	43.3	156.9	163.8	169.4	179.7	227.7 **
$10,000–99,999	33.5	35.0	35.6	37.8	44.7	159.4	167.6	172.4	183.5	232.7 **
$100,000–249,999	37.3	39.0	39.6	41.8	49.2	200.6	211.3	219.2	231.9	294.4 **
$250,000–999,999	38.1	40.0	40.8	43.0	51.3	206.4	218.4	226.7	239.1	305.0 **
$1,000,000+	36.5	38.5	38.9	41.3	48.8	200.8	211.5	218.6	233.3	298.3 **
Tenure										
Owned or being bought	—	—	—	—	—	162.0	170.5	176.1	185.7 *	231.7 **
Rented	—	—	—	—	—	198.1	208.1	215.5	230.1 *	298.4 **

Note: TIS = time in sample, — = not applicable.
*Significantly different from 7-TIS design at the 95% confidence level.
**Significantly different from 7-TIS design at the 99% confidence level.

4. Conclusions

For both violent crimes and property crimes, the 4-TIS design achieves the largest effective sample sizes while still ensuring that the (overall) victimization estimates are not significantly different from the current estimates. The 3-TIS and 1-TIS designs, on the other hand, sometimes achieve larger effective sample sizes, but both designs produce estimates that are significantly different from the current estimates at either the subpopulation level (3-TIS design) or subpopulation and overall level (1 TIS). Moreover, the 4-TIS design reduces the RSEs for all types of crime.

The conclusion that the 4-TIS design has preferred properties compared with all other designs holds for both the KNIC and KCC models. In general, the recommendation is to use a design that maintains the current number of interviews per year. When maintaining the same number of interviews, a lower number of TISs results in higher effective sample sizes. Designs with fewer TISs produce lower design effects in general. However, maintaining the same number of interviews costs more due to the increase in the number of in-person interviews. Therefore, the decision about which 4-TIS design is preferred (KNIC or KCC) is a matter of cost. When KNIC, the cost of the 4-TIS design is 4.8% greater ($1.2 million per year) than the 7-TIS design.

However, for the additional cost of $1.2 million, the 4-TIS design only reduces the RSE for violent crime by 7.9% and reduces the RSE for property crime by 11.0% compared with the 7-TIS design. The KCC 4-TIS design provides improvements in the effective sample size, although not as great as the KNIC 4-TIS design, while having only a slightly lower reduction in the RSE (violent victimization has a reduction of 5.25%, while reduction in the RSE is the same as the KNIC reduction for property crime). Moreover, unlike the 3-TIS and 1-TIS designs, when costs are kept constant, the 4-TIS design produces estimates that are not significantly different from the 7-TIS design for all subpopulation characteristics and types of crimes.

5. Next Steps

If BJS would consider transitioning the NCVS to a 4-TIS design because of these findings, several additional steps would be required to determine the feasibility of this change. First, a more thorough cost assessment would need to be conducted using accurate and detailed cost data provided by the Census Bureau. Second, considerations regarding the impact of integrating a 4-TIS design into the existing rotating panel scheme would have to be taken into account. Because more households would be sampled each rotation period, it would be necessary to assess whether a design with additional primary sampling units (PSU) is more effective than increasing the caseload in the existing PSUs. Additional considerations include how the allocation of Census Bureau field interview staff would be affected, potential changes to the instrument to adjust for items currently administered in every other interview, and potential modifications to bounding and weighting adjustments.

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Appendix A: Alternative rotation schemes

Table A-1. Rotation scheme for a 5-time in sample design

	Sample number							
	1 Rotation group				2 Rotation group			
	1	2	3	4	1	2	3	4
SeqSem	N	N	N	N	N	N	N	N
1	10,108							
2	10,108	10,108						
3	10,108	10,108	10,108					
4	10,108	10,108	10,108	10,108				
5	10,108	10,108	10,108	10,108	10,108			
6		10,108	10,108	10,108	10,108	10,108		
7			10,108	10,108	10,108	10,108	10,108	
8				10,108	10,108	10,108	10,108	10,108
9					10,108	10,108	10,108	10,108
10						10,108	10,108	10,108
11							10,108	10,108
12								10,108

Table A-2. Rotation scheme for a 4-time in sample design

	Sample number					
	1 Rotation group			2 Rotation group		
	1	2	3	1	2	3
SeqSem	N	N	N	N	N	N
1	1,250					
2	1,250	1,250				
3	1,250	1,250	1,250			
4	1,250	1,250	1,250	1,250		
5		1,250	1,250	1,250	1,250	
6			1,250	1,250	1,250	1,250
7				1,250	1,250	1,250
8					1,250	1,250
9						1,250

Table A-3. Rotation scheme for a 3-time in sample design

	Sample number			
	1 Rotation group		2 Rotation group	
	1	2	1	2
SeqSem	N	N	N	N
1	16,990			
2	16,990	16,990		
3	16,990	16,990	16,990	
4		16,990	16,990	16,990
5			16,990	16,990
6				16,990

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Appendix B: Distributions of number of persons age 12 or older living in a household

Table B-1. Number of sampled persons by interview type, time in sample, household status, and whether the household responded in a previous time in sample

		First TIS			Same HH interviewed the previous TIS*			Replacement HH since the previous TIS			Non-interview in the previous TIS: HH has responded previously			Non-interview in the previous TIS: HH has not responded previously			
TIS	Person Resp.	IP	Phone	Non-interview	IP	Phone	Non-interview	IP	Phone	Non-interview	IP	Phone	Non-interview	IP	Phone	Non-interview	Total
1	No	—	—	13,156	—	—	—	—	—	—	—	—	—	—	—	—	13,156
	Yes	76,271	26,665	—	—	—	—	—	—	—	—	—	—	—	—	—	102,936
2	No	—	—	—	—	—	11,029	—	—	591	—	—	1,183	—	—	—	12,816
	Yes	—	—	—	24,092	53,257	—	3,113	880	—	4,892	2,205	—	—	—	—	88,497
3	No	—	—	—	—	—	10,008	—	—	596	—	—	426	—	—	382	11,413
	Yes	—	—	—	20,182	46,749	—	3,563	938	—	1,660	740	—	736	722	—	75,305
4	No	—	—	—	—	—	8,601	—	—	574	—	—	224	—	—	511	9,910
	Yes	—	—	—	16,888	40,607	—	3,511	801	—	896	419	—	762	760	—	64,647
5	No	—	—	—	—	—	7,244	—	—	498	—	—	132	—	—	399	8,279
	Yes	—	—	—	14,704	34,294	—	3,143	754	—	590	260	—	695	700	—	55,150
6	No	—	—	—	—	—	5,890	—	—	365	—	—	84	—	—	376	6,716
	Yes	—	—	—	12,038	28,381	—	2,659	610	—	372	181	—	550	594	—	45,387
7	No	—	—	—	—	—	4,287	—	—	261	—	—	53	—	—	277	4,878
	Yes	—	—	—	10,746	21,757	—	2,151	429	—	282	120	—	510	430	—	36,427

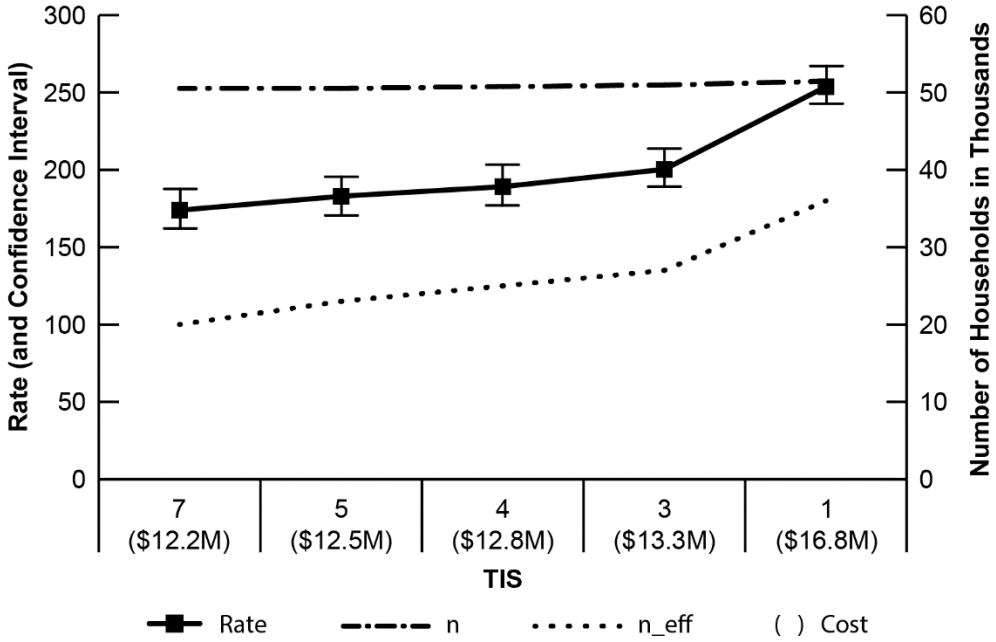
Note: HH = household, IP = in person, TIS = time in sample, — = not applicable.
*Possibly due to a coding error, a few households were coded as both "Same HH Interviewed in the Previous TIS" and "never previously responded." Those households are not included in the table because there are very few of them (51 cases in this restricted dataset). For these cases, the same interview type distribution as for those households that previously responded was applied, but a cost of $250 was assumed.

Table B-2. Distribution of number of persons age 12 or older per household

Number of persons age 12 or older	Percent
1	31.079
2	46.355
3	13.348
4	6.5195
5	1.9959
6	0.5362
7	0.1084
8	0.0351
9	0.0141
10	0.0053
11	0.0027
12	0.0004
Total	100

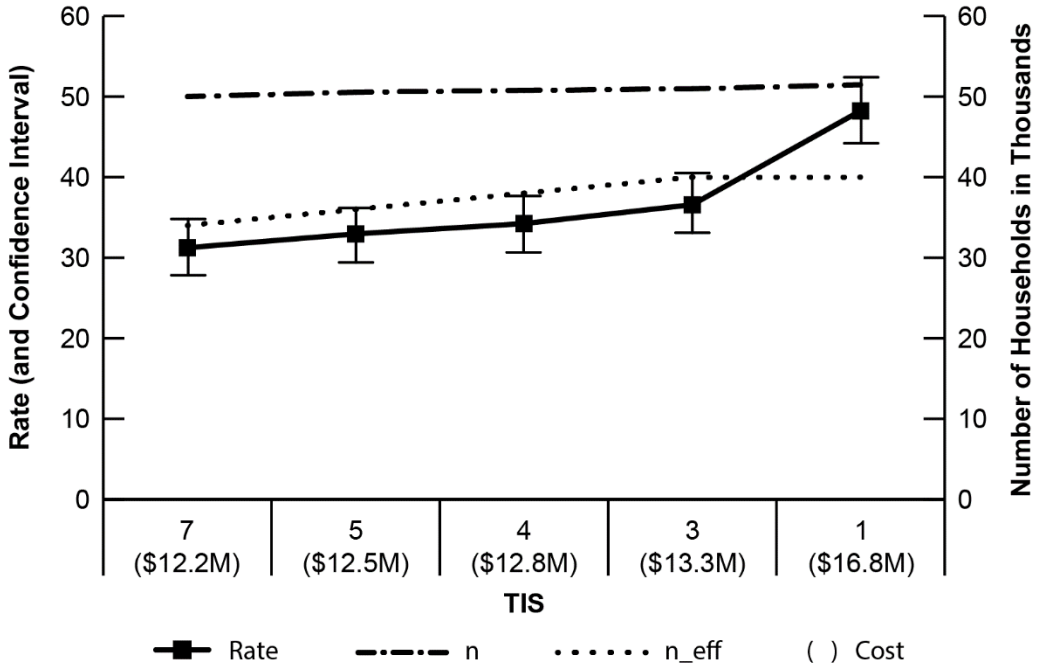
Appendix C. Impact of alternative designs, by type of crime under keeping the number of interviews constant conditions

Figure C-1. Property victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



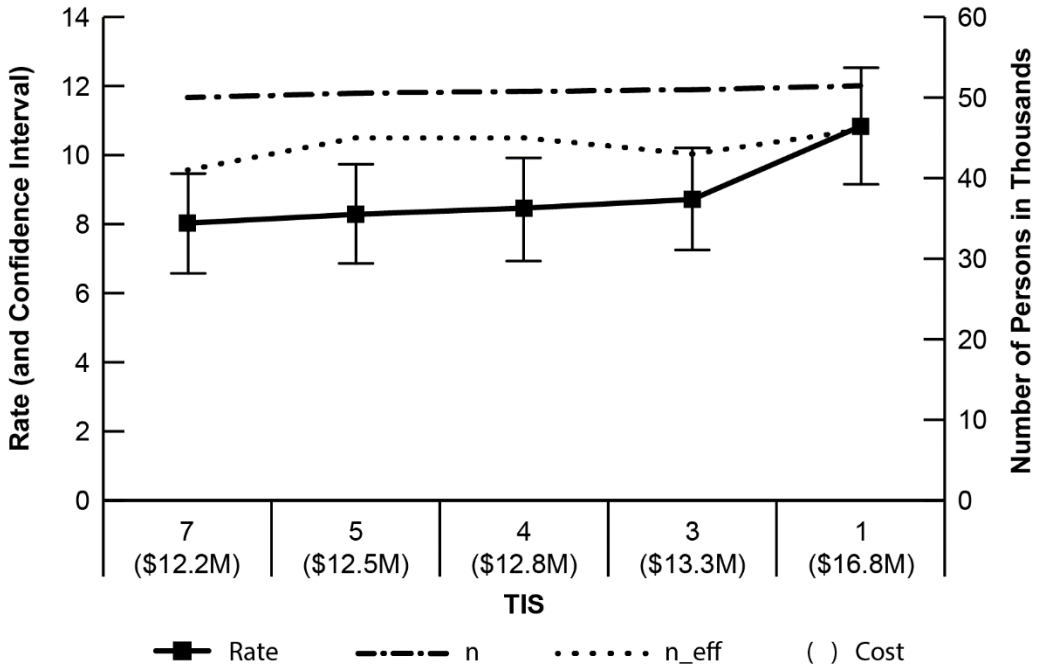
Note: TIS = time in sample.

Figure C-2. Household burglary victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



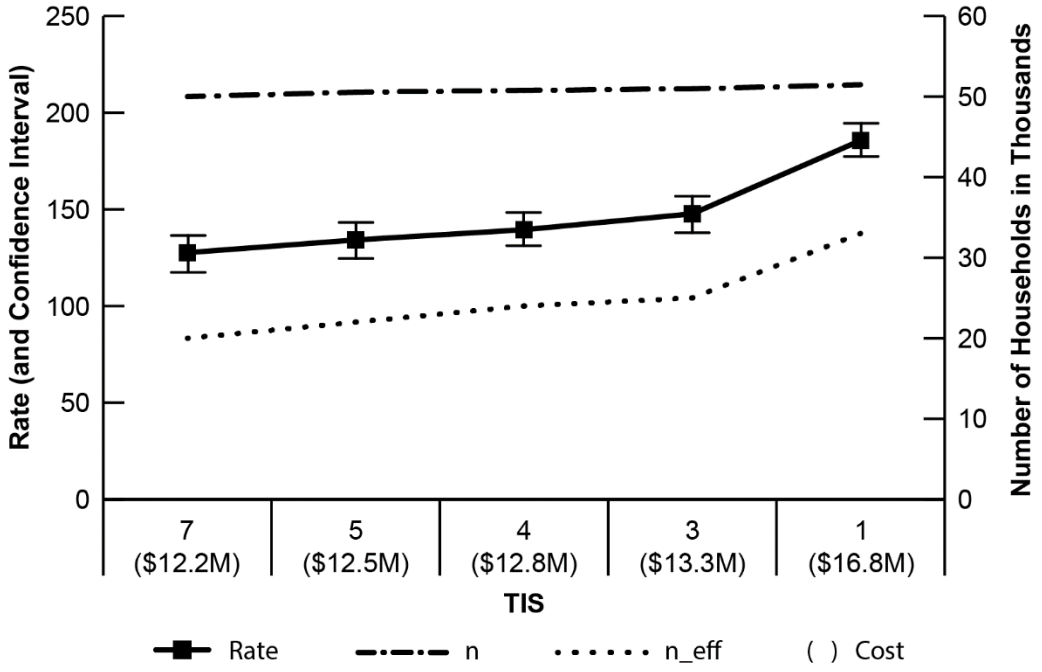
Note: TIS = time in sample.

Figure C-3. Motor vehicle theft victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



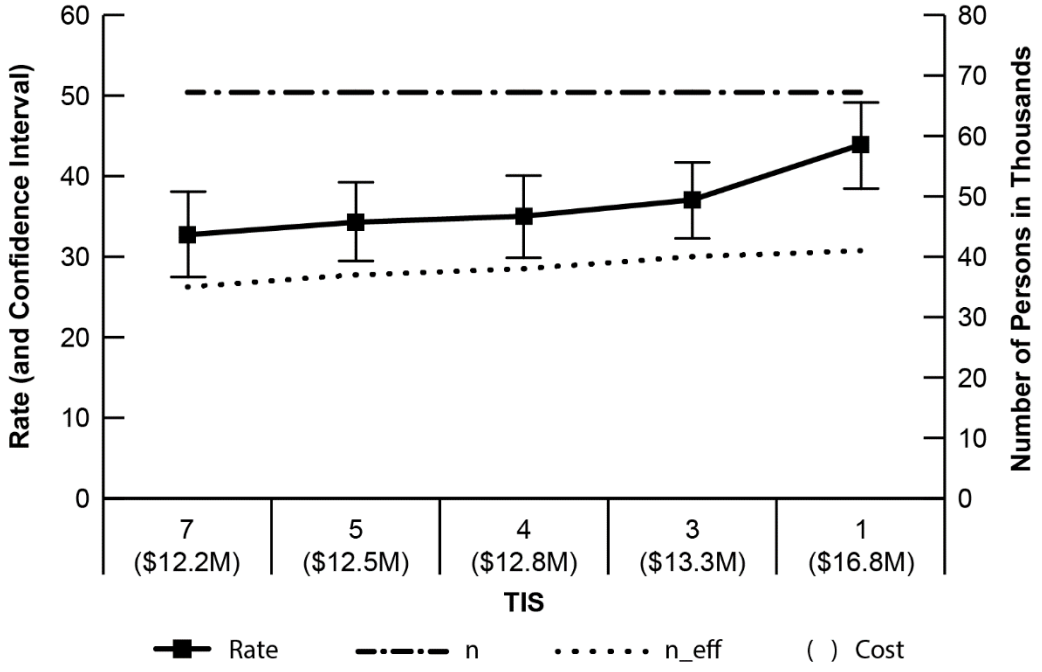
Note: TIS = time in sample.

Figure C-4. Theft victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



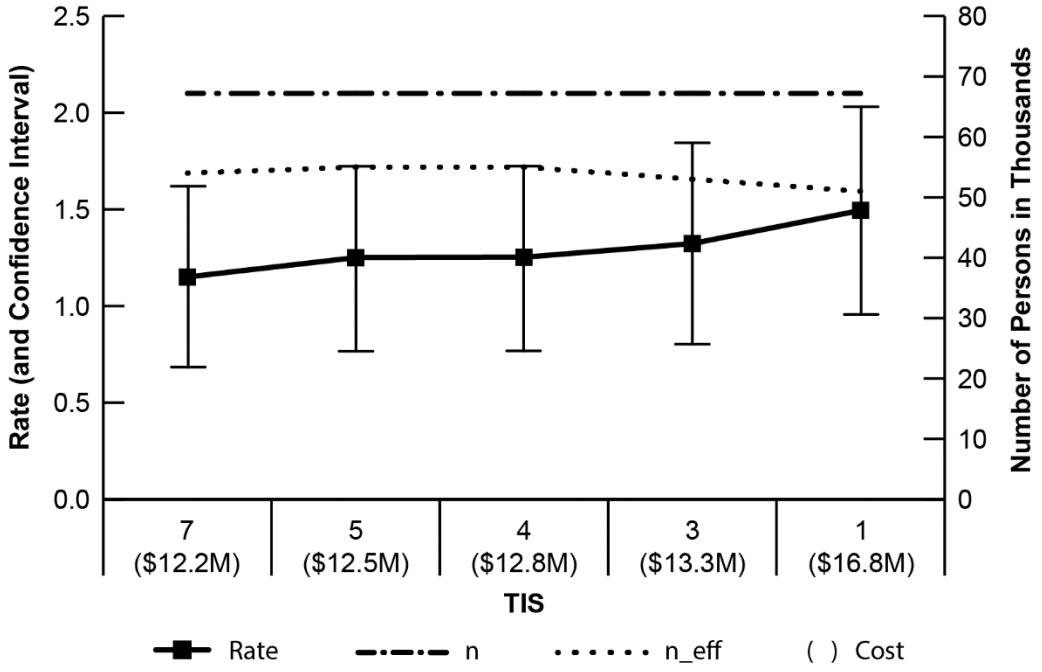
Note: TIS = time in sample.

Figure C-5. Violent victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



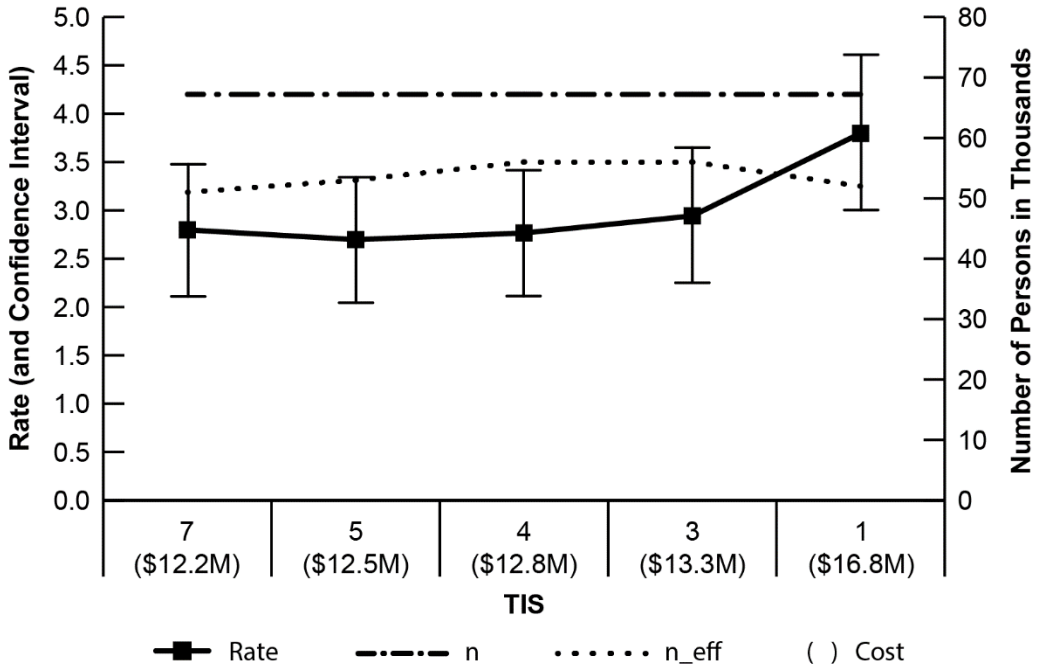
Note: TIS = time in sample.

Figure C-6. Rape and sexual assault victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



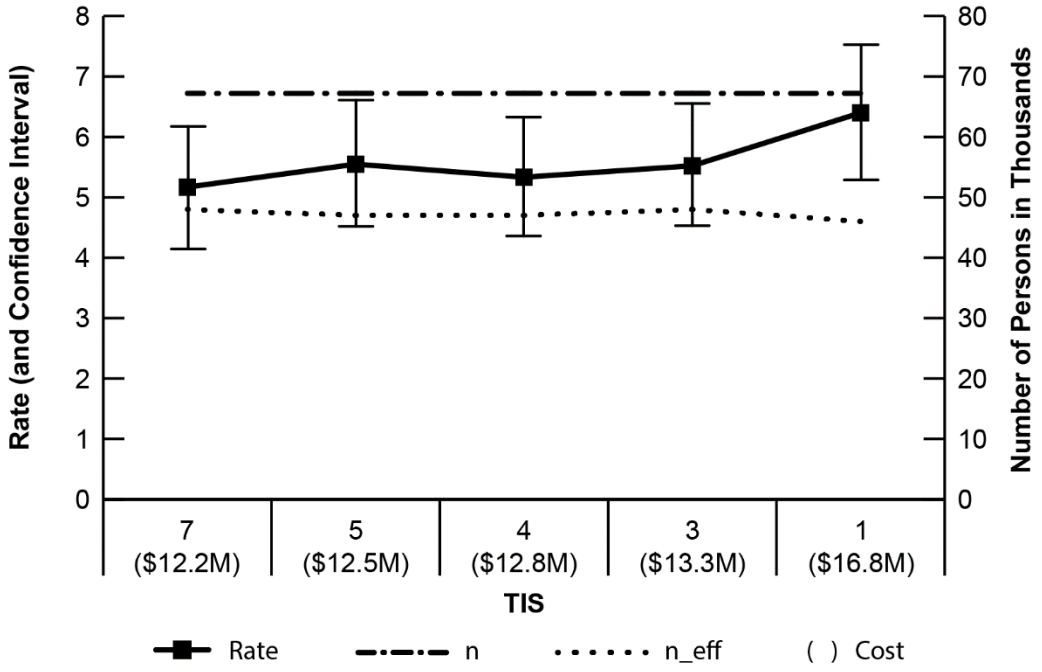
Note: TIS = time in sample.

Figure C-7. Robbery victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



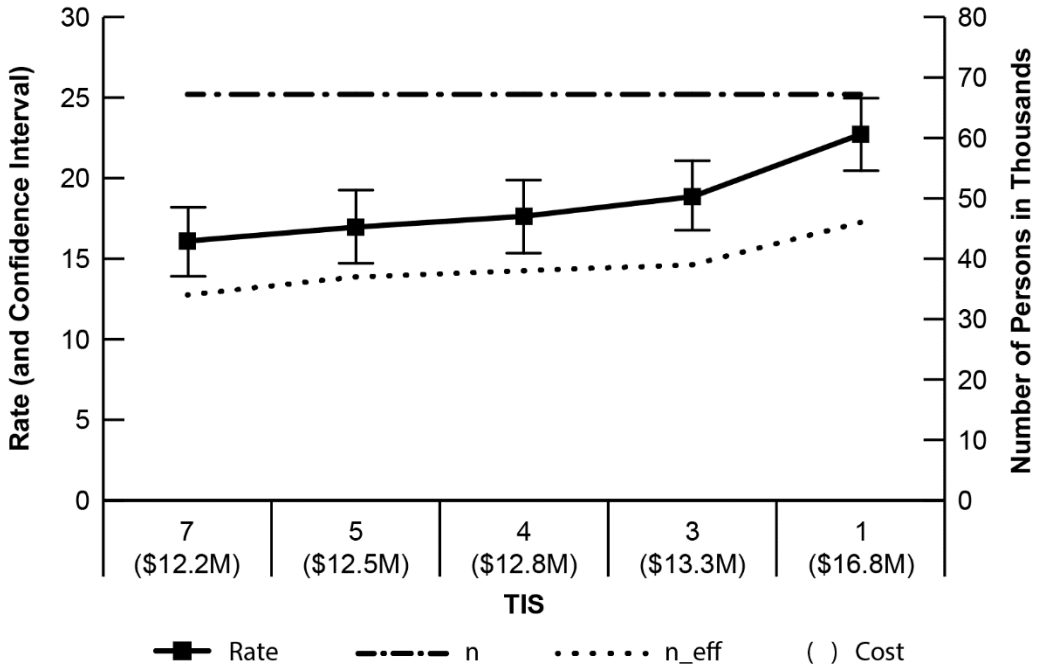
Note: TIS = time in sample.

Figure C-8. Aggravated assault victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



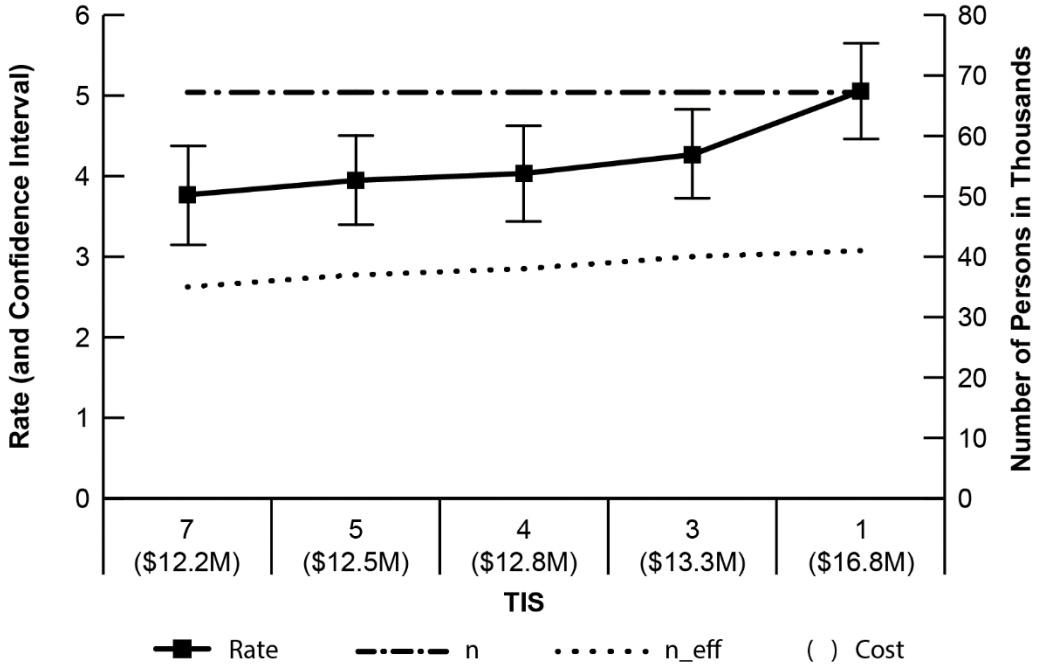
Note: TIS = time in sample.

Figure C-9. Simple assault victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



Note: TIS = time in sample.

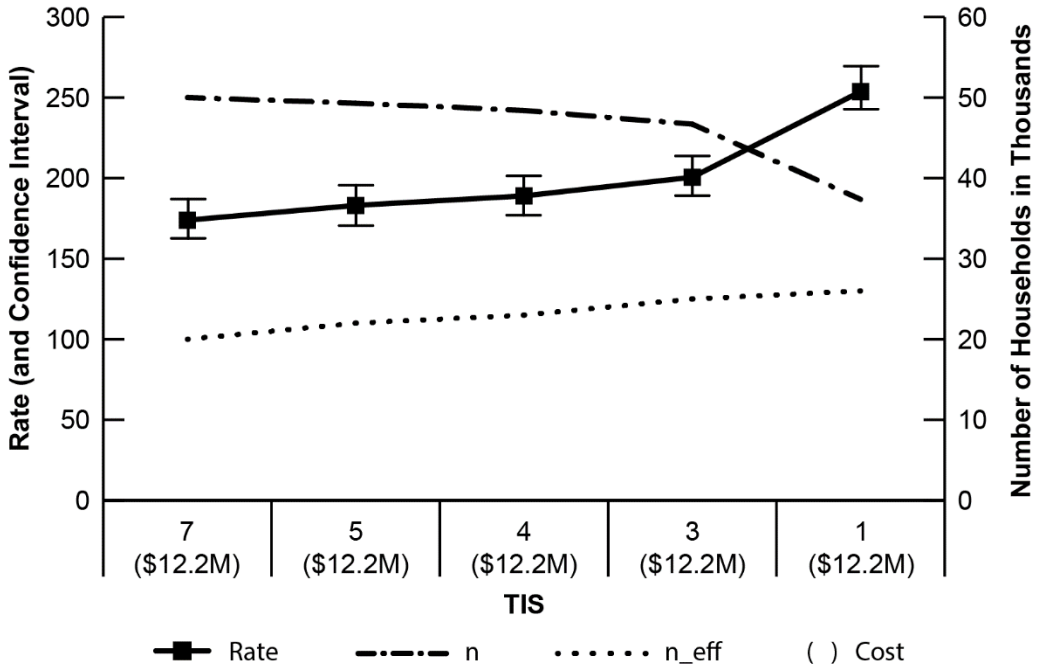
Figure C-10. Intimate partner violence victimization rate, nominal and effective sample sizes, and cost when keeping the number of interviews constant by alternative design



Note: TIS = time in sample.

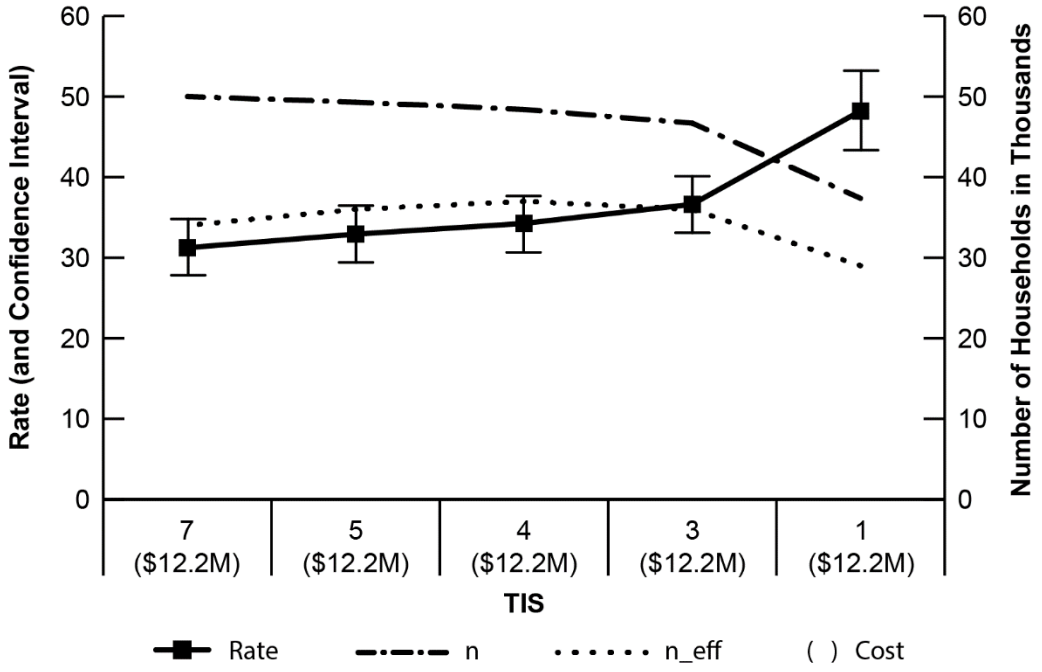
Appendix D. Impact of alternative designs, by type of crime under keeping the cost constant conditions

Figure D-1. Property victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



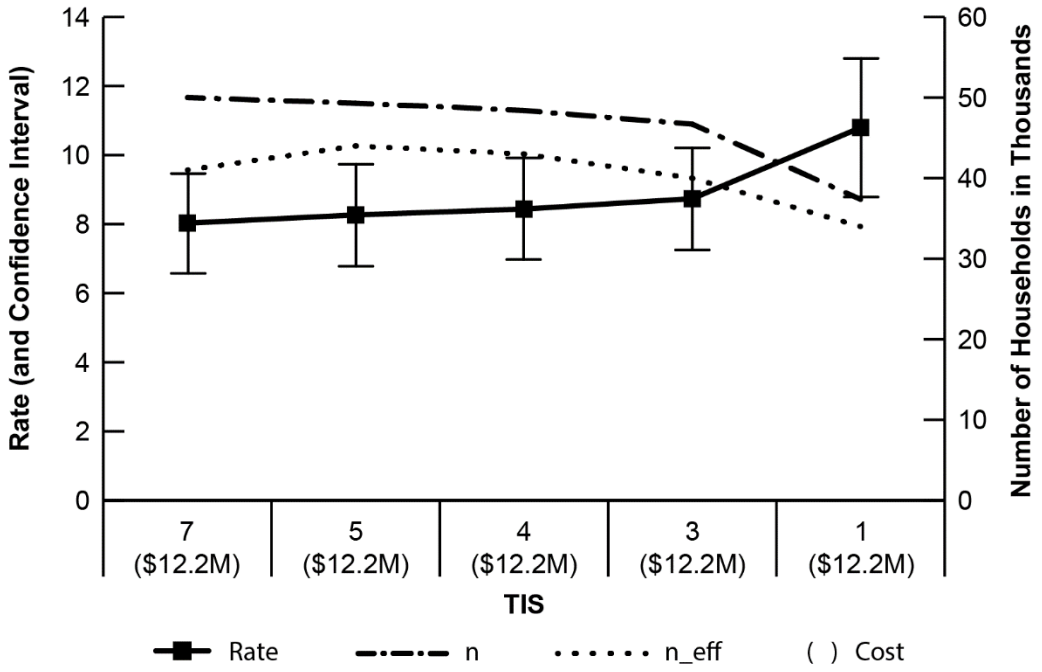
Note: TIS = time in sample.

Figure D-2. Household burglary victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



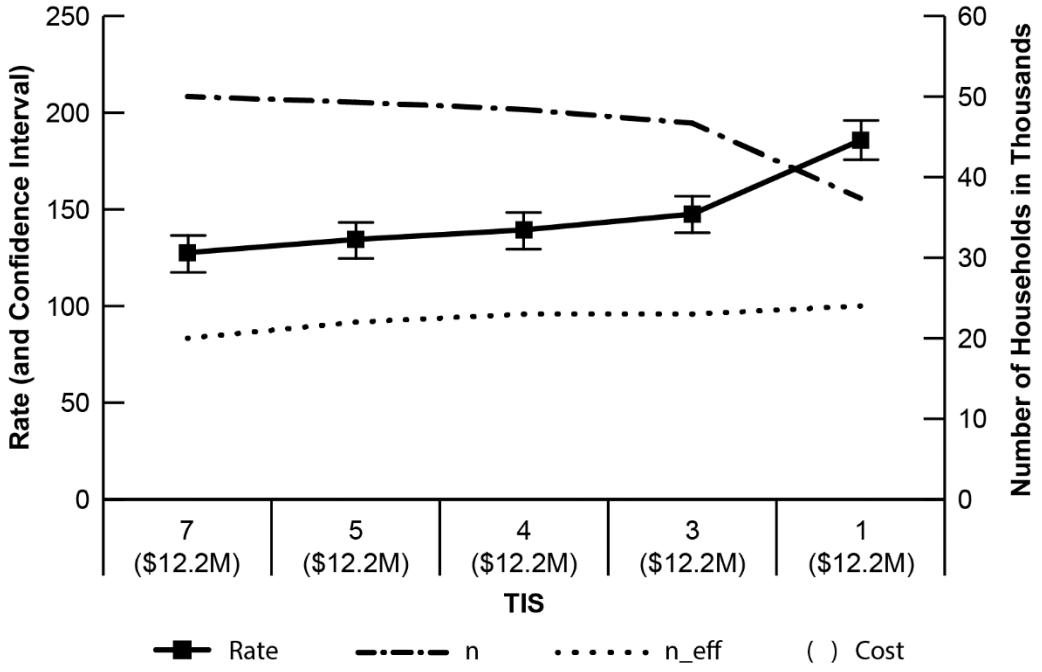
Note: TIS = time in sample.

Figure D-3. Motor vehicle theft victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



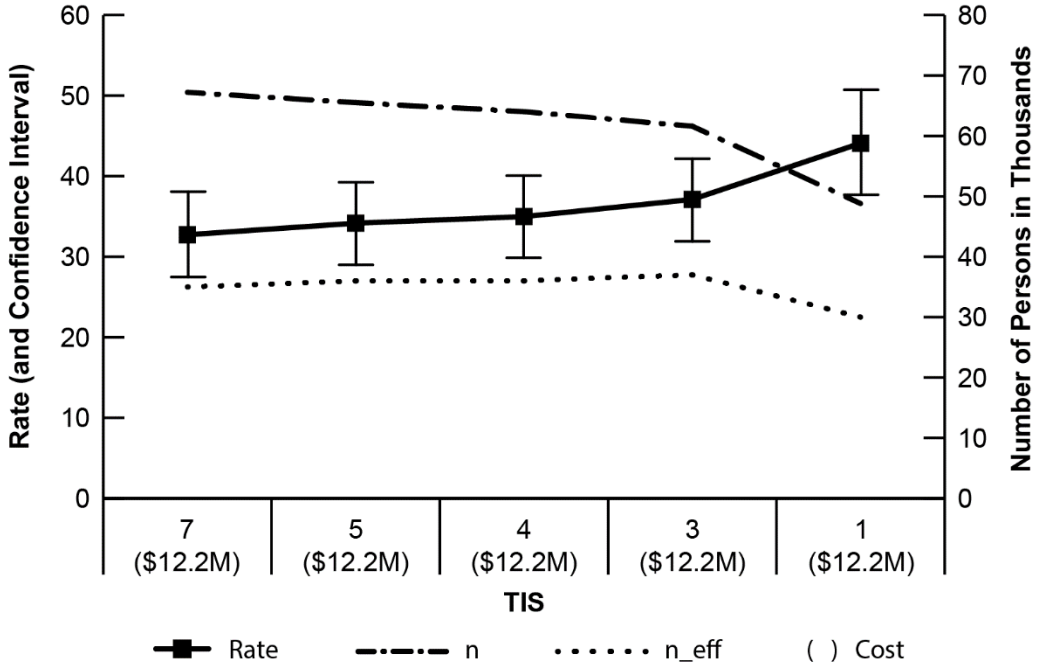
Note: TIS = time in sample.

Figure D-4. Theft victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



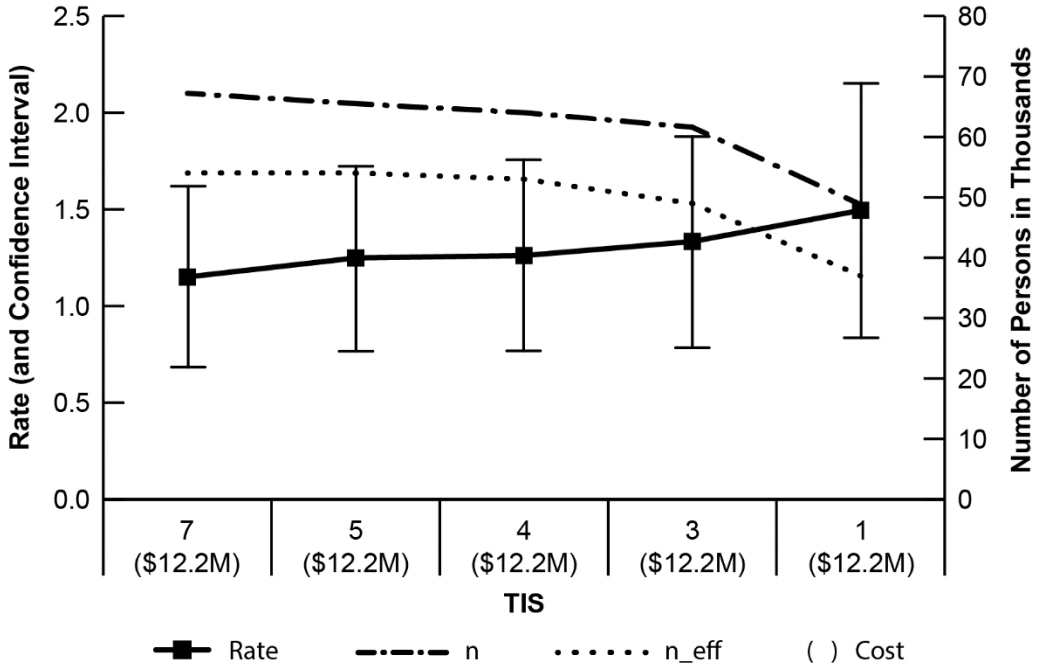
Note: TIS = time in sample.

Figure D-5. Violent victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



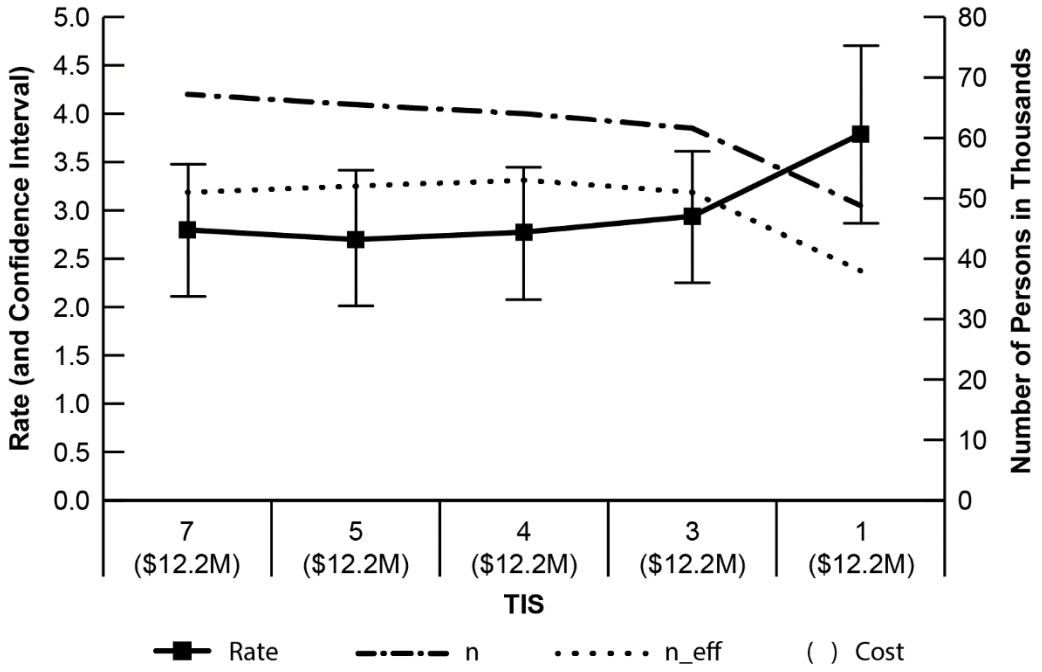
Note: TIS = time in sample.

Figure D-6. Rape and sexual assault victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



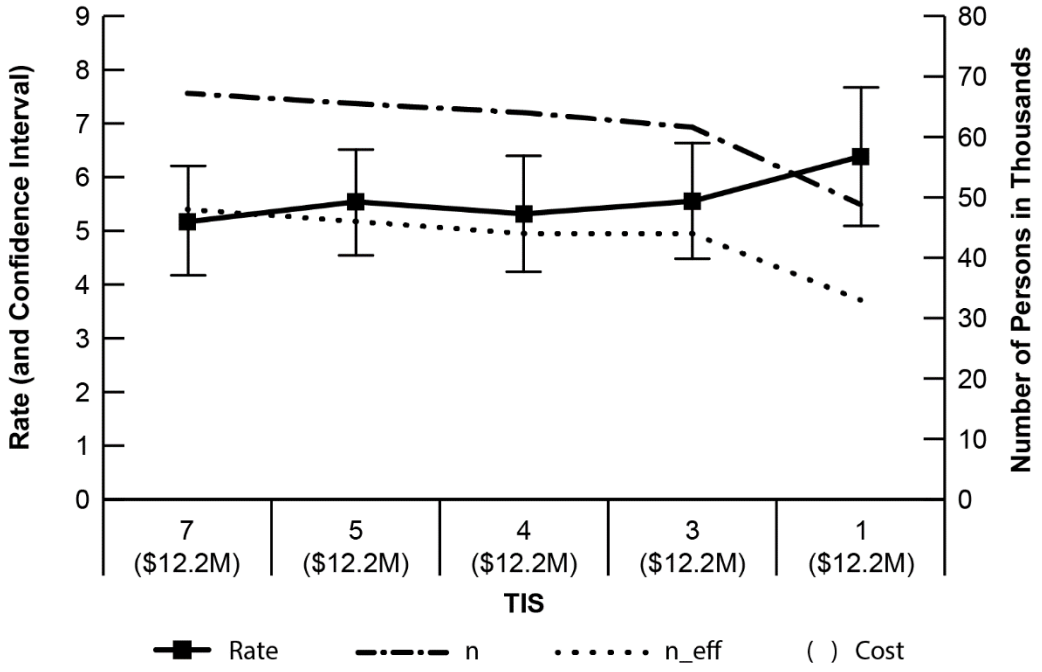
Note: TIS = time in sample.

Figure D-7. Robbery victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



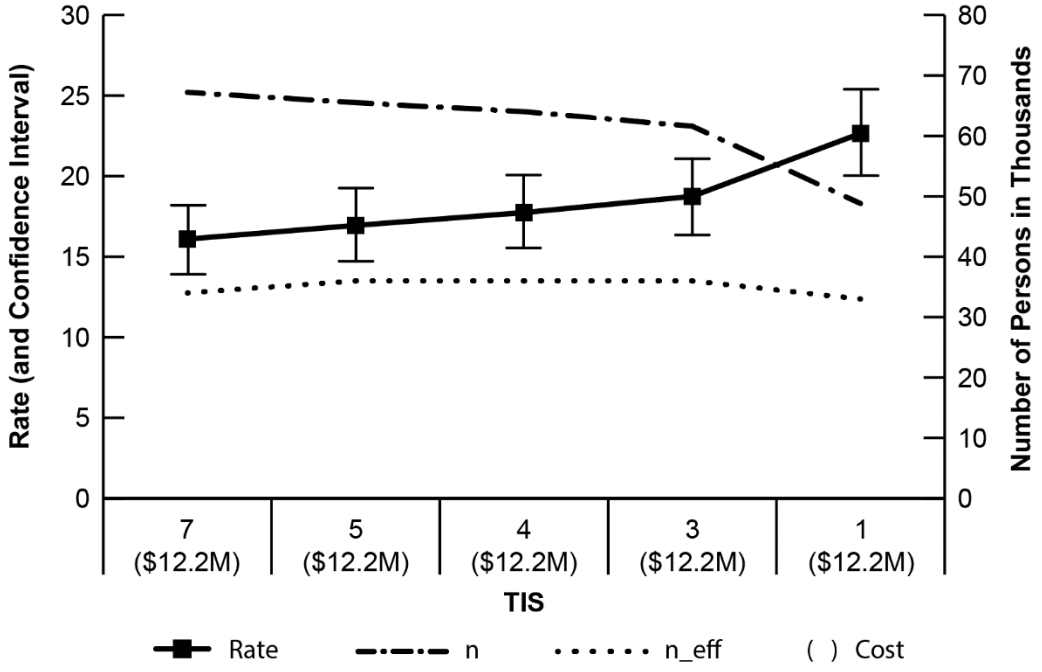
Note: TIS = time in sample.

Figure D-8. Aggravated assault victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



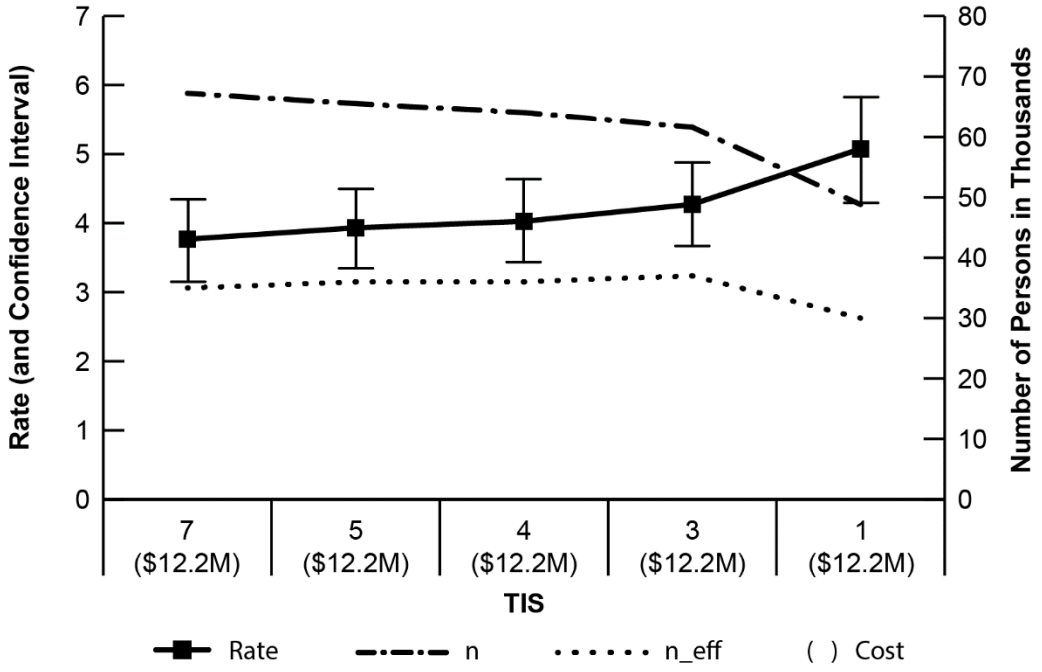
Note: TIS = time in sample.

Figure D-9. Simple assault victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



Note: TIS = time in sample.

Figure D-10. Intimate partner violence victimization rate, nominal and effective sample sizes, and cost when keeping the cost constant by alternative design



Note: TIS = time in sample.

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