Dynamic Drivers of Successful Social Impact Bonds

Robert J. White III[1] , David N. Ford, Ph.D., P.E.[2]

Zachry Department of Civil Engineering, Texas A&M University

3136 TAMU, College Station, TX 77843-3136

Telephone: 979.845.3759

Facsimile: 979.845.6554

robertjwhite@tamu.edu; davidford@tamu.edu

Abstract

Public goods and services, such as prisons, are often underfunded compared to private goods and services. Social Impact Bonds (SIB) are a new financial vehicle to increase the use of private funds for public good. SIB use a pay for performance structure to change a critical reinforcing loop from a vicious cycle of decay to a virtuous cycle of improvement. A a case study model of the Her Majesty's Prison (HMP) Peterborough SIB is developed and analyzed to understand the roles of high leverage parameters and feedback loops in the SIB success or failure for the two primary participants (HMP system and SIB investors). Program effectiveness and unit program costs are found to be two high leverage SIB design characteristics. The analysis and model are used to make recommendations for both the owners and investors concerning SIB design.

Keywords: public goods, finance, prisoner rehabilitation, Social Impact Bond, Recidivism, Rehabilitation, Program Finance, Pay for Performance, Peterborough, project finance

Introduction

Public goods and services tend to be underfunded compared to private goods and services. This is partially because they are often non-excludable and non-rival. Services are non-excludable when they cannot be restricted when in use. Services are non-rival when one party's use does not impact its use by others. Street lights are a simple example of such a public good. They are non-excludable because everyone sees the objects they light up, and they are non-rival because one person's use of the street lights does not impair or hinder another's use of the light.

[1] PhD Student, Zachry Department of Civil Engineering, Texas A&M University. robertjwhite@tamu.edu
[2] Associate Professor and Urban/Beaver Development Professor, Zachry Department of Civil Engineering, Texas A&M University. davidford@tamu.edu

Some people (free-riders) prefer excludable or rival goods and services, leading them to undervalue and therefore underfund public goods and services(Gruber 2011). This is a problem when the social benefit for public goods are greater than the, excludable or rival, private goods (Marwell and Ames 1981). Prison systems are non-excludable and non-rival and often experience underfunding due to the free-rider problem (Marvell and Moody 1998).

Prisons measure performance in multiple dimensions. One measure is the population of prisoners held in prisons. Assuming the correct population is being held, a lower population indicates more success. This objective is partially reflected in the prison's recidivism, the fraction of released prisoners that are reconvicted (Disley, Rubin, Scraggs, Burrowes, & Culley, 2011; Moynihan, 2008). Prisons also measure performance using cost (e.g. dollars per prisoner-year). Like in many systems, these performance measures create tradeoffs. Rehabilitation programs can lower the recidivism rate for a prison system, but increase the cost per prisoner(Loder, et al. 2010, Mulgan, et al. 2011). Therefore efforts to limit cost can prevent the initiation and use of rehabilitation programs. Thus rehabilitation programs are likely to be underfunded when cost per prisoner is the performance metric. Therefore, a major challenge for prisons systems is how to fund rehabilitation programs with little public funding (Moynihan D. P., 2008; Loder et al., 2010; Mulgan et al., 2011). Donald Moynihan (2008) describes the Alabama Department of Corrections (ALDOC) as an example of this dilemma. ALDOC was underfunded, requiring it to operate at almost 200% capacity (Britt 2012). Single guards were responsible for 200 prisoners, forcing them to stand back and try to prevent full scale riots (Britt 2012). Under such circumstances funds for rehabilitation programs could not even be considered.

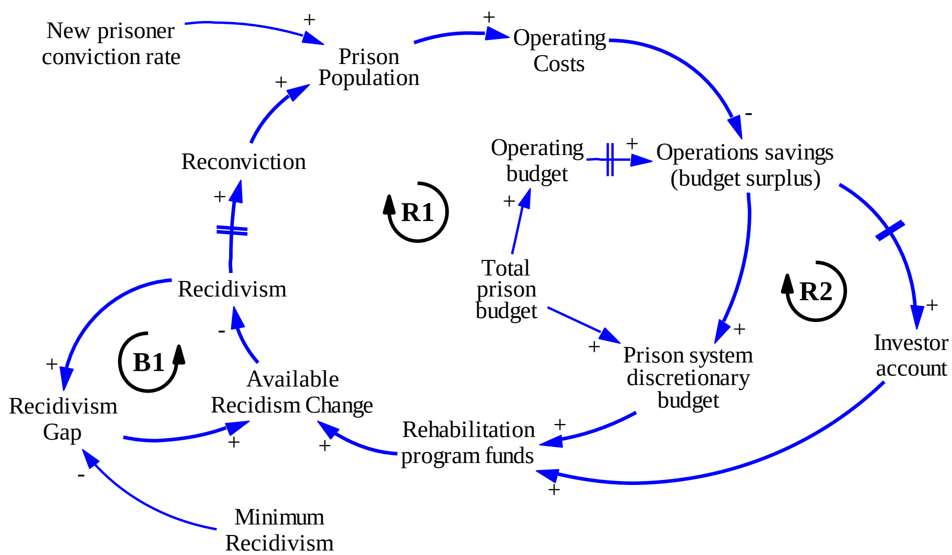
Social Impact Bonds (SIB)

Social Impact Bonds (SIB) are one potential solution for using private funds to develop and support public goods, such as prisoner rehabilitation programs. Social Impact Bonds are a new[3] and innovative form of performance-based contracting that integrates the provision of public services, the "do good for others" altruism of non-government organizations (NGO), and the profit motive of private capital markets. In a SIB private sector investors and a public sector agency agree that investor returns will be contingent upon the creation of specific social

[3] The term "Social Impact Bond" was coined by the Young Foundation in 2008 (Loder et al., 2010)

outcomes by an NGO that result in tangible savings to the public sector. A portion of these savings are paid to the investors if, and only if, specific improvement targets are met. Therefore, a SIB links investor returns to monetized outcomes. See Mulgan et al., (2011), Social Finance (2009, 2011b), and Young Foundation (2010) for more on Social Impact Bonds.

Figure 1 shows a portion of the feedback structure of a prisoner rehabilitation program. When operating as a vicious cycle of decay reinforcing loop 1 (R1) degrades prison system performance by reducing rehabilitation programs and thereby increasing recidivism as budgets are reduced, which increases reconvictions, prison populations and costs, thereby reducing funds for rehabilitation programs farther. Figure 1 also illustrates how the challenge described above can be initiated if the total prison budget (Figure 1, center) is constrained, requiring a tradeoff between the operating and discretionary budgets. A reduction in the total budget of a prison system operating in a steady state can reduce the discretionary budget enough to initiate the vicious cycle of decay.



Legend of Loops

R1 – Paid-from-Success rehabilitation loop: Prison budget funds program which reduces population and generates savings which are used to pay for the program

R2 – Social Impact Bond loop: SIB invests in rehabilitation program, reducing population and creating savings, part of which are paid to investors as returns

B1 – Limits to Improvement loop: Decreased recidivism reduces improvement available, which limits the amount of future recidivism reduction

Figure 1: Partial Feedback Structure of a Prison Rehabilitation Program Financed with a Social Impact Bond

However, reinforcing loop 1 (R1) in Figure 1 also describes a potential solution if the reinforcing loop operates as a virtuous cycle of improvement instead of a vicious cycle of decay. In this behavior mode loop R1 depicts the use of a paid-from-savings approach in which a rehabilitation program reduces recidivism and then reconvictions, thereby reducing a prison's population and operating costs. This increases operating savings, which can be used to continue to fund the rehabilitation program. These improvements are limited by the minimum recidivism that the rehabilitation programs can create (Figure 1, loop B1). Changing the behavior mode of this reinforcing loop into a virtuous cycle of improvement is the primary objective of a Social Impact Bond applied to prisoner rehabilitation. A SIB can solve this financing problem by having its investor provide the required funds to start and initially operate a rehabilitation program and be repaid (with profit) from the operating savings (Figure 1, loop R2). Thus a SIB can change the prison budget dynamics from tradeoffs among alternative uses or a vicious cycle of decay to the use of savings from reduced recidivism to continuously improve the prison system[4]. After the SIB ends the prison system can operate the rehabilitation program in perpetuity with its share of the savings generated by the SIB-funded program and future savings. In addition, after the SIB has ended the investors can continue this dynamic by reinvesting in a larger or different rehabilitation programs (Disley et al., 2011). See Strickland (2010), Loder et al. (2010), Mulgan et al. (2011), and von Glahn and Whistler (2011) for detailed descriptions of a SIB for prisoner rehabilitation.

Traditional bonds and public private partnerships (P3) are common forms of funding for public programs. SIBs are similar to public private partnerships (P3) in that investor returns depend on performance. However, the risk and reward structure of SIBs distinguish them from public private partnerships and traditional bonds. Mulgan et al., (2011) suggest four categories of program risk that can be used to compare SIBs to traditional bonds and P3:

- Performance risk[5] is the risk that the public agency may not experience the improved outcomes and capture the anticipated savings. For example, in a prisoner rehabilitation program performance risk reflects the possibility that released prisoners will be convicted of additional crimes.

[4] However, there are natural limits to growth (Senge, 1990) such as minimum recidivism fractions and maximum returns, not included for clarity. These are included in the formal model but not in the causal loop diagram for clarity.
[5] Mulgan et al., (2011) refer to performance risk as basis risk.

- Measurement risk is the risk that the measures of performance may not accurately and equitably depict the outcomes. For example, in a prisoner rehabilitation program measurement risk reflects the possibility that recidivism may not adequately describe prison system population and operating cost changes.
- Execution risk is the risk that programs may not scale up from a pilot stage. For example, in a prisoner rehabilitation program execution risk reflects whether a test program for short term offenders at one prison can generate the same results if used for other prisoner types and prisons.
- Unintended consequences are the risks of creating policy resistance that will defeat the program objectives. For example, one unintended consequence in a prisoner rehabilitation program could be the reduction of prison budgets as savings are captured, thereby providing inadequate funds to maintain the rehabilitation program.

In a traditional bond for a public sector program the owner (e.g. public prison system) commits to paying the investor specified returns regardless of the performance of the program. Therefore, the owner holds all four of these types of risk in a traditional bond. In a public private partnership much of the performance, measurement, and execution risks are transferred to the investors and developers of the project, and the unintended consequences risks are shared. For example, a toll road developer typically takes the traffic volume (performance), toll collection (measurement), and scale (execution) risks, but would only bear some of the unintended consequence risk (e.g. lower traffic due to higher tolls but not regulation changes). A SIB differs from the traditional bond risk / reward structure by having the investors assume the performance risk and measurement risks (like in a P3). But, like a traditional bond, the SIB owner holds the execution risk (due to the limited and specified scale of the SIB) and the more of the unintended consequences risk than in a P3 (Mulgan et al., 2011; Miraftab, 2004; Hatry, 2006). SIB investors would be expected to require a higher investment return rate than traditional bond investors for bearing the additional risks (Loder et al., 2010; Mulgan et al., 2011), but (presumably) less than the returns of a P3 (ceteris paribus). Notably, the bearing of the performance risk by the SIB investor creates an incentive for investors to actively participate in the program (Mulgan et al., 2011).

Due to the delayed feedback structure of a SIB (e.g. Figure 1) the system dynamics methodology (Sterman, 2000; Forrester, 1964) can provide valuable insight to the drivers of SIB success or failure through the SIB structure's impacts on the risks and rewards of its two primary stakeholders (Damnjanovic & Ford, 2011). Modeling a SIB-financed system can potentially improve the design and management of SIBs and their applications. These insights and improvements would accelerate the development if SIBs as a new financing vehicle, increase SIB investor confidence, and thereby accelerate its widespread adoption. The current work develops, analyzes, and uses a system dynamics model of the only known operating SIB and draws conclusions for SIB development and use.

The HMP Peterborough Social Impact Bond

In 2010 the United Kingdom (UK) initiated the first SIB through the Ministry of Justice (MOJ). The six-year SIB is designed to reduce the recidivism of released short term offenders from the Her Majesty's Prison (HMP) Peterborough (Strickland, 2010; Disley et al., 2011; Cave, Williams, Jolliffe, & Hedderman, 2012) by reducing the reoffending rate of the released offenders (Strickland, 2010; Cave et al., 2012). The program is operated by NGOs that consist of organizations with proven track records but insufficient funds to operate on a scale as large as the Petersboro SIB. Savings are expected due to reductions in the number of arrests, convictions, and prison terms, all which impose costs on HMP Petersboro.

The Petersboro SIB potentially addresses at least two major challenges to the success of rehabilitation programs: lack of adequate resources, and overly aggressive implementation schedules (Loder et al., 2010). The Bridges to Life rehabilitation program (Bridges To Life, 2011, Maybield-Geiger and Rudnicki, 2007) is an example of how successful a program can be if these two challenges are addressed. The SIB addresses the resources issue by incentivizing investors to provide adequate funds to allow success. The SIB addresses the implementation schedule challenge by structuring oversight of the program by investors, who will seek to keep the program slow enough to allow for its success.

The Petersboro SIB investors provided £5 million across six years paid through a special purpose vehicle (SPV) to the NGOs (Strickland, 2010). To measure performance the Peterborough SIB specifies four cohorts of released prisoners. Each of the first three cohorts has a maximum of 1000 prisoners in each. The fourth is an accumulation of the first three cohorts (Cave at al., 2012). If the program reduces recidivism by 10% for any of the first three cohorts, or 7.5% for the fourth (cumulative) cohort, then the MOJ pays a portion of the savings to the investors(Strickland 2010)[6]. However, if the reconviction targets are not met, then the investors receive no performance payments for the failed cohort.

If successful, the Peterborough SIB will provide the investors with an attractive return and the MOJ with three practical benefits. First, HMP Peterborough would have a sustainable program able to fund its own rehabilitation programs. Second, the sustainable program could be replicated in similar prisons for similar offenders, thereby further improving the HMP system. Third, the HMP Peterborough SIB case could serve as a model for expanding SIBs beyond the domain of prison systems, to other public services and infrastructures. Understanding the feedback structure of the Petersboro SIB is critical to explaining its performance and success or failure.

Research Approach and Model Structure

The system dynamics modeling methodology (Sterman, 2000; Forrester, 1964) was used because of its ability to formally describe and simulate the impacts of feedback structures in managed system. The current study developed a formal model of the Petersboro SIB for rehabilitation, analyzed the model to identify high leverage system components, and used those results to investigate SIB design issues as them impact performance outcomes of the SIB investors (IRR) and owners (prison population reduction).

The Peterborough SIB model has three sectors, depicting the prison system, the performance measurement, and SIB finances. In general, the prison system structure models the flow of prisoners through the system and the effects of the SIB on prison population dynamics(Strickland 2010). The performance measurement sector compares the prisoners in the Peterborough cohorts and a comparison group of prisoners to assess the performance of the SIB (Cave et al., 2012). The SIB finances sector use the performance assessment to simulate the financial returns to investors according to the SIB (Strickland, 2010; Disley et al., 2011; Cave et al., 2012).

[6] Returns to the Petersboro SIB investors are also constrained by minimum and maximum interest paid on the invested funds. See Cave et al. (2012) for details. These constraints are incorporated in the model.

The prison system structure provides a simplified view of how people move in, out, and around the prison system[7]. New offenders are incarcerated from the general population (Figure 2, upper left). In the model released prisoners unknowingly one of two stocks, those who function within the norms of society (rehabilitated offenders) or those who will recommit (undiscovered reoffenders). At the time of release the actual prison system does not know what fraction of released prisoners will recommit, be arrested and convicted again, and reenter the prison. But the model distinguishs these stocks and their related flows and uses Stickland's (2010) historical value of 75% re-offending fraction to initialize the model. Rehabilitated prisoners After their release, prisoners are reintroduced to society where they either (i.e. are rehabilitated, Figure 2, top center) or recommit crimes (i.e. are unrehabilitated, Figure 2, left) and will eventually re-offend, be arrested and convicted, and returned to prison (Figure 1, bottom) (Disley et al., 2011). The model simulates these two types of released prisoners separately. Rehabilitated prisoners leave the system after the one-year probation period (Figure 2, upper right). Those that will recommit and be reconvicted remain under the same probation period until they are reconvicted. Once reconvicted, a prisoner returns to the prison for the duration of their holding, where they are again released into the same system (some being rehabilitated and the rest unrehabilitated). The prison system has a structure of stocks and flows similar to the rework cycle in most system dynamic project management models (see Lyneis and Ford, 2007) with work being replaced by prisoners, the fraction requiring rework being replaced by the recidivism fraction, and the quality assurance function replaced by the probation period. Similar to how improved work quality reduces rework in project models, reducing the recidivism of first time offenders can greatly reduce the magnitude of repeat offenders(Langan and Levin 2002).

[7] The model retains all prisoners, so that none are lost, e.g., to crime escalation or death. Therefore the model is accurate as long as these anomalies remain insignificance (Cave at al., 2012). The limit of insignificance is determined by Cave et al., (2012). .

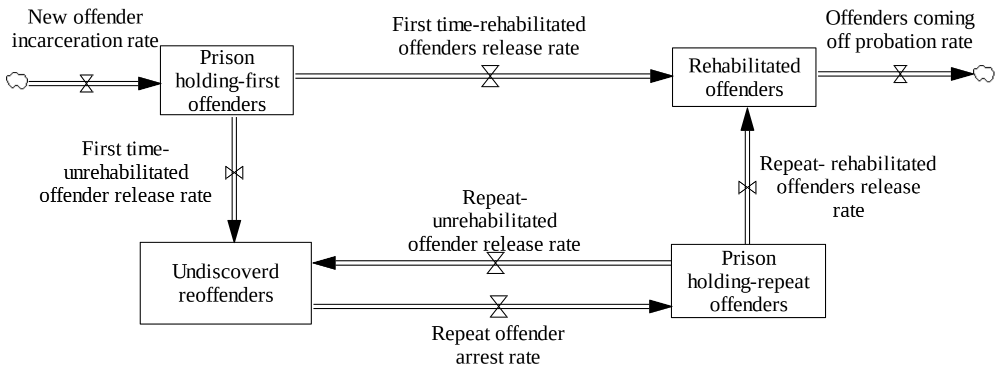


Figure 2: Petersboro SIB Model: Prison Sector Stock and Flow Structure

To assess SIB performance the performance measurement sector compares the prisoners in the four Peterborough cohorts to four parallel cohorts in a comparison group of prisoners at other UK prisons. The effects of large scale factors such as a national decline in crime do not influence program performance because prison reconviction is compared to concurrent prisoner cohorts. Recidivism is used as the performance measure (Cave et al., 2012). Success is defined as a reduction in recidivism of 10% or more than the recidivism change in the comparison cohort for each of the three 1000 prisoner (maximum) cohorts at Petersboro or a reduction in recidivism of 7.5% or more than the recidivism change in the comparison cohort for the fourth (combined) Petersboro cohort. If the performance meets either of these targets the MOJ pays the SIB investors a specified[8] fraction of the savings captured by the MOJ.

The SIB financial sector uses the assessments of success from the performance measurement sector to simulate payments to investors and calculate returns. Investors providing funds for program operations and expenses create outflows of investor cash. Loder et al. (2010) and Mulgan et al. (2011) describe the costs of the program, including the overhead for the special purpose vehicle used to structure and operate the SIB. If the program is successful the MOJ makes payments based on savings captured to the SIB investors, creating cash inflows to the investors. The benefits of the program used to determine payments are the savings in reconvictions and re-incarceration (Strickland, 2010; Mulgan et al., 2011; Cave et al., 2012). The modelers assumed (consistent with the SIB intent) that if the program is successful the MOJ will use its savings (including those that were used to pay SIB investors) to continue to operate the

[8] The fraction is specified in the SIB contract but has not been made public.

rehabilitation program. This closes the “big” feedback loop from funding from the SIB through the prison system, performance measurement and finances, and back to funding the program (by the MOJ after the SIB), and the shifting of dominance from loop R2 in Figure 1 (SIB-based success) to loop R2 (internally supported success). If, in contrast, the program is unsuccessful the MOJ makes no payments to the SIB investors and the program closes out after the investment period. Standard formulas with an assumed discount rate are used to estimate internal rate of return (IRR) and the net present value (NPV) of the SIB for the investor.

Model Calibration, Typical Behavior, and Validation

Model Calibration

The model was calibrated to the Peterborough SIB case using publicly available literature as referenced above. Langan & Levin (2002), Loder et al. (2010), Strickland (2010), Mulgan et al. (2011), Disley et al. (2011), and Cave et al., (2012) describe the program impact, costs, assessment process and timing, and magnitude. Mulgan et al. (2011) and Loder et al. (2010) describe the expected impact of the rehabilitation program as well as various costs added to the assessment. Strickland (2010) identifies the value of investment and limits of the investment. Disely et al. (2011) also provide results of a preliminary assessment of the SIB in terms of magnitude and affect. Model values coincide with the information on the SIB and program found in this literature. Values that were not described in the literature were estimated and the model initially set to steady state conditions. For example, Disely et al. (2011) noted that about 315 new offenders entered HMP Peterborough in just over six months and the steady state model uses about 317 in a similar time frame. Cave et al. (2012) noted that the normal reconviction rate for HMP Peterborough was 1.64 persons per month for data collected up to one year after the close of the cohort. The calibrated model calculates about 1.53 persons per month in a similar time frame.

Typical Model Behavior

Typical model behavior is illustrated by two performance variables of the SIB investors and MOJ. Although recidivism is the metric used in the SIB, a (perhaps ***the***) primary performance measure of the MOJ is the reduction in the Peteresboro population. Figure 3 shows the simulated behavior over time of this variable for the calibrated model.

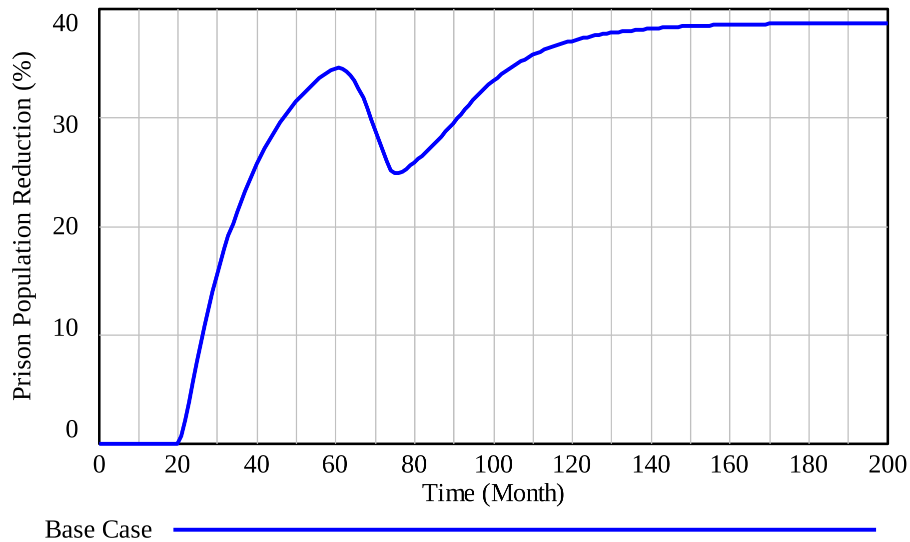


Figure 3: Typical Model Behavior – HMP Petersboro Prison Population Reduction

After a period of steady state operations (months 0-20) the program begins and more prisoners are rehabilitated in the Peterboro system, reducing the prison population (months 20-60). However, as available funds decrease, so does the number of prisoners allowed to enter the program, slowing the rate of improvement (months 30-60) and eventually reversing the progress and causing an increase in prison population when SIB funds have been depleted (months 60-75). After the completion of the program funded by the SIB the rehabilitation program is continued by the MOJ (consistent with van Golahn and Whistler, 2011), initially using the savings generated by the SIB funded program. This causes the prison population to reduce again, approaching a steady state at its maximum which is controlled by a minimum recidivism (months 75-200). We later describe the potential dangers of the temporary increase in prison population and use the model to investigate the causes and a possible solution.

The primary performance measure of the SIB investors is their return, reflected in the internal rate of return. Figure 4 shows the internal rate of return for SIB investors for the calibrated model case.

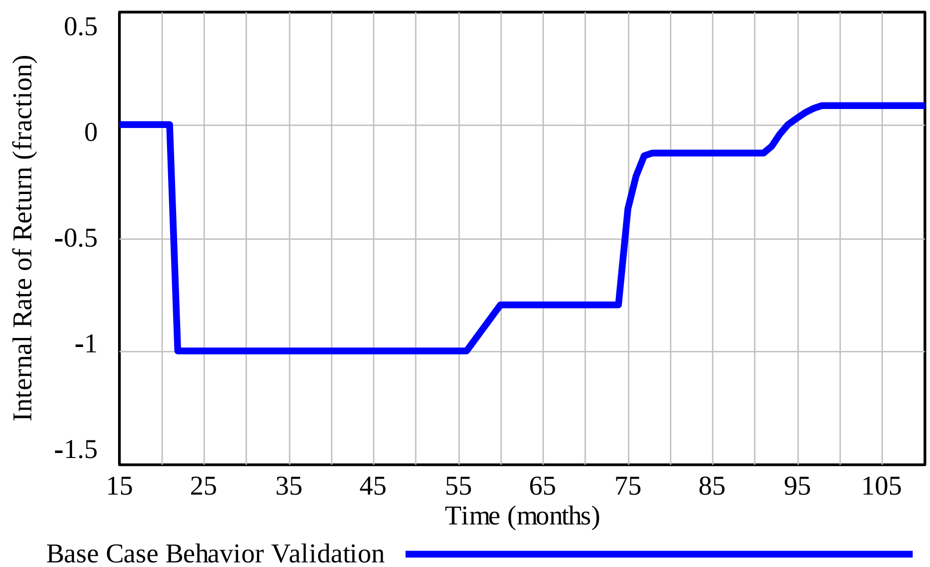


Figure 4: Typical Model Behavior – HMP Petersboro SIB Internal Rate of Return

The SIB-funded program starts in month 20, paying startup and operating costs. Until returns are paid to the investors the IRR is -100%. The success or failure of the first cohort occurs after the first assessment period, when (for the base case) success reduces recidivism and creates savings. This initiates the first payment by the MOJ to the SIB investors (month 57), consistent with Cave et al. (2012) and Mulgan et al. (2011). Similarly, the second and third successful cohorts are paid starting in months 75 and 92, each increasing the IRR. In the actual Petersboro case and the calibrated model used for the base case the IRR is limited to 8.25% (months 100-200). Model analysis results are used later to investigate performance without this limit.

Model Validation

The model contains a total of 141 variables consisting of 23 basic stocks and 24 flows (with five arrays), and 29 exogenous variables. The model structure is based upon the extensive literature specifically about the Petersboro SIB case referenced in the model structure description above. Of the 29 exogenous variables 14 used values taken from the literature specifically about HMP Petersboro or HMP system. The values of four of the remaining exogenous variables were supported from other literature but that literature provided inconsistent values. These ranges were used in extreme conditions testing. Four more were supported by other literature. The remaining seven were used to establish steady state conditions (e.g. initial values of stocks) or estimated by the modelers.

The model generated reasonable behavior when each of the 29 exogenous variables were set to extreme values. More specifically, each exogenous variable was tested for its impact on several outcome variables, including SIB investor IRR, offender release rate, and the reconviction fraction. For example, when the Normal Recidivism Discovery Time (average time to discover that a released prisoner has re-offended) was set to a relatively high value (twelve months[9]) the SIB investor IRR decreases because there are fewer reconvictions for every unrehabilitated prisoner and therefore less savings and reduction in recidivism. See the supporting documents for details on the extreme conditions testing and results.

The Petersboro SIB has not progressed adequately to provide actual behavior data for use in model validation. However, the literature describes the expected behavior for the case, including Disely et al. (2011) reviewing the expectations for both how investors earn money as well as how the SIB financially functions, Cave et al. (2012) describes how the third party assessor of performance defines the limits among the different cohorts and determines cohort success, Langan and Levin (2002) describing how the prison system creates a perpetual cycle of offences, and Mulgan et al. (2011) describing the transfer of risk, cost savings to the MOJ, and flows of capital between key stakeholders. The models behavior is consistent with the expected behavior for financial and other performance measures. For example, Disely et al. (2012) describes the increase in investor returns due to either a decrease in reconvictions, or an increase in the investors’ share of the total savings. By varying these two parameters the model also simulates this increase in returns (Figure 5), building confidence in the ability to generate “the right behavior for the right reasons”.

[9] The prisoners targeted by the program are limited to those with short (12 months or less) sentences and the average sentence served was about three months. Therefore twelve months for discovering a re-offense is relatively long.

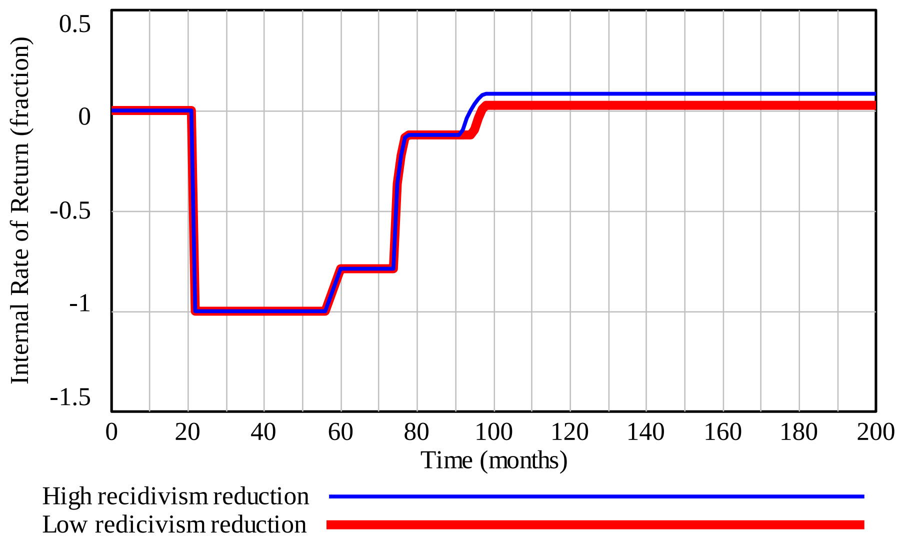


Figure 5: Behavior Validation Test of SIB Return based on Recidivism Reduction

As another example of model behavior validation the model successfully reflects the expectation that the government would continue a successful program, as described by Glahn and Whistler (2011). The model's behavior is consistent with what would be expected in the operation of the actual SIB at HMP Petersboro.

Based on these model validation tests the Petersboro SIB model is considered valid for investigating the impacts of SIB design parameters on system behavior and performance.

Model Analysis

Model analysis to identify and describe high leverage parameters was performed in two steps. First statistical screening (Taylor, Ford, and Ford, 2010; Ford and Flynn, 2005) was used to identify high leverage parameters for one performance measure for the MOJ (prison population reduction) and for one performance measure for SIB investors (IRR). Statistical screening is a simple, structured, and user-friendly means of identifying high leverage model parameters based on model behavior. Statistical screening quantifies parameter influence throughout simulation, thereby describing the evolution of exogenous impacts on behavior. In addition, statistical screening provides modelers with the objective model analysis results required to generate clear behavior distinctions. Consistent with the application of statistical screening (Taylor et al., 2010), the time frame after the SIB is completed (months 100-165) was chosen as the focus of the analysis. The results of the statistical screening analysis were used to identify two of the highest leverage parameters that could be influenced by SIB designers. These were then described with univariant sensitivity analysis. See the model analysis supporting documentation for details on these analyses.

Figure 6 shows the results of the statistical screening analysis the most influential exogenous variables that impact the prison population reduction. The analysis results show the relative influence of the four exogenous parameters with the most impact on the prison population reduction. Correlation coefficient values farther from zero indicate more influence. Positive values indicate movement in the same direction and vice versa. The results indicate that, after the SIB is over, the reduction in recidivism, maximum cohort size, reference (pre-program) recidivism fraction, and unit program cost (per participant) are most influential on the prison population reduction (in decreasing order of influence). The reduction in recidivism after the SIB is particularly important because it is a metric of program effectiveness, something that SIB designers can influence through their choice, design, and management of the rehabilitation program. Similarly, the unit program cost can also be influenced by SIB designers and managers.

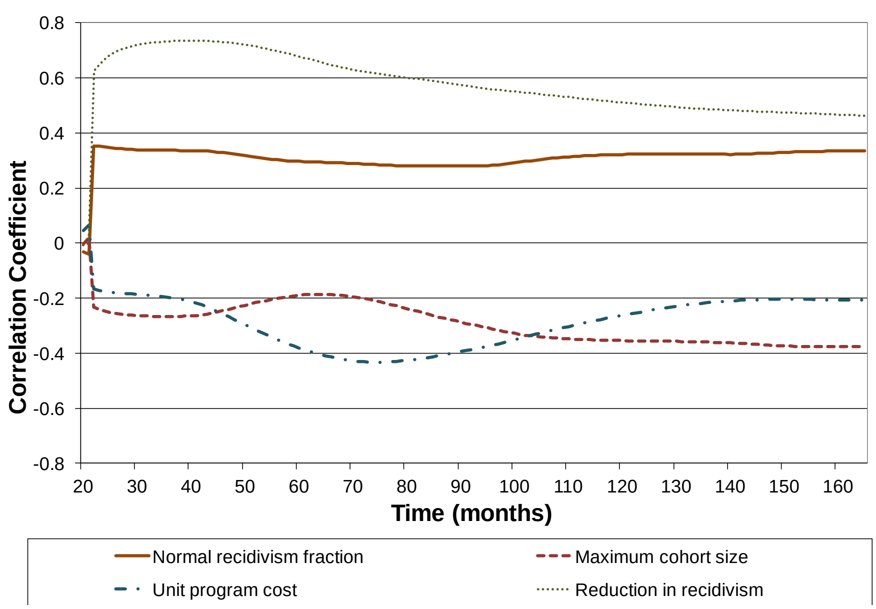


Figure 6: Statistical Screening Model Analysis Results: Prison Population Reduction

Figure 7 shows the results of the statistical screening analysis for the four most influential exogenous variables that impact the SIB investor IRR. The analysis results show that, in decreasing order of influence, the relative influence of the four exogenous parameters with the most impact on the SIB investor internal rate of return. The results indicate that, after the SIB is over, the reduction in recidivism, unit program cost, unit cost of conviction, and investor discount rate are most influential on SIB investor IRR.

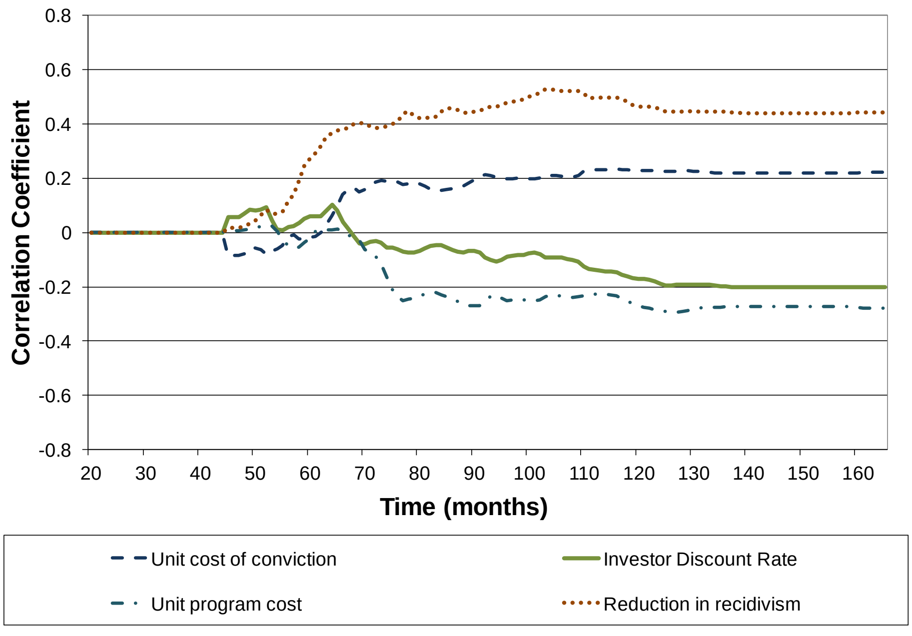


Figure 7: Statistical Screening Model Analysis Results: SIB Investor Internal Rate of Return

The results of the two statistical screening analyses indicate that reduction in recidivism and unit program cost are two of the highest leverage parameters for both the MOJ and SIB investors that SIB designers can influence. Consistent with model analysis using statistical screening (Taylor et al., 2010), the model structure is used to link these parameters to potential drivers of system behavior and performance (e.g. feedback loops, delays, accumulations). Both variables have a direct impact on the strength of core feedback loops in the Petersboro SIB. Increasing the program effectiveness and thereby the reduction in recidivism (Figure 1, left side) reduces reconvictions, prison population (a MOJ performance metric), operating costs, and thereby savings that generate return for SIB investors (Figure 1, Paid-from-Success rehabilitation loop R2). As described above, strengthening this loop drives the Social Impact Bond loop

(Figure 1, loop R1) that allows the MOJ to operate the rehabilitation program on a self-sustaining basis. This demonstrates the critical role of understanding and managing these two feedback loops.

However, knowing what system parameters and feedback loops have the most influence does not provide operational recommendations to system designers and managers because the amount of benefits derived from changes, limits of change, difficulty of change, cost of change, and other factors impact the attractiveness of change alternatives. Knowing the relative amounts of leverage that each of these parameters have on performance can facilitate SIB design. Therefore, univariant sensitivity analysis, initially using the calibrated model as a base case, was performed to better describe their impacts. Figure 8 shows the relative impacts of these two variables on prison population reduction. These results indicate that the reduction in recidivism has an equal or larger impact on prison population than the unit program cost and that reducing the unit cost below a specific value (40% above the base case cost in these simulations) does not reduce the prison population. This latter lack of impact is due to the program having achieved the maximum possible reduction in recidivism.

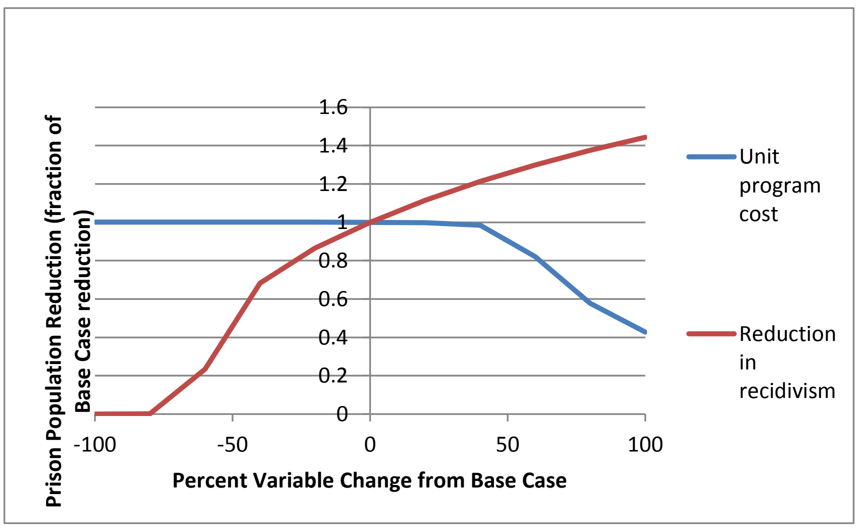


Figure 8: Results of Univariant Sensitivity Analysis with Base Case: Prison Population Reduction

Figure 9 shows the results of the univariant sensitivity analysis for the impacts of the reduction in recidivism and unit program cost on the SIB investor internal rate of return.

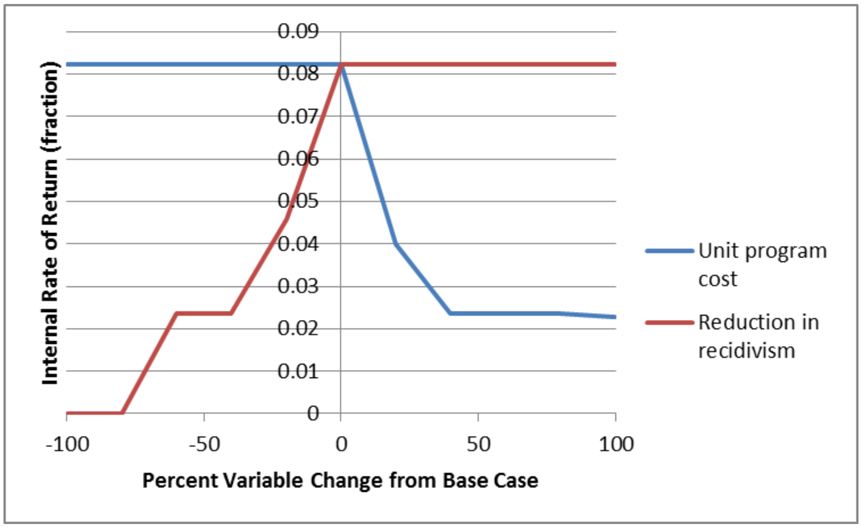


Figure 9: Univariant Sensitivity Analysis Results with Base Case: SIB Investor Internal Rate of Return

SIB investor IRR increases as the final recidivism reduction increases from a loss of all invested funds if recidivism reductions are not adequate and no cohorts are successful to the calibrated reduction values, after which they remain constant at 8.25% (Figure 9, top). This limit is because the Petersboro SIB and the model include a maximum return regardless of performance. Similarly, SIB investor IRR increases as the program cost per participant decreases from 2.27% when costs are double the Petersboro costs (Figure 9, lower right) to a return of 8.25% at the calibrated costs (Figure 9, upper left). Returns fall to -100% because there are no successful cohorts if there is inadequate reduction in recidivism (Figure 9, lower left) or 2.37%, the minimum return for successful cohorts in the SIB, if unit costs are very high (Figure 8, lower right). As shown by similar slopes in Figure 9 near the base case conditions, reductions in recidivism and unit program cost have similar amounts of leverage near the base case conditions and less influence with increased variance from base case conditions. To better understand performance for other possible SIB designs the model was altered to remove the 8.25% maximum allowed return and 2.37% minimum return on successful cohorts[10]. The univariant sensitivity analysis was repeated and the results are shown in Figure 10.

[10] The results of the univariant sensitivity analysis for prison population reduction do not change if the limits on the SIB investor returns are removed.

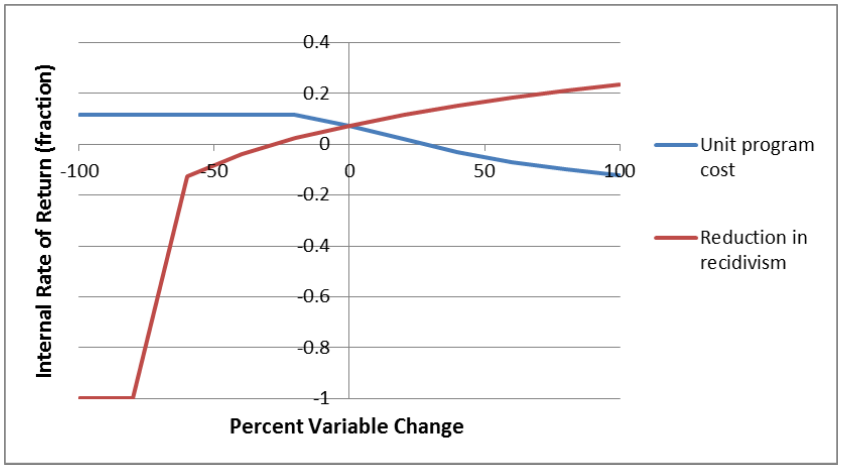


Figure 10: Univariant Sensitivity Analysis Results with Unlimited Return: SIB Investor Internal Rate of Return

Note the different vertical scale in Figure 10 when compared to Figure 9. Results indicate that a reduction in recidivism that is twice as large as the base case (i.e. if the program is very effective) can generate much larger returns when returns are unrestricted (23.49% vs. 8.25%). Similarly, returns can increase from 8.25% to 11.61% if program costs are cut to at least 80% of the calibrated costs if returns are not limited. However, unconstrained returns can fall to -12.1%, well below the minimum return of 2.37% (Figure 9) with high costs. This illustrates how the SIB investor traded away the opportunity for a higher reward if the program was very successful to gain some protection with a minimum return in case costs were high.

Model Use

The dynamics of the Petersboro SIB provide insights into the challenges for SIB design. The model was used to investigate potential solutions to those challenges. First, from the MOJ perspective, the temporary increase in prison population at the end of the SIB funded program (Figure 3) could cause HMP managers to believe that the rehabilitation program cannot succeed without SIB funding. They might then refuse to use the savings to continue the program, thereby causing a return of the prison population to its pre-program level and loss of social benefits. We hypothesize that this "worse before better" scenario may be because of an intuitive but misguided funding delay. In the model the MOJ does not start funding the program from savings until well after the program begins to limit participation due to funding. The reason is that the

MOJ is (reasonably) waiting until the program has been assessed. This delay creates a 15 month (base case) period of no funding and therefore reduced or no program participation. We used the model to test this hypothesis by starting MOJ funding of the program at a series of times starting nine months earlier than the base case and ending six months after the based case. The results (Figure 11) support our hypothesis by showing that reducing the delay nine months keeps the prison population reduction above 32% instead of letting it drop to a 25% reduction (base case) and that increasing the delay by six months allows the reduction to drop to almost 20%.

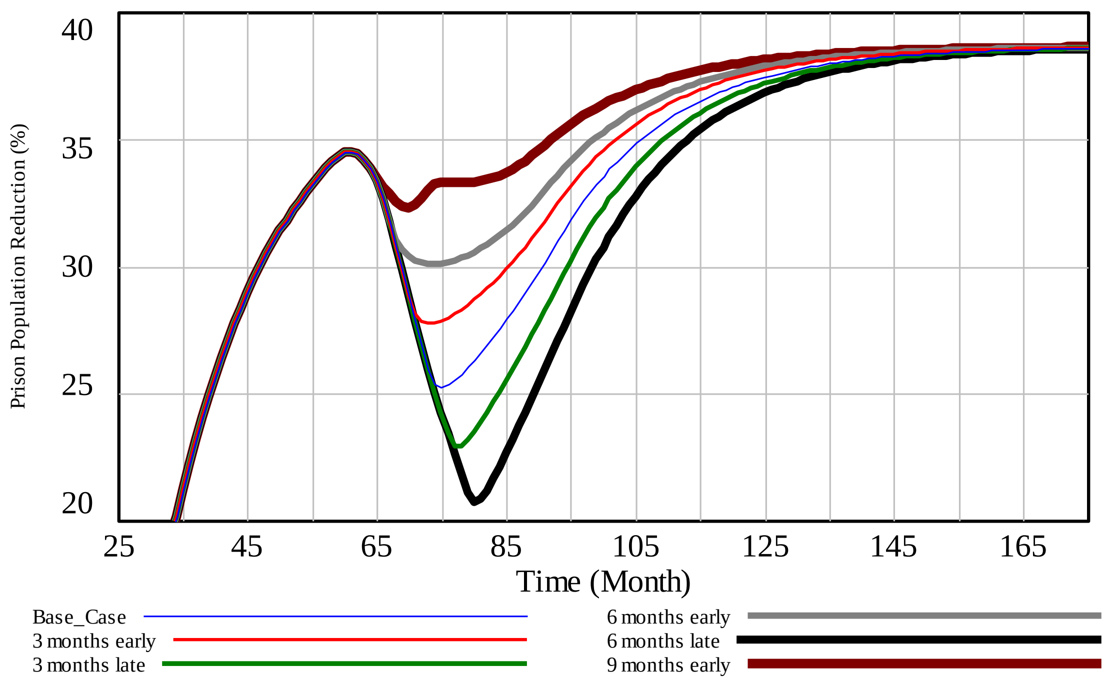


Figure 11: Decrease in Prison Population based on MOJ Funding Start Time

Perhaps more important, the Petersboro SIB design may prevent one of the key aspects of SIBs from being implemented. One of the objectives of shifting performance risk to SIB investors is to make them active managers of intervention to improve their returns (e.g. see Loder et al., 2010). This change from traditional bonds can activate management and other expertise in the private sector to improve performance of changes in public goods. In the Petersboro case the SIB investors do not receive returns, and thereby financial information, on the performance of their investment until 2.5-4 years after their first investment and until after the second or third cohort has been funded. Therefore they receive feedback on their financial performance too late to change the program to improve it and thereby improve their return. In feedback terms this is the delay between “Operations savings (budget surplus)” and “Investor account” in Figure 1 being too large to allow feedback loop R2 to provide continuous SIB funding or signal that program changes are required. SIB designers would like SIB-funded programs to be long enough that investors can actively work to make programs successful, thereby increasing the social benefits, returns to investors, and attractiveness of SIB investments for continued, future, or other public good improvements. Assuming some time is required to assess financial and operational performance, and to design and implement intervention changes, future SIB designs may be improved by having SIB investors funding extend until significantly after initial returns are (or are not) paid by owners.

Conclusions:

A system dynamics model of the only known operating Social Impact Bond to fund a prisoner rehabilitation program at the Petersboro prison in the United Kingdom was developed and validated. The model was analyzed using statistical screening to identify high leverage parameters for one important performance metric for both the owner and investors. Univariant sensitivity analysis was then used to describe the impacts of the two highest leverage parameters that can be used in SIB design. The analysis results were used to investigate two SIB design issues.

The highest leverage parameters for the final reduction in the prison population (MOJ performance metric), in decreasing order of influence, were found to be the fractional reduction in recidivism, maximum cohort size, reference (pre-program) recidivism fraction, and unit program cost (per participant). The highest leverage parameters for final SIB investor returns were found to be the fractional reduction in recidivism, unit program cost, unit cost of conviction, and investor discount rate. These high leverage parameters influence the strength of the feedback loops that control the prison population and savings captured by the MOJ and partially paid to investors. To maximize SIB performance designers and managers must understand and influence the strength of this feedback loop.

The two parameters shared by the performance measures identified with statistical screening analysis are also two parts of the system that SIB designers can influence: program effectiveness (reduction in recidivism) and unit program cost. The univariant analysis revealed that the constraints built into the SIB agreement controlled the relative effectiveness of these parameters on performance, particularly return limits on investor performance. Univariant analysis without those constraints indicate that program effectiveness has equal or more influence on MOJ performance (prison population) and investor performance (IRR) than unit program cost. This suggests that SIB designers should focus on developing and selecting highly effective interventions, with less regard for costs (which also might decline over time due to learning curve effects).

The work also identified two potentially fatal characteristics of the Petersboro SIB design. First, the delay between the end of investments in the program and information feedback to investors (through the first returns) about performance could prevent the program from becoming self-sustaining by creating a temporary increase in the prison population. Reducing the delay by having the MOJ start funding the program before the testing of the SIB is a counterintuitive policy that can address this challenge. Second, ending investor funding before they receive feedback on SIB financial performance may prevent the SIB investors from being active participants by effectively influencing the system intervention for improved performance and higher returns. This challenge can be addressed in future SIB-funded programs with longer SIB-investor funding and should improve as a track record of performance is established.

The current work can be extended with additional analysis of SIB design principles using the model. It can also be used as the basis for modeling other planned and operational application of the SIB approach. Finally, the model can be used to model the application of SIBs to other systems that generate savings from improvements, such as sustainability improvements to built infrastructure. Continuing to improve the understanding of the dynamics of the application of Social Impact Bonds will provide the basis for better design and management, leading to increased benefits from public goods and increased returns for investors.

References

(BTL), Bridges To Life. *Goals, Outcomes, and Evaluation.* 2011. http://www.bridgestolife.org/index.php?option=com_content&view=article&id=7&Itemid=67 (accessed May 09, 2013).

Britt, Bill. "Alabama's Prison Dilemma." *Alabama Political Reporter.* April 30, 2012. http://www.alreporter.com/archives/2011-december/832-alabamas-prison-dilemma.html.

Cave, Sion, Tom Williams, Darrick Jolliffe, and Carol Hedderman. "Peterborough Social Impact Bond: an independent assessment." *Justice.gov.uk.* May 16, 2012. http://www.justice.gov.uk/downloads/publications/research-and-analysis/moj-research/peterborough-social-impact-bond-assessment.pdf (accessed August 20, 2012).

Damnjanovic, Ivan D., and David N. Ford. "Social Impact Bonds for SustainabilityImprovement in Built Infrastructures." College Station: White Paper, July 08, 2011.

Disley, Emma, Jennifer Rubin, Emily Scraggs, Nina Burrowes, and Dierdre Culley. *Lessons learned from the planning and early implementation of the Social Impact Bond at HMP Peterborough.* Research Series, Ministry of Justice, 2011.

Ford, David N., and Durward K. Sobek. "Adapting Real Options to New Product Development by Modeling the Second Toyota Paradox." *IEEE Transactions on Engineering Management*, 2005: 175-85.

Glahn, Drew von, and Caroline Whistler. "Translating Plain English: Can the Peterborough Social Impact Bond Construct Apply Stateside?" *Investment Review*, 2011: 58-70.

Gruber, Jonathan. *Public Finance and Public Policy.* New York: Worth Publishers, 2011.

Hatry, Harry. *Performance Measurement: Getting Results.* 2nd. Washington, D.C.: The Urban Institute, 2006.

Langan, Patrick A., and David J. Levin. "Recidivism of Prisoners Released in 1994." *Federal Sentencing Reporter*, 2002: 58-65.

Loder, John, Geoff Mulgan, Neil Reeder, and Anton Shelupanov. *Financing Social Value: Implementing Social Impact Bonds.* Working Paper, The Young Foundation, 2010.

Lyneis, James M., and David N. Ford. "System dynamics applied to project management: a survey, assessment, and directions for future research." *System Dynamics Review*, 2007: 157-89.

Marvell, Thomas B., and Carlisle E. Moody. "The impact of out-of-state prison population on state homicide rates: displacement and free-rider effects." *Criminology*, 1998: 513-36.

Marwell, Gerald, and Ruth E. Ames. "Economists Free Ride, Does Anyone Else?" *Journal of Public Economics*, 1981: 295-310.

Mayfield-Geiger, Sue, and Jean West Rudnicki. "Remarkable Men!" *Change Magazine*, June 2013: 16-8.

Miraftab, Faranak. "Public-Private Partnerships: The Trojan Horse of Neoliberal Development?" *Journal of Planning Education and Research*, 2004: 89-101.

Moynihan, Donald P. *The Dynamics of Performance Management: Construction Information and Reform.* Washington D.C.: Georgetown University Press, 2008.

Mulgan, Geoff, Neil Reeder, Mhairi Aylott, and Luke Bo'sher. "Social Impact Investment: the challenges and opportunity of Social Impact Bonds." *The Young Foundation.* March 2011. http://www.youngfoundation.org/social-impact-investment-november-2010 (accessed January 18, 2012).

Osborne, David, and Peter Hutchinson. "Budgeting for Outcomes." *Government Finance Review* 20, no. 5 (2004): 10-4.

Senge, Peter M. *The Fifth Discipline: The Art & Practice of The Learning Organization.* New York: Doubleday, 1990.

Social Finance Limited. "Peterborough Social Impact Bond." *Social Finance.* 2011. http://www.socialfinance.org.uk/sites/default/files/SF_Peterborough_SIB.pdf (accessed September 15, 2012).

Sterman, John D. *Business Dynamics: Systems Thinking and modeling for a Complex World.* New York: Irwin McGraw-Hill, 2000.

Strickland, Pat. "Social impact Bonds - the Pilot at Peterborough Prison." *Parliament.uk.* November 12, 2010. www.parliament.uk/briefing-papers/SN05758.pdf (accessed February 15, 2012).

Taylor, TRB, Ford, DN and Ford, A. “Improving model understanding using statistical screening”. System Dynamics Review. Vol. 26, No. 1. Pp. 73-87. Jan.-March, 2010

Young Foundation “Social Impact Bonds In Health” Oct., 2010). http://www.youngfoundation.org/social-impact-bonds-health. accessed May 26, 2011.