Recidivism of Finnish Prisoners – An Empirical Analysis

Anssi Keinänen
and
Tuukka Saarimaa

ISBN 952-458-744-0
ISSN 1795-7885
no 30

Recidivism of Finnish Prisoners – An Empirical Analysis*

Anssi Keinänen and Tuukka Saarimaa**

Department of Business and Economics
University of Joensuu
P.O. Box 111
FI-80101 Joensuu, Finland
E-mail: anssi.keinanen@joensuu.fi,
tuukka.saarimaa@joensuu.fi

September 2005

Abstract

In this paper we study the recidivism behaviour of Finnish prisoners. We estimate a logistic regression model for Finnish convicts who were released from prison and followed for four years after their release. We find that the probability of recidivism reduces with age. This is true for both men and women, although for women the pattern is less clear. Empirical results did not support the specific deterrence effect hypothesis of imprisonment because the number of past prison sentences clearly increased the probability of recidivism, and furthermore, the duration of last prison spell seemed to have no effect on the probability of recidivism. However, this result is only suggestive. In order to make conclusive judgments on specific deterrence we would need a control group of offenders who were given an alternative punishment for a similar offence.

Keywords: recidivism, specific deterrence, imprisonment.
JEL classification: K14, K42.

---

* Paper presented at the 3rd Scandinavian Association of Law and Economics Conference "Economics of Law Enforcement", June 17–18, 2005. CBS, Copenhagen.
** The authors would like to thank the Finnish Criminal Sanction Agency, and especially, senior researcher Kimmo Hypén for providing the data. Thanks also to Jukka Savolainen for helpful comments and suggestions.

1 Introduction

Imprisonment can reduce crime in three ways.[1] First, for as long as the offenders are incarcerated they cannot commit crimes outside of prison.[2] Second, imprisonment deters people from committing crimes. The deterrence effect can be divided into general and specific deterrence. General deterrence refers to the effect of sanctions on all potential offenders, whereas specific deterrence refers to the effect of a sanction on the punished. In other words, general deterrence is what deters the general public from committing offences and specific deterrence is what deters offenders from committing new offences. Third, individuals may be rehabilitated while in prison, e.g. through educational programs, which reduces the propensity to commit crimes. In this paper we concentrate on the specific deterrence effects of imprisonment. More precisely the aim of the paper is to study the effects of the number and duration of past prison sentences on the probability of recidivism of Finnish convicts.[3]

One of the main topics in economic analysis of crime is the attempt to determine the optimal type and level of criminal punishment, and detection probability. Usually, theoretical comparisons are made between monetary and non-monetary sanctions, e.g. fines and imprisonment. Because non-monetary sanctions are costly to impose compared to monetary sanctions, some economists argue that the optimal way to impose criminal sanctions is to use monetary sanctions up to the maximum wealth of the offender before non-monetary sanctions are used.[4]

However, in many occasions monetary sanctions alone are not sufficient to deter criminal acts and therefore the use of non-monetary sanctions may be desirable. The most general reason for the use of non-monetary sanctions is that the offender's wealth is too low compared to the level of a deterring sanction. In addition to the offender's wealth constraint, a number of other reasons have been presented why non-monetary sanctions are used to deter crimes. First, non-monetary sanctions, e.g. imprisonment, are needed to create marginal deterrence effects, i.e.

[1] See e.g. Shavell (2004).
[2] Two conditions must be met in order for incarceration to reduce crime rates. First, criminals incapacitated by imprisonment must not be replaced immediately by new criminals and second, imprisonment must reduce the total number of crimes committed by repeated offenders over their criminal career. See e.g. Cooter and Ulen (2004), p. 494.
[3] Of course also detection probability is an important general and specific deterrent. However, in this study we are unable to control for differences in detection probability.
[4] See e.g. Polinsky and Shavell (1984) and also Becker's (1968) seminal work on the subject.

incentives for offenders to commit less harmful acts.[5] Second, non-monetary sanctions are used to restrict and prevent individuals from engaging in undesirable acts in a free society by (partly) removing them from it. The most familiar form of incapacitation is imprisonment, but also, community services restrict offenders' freedom by involving some active contact with a penal agent. Third, non-monetary sanctions may create larger general and specific deterrence effects than pure monetary sanctions.

Results from previous studies indicate that imprisonment seems to be a poor deterrent in the specific deterrence sense. Recidivism rates of those who were imprisoned are not that much lower than for those given a community sentence. On the other hand, longer prison sentences are not associated with lower recidivism. For example, Smith et al. (2002) concluded after analysing the effects of sanctions on recidivism in over a hundred studies that prison sanctions should not be used with the expectation of reducing criminal behaviour and that excessive use of incarceration may have substantial cost implications. However, even if imprisonment is not an effective specific deterrent the general deterrence effects of imprisonment may be sufficiently high for imprisonment to be socially optimal. For example, Levitt (1996) finds that the general deterrent impact of incarcerating one additional prisoner amounts to a reduction of approximately two violent crimes and 15 crimes overall per year. On the other hand, Tauchen et al. (1994) find that the general deterrence effects are strongest for individuals with limited previous contact with the justice system.[6]

One of the main findings in the literature of recidivism is that there are a small number of offenders who commit a large number of crimes.[7] If the authorities were able to predict more precisely the individuals who are more likely to commit more crimes, a large number of crimes could be prevented more efficiently. Furthermore, more intensive rehabilitation programmes could be directed at offenders who are more likely to commit new crimes.

Empirical results on deterrence effects of different sanctions are needed to help the courts in the selection of optimal type of punishment for the offender, and thus, to improve the

[5] See e.g. Shavell (1985).
[6] In general, Levitt (1996) finds much stronger deterrence effects from prison population on crime rates compared to e.g. Tauchen et al. (1994). Cornwell and Trumbull (1994) find that both labour and criminal justice strategies are important in deterring crime and that the effectiveness of law enforcement incentives has been greatly overstated.
[7] See Avio (1999) for a recent survey of the literature.

effectiveness of criminal policy.[8] For example, according to the Penal Code of Finland, the courts can make a choice between conditional and unconditional imprisonment unless the seriousness of the offence, the guilt of the offender as manifest in the offence, or the criminal history of the offender requires the imposition of an unconditional sentence of imprisonment.[9] Similarly, courts can decide whether an offender who is sentenced to a fixed term of unconditional imprisonment of at most eight months shall be sentenced instead to community service, unless unconditional sentences of imprisonment, earlier community service orders or other weighty reasons are to be considered bars to the imposition of the community service order.[10] In this light it is very important to have information on the specific deterrence effects of different sanctions.

Although we are unable to make any comparisons of different sanctions with the data at hand we are to some extent able to study how the length of the most recent prison term and possible previous prison terms affect the probability of recidivism. Of course, because of the aforementioned handicap the results should be viewed as suggestive. The rest of the paper is organized as follows. In section 2 the data is described in more detail. Section 2 also presents the empirical model and variables used. In section 3 estimation results are presented and section 4 concludes.

2 Data and empirical methods

2.1 The data

We use a random sample from a dataset collected from the Central Prisoner Register by the Finnish Criminal Sanction Agency. The data include information on newly released inmates who are then followed for a period of time. The collection period is from the beginning of 1993 to the end of July 2004 and each released inmate was followed for a period of four years. Three outcomes are possible in this setting. First, the individual commits a crime during the follow-up and is sentenced back to prison. Second, the individual does not commit

[8] See e.g. DiIulio (1996).
[9] The Penal Code of Finland, chapter 6, section 9.
[10] The Penal Code of Finland, chapter 6, section 11.

a crime during the follow-up.[11] And finally, the individual does not commit a crime during the follow-up period, which is shorter than four years because the individual was released after January 2000 or the individual has died during the follow-up. The last cases refer to censoring. As a solution to the censoring problem we omit those individuals whose theoretical follow-up period would have been shorter than four years, i.e. we omit the individuals who were released after January 2000**.** Unfortunately, we have no data on mortality. After the omission the data includes about 2 000 individuals with almost 8 000 prison terms.

The data include the following information on the individuals: age at the time of release, sex, length and number of all prison sentences and the respective year of release. Some data insufficiencies should be mentioned. In the data an individual is considered a recidivist even if the "new" crime was committed before the individual was sentenced to prison in the first place or the individual committed the crime while in prison, i.e. before release. For example, Hypén (2004) reports that in Finland almost 25 percent of all re-sentenced prisoners who were released in 1996 were sentenced to prison for crimes committed before the end of the initial prison sentence. This has to be taken into account when interpreting the results. Furthermore, the data do not include those individuals who are in remand imprisonment.

However, most significant drawback of the current data is that there is only limited amount of information available of the individuals. The type of crime committed, alcohol or drug abuse may be important factors explaining the probability of recidivism. For example, drunken drivers are likely to exhibit different recidivism patterns than individuals committing property or violent crimes. However, the Central Prisoner Register data does not include these variables. These factors can be only partially controlled for with the information available to us at the moment. Thus, due to the lack of control variables for individual heterogeneity, the results should be interpreted with caution at this point. Fortunately, the Finnish Criminal Sanction Agency is collecting a new data set where more information is collected from the released convicts and it should at our disposal in the near future.

[11] More precisely, the individual does not go back to prison. The individual may commit a crime, but is not convicted, because the crime is undetected, some other sanction instead of imprisonment was chosen or the case is still in the criminal process.

2.2 Descriptive statistics

Some descriptive statistics from the data are presented in Table 1. The number of prison terms in the data is 7 781 and the number persons who have served these prison terms is about 2 000. This means that on average the individuals in the data have 4.5 sentences. The duration of the most recent sentence of the individuals was on average about 231 days. Those who were reconvicted during the follow-up period stayed out of prison on average for about 669 days.

Table 1. Descriptive statistics from the data.

	All	Men	Women	First-timers	2 to 4	5 or more
Number of prison terms	7 781	7 491	290	2 038	2 961	2 782
Number of prison terms per observation	4.5	4.5	3.0	1.0	2.8	8.7
Average age when released	34.0	34.0	33.9	31.4	31.8	38.3
Avarege last sentence (days)	231	231	243	237	209	248
Average spell between sentences (days)	669	661	884	770	687	604

The number of sentences where the criminal was a woman is low: only 290 cases, a mere 3.7 percent of all cases. Otherwise the descriptive profile for women is not much different than that of men. We also divided the cases into groups based on the number of prison sentences. First-timers are on average younger, serve shorter sentences and are out for a longer period before recidivism. About one third of the cases had five or more prison sentences.

2.3 The model

We model the probability of recidivism with a logistic regression model (the logit model). Let *y* denote a binary outcome variable denoting whether the individual is re-sentenced to prison, where $y = 1$ denotes a re-sentence, and $y = 0$ for those individuals who are not re-sentenced. Now, if we assume that the probability of recidivism follows the logistic distribution the conditional expectation of *y* can be written as

$$E\left[y_i \mid x_i\right] = \pi\left(x_i\right) = \frac{e^{\mathbf{x}_i'\boldsymbol{\beta}}}{1+e^{\mathbf{x}_i'\boldsymbol{\beta}}}, \tag{1}$$

where $\mathbf{x}$ is a $n \times 1$ vector of covariates and $\boldsymbol{\beta}$ is a $k \times 1$ vector of parameters. The likelihood function for the data with *n* observations is

$$L(\boldsymbol{\beta}) = \prod_{i=1}^{n} \pi(x_i)^{y_i} \left(1 - \pi(x_i)\right)^{1-y_i}, \tag{2}$$

and the log-likelihood can be written as

$$\log L(\boldsymbol{\beta}) = \sum_{i=1}^{n} \left[y_i \ln \pi(x_i) + (1 - y_i) \ln(1 - \pi(x_i)) \right]. \tag{3}$$

The estimates for the parameters are obtained by finding the values of $\boldsymbol{\beta}$ that maximize the log-likelihood function. The results from the logistic regression model are interpreted using the so-called odds ratios (*OR*). Odds is defined as the ratio of the probability that the event of interest occurs to the probability that it does not, whereas odds ratio is a ratio of two odds. Let $\mathbf{e_j}$ be a $k \times 1$ vector where the *j*:s element is one and the rest are zeros. Now the odds ratio is defined as

$$OR = \frac{\pi(\mathbf{x_i} + \mathbf{e_j}) / \left[1 - \pi(\mathbf{x_i} + \mathbf{e_j})\right]}{\pi(\mathbf{x_i}) / \left[1 - \pi(\mathbf{x_i})\right]} = \exp(\beta_j). \tag{4}$$

The numerator in (4) is the odds of an event occurring when there is a change from zero to one of one covariate when other covariates are controlled for. The interpretation of the odds ratio is as follows. If the *OR* equals one there is no change in the odds of the event occurring when there is a change in a covariate. On the other, hand if the *OR* is over (under) one the odds of the event occurring has increased (decreased), i.e. the probability that the event occurs has risen (fallen) compared to the probability that it does not. For example, when modelling recidivism with a logistic regression if we have a dummy variable indicating a woman inmate and the *OR* for the dummy is over one, we can say that women have a higher probability of recidivism compared to men when other covariates are controlled for.

3 Empirical results

We estimated four different models according to how many years the individual was followed. This will give information on how the probability of recidivism changes as more time passes from the release. We also estimated separate models for men and women. The explanatory variables include age, number of prison sentences, the duration of the most recent sentence served and the point in time when the observation was released from prison. As mentioned earlier some possibly very important variables are left out. In our models the duration of the most recent prison sentence controls for some of the variation in crime type. Although the cases where the individual has committed several crimes complicate the interpretation, the duration of the most recent sentence can be seen as proxy for the severity of the crime or crimes committed. This of course undermines the strength of this variable as a measure for specific deterrence. The results for the model where the follow-up time is the maximum four years are presented in Table 2. Results for the models where the follow-up time is one, two and three years are in the Appendix in Tables A1–A3, respectively.

First, we present some general remarks and review the model diagnostics. During the four year follow-up time about 55 percent of all male convicts are re-sentenced to prison. For women the percentage is lower at 46.8. The sensitivity of predictions describes the proportion of all re-sentenced prisoners who are correctly predicted to be reconvicted. In the model where the follow-up time is four years the percentage of correctly specified recidivists is 77.7 for men and 60.2 for women. The specificity of predictions, on the other hand, is the proportion of all those who are not re-sentenced who are also predicted to be a non-recidivist by our models. The specificity measures are much lower compared to sensitivity for men whereas for women it is the other way around. The LR-test clearly rejects the hypothesis that all the covariate coefficients are zero in all model specifications. Furthermore, the Hosmer-Lemeshow goodness-of-fit test suggests a reasonable fit of our model despite the fact that potentially important covariates were not available.[12]

[12] The Hosmer-Lemeshow test can be used to test whether observed binary responses, y, conditional on a vector of covariates, $\mathbf{x}$, are consistent with predictions. The test is based on a chi-squared statistic that compares the observed and expected cell frequencies in the $2*g$ table, as found by sorting the observations by predicted probabilities and forming g groups. For example, if $g = 10$ the subjects are divided into ten equal size groups and ordered according to the predicted probabilities so that the first group contains the subjects having the lowest estimated probabilities etc. See Hosmer and Lemeshow (1989, pp. 140–145) for more details.

Table 2. Logistic regression results, follow-up time four years.

	Men		Women	
	Odds ratio	**P-value**	**Odds ratio**	**P-value**
Age (years)[a]				
16–18	6.01	0.000	No observations	
19–21	2.43	0.000	8.33	0.077
25–27	0.67	0.000	0.65	0.479
28–30	0.50	0.000	1.42	0.551
31–33	0.35	0.000	1.00	0.996
34–36	0.35	0.000	0.56	0.356
37–39	0.25	0.000	0.63	0.463
40–42	0.21	0.000	0.24	0.032
43–45	0.15	0.000	0.16	0.026
46–48	0.12	0.000	0.25	0.073
49–51	0.13	0.000	No observations	
52–54	0.11	0.000	No observations	
55–57	0.05	0.000	No observations	
58–60	0.08	0.000	No observations	
Times in prison[b]				
2–3 times	2.14	0.000	2.00	0.029
4–6 times	3.82	0.000	4.89	0.000
7–10 times	6.46	0.000	11.0	0.001
11–19 times	11.8	0.000	13.2	0.001
20 or more	21.5	0.000	No observations	
Duration of last sentence[c]				
Less than 6 months	0.80	0.002	0.75	0.468
12 to 24 months	1.01	0.935	0.61	0.344
2 to 4 years	1.14	0.329	1.37	0.671
over four	0.81	0.259	0.20	0.148
Year of release[d]				
1994	0.98	0.795	1.32	0.544
1995	0.91	0.294	0.80	0.648
1996	0.89	0.219	1.21	0.692
1997	1.20	0.059	1.33	0.556
1998	1.36	0.001	3.30	0.014
1999	1.54	0.000	3.43	0.027

Diagnostics men:		*Diagnostics women:*	
Number of obs.	7 491	*Number of obs.*	290
Percentage of recidivism	54.9	*Percentage of recidivism*	46.8
Log-L	-4 507	*Log-L*	-169
LR-test (p-value)	1 300 (0.000)	*LR-test (p-value)*	55.3 (0.000)
Pseudo R^2	0.13	*Pseudo R^2*	0.14
Hosmer–Lemeshow (p-value)	9.35 (0.313)	*Hosmer–Lemeshow (p-value)*	5.19 (0.737)
Sensitivity	77.7	*Sensitivity*	60.2
Specificity	55.7	*Specificity*	72.9

[a] *Age-dummies, reference group are 22–24*

[b] *Refecence group are first timers*

[c] *Reference 0.5–1 years*

[d] *Reference is 1993*

For men there seems to be a clear reduction in the probability of recidivism as age increases. For women the effect of age is not so clear but there is a same tendency apparent. It is difficult to identify true age effects from the effects that correlate highly with age, such as wealth, income, risk aversion or family conditions. In order to clarify the age effects we plot the predicted probability of recidivism as a function of age with different follow-up periods. In Figure 1 the predicted probability of recidivism is depicted for men who are first-timers and whose most recent sentence was 6 to 12 months.

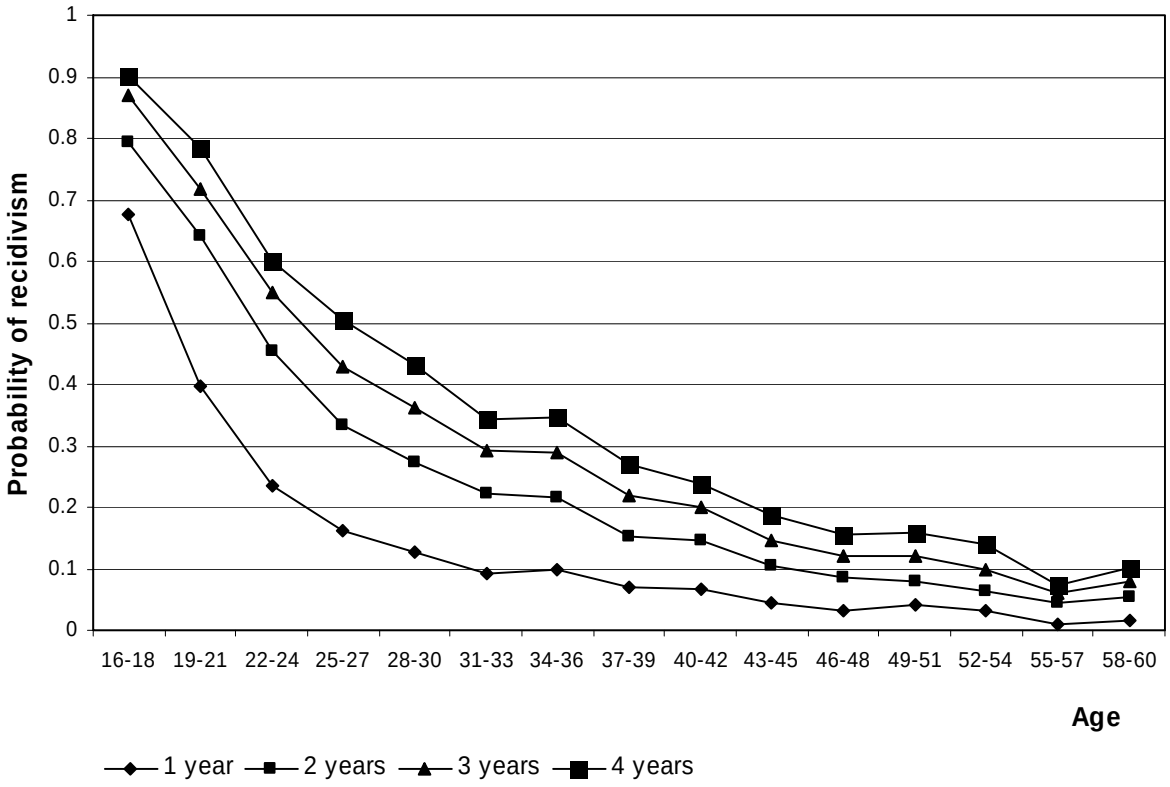

Figure 1. Probability of recidivism according to age, men.

For example, after a four year follow-up time, almost 90 percent of 16 to 18 year old first-time male offenders returned to prison at least once, whereas the recidivism rate of 49 to 51 year old first-time male offenders was slightly less than 20 percent. The probability of recidivism clearly increases with the follow-up time for young men whereas in older age categories the differences are much smaller.

Figure 2 illustrates the same ambiguity in the age effect for women that was apparent in the model results in Table 2. However, after the age of 21 there is sharp a drop in recidivism. An interesting finding in Figure 2 is that there is no clear pattern how the follow-up period after one year affects the probability of recidivism of women.

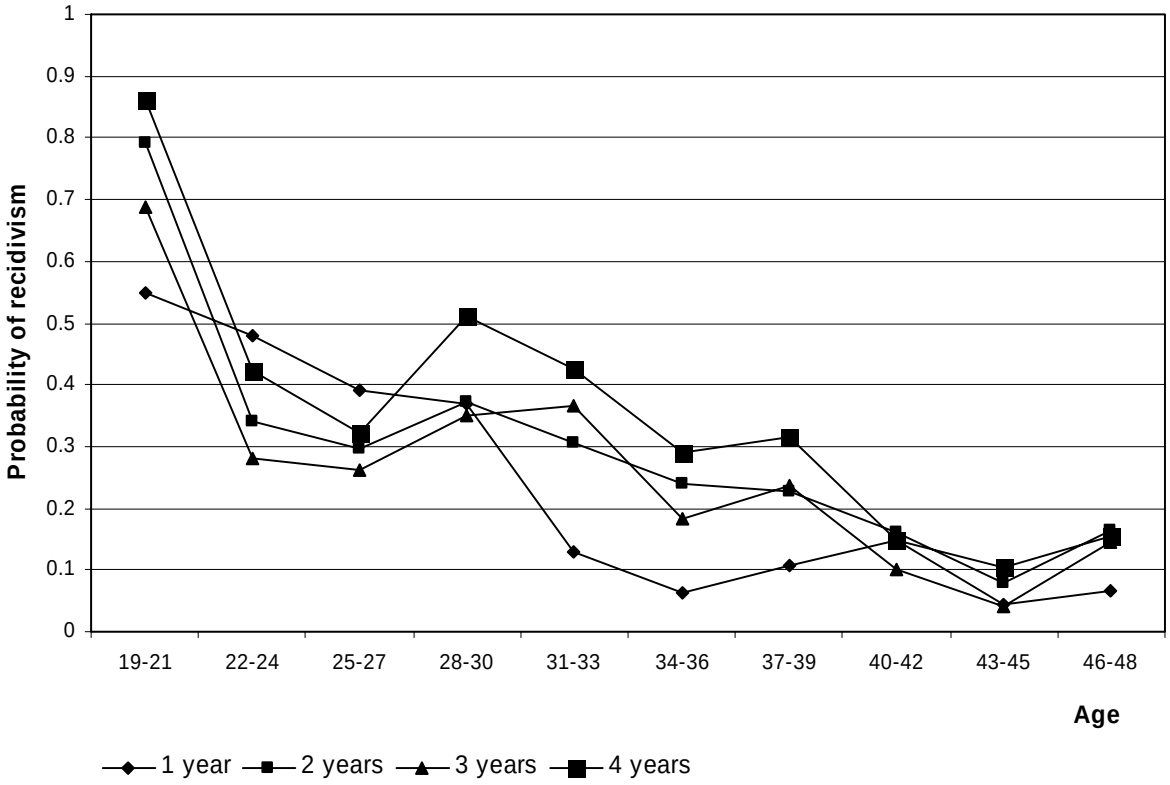

Figure 2. Probability of recidivism according to age, women.

The number of past prison sentences clearly increases the probability of recidivism**.** There are several possible reasons behind this phenomenon. First, stigma costs are greatly reduced as the number of prison sentences grows. This means that the consequences or costs of committing a crime are reduced. On the other hand, recidivism constitutes a basis to increase the severity of the punishment, which should, in theory, increase the deterrence effect. Second, opportunity cost, i.e. the expected utility from legal actions, of crimes reduces. For example, employment opportunities diminish after prison sentences. Third, it is sometimes argued that, in fact, criminals learn to be “better” criminals during the prison sentence, which

might increase their criminal activity after release. However, such experiences might also decrease the detection probability.

In Figure 3 the predicted probability of recidivism for men is plotted against the frequency of prison sentences. The predicted probabilities are calculated for individuals at ages 22 to 24 and for whom the duration of their most recent prison sentence was 6 to 12 months. After a four year follow-up period, about 60 percent of first time offenders returned to prison, while recidivism rate was well over 90 percent of those who have been in prison over 20 times before. The same tendency is apparent in Figure 3 as in Figure 1: there is very little difference between the follow-up periods of three and four years.

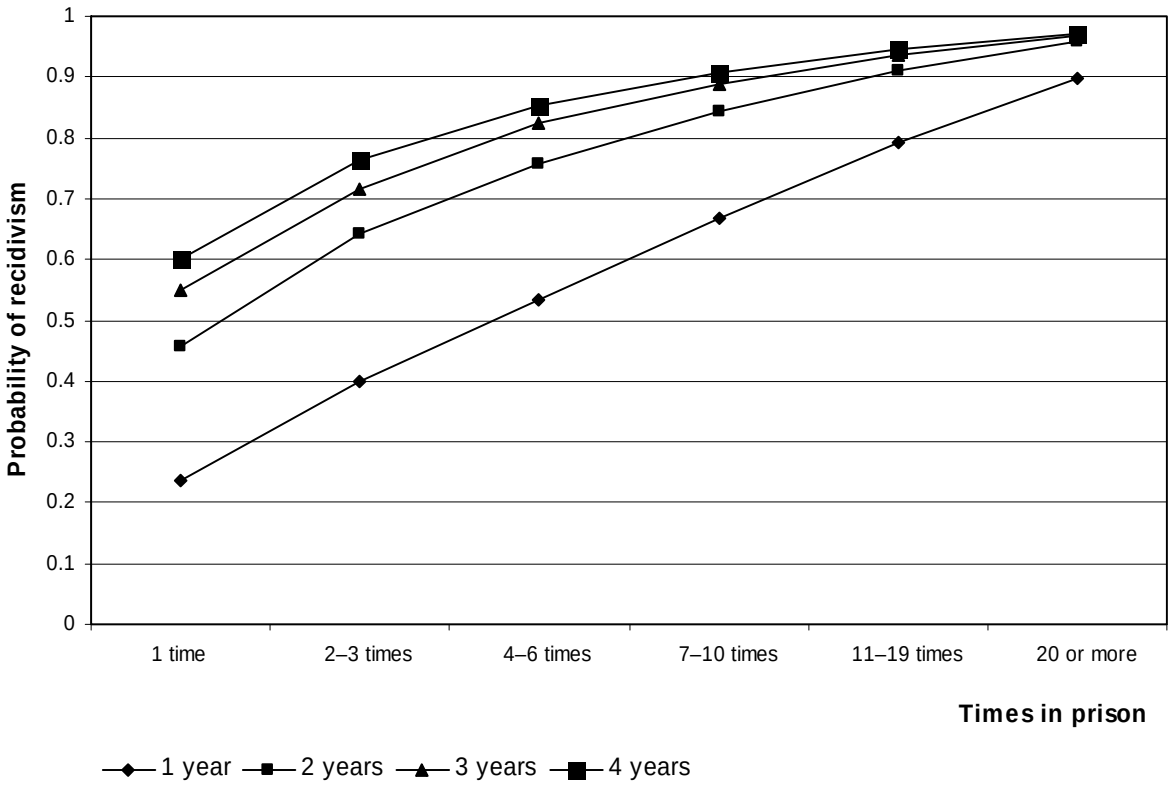

Figure 3. Probability of recidivism according to times in prison, men.

The number of prison sentences seems to have a similar effect on the recidivism probability for women as can be seen from Figure 4. After a four year follow-up period, half of first time

offenders did not return to prison, while recidivism rate was about 90 percent for those who have been in prison for 7 to 10 times.

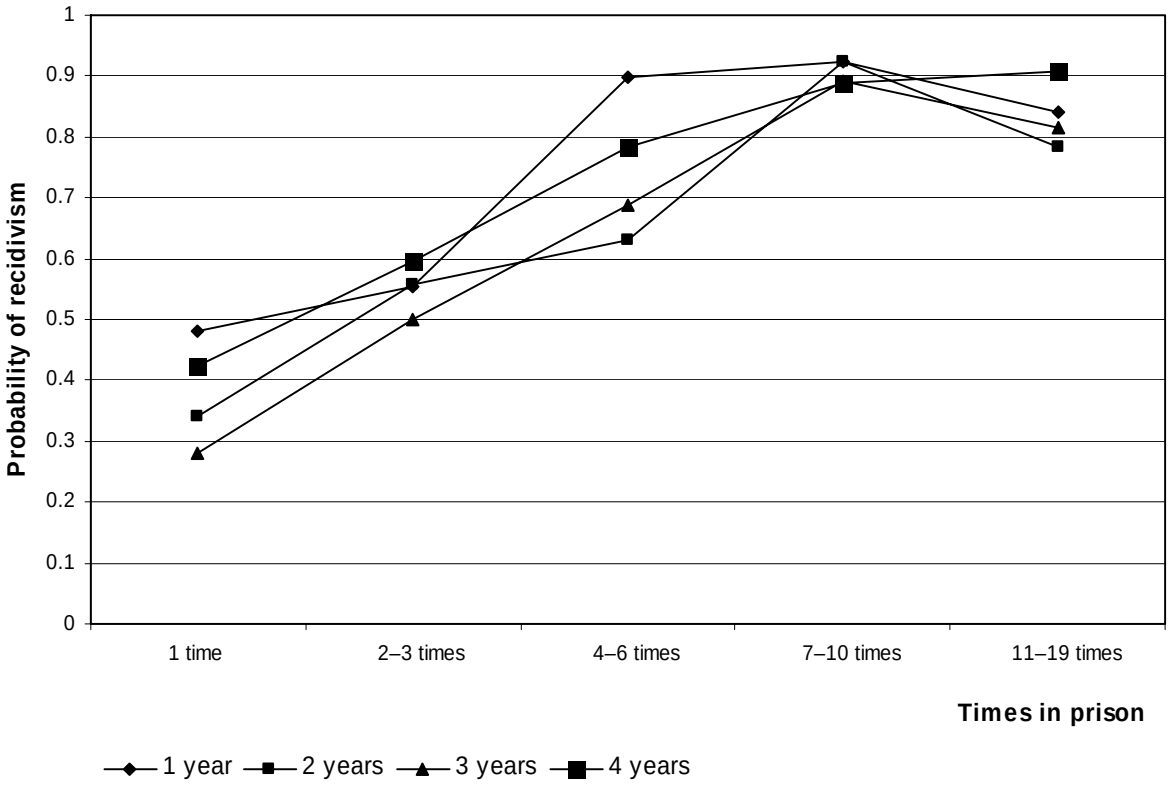

Figure 4. Probability of recidivism according to times in prison, women.

The duration of the last prison spell seems to have no clear effect on the probability of recidivism. This is true for both men and women. For men those that have served less than six months have a lower probability of recidivism compared to the reference group, which has served six to twelve months. Of course, in order to truly capture specific deterrence effects we should compare the specific deterrence effect of imprisonment against specific deterrence effects from other criminal sanctions such as fines, community service and conditional imprisonment.

A final note on the results is that for some reason the recidivism probability has risen in the late 1990's. This is true for both men and women. The year of release dummy-variables may capture changes in the prison population in time. For example, the prisoners released in 1999

may have different criminal history in terms of crime type compared to those released in 1994. However, with the data at hand we are unable and unwilling to make any conjecture on the reasons behind this phenomenon.

4 Conclusions

In this paper we concentrated on the recidivism behaviour of Finnish convicts. The aim of the paper was to study the effects of the number and duration of past prison sentences on the probability of recidivism. Empirical results did not support the specific deterrence effects of imprisonment. The number of past prison sentences clearly increased the probability of recidivism, and furthermore, lengthier prison spells were not associated with lower probability. On the contrary, those who served less than six months were less likely to go back to prison. However, the results should only be seen as suggestive because in order to truly capture specific deterrence effects one would need another punishment type as a benchmark against which imprisonment is compared.

Due to the lack of relevant explanatory variables, most important of which is crime type, we conclude that suggestions on selective incapacitation programs should not be made according to our results. In order to make some recommendation we should observe a specific group whose recidivism probability is near unity.[13] In the future, data from the Central Prisoner Register by the Finnish Criminal Sanction Agency should be improved by collecting more information on offenders, e.g. education, health, ability to work, drug or alcohol abuse and most importantly criminal history including crime type. Otherwise, it is very difficult to make any meaningful analysis of imprisonment. Furthermore, for some reason the recidivism probability has risen in the late 1990's. Unfortunately, we are unable to make any conjecture on the reasons behind this phenomenon. This should be a fruitful topic for further research when better data come available.

[13] See Schmidt and Witte (1987) for a discussion.

References

Avio, Kenneth L. (1999): The Economics of Prisons. In Bouckaert, Boudewjin and De Geest, Gerritt (eds.): *Encyclopedia of Law and Economics*, Vol. V, pp. 394–433. Edward Elgar, Cheltenham. Also available at: http://allserv.rug.ac.be/~gdegeest/8300book.pdf.

Becker, Gary S. (1968): Crime and Punishment: An Economic Approach. *Journal of Political Economy*, Vol. 76, No. 2, pp. 169–217.

Cooter, Robert and Ulen, Thomas (2004): *Law and Economics, 4th edition*. Pearson Addison Wesley.

Cornwell, Christopher and Trumbull, William N. (1994): Estimating the Economic Model of Crime with Panel Data. *Review of Economics and Statistics*, Vol. 76, No. 2, pp. 360–366.

DiIulio jr., John, J. (1996) Help Wanted: Economists, Crime and Public Policy. *Journal of Economic Perspectives*, Vol. 10, No. 1, pp. 3–24.

Hosmer jr., David, W. and Lemeshow, Stanley (1989): *Applied Logistic Regression*. John Wiley & Sons, New York.

Hypén, Kimmo (2004): *The Released from Prison in Finland 1993–2001 and the Re-entered* (In Finnish). The Criminal Sanction Agency, Publications 1/2004, Helsinki.

Levitt, Steven D. (1996): The Effect of Prison Population Size on Crime Rates: Evidence from Prison Overcrowding Litigation. *Quarterly Journal of Economics*, Vol. 111, No. 2, pp. 319–351.

Polinsky, A. Mitchell and Shavell, Steven (1984): The Optimal Use of Fines and Imprisonment, *Journal of Public Economics*, Vol. 24, Issue 1, pp. 89–99.

Schmidt, Peter and Witte, Ann Dryden (1987): Predicting Criminal Recidivism Using "Split Population" Survival Time Models. *NBER Working Paper*, No. 2445.

Schmidt, Peter and Witte, Ann Dryden (1990): Some Thoughts on How and When to Predict in Criminal Justice Settings. In *New Directions in the Study of Justice, Law, and Social Control*, edited by the School of Justice Studies, Arizona State University. Plenum Publishing Company, New York.

Shavell, Steven (1985): Criminal Law and the Optimal Use of Nonmonetary Sanctions as a Deterrent. *Columbia Law Review*, Vol. 85, pp. 1232-1262.

Shavell, Steven (2004): *Foundations of Economics Analysis of Law*. Harvard University Press, Cambridge.

Smith, Paula; Goggin, Claire and Gendreau, Paul (2002): The Effects of Prison Sentences and Intermediate Sanctions on Recidivism: General Effects and Individual Differences. Public Works and Government Services, Canada.

Tauchen, Helen; Witte, Ann Dryden and Griesinger, Harriet (1994): Criminal Deterrence: Revisiting the Issue with Birth Cohort. *Review of Economics and Statistics*, Vol. 76, No. 3, pp. 399–412.

APPENDIX. Additional result tables.

Table A1. Logistic regression results, follow-up time one year.

	Men		Women	
	Odds ratio	**P-value**	**Odds ratio**	**P-value**
Age (years)[a]				
16–18	6.82	0.000	No observations	
19–21	2.14	0.000	1.32	0.779
25–27	0.63	0.000	0.69	0.607
28–30	0.48	0.000	0.63	0.519
31–33	0.33	0.000	0.16	0.029
34–36	0.35	0.000	0.07	0.006
37–39	0.25	0.000	0.13	0.022
40–42	0.23	0.000	0.19	0.053
43–45	0.15	0.000	0.05	0.020
46–48	0.11	0.000	0.08	0.020
49–51	0.13	0.000	No observations	
52–54	0.11	0.000	No observations	
55–57	0.03	0.000	No observations	
58–60	0.05	0.000	No observations	
Times in prison[b]				
2–3 times	1.90	0.000	1.35	0.525
4–6 times	3.39	0.000	9.56	0.000
7–10 times	5.90	0.000	13.2	0.002
11–19 times	10.6	0.000	5.72	0.107
20 or more	29.6	0.000	22.7	0.083
Duration of last sentence[c]				
Less than 6 months	1.07	0.368	0.31	0.013
12 to 24 months	0.96	0.702	0.18	0.032
2 to 4 years	0.87	0.379	0.16	0.127
over four	0.91	0.686	0.22	0.236
Year of release[d]				
1994	0.89	0.434	0.81	0.748
1995	0.98	0.062	0.80	0.737
1996	0.88	0.359	0.99	0.983
1997	1.09	0.064	0.49	0.320
1998	1.19	0.435	0.83	0.780
1999	1.33	0.072	1.43	0.582

Diagnostics men:		*Diagnostics women:*	
Number of obs.	7 491	*Number of obs.*	290
Percentage of recidivism	25.4	*Percentage of recidivism*	15.5
Log-L	-3 806	*Log-L*	-103
LR-test (p-value)	878 (0.000)	*LR-test (p-value)*	43.8 (0.012)
Pseudo R^2	0.10	*Pseudo* R^2	0.17
Hosmer–Lemeshow (p-value)	7.0 (0.537)	*Hosmer–Lemeshow (p-value)*	8.3 (0.406)
Sensitivity	15.3	*Sensitivity*	13.3
Specificity	96.0	*Specificity*	98.8

[a] *Age-dummies, reference group are 22–24*

[b] *Refecence group are first timers*

[c] *Reference 0.5–1 years*

[d] *Reference is 1993*

Table A2. Logistic regression results, follow-up time two years.

	Men		Women	
	Odds ratio	**P-value**	**Odds ratio**	**P-value**
Age (years)[a]				
16–18	4.59	0.000	No observations	
19–21	2.13	0.000	7.34	0.041
25–27	0.60	0.000	0.82	0.755
28–30	0.45	0.000	1.15	0.821
31–33	0.34	0.000	0.86	0.810
34–36	0.33	0.000	0.61	0.458
37–39	0.21	0.000	0.57	0.397
40–42	0.20	0.000	0.37	0.163
43–45	0.14	0.000	0.17	0.054
46–48	0.11	0.000	0.38	0.238
49–51	0.10	0.000	No observations	
52–54	0.08	0.000	No observations	
55–57	0.05	0.000	No observations	
58–60	0.07	0.000	No observations	
Times in prison[b]				
2–3 times	2.15	0.000	2.45	0.008
4–6 times	3.73	0.000	3.30	0.007
7–10 times	6.48	0.000	23.4	0.000
11–19 times	12.3	0.000	7.09	0.015
20 or more	28.5	0.000	No observations	
Duration of last sentence[c]				
Less than 6 months	0.87	0.048	0.61	0.281
12 to 24 months	0.94	0.549	0.41	0.136
2 to 4 years	1.07	0.602	0.55	0.118
over four	0.82	0.280	0.06	0.004
Year of release[d]				
1994	0.89	0.152	1.41	0.482
1995	0.81	0.019	1.06	0.911
1996	0.79	0.011	1.28	0.627
1997	1.00	0.991	1.10	0.849
1998	1.03	0.762	2.13	0.130
1999	1.30	0.005	2.54	0.090

Diagnostics men:		*Diagnostics women:*	
Number of obs.	7 491	*Number of obs.*	290
Percentage of recidivism	43.0	*Percentage of recidivism*	33.5
Log-L	-4 515	*Log-L*	-158
LR-test (p-value)	1205 (0.000)	*LR-test (p-value)*	46.1 (0.003)
Pseudo R^2	0.12	*Pseudo* R^2	0.13
Hosmer–Lemeshow (p-value)	8.33 (0.402)	*Hosmer–Lemeshow (p-value)*	9.86 (0.275)
Sensitivity	55.6	*Sensitivity*	35.8
Specificity	76.0	*Specificity*	93.1

[a] *Age-dummies, reference group are 22–24*

[b] *Refecence group are first timers*

[c] *Reference 0.5–1 years*

[d] *Reference is 1993*

Table A3. . Logistic regression results, follow-up time three years.

	Men		Women	
	Odds ratio	**P-value**	**Odds ratio**	**P-value**
Age (years)[a]				
16–18	5.46	0.000	No observations	
19–21	2.09	0.000	5.65	0.077
25–27	0.62	0.000	0.91	0.881
28–30	0.46	0.000	1.38	0.591
31–33	0.34	0.000	1.47	0.527
34–36	0.33	0.000	0.57	0.382
37–39	0.23	0.000	0.79	0.717
40–42	0.20	0.000	0.29	0.076
43–45	0.14	0.000	0.11	0.015
46–48	0.11	0.000	0.43	0.286
49–51	0.11	0.000	No observations	
52–54	0.09	0.000	No observations	
55–57	0.05	0.000	No observations	
58–60	0.07	0.000	No observations	
Times in prison[b]				
2–3 times	2.06	0.000	2.55	0.004
4–6 times	3.81	0.000	5.60	0.000
7–10 times	6.51	0.000	21.4	0.000
11–19 times	12.2	0.000	11.4	0.003
20 or more	23.9	0.000	No observations	
Duration of last sentence[c]				
Less than 6 months	0.84	0.014	0.70	0.358
12 to 24 months	0.97	0.727	0.45	0.137
2 to 4 years	1.10	0.479	1.08	0.917
over four	0.85	0.372	0.05	0.037
Year of release[d]				
1994	0.93	0.354	1.19	0.703
1995	0.85	0.068	0.75	0.577
1996	0.87	0.118	0.80	0.643
1997	1.07	0.486	1.06	0.906
1998	1.27	0.012	1.89	0.188
1999	1.47	0.000	2.66	0.080

Diagnostics men:		*Diagnostics women:*	
Number of obs.	7 491	*Number of obs.*	290
Percentage of recidivism	50.8	*Percentage of recidivism*	41.5
Log-L	-4 551	*Log-L*	-164
LR-test (p-value)	1280 (0.000)	*LR-test (p-value)*	58.0 (0.000)
Pseudo R^2	0.12	*Pseudo R^2*	0.15
Hosmer–Lemeshow (p-value)	13.7 (0.091)	*Hosmer–Lemeshow (p-value)*	12.4 (0.133)
Sensitivity	73.0	*Sensitivity*	53.3
Specificity	61.0	*Specificity*	85.5

[a] *Age-dummies, reference group are 22–24*

[b] *Refecence group are first timers*

[c] *Reference 0.5–1 years*

[d] *Reference is 1993*