



Home Office

An impact assessment of the Prolific and other Priority Offender programme

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Home Office Online Report 08/07

The views expressed in this report are those of the authors, not necessarily those of the Home Office (nor do they reflect Government policy).

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Executive summary

Background to the research

- Previous research indicates that a small number of offenders are responsible for a disproportionate amount of all crime. The Prolific and other Priority Offender (PPO) programme, implemented from 6 September 2004, prioritises and directs resources to these offenders.
- There are three complementary strands to the PPO programme.
 1. Prevent and Deter (P&D), that aims to stop young people from engaging in offending behaviours and becoming the prolific offenders of the future.
 2. Catch and Convict (C&C), that aims to reduce offending by PPOs through apprehension and conviction, and through licence enforcement, by ensuring a swift return to the courts for those who continue to offend.
 3. Rehabilitate and Resettle (R&R), that aims to rehabilitate PPOs who are in custody or serving sentences in the community, through closer working between all relevant agencies and continued post-sentence support.
- This report is based upon the Research Development and Statistics (RDS) national evaluation of the PPO programme. The present report addresses the adult strands (C&C and R&R) of the PPO programme. The P&D strand was implemented later than the other strands and fell outside the timescale of the research.

Method

- The National PPO evaluation began in 2005 and is a large-scale and wide-ranging evaluation combining a number of complementary research strands. The national evaluation of the PPO programme examines the implementation, interventions and outcome of the programme for PPOs. The key aims of the evaluation can be summarised by the following questions:
 1. identify which offenders have been selected as PPOs;
 2. explore how schemes have been implemented;
 3. identify what interventions PPOs receive;
 4. understand the experiences and perceptions of those engaged by the PPO scheme; and
 5. explore the impact the PPO programme may have had on offending.
- The first three research questions were in part answered in a previous Home Office publication (Home Office, 2005a). The current report seeks to address the final two questions – with a specific focus on the impact of the PPO programme on levels of offending.
- A number of complementary research methods were used which, when taken together, aimed to provide a reasonable indication of the impact of the PPO programme. The methods used were a combination of offender interviews, PPO staff interviews, an analysis of the offending of PPOs prior to and following their entry onto the PPO programme, and an attempt to draw comparisons between any changes in PPO offending with an appropriate control group identified using a statistical technique called Propensity Score Matching (PSM).
- A total of sixty interviews were undertaken with PPOs from PPO schemes in each of the ten Government Office regions. Forty-eight interviews were with PPOs currently on the scheme at the time of the interviews, whilst 12 had been deselected. Eleven of

the 60 PPOs were interviewed in prison. The data collection was carried out in June and July 2006.

- Fifty-two interviews were undertaken with key PPO staff (representing police, probation and Crime and Disorder Reduction Partnership representatives) from one PPO scheme in each of the ten Government Office regions. The fieldwork was carried out in June and July 2005.
- Propensity Score Matching is a statistical technique which attempts to mimic the effects of random assignment through the construction of a control group post-hoc. Its purpose is to provide a statistically reliable assessment of the effect of a particular intervention, in this case the PPO programme, when compared to a control group of similarly matched persons not subject to the intervention (i.e. non PPOs). Using the PSM technique, each PPO was matched to a member of a control group drawn from the Police National Computer (PNC) who, statistically, had a similar probability of being selected as a PPO as PPOs themselves, but who were not, for whatever reason targeted as PPOs. The matching used observed characteristics, such as the number of times the offender had been to prison, to predict the probability of the offender being a PPO.

Results

Results from the analysis on offending:

- Comparing the total number of convictions in the 17 months before and following the PPO programme shows that there has been a 43 per cent reduction in the offending of the entire PPO cohort.
- The PPO cohort exhibited a sharp reduction in offending following entry onto the PPO programme. In the first 17 months of the scheme the PPOs had a reduction of 62 per cent in the overall level of convictions compared to the beginning of the scheme.
- The PPO cohort had a reduction in the rate of their offending following entry onto the programme. The average rate of offending fell from 0.51 convictions per month per PPO in the 12 months prior to entry onto the scheme to 0.39 for the 12 months following entry, a reduction of 24 per cent.
- The PPO cohort had a marked decrease in the number of days between committing their offence and being sentenced in court in the year following entry on the programme. PPOs were, on average, likely to be processed 13 days sooner in the first 12 months of the programme than the corresponding period prior to their entry onto the scheme.
- In practice, the attempt to generate a robust counterfactual using PSM was judged to have been less successful than originally hoped. This ultimately limited the conclusions that could be drawn about the specific impact of the PPO initiative on levels of offending, as distinct from other interventions and factors that may also have influenced offending levels amongst PPOs. *Thus it is not possible to state the extent to which the reduction in offending observed in the PPO cohort is solely attributable to the PPO intervention.* Further detail is included in the report.
- Notwithstanding, the results from the qualitative interviews with PPO staff and offenders (see below) support a positive assessment of the PPO programme and, while no firm conclusions can be drawn around the specific impact of the PPO scheme on levels of offending at this stage, the results are nonetheless encouraging.

Data from the interviews indicate the following:

- The majority of PPOs were largely positive about the programme.
- PPOs were aware of the additional enforcement aspects of the scheme and the consequences of non-compliance. The PPO programme was viewed by offenders as more stringent than their previous criminal justice experiences.
- Regarding the rehabilitative elements of the programme, the majority of PPOs welcomed the additional support and interventions they had received whilst on the scheme.
- The majority of PPOs interviewed reported either a reduction in their offending or that they had stopped offending altogether since engaging with the scheme.
- Staff were largely positive about the scheme, and were able to discuss instances of success for the programme in terms of both Catch and Convict and Rehabilitate and Resettle.

1. Introduction

The National PPO evaluation examines the Catch and Convict and Rehabilitate and Resettle strands of the programme. It is a long-term project combining a number of complementary strands. The national evaluation of the PPO programme examines the implementation, interventions and outcome of the programme for PPOs. This can be summarised by the following questions:

- identify which offenders have been selected as PPOs;
- explore how schemes have been implemented;
- identify what interventions PPOs receive;
- understand the experiences and perceptions of those engaged by the PPO scheme; and
- explore the impact the PPO programme may have had on offending.

The current report seeks to address the final two questions – with a specific focus on the impact of the PPO programme on levels of offending. The current report examines the offending of the first cohort of PPOs, who entered the PPO programme in 2004, as measured by recorded convictions. A technique called Propensity Score Matching (PSM) was used to generate a control group to allow comparison with the PPO cohort. In addition, offender and PPO staff views were obtained to understand more fully the impact of the PPO programme.

The report begins by exploring the background and other aspects of the PPO programme. This is followed by a description of the various research methods employed and the results of the research. The report concludes with a discussion of the key findings.

Background to the PPO programme

Research carried out in 2001 concluded that, of a total offending population of around one million, only approximately 100,000 offenders (10% of all active offenders) were responsible for half of all the crime committed in England and Wales (Home Office, 2001). In other words it appears that a relatively small number of offenders were far more criminally active than others and contributed disproportionately to the overall crime levels. The most active 5,000 of this group were estimated to be responsible for one in ten offences (Home Office, 2002). Although some of the assumptions behind this figure have been challenged (e.g. Garside, 2004), it is generally accepted that focusing additional resources on the most active offenders could bring about better outcomes in terms of reduced crime rates and improve public confidence in the criminal justice system. For wider research concerning criminal careers and their development see Soothill, Ackerley and Frances (2003) and Farrington (2005).

The Persistent Offender Programme was launched in 2002 as part of the Narrowing the Justice Gap programme (Narrowing the Justice Gap, 2002). The aim was to target resources from across each Crime and Disorder Reduction Partnership (CDRP) at offenders in the community with six or more convictions over the previous 12 months. These schemes were evaluated in 2003 (Home Office, 2005c).

That evaluation was primarily focused upon staff and offender perceptions of the scheme and did not include a full reconviction analysis. The Home Office evaluation (Home Office, 2005c) reported that the selection criteria for the Persistent Offender programme was seen by practitioners as being too rigid. They felt the scheme did not take into account important factors in an offender's pattern of behaviour, such as:

- the number of crimes that an offender could be responsible for without a conviction;
- offences that were left unreported; and
- the type of offence committed.

Areas operating the scheme felt that offenders who were included were not necessarily those causing the greatest harm to their communities. They argued for a more flexible and localised definition that could include a wider definition of 'other priority' offenders.

Other research on the effectiveness of similar schemes, such as the Burnley/Dordrecht Initiative (Chenery and Pease, 2000) and Intensive Supervision (Gendreau, Goggin, and Fulton, 2001) showed mixed findings but indicated little evidence of a reduction in reconviction due to the schemes.

Some schemes did report promising early results on convictions (Chenery and Deakin, 2003; Worrall, Mawby, Heath and Hope, 2003). However, such research was limited by small sample sizes and the lack of well matched comparison groups. Other PPO research has had more of a focus on implementation issues such as emphasising partnership working (Mawby and Worrall, 2004; Worrall and Mawby, 2004). For a fuller discussion of effectiveness refer to Moore *et al.*, (2006).

These themes – tackling the most active offenders, local criteria for selection, and local delivery of programmes to address offending – were central to the development of the Prolific and other Priority Offenders Programme. Early findings from the PPO evaluation were published as a Development and Practice Report (DPR) in October 2005 (Home Office, 2005a) indicating that PPOs started offending earlier and were more criminally versatile than a general sample of offenders (Home Office, 2005a). There were some promising findings regarding the impact of the scheme on offending, as measured by recorded convictions. During the first six months there was a ten per cent reduction in recorded convictions for a PPO cohort compared to the six months prior to the start. However, this was without a control or comparison group and only over a six-month period, meaning that it was not possible to estimate whether the observed reduction in offending might be attributable to the PPO scheme.

Outline of the PPO programme

The PPO programme was announced by the Prime Minister in March 2004. The programme was conceptualised as being an end-to-end process that specifically targeted the small number of most active and/or problematic offenders. It was designed to give offenders a choice between the cessation of offending with the acceptance of support in the form of rehabilitative programmes or to carry on offending resulting in prompt arrest and punishment.

The PPO programme is comprised of three complementary strands.

- *Prevent and Deter*

This is aimed at those young offenders who are most at risk of becoming the next generation of prolific offenders. Principally, the Prevent and Deter strand aims to stop the supply of new prolific offenders by: reducing the opportunities for re-offending (so that those who are already criminally active do not graduate into prolific-offending lifestyles); and more generally reducing the numbers of young people who become involved in crime in the first place.

- *Catch and Convict*

The goal here is to prevent PPOs from offending by apprehension and conviction through licence enforcement and by ensuring a swift return to the courts for those PPOs continuing to offend. Catch and Convict (C&C) responds to the need for robust and proactive criminal justice processes to ensure that there is effective investigation, charging and prosecution of PPOs.

- *Rehabilitate and Resettle*

This aims to rehabilitate PPOs who are in custody or serving sentences in the community through closer working between all relevant agencies and continued post-sentence support. Rehabilitate and Resettle (R&R) provides support and priority access to services in the community and pre-release support for those serving custodial sentences.

Every CDRP (or Community Safety Partnership in Wales) is responsible for setting up and implementing its own PPO scheme. Occasionally, neighbouring CDRPs would collaborate to deliver a joint scheme. There was also a responsibility to establish a PPO scheme with the police and the probation service as lead partners in the delivery. In order to ensure that at least 5,000 offenders were identified for the programme across the country CDRPs/CSPs were required to identify, as a minimum, 15-20 offenders in their area for targeted monitoring and intensive management. In the high crime areas (such as some inner London boroughs), or in CDRPs that covered two or more police Basic Command Units, a larger number of offenders was required. Within the first two months of the programme's implementation (September and October 2004) a total of 7,801 individuals were identified as PPOs (Home Office, 2005a).

In order to support CDRPs/CSPs in their delivery of the PPO scheme, the Home Office issued guidance on the local implementation of the programme. The guidance for the Catch and Convict strand was issued on 6 July 2004, and for the Rehabilitate and Resettle strand on 8 September 2004, (Home Office, 2004b, Home Office 2004c). Offenders were tracked by a computer system known as JTrack which facilitated a more co-ordinated approach by local partners in managing and targeting PPOs. JTrack allows practitioners in police forces and Crown Prosecution Service areas in England and Wales to track offenders from arrest to finalisation in a consistent way and measure their success in doing so.

Selecting and deselecting PPOs

One fundamental aspect of the programme is identifying the most prolific and troublesome offenders in a community for inclusion in the scheme. As such, the selection process is crucial to the success of the programme in reducing overall crime levels. The initial guidance, in keeping with the ethos of flexibility, did not attempt to provide a national standardised definition of a PPO. Instead, local areas were free to determine their own definitions, based on general criteria set out by the Home Office. The key criteria for selecting PPOs were outlined as follows:

- the nature and volume of the crimes they are committing;
- the nature and volume of other harm they are causing (e.g. as a consequence of their gang leadership or anti-social behaviour); and
- local criteria, based on the impact of the individuals on their communities.

In addition, the guidance set out a scoring matrix which could be used to aid the identification and selection of PPOs (Home Office, 2004b, p.19). Analysis undertaken as part of PPO research showed that the majority of schemes use a matrix of some kind. The matrix assigns a numerical value to a range of characteristics against which each PPO can be measured. The scores are summed and offenders scoring above a threshold would be included in the scheme and those below not included. The reasons for using a matrix were to ensure an audit trail and to demonstrate transparency in the selection process. However, the use of a scoring matrix was not mandatory nor, where it was used, was any guidance offered for relative weighting of the selection criteria and appropriate threshold score.

The original guidance provided less information in relation to the criteria for deselecting PPOs. However, more recent guidance on deselection (Home Office, 2005b) has placed an emphasis on evidence of a cessation of offending or intelligence to the same effect or a lengthy custodial sentence (more than ten years).

Managing PPOs

Once suitable individuals are identified, schemes are expected to manage them through a combination of enforcement measures and incentives to change behaviour. The aims of the schemes are to:

- enhance arrest, investigation, detection, charging and prosecution of offenders, bring to justice as much of the criminality committed by the targeted PPOs as possible (by proactive police work such as increased supervision and monitoring);
- reduce re-offending by PPOs and, in theory, reduce the number of victims of crime;
- develop a rapid and effective partnership intervention which enables effective supervision and monitoring of PPOs; and
- address non-compliance/re-offending speedily and effectively with a rapid return to court or prison where appropriate.

The initial PPO guidance discussed the need for a joined-up approach, with all partners focused on the same group of offenders, through the setting up of a PPO scheme (Home Office, 2004b).

The spirit of the guidance is to accommodate existing work on prolific offenders, while providing support for areas developing new schemes, acknowledging that there will be variation and different approaches to tackling this problem, according to local needs. (Home Office, 2004b p.3)

PPO schemes were to be multi-agency partnerships, based upon very close working relationships between the police and probation services locally to identify, monitor and intensively manage PPOs.

An essential feature of the PPO programme was that it should tailor responses to local problems and should avoid a prescriptive approach regarding implementation. In doing so, the PPO programme embraces the use of local knowledge, practitioner expertise and previous experience of similar schemes. The individual stakeholders, practitioners and specific agencies are responsible for all decision-making throughout, from how to choose the prolific offenders through to which interventions they may receive and how often they may receive them. These factors were all designed with a specific intention: to reduce the crime levels of the offenders on the PPO programme. It is this question that the current report addresses.

2. Method section

The aim of this section is to outline some of the key issues in researching the PPO programme and the specific methods utilised in the impact assessment. A number of research methods were selected that when viewed together would aim to provide a good overview of the PPO programme.

Design

The design of the evaluation centred upon an analysis of the level of offending amongst the PPO cohort both prior to their entry onto the scheme and in the period following it. This analysis was supplemented by a series of qualitative interviews with both PPOs and key members of staff working on the PPO programmes in local areas. A key aspect of the present report was the attempt to generate a suitable comparison group using Propensity Score Matching. Further information about these components of the evaluation is provided in this section.

Reconviction Analysis using Propensity Score Matching

A perennial theme for evaluative research is the question as to ‘what would have happened to those who received a given intervention, if they had not received it?’ Put simply, how would offenders have behaved if they were not subject to the PPO treatment? This is often referred to as the ‘counterfactual’, that is an estimate of the circumstances that would have prevailed had a new policy or intervention not been introduced. By comparing counterfactual outcomes (often referred to as either control or comparison group outcomes) with outcomes measured

for those individuals subject to the new policy or intervention, causality or attribution can be established or inferred.

Measuring the counterfactual is a difficult task. To estimate the 'true' counterfactual, researchers use a variety of methods, depending on circumstances and opportunities open to them. Some popular methods include:

- single group pre and post-test designs;
- two group pre and post-test designs;
- statistical matching designs (e.g. propensity score or cell matching);
- time series analysis;
- Regression Discontinuity Designs (RDD); and
- Randomised Control Trial (RCT) designs.

The RCT design is generally viewed as the most robust approach. If implemented correctly it guarantees control and treatment groups will be comparable by the elimination of extraneous variables and selection bias. However, RCTs are not feasible when variables cannot be manipulated due to ethical concerns, are challenging to implement, are expensive or when several years must pass before the results are known.

The RCT design did not prove feasible for the PPO evaluation largely due to ethical and implementation issues. The PPO evaluation also considered a Regression Discontinuity Design to assess impact. This proved not to be feasible due to the diverse range of factors and scoring systems used for PPO selection. For the RDD to be successful, one would have required a standardised set of selection criteria whereby an individual would always have become a PPO. Due to the local variations in selection methods this was not possible.

A number of authors have argued that Propensity Score Matching offers a robust and suitable alternative to the RCT design (Dehejia and Wahba, 2002). The PSM approach is a strategy that corrects for selection biases in making estimates about the counterfactual. PSM employs the predicted probability of group membership (in this case of being a PPO) based on observed predictors, usually obtained from logistic regression, to create a strong counterfactual group. The propensity score can, therefore, be used to match the individuals receiving the treatment to a group with a similar probability of receiving the treatment that did not. For example, even if two individuals are not exactly alike in all covariates – they have a similar statistical likelihood of receiving the intervention.

The history of PSM can be dated back to the 1970s and the work of James Heckman (Blundell, 2001) and to the 1980s (Rosenbaum and Rubin, 1984). The main limitations of the PSM technique are that large samples are required and hidden bias may remain as the matching is only possible for observed variables. This is always an important point, especially so considering the variability in selection criteria for PPOs among local areas. An important assumption, therefore, is that as much as possible of all the information used in selecting individuals for the intervention is contained in the observed variables. The key selection criteria for PPO selection include the individual's criminal history and type of offence. This information is contained on the PNC and as such it was decided to test the feasibility of the PSM approach. On balance, and notwithstanding its potential limitations (the importance of the unobserved variables), a PSM approach was selected because it offered the strongest available design.

Offender interviews

Offender interviews were undertaken to further enhance the research by providing qualitative evidence as to the impact of the PPO programme on offenders. A total of 60 interviews were undertaken with PPOs from schemes across each of the ten Government Office regions. Schemes generated a list of their PPOs and those to be interviewed were selected at random from this list. Forty-eight PPOs were currently on the scheme at the time of the interviews, whilst 12 had been deselected. Eleven of the 60 PPOs were interviewed in prison. The data collection was carried out in June and July 2006.

Semi-structured interviews were undertaken with 55 males and five females. The most common age category was from 26 to 30 years (23 per cent, n=14), followed by 21 to 25 years (20 per cent, n=12) and 31 to 35 years (17 per cent, n=10).

With the exception of one, the entire sample of PPOs interviewed had used illegal drugs. Heroin and crack cocaine were the problematic substances for the majority of users and ex-users. Amphetamines had also been reported as a significant problem in the past for a small number of offenders interviewed. Three-quarters of PPOs stated that their main reason for committing crime was to fund a drug habit. In fact as many as 50 offenders stated that over the last three years their drug use had been connected to their offending.

Staff interviews

Staff interviews were undertaken to further enhance the research by providing qualitative evidence as to the impact and wider perceptions of the PPO programme. Staff from each core PPO agency (the CDRP, the police and probation services) were invited for interview. In total, 52 interviews were held with key PPO staff in PPO schemes from each of the ten government Office regions. The fieldwork was carried out in June and July 2005.

A semi-structured interview schedule was designed and conducted face to face. Interview schedules were designed to capture key aspects of the PPO programme: set-up and implementation of the PPO scheme (scheme structure, difficulties in the set-up); value of data sharing and partnership work; selection and deselection of PPOs; operating Catch and Convict; operating Rehabilitate and Resettle; costs and demands of the PPO scheme and other general issues (i.e. PPO practitioner's general views, the link between the two strands, JTrack and good practice).

3. Results

This section outlines the characteristics of PPO and PSM samples and a brief comparison of the PPO cohort compared to the general offending population. This is followed by a cohort analysis of PPO offending, staff and offender views and finally the results from the PSM analysis – along with the suitable caveats where appropriate.

Sample

All offenders identified on the JTrack database as PPOs in September and October 2004 (n=7,801) were used to generate the cohort. Data drawn from the Police National Computer was obtained on 7,557 of these individuals. The Appendix includes, as part of the PSM model verification, a number of demographic breakdowns comparing the PPO and PSM samples, split by PSM banding. As well as testing the PSM model it provides a good overview of the two samples.

PPOs compared to the general offending population

As discussed earlier, one of the stages in generating the PSM control group was to identify the general offending population from which the PSM cohort would be drawn. This would allow comparison of the PPO cohort to a general offending population in order to generate a greater understanding of PPO characteristics. Comparison of these two groups highlights a number of key differences between PPOs and the general offending population. The key findings are similar to those reported previously (Home Office, 2005a) when an Offenders Index snapshot was used as a comparison group. The key differences identified in the present study are as follows:

- PPOs had more convictions in their history (as one might expect);
- PPOs were more criminally versatile;
- PPOs are more likely to commit acquisitive offences;

- PPOs tend to start their criminal career earlier; and
- Eighty-one per cent of PPOs had received a custodial sentence in their criminal career prior to starting the PPO programme, with 42 per cent receiving their first sentence before the age of 18. This compares to 33 per cent of the general offending population who have received a custodial sentence with only nine per cent receiving one under the age of 18.

This seems to indicate that the PPO population show a range of differences when compared to a general offending population. Most of these are contrasts that one would expect to find. It also indicates that on the whole, appropriate individuals have been targeted by PPO schemes. However, these factors will also determine the criminal justice interventions received beyond the PPO scheme and therefore affect the purity of the control group comparisons.

The impact of the PPO programme

Addressing the impact of a given policy or intervention without the randomisation of participants to the intervention (i.e. an RCT) can be challenging, as impact cannot easily be attributed solely or exclusively to the particular intervention of interest, as distinct, from other interventions or extraneous factors. In consideration of this issue, the current research used a variety of measures that should provide a good understanding of impact when viewed in combination. These included an analysis of offending levels within the PPO cohort, qualitative interviews with key PPO staff and PPOs and, finally, a comparison with a control group of individuals with seemingly similar characteristics derived using Propensity Score Matching.

Levels of offending within the PPO cohort

The first step of the analysis was to conduct a within-cohort analysis. This compared PPO criminal convictions leading up to and after the inception of the PPO programme. No comparison was made at this stage with the control group. This analysis can be seen in Figure A.

This seems to indicate a successful outcome of the PPO programme. The PPO cohort have a steady rise in their criminal behaviour until they commence the PPO programme at which point there is a sharp decrease followed by a period of steady decline in recorded criminal convictions.

Figure A: PPO cohort's criminal convictions leading up to and following the PPO scheme

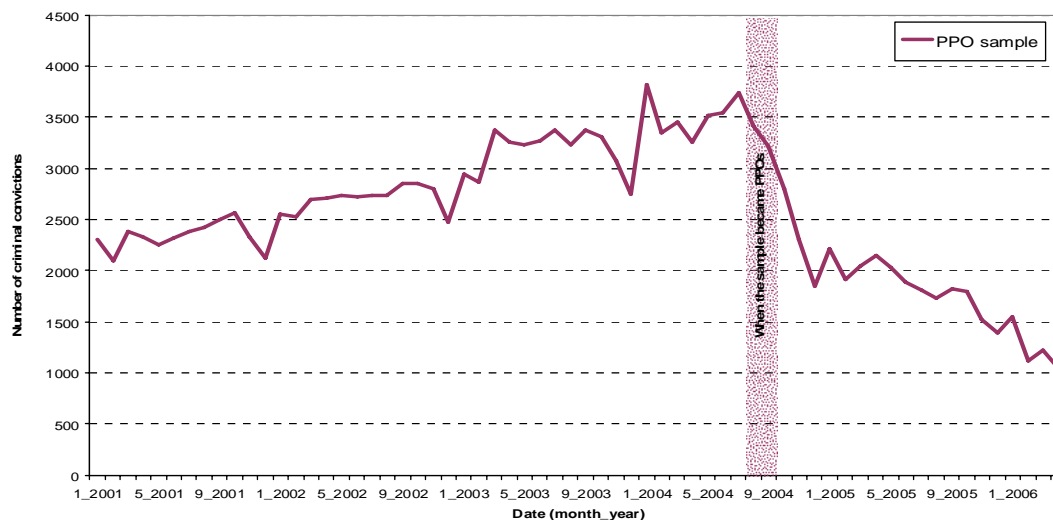


Figure A shows a 62 per cent reduction in recorded convictions by PPOs over the first 17 months following entry onto the scheme. Comparing the sum of convictions in the 17 months pre and post-entry onto the PPO programme shows that the PPO cohort had a 43 per cent reduction in offending (55,031–31,377 convictions). The only sustained decrease in convictions for this group occurred following entry onto the PPO programme.

This initial drop has not been caused by an incarceration effect (a sudden rise in custodial sentences). To assess the impact of custodial sentences on the analysis, the PPO cohort was divided into those who had received and those who had not received a custodial sentence whilst on the programme. Both groups displayed the sharp reduction in convictions previously identified (see Figure M in the appendix).

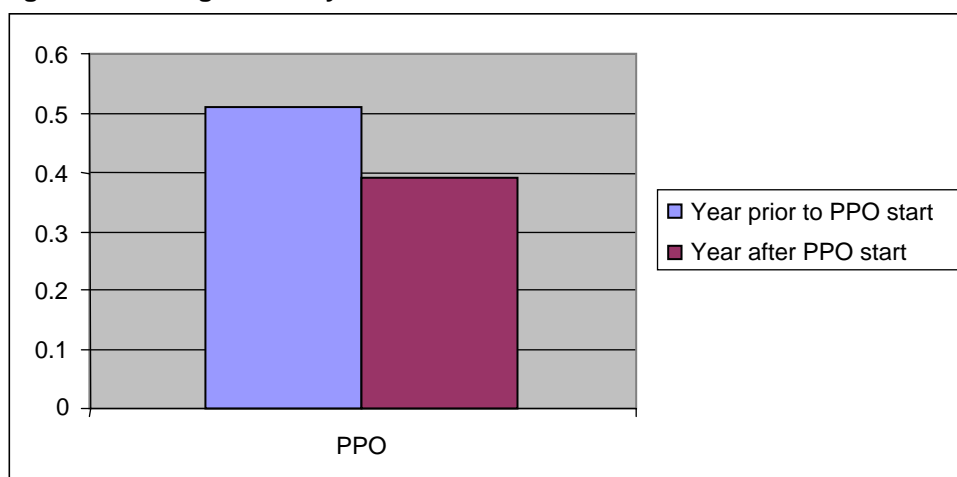
While the clear inference from this within-cohort analysis is that something happens to the PPO cohort at the start of the PPO programme that leads to a drop in their levels of offending, it is not possible to ascertain how much of this drop is attributable to the PPO programme alone. The comparison with the PSM control provides this information and will be discussed further below.

The rate of offending within the PPO cohort

A further way to examine the impact of the PPO programme is to consider the individual rate of offending (as measured by the mean number of convictions per month) and how this has changed. This is potentially an important issue considering these are prolific offenders and as such a cessation of all offending is unlikely whereas a decrease in the rate of offending may yield important results.

Figure B shows that in the year leading up to the programme, the PPOs had a mean of .51 (range .08–6) convictions per month falling to .39 (range .09–4) in the year following entry onto the PPO scheme, a reduction of 24 per cent. This indicates that on average, in the year leading up to the beginning of the PPO scheme the typical PPO would be convicted for an offence every other month and in the year following entry, a conviction every three months. This analysis only included those active offenders with convictions in the relevant time periods. These data accord with the previous graphs that indicate the PPOs were being convicted for more offences leading up to the PPO start.

Figure B: Average monthly conviction rates for PPOs

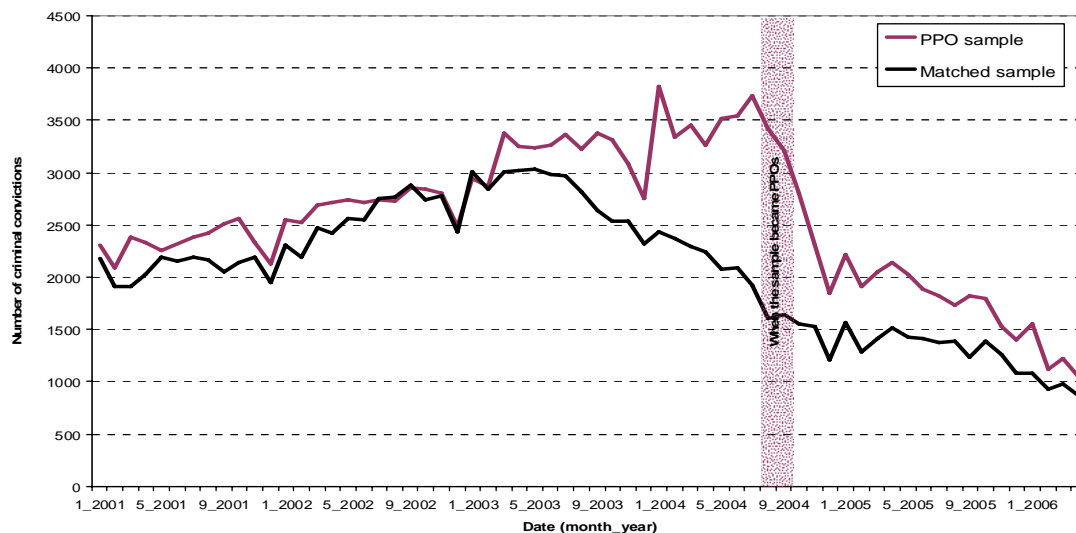


Results from the PSM matching technique

As discussed in the method section, one of the key challenges for the PPO evaluation was the generation of a strong counterfactual. PPOs by the very nature of their selection onto the programme should display a number of distinct characteristics. This is evidenced through PPOs being more criminally versatile, beginning their offending career earlier and the majority

of them having a custodial sentence before the age of 21. The PSM technique offered a viable method of generating a robust control group. Figure D describes the criminal convictions of the PPO and PSM cohorts leading up to and following the inception of the programme.

Figure C: The PPO and PSM matched cohorts' criminal convictions leading up to and following the PPO scheme



As can be seen, the two groups have a similar level of convictions throughout their career until around the middle of 2003, at which point:

- the PPO cohort continue to increase in convictions up until the PPO start (September 2004) which is then followed by a sharp decrease over the first few months of the scheme and then by a steady decline in convictions up until the end of the research period;
- the PSM cohort begins a steady decrease in recorded convictions that lasts until the end of the research period, there seems to be no fluctuation in their convictions as a result of the introduction of the PPO programme.

The divergence of the two groups prior to the introduction of the PPO programme was unexpected. This raises the issue of how much trust can be placed in the comparison between the groups.

Even though the model was statistically strong, on the whole the PSM technique has failed to yield a valid counterfactual. This is a crucial issue and one that is discussed in depth in the following section. Therefore, no firm conclusion on the impact of the PPO programme should be based solely on results from the PSM technique. However, such a comparison does shed light on the PPO selection process, and provide some pointers for the future refinement of the PSM model. It would also appear to illustrate how, even in the presence of an apparently tight matching process, a valid comparison is not necessarily guaranteed.

Acknowledging the limitations of the comparison, if one looks at the start of the programme for the first 17 months, one sees a 62 per cent reduction for the PPO cohort compared to a 42 per cent drop for the control group. This can be further broken down by month, so after:

- three months: the PPO reduction is 33 per cent, the control group 27 per cent;
- six months: the PPO reduction is 27 per cent, the control group 20 per cent;
- twelve months: the PPO reduction is 42 per cent, the control group 27 per cent.

Regardless of the divergence between the two groups, however, it is worth noting that there is no other point of the criminal career of either the PPO or PSM cohorts where there is such a drop as the one evident following entry onto the PPO programme.

Comparisons of the rate of offending between the PPO and PSM control showed that in the year leading up to the programme, PPOs had a mean of .51 convictions (range .08 to 6) per month and .39 convictions (range .09 to 4) in the year following the start. Equivalent figures for the control group were .47 (range .08 to 5.5) and .41 (.08 to 4.5). As with the comparisons on the overall level of offending, one cannot rely on this measure as a robust indicator of impact because the fall in the control group's offending predate the PPO scheme.

Finally, comparisons of the average speed to court between the PPOs and the control group suggest that there was little overall change within the control group in the average number of days between having committed an offence and being sentenced in court. By contrast the PPO groups were processed on average 13 days sooner when they were on the PPO programme.

Challenges with the PSM technique

A key issue for the research is why the two groups that appear to be statistically very similar behave differently regarding convictions. As discussed earlier and outlined in the Appendix, the two groups are statistically a good match for one another. The model included factors such as the Copas rate which is a measure of the rate of offending, socio-demographic details and criminal career factors. Yet, the two groups are behaving differently, diverging in mid-2003, just over 12 months prior to the onset of the programme. Ideally, the research would expect to see the two groups performing equally with respect to convictions up to the start of the PPO scheme. The fact they are not requires further consideration.

There are a range of explanations that could hypothetically account for such a difference. Examples are shown below.

- There is a problem in the model used. Even though the model is statistically strong, it seems likely that unobserved variables have disrupted the PSM process. There were a range of selection criteria that could not be accounted for such as police or probation intelligence or individual CDRP priorities affecting decision-making. Local studies may be better placed to model for such factors as local intelligence and individual CDRP priorities.
- It is possible that once practitioners were aware that the PPO scheme was to be implemented they began to identify potential PPOs (prior to the official launch date) resulting in increased convictions for this group, demonstrated by the peak rate of convictions for PPOs being at the onset of the programme.
- Local police forces had a considerable amount of discretion in whom they selected for the PPO scheme, but it is likely that they prioritised those who had offended regularly in, say, the 6-12 months prior to its start. This would effectively have superimposed a secondary time frame which was not modelled for, which could partly explain the divergence
- It is possible that another intervention resulted in the PSM cohort's convictions to reduce during 2003. For example, drug testing on charge was introduced in mid-2003 as part of the Drug Interventions Programme. If the PSM sample had been impacted by another intervention, this clearly had no effect on PPO convictions which rose steadily until September 2004. It may be because these PPOs were effectively excluded from that intervention.
- It is possible that there were wider sentencing and other criminal justice system changes. However, this is unlikely as it would have presumably impacted upon both groups.

Analysis of the speed to court within the PPO cohort

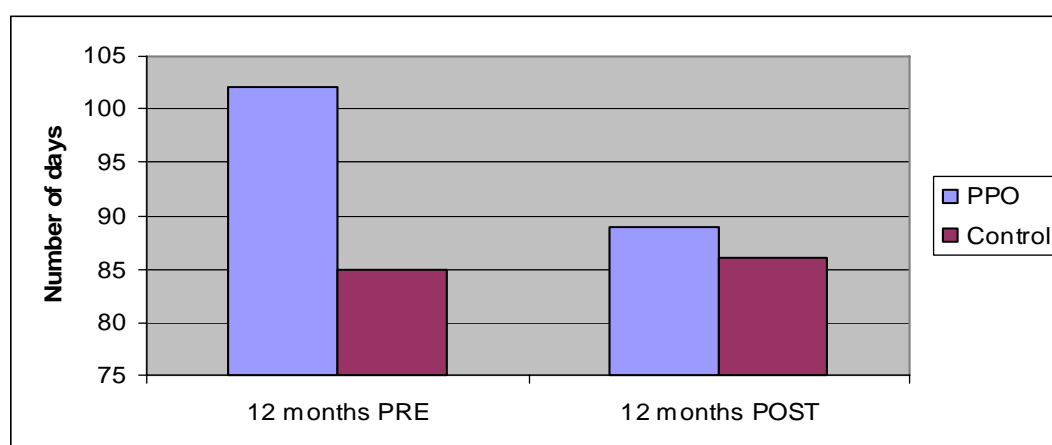
A key aspect of the PPO programme is the Criminal Justice System Premium Service. This details a range of factors that PPOs should receive, for example fast tracking to court and multi-agency working. The data available allowed an investigation of speed to court, defined as the number of days between committing the offence and being sentenced in court.

Figure D provides a graphical representation of the speed to court for the PPOs and the PSM control group both in the year prior to and the year after start of the PPO programme. A possible objection to making such a comparison is that – as with the analysis on offending – the two groups were markedly different in characteristics even *before* the intervention, so it does not compare like with like. Provided, however, that the PSM group is regarded as a 'benchmark' (a group of high offenders somewhat similar to the PPOs, but not subject to the scheme, with whom a comparison might be useful) rather than a true counterfactual (a model for how the PPOs would have behaved had the intervention not taken place) this comparison is a reasonable one to make. In particular, it provides an assessment of how other changes in the criminal justice system, independently of the PPO scheme, might have affected speed to court.

As can be seen, there seems to have been considerable improvement with PPOs now processed more speedily (on average 13 days sooner) in the first year of the programme than the year prior to the programme. Over the same period the control group had little change, actually having a slightly slower speed to court in the year after the scheme had started. An interesting question is why the PPO cohort had a much slower speed to court in the year prior to the PPO start. A possible explanation for this is the disruptive nature of PPOs during this process, for example avoiding hearings or delaying sentences.

This improvement seems to indicate that the PPO Criminal Justice Service Premium Service is working. The speed to court for PPOs decreased for all offence types (in contrast to the control group) with the best improvement being robbery (42 days sooner); domestic burglary (25 days sooner); and violence (20 days sooner).

Figure D: The mean speed to court measured in days in the year before and following PPO start for PPOs and the control group



Offender views on the impact on the scheme

To add to the understanding of the impact of the PPO programme, a number of interviews were conducted with 52 PPO staff and 60 offenders.

The majority of PPOs interviewed were largely positive about the programme. Importantly for the PPO programme, the 'carrot and stick' approach was fairly well understood. PPOs were aware of the additional enforcement aspects of the scheme and the outcomes of non-

compliance, so much so that the scheme was regarded as more stringent than previous programmes and the most commonly expressed negative about the scheme was police monitoring or police being “*just always on your case*”. Nonetheless, the offenders did appreciate that this was helping to keep them out of trouble and many PPOs expressed positive views regarding the police, summed up by one offender who stated that “*the old bill are only there to help you... they are not always trying to catch you out*”.

Regarding the rehabilitative elements of the programme, the majority of PPOs spoken to welcomed the additional support and interventions they had received whilst on the scheme. Probation was mentioned positively by the majority of interviewees. Over half of PPOs interviewed found the drug treatment and testing to be a positive aspect of the scheme. This is important when one remembers that three-quarters of the offenders interviewed stated that their primary reason for crime was to fund a drug addiction. There was sometimes confusion as to whether the interventions being received were part of the PPO or an aspect of another intervention. Many noted how different their probation visits were to those they had experienced previously.

There was no support in the past – you had to go once a week to see a probation officer for two minutes – it was like clocking in out once a week. All that did was keep you out of prison for a certain amount of time until you got nicked again. Now you get all the help that you can.

[If I was] given this sort of help when I was about 15 or 16, instead of waiting until I was 21 or 22 ... I wouldn't have ended up going back to jail.

The majority of PPOs interviewed reported a reduction or had claimed to have stopped offending altogether since engaging with the scheme. This seems consistent with the within-cohort analysis previously discussed.

My offending has decreased and in my case, sometimes when I was close to offending I would actually picture the two police officers, they would be in my mind, to think I have to see them this week ... it deters you from committing offences just to know that you are going to be seeing police officers.

Offenders provided a number of reasons for this cessation of offending:

- the benefits of the interventions (i.e. drug treatment – they did not need to offend to fund their drug use);
- the intensity and structure of the PPO scheme (in the community) meant that they were occupied with little time to commit offences; and
- the regular police monitoring acted as a deterrent to committing crime.

Staff views on the impact of the scheme

The PPO staff interviewed were largely positive regarding the impact of the scheme and were able to describe cases of success, both in the rehabilitative and proactive policing aspects of the PPO programme. To illustrate the point, what follows are three cases described by staff to highlight the effect that the PPO scheme has had. Whilst these cannot be generalised to all offenders, they do provide powerful examples of success for both the C&C and R&R strands. Refer to Home Office (2007) for further information on the implementation of the PPO programme and the lessons learned.

Case one

We have one lad who was a drugs user... and so did his partner, so you can't really work with one, without working with the other. So we took both of them on board. They worked closely with us; they've completely turned their lives around. We introduced them once they were

stable to Progress to Work. He has found employment, and subsequently been promoted within that employment. We went round a few weeks ago, they've bought themselves a car and they were desperate to show us the insurance policy for the car and to be perfectly honest with us, they'll say they've used [drugs] recreationally, but felt so guilty afterwards, and their life is just tremendous in comparison. (Police representative)

Case two

We picked up one lad, who, he was 17 ... but he was being released from HMP, he was homeless, he had no clothing, apart from what he stood up in, he had no means of support, no money, no food.... The team were no longer working with him because he'd finished his sentence, and it was two weeks prior to his 18th birthday, so basically they were opening the prison gates, and just letting this lad out, totally unsupported. Because he was a PPO, we managed to pull together all the agencies, and he actually left prison, he was collected by the Youth Offending Worker, who took him to pre-arranged appointments with Connexions, with the Benefits Agency. They were all appointments that we'd set up, we secured him accommodation, in supported tenancy, so he had his own little flat, and he had the support of workers within the scheme, we got him a food parcel, just to sort of help him out, and we've worked with him intensively ... he must have been back in the community about six months now, and he's still crime free... and I know last week he had a job interview. (Police representative)

Case three

An example is this chap. He was coming out of prison and openly said that he will commit crime. He is a racist, very anti-women, basically there's hardly anyone he likes and he was coming out of prison and we said, well how can we get anything done with him, knowing he's coming out? He is going to commit a crime. We took him to a meeting, spoke to the other agencies. The YOT and Probation were aware of him ... I went to visit him in prison. We sat down and spoke to him; explained the scheme to him and he said 'I'll go on the scheme but I will commit crime – that is me'. So we made him a PPO, put some surveillance in and when he came out of prison ... They did surveillance on him and within two days he had committed a crime, got caught and is back in prison. (Police representative)

4. Discussion

This report has presented results from the national PPO evaluation. The programme was introduced in 2004 to tackle the most prolific and troublesome offenders in England and Wales. Whilst there has been previous research on the PPO programme, none has been able to address robustly the issue of offending following entry onto the PPO scheme at a national level. Early findings from the Home Office evaluation were published recently (Home Office, 2005) and alongside the current report a further publication is available that examines the set-up and implementation of the programme (Home Office, 2007).

The most robust research method to evaluate the PPO programme would have been an RCT. As previously discussed, this proved not to be feasible and so a range of other methods have been employed that when viewed together provide a rich understanding of the impact of the PPO programme. These included a cohort analysis, interviews with PPO staff and offenders, an analysis of the speed to court and offending rates, and an attempt to generate a strong PSM control group. As discussed there are important caveats and research questions regarding the control group and these have been discussed in some detail. Ultimately the PSM methodology did not provide a definitive measure of the impact of the PPO scheme on offending behaviour.

Notwithstanding the failure to generate a reliable control group, a broad overview of these results indicates a marked reduction in offending following the entry onto the PPO programme, reductions in the average rate of offending and marked improvements in the fast-tracking of PPOs to court. Indeed, when viewed alongside qualitative data detailing the views of PPOs and staff there is positive evidence of the impact of the PPO programme for the first cohort of PPOs.

A number of methods were employed, so that when viewed in combination the evaluation would provide a multi-dimensional picture of the PPO programme, from which strong results could hopefully be drawn. One of these methods, Propensity Score Matching, is viewed by many academics as the strongest research method outside of the Randomised Control Trial. In the absence of randomisation, PSM can offer a realistic and time-effective alternative for the evaluation of social policy, and one that offers a self-diagnostic quality. PSM is not appropriate for use in all situations. Specifically, and this report is a clear demonstration, it is only feasible when selection to the relevant intervention or policy is based upon observed variables. In the present case of PSM, it is likely that the influence of unobserved variables has weakened the control group. However, PSM should be viewed as a complement to the standard techniques used by researchers, providing that the underlying assumptions are met (Dehejia and Wahba, 2002).

If local areas are seeking to evaluate their PPO work there are a number of themes they may wish to address. A crucial issue would be the long-term impact of the PPO programme and as such the longitudinal follow-up of this first cohort of PPOs testing the sustainability of the programme (to re-examine the PPO convictions levels again in the future). It may also be of interest to conduct an analysis of a later cohort of PPOs to examine the demographic characteristics and the impact for this group. This would allow for any implementation challenges to have been largely overcome. Perhaps the most important question is the impact of the PPO programme on local crime rates. One of the core assumptions behind the programme was that by targeting the most prolific offenders, this would not only drive their individual offending levels down but also overall crime levels. It may also be useful to revisit the PSM matching methodology and explore the possibility of further developing the models of offending to establish a better match with any control group. It would also be worthwhile to attempt a further exploration of the specific areas of PPO schemes that appear to facilitate a successful outcome.

The PPO programme targets the most troublesome and prolific offenders in England and Wales. As such, any positive outcome should be welcomed as a result that will benefit not only the offenders concerned, but also the wider community. The variety of positive outcomes

evident from this research provides an encouraging picture of the impact of the PPO programme for the first cohort of PPOs.

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6. Appendix: Propensity Score Matching and technical notes

Covariates in the PSM model and predictive power

To produce the model, the general offending population was resampled to reduce the number of offenders used in the logistic regression. A number of different scenarios were used and the analysis of the differences between the general population and the PPO sample was drawn upon. The final model had an Area Under Curve of 0.866 which means that it offers an excellent level of discrimination. The model was then rerun a number of times on different samples to ensure that it was accurate for the general population and was tested for correlation between the variables which would have affected the ability of the model to predict whether an offender was a PPO. Figure E presents the final factors in the model.

Figure E: The final factors in the predictive model

	B	Sig	Exp(B)
Constant	-0.956	<0.001	0.384
Criminal career variables			
Copas – the rate of offending.	0.302	<0.001	1.352
The length criminal career up until starting the PPO	-0.036	<0.001	0.964
Socio-demographic variables			
Male (reference)			
Female	-0.629	<0.001	0.533
Aged less than 18 (reference)			
18 to 20	-0.821	<0.001	0.440
21 to 25	-1.507	<0.001	0.222
26 to 30	-1.695	<0.001	0.184
More than 30	-2.096	<0.001	0.123
Previous offence categories			
Number of previous theft offences (Log)	0.172	<0.001	1.187
Number of previous handling offences (Log)	0.488	<0.001	1.628
Number of previous domestic burglary offences (Log)	0.537	<0.001	1.710
Number of previous other burglary offences (Log)	0.262	<0.001	1.299
Number of previous absconding and bail offences (Log)	0.106	0.001	1.112
Number of previous motoring offences (Log)	0.101	<0.001	1.106
Number of previous taking and driving away offences (Log)	0.165	<0.001	1.180
Previous convictions			
Greater than 3 previous convictions	1.388	<0.001	4.008
Previous prison			
Had a previous custodial sentence (binary)	1.040	<0.001	2.828

It is worth reiterating that the PSM model is statistically strong; however, one of the limitations of PSM is that only observed covariates can be included in the model. Previous PPO research has indicated that while criminal behaviour and history are key selection criteria (Home Office, 2005a), some other frequent selection factors include police intelligence, drug use and CDRP priorities. The model used the PNC computer to develop the model and as such was not able to incorporate such variables into the model.

Model development and checks

A number of stages are necessary to conduct Propensity Score Matching, in brief these are:

- *Identify the intervention sample*

As part of the PPO evaluation the first cohort of PPOs was already identified (Home Office, 2005a). The current research covers all PPOs selected in the first two months of the PPO programmes inception in September 2004, a total of 7,557 individuals.

- *Identify the offending population from which to draw the control group*

One of the first aspects of the PSM technique was to define the general offending population from which the PSM sample would be drawn. Analysis revealed that the majority of the PPO sample had been convicted at court in the two years prior to becoming a PPO. Therefore, the general offending population was restricted so that they had to have been convicted during the two-year period prior to the commencement of the PPO programme; that is between 6 September 2002 and 6 September 2004. For all of the analysis each member of the control group was assumed to *potentially* have become a PPO on 6 September 2004 (this corresponds with the PPO sample). The general offending sample used represented slightly less than ten per cent (216,886 offenders) of all the offenders who were convicted during the selected time period.

- *Identify the relevant characteristics*

For good PSM the overlap between the intervention and comparison should be identified. One should match as much as possible on variables that are precisely measured and stable and relevant to the intervention in question. Previous research (Home Office, 2005a) demonstrated that criminal history and offence type were two of the most common selection criteria for PPOs. For the current analysis PNC data were used to develop the model. However, as discussed elsewhere the effect of unobserved variables cannot be ruled out.

- *Develop a model to predict the likelihood of receiving the intervention*

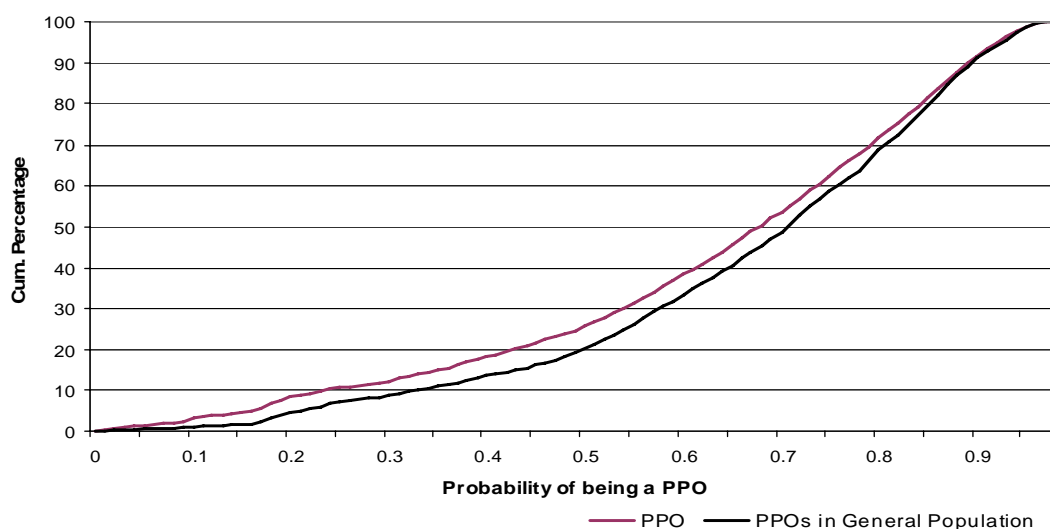
Initially a number of bivariate analyses were employed to explore the association between the two samples (PPO and the general offending sample). This was followed by a series of logistic regression analysis incorporating a wide variety of variables from the PNC computer to develop the probability of each offender receiving the PPO treatment. The final PPO model had an Area Under Curve (AUC) of 0.866 which means that it offers a good level of discrimination. The discrimination refers to the fact that the model should predict results accurately. The model contained a range of variables covering the criminal career, socio-demographic factors, types of offences, previous convictions and previous custodial sentences. Figure E presents the final factors in the model.

- *Test the model*

The model to predict likelihood of being a PPO was then rerun a number of times on different samples to ensure that it was accurate for the general population and was tested for correlation between the variables which would have affected the ability of the model to predict whether an offender was a PPO.

An additional test was undertaken that was slightly different to the tests that would normally be used for Propensity Score Matching. All offenders who became a PPO after the end of October were removed from the analysis at the matching stage. They were then entered into the model and given a probability of becoming a PPO which was then used to see if the model predicted future PPOs accurately. This is a crucial test for the model. As Figure F shows, the majority of future PPOs were given very high probabilities of becoming PPOs. For example over three-quarters of the PPOs in the general population had a probability of becoming a PPO of over 50 per cent. This provides an additional quality check as to the strength of the model used and the rationale to proceed with the PSM technique.

Figure F: The probability of becoming a PPO for the PPO sample and for offenders in the general population who subsequently became a PPO



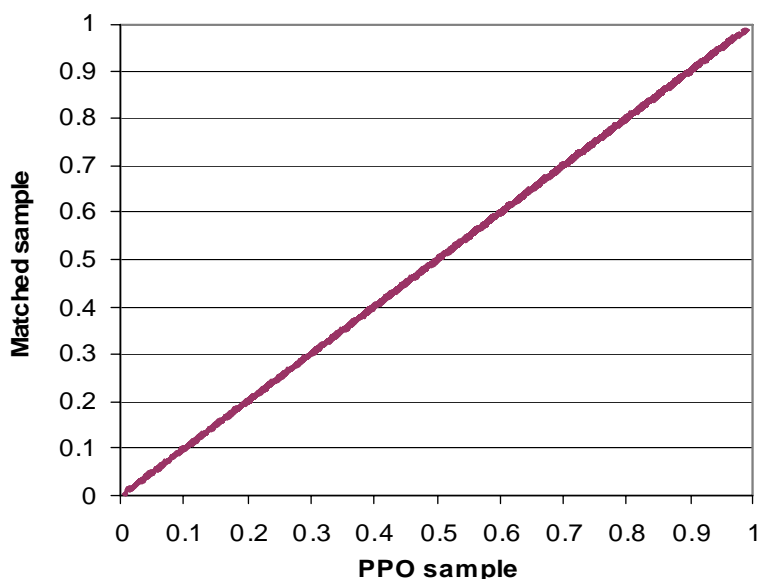
- Matching each member of the intervention group to the control group.*
 Caliper matching was used in the PSM technique. This matches each PPO to one offender in the general offending population but sets a tolerance level on the difference between the two probabilities of being a PPO. In this case the tolerance was set at 0.01. This meant that the probabilities of the PPO and the offender in the general sample had to be within 0.01 of each other. This is a tight match that was possible due to the extremely large size of the general population. All of the PPOs were successfully matched.

- Testing the match*
 The first stage of testing the match was to assess the distribution of the propensity score in the treatment (PPO sample) and comparison groups (matched sample). The second test involved using the balancing test proposed in Rosenbaum and Rubin (1983). This operates by dividing the treatment group into a number of strata based on the propensity score. If the treatment and comparison groups are not significantly different from each other within these strata then the participation model has been adequately specified to balance the characteristics (Bryson, Dirsett and Purdon, 2002).

The PPO sample and the matched sample were tested with a number of characteristics and it was clear that the samples tended to have similar characteristics within each of the bands. This suggests that the match was statistically successful and could be used to evaluate the PPO programme. Although, as discussed in the report, there are differences between the PPO sample and the matched sample in the number of offences committed directly before the PPO programme. The reader should also recall the caveat that, if the criteria used in the matching do not exhaust those on the ground, the analysis is vulnerable.

An essential aspect of the PSM procedure are the checks that the PSM model undergoes to ensure a valid comparison between the treatment and control group. The first stage of testing the match is to assess the distribution of the propensity score in the treatment (PPO sample) and comparison groups (matched sample). As can be seen from Figure G below, the distribution of propensity scores matched well between the groups.

Figure G: Comparing the propensity score in the PPO sample and the matched sample



The second test involves using the balancing test proposed in Rosenbaum and Rubin (1983, 1984). This operates by dividing the treatment group into a number of strata based on the propensity score. If the treatment and comparison groups are not significantly different from each other within these strata then the participation model has been adequately specified to balance the characteristics (Bryson, Dorsett and Purdon, 2002). In this case the propensity score has been banded into the deciles outlined in the following table.

Figure H: The PPO and PSM groups split by banding

	Start of propensity score	End of propensity score	Number of PPOs	Number of matched sample
Band 1	0	0.2457570620	756	756
Band 2	0.2457570620	0.4406574340	756	755
Band 3	0.4406574340	0.5543683440	755	756
Band 4	0.5543683440	0.6282041260	756	756
Band 5	0.6282041260	0.6928902400	756	757
Band 6	0.6928902400	0.7522664920	755	753
Band 7	0.7522664920	0.8063567240	756	757
Band 8	0.8063567240	0.8583785460	755	756
Band 9	0.8583785460	0.9064285640	756	753
Band 10	0.9064285640	1	756	758

The following graphs explore key demographic differences between the PPO and control group split by bands: in particular, sex, the average number of previous offences, custodial sentences and ethnicity.

As can be seen from the graphs below, in respect of gender, the average number of convictions and previous custodial sentences, the two groups have a similar breakdown within each of the bands.

Figure I: Comparing the probability bands by sex (male)

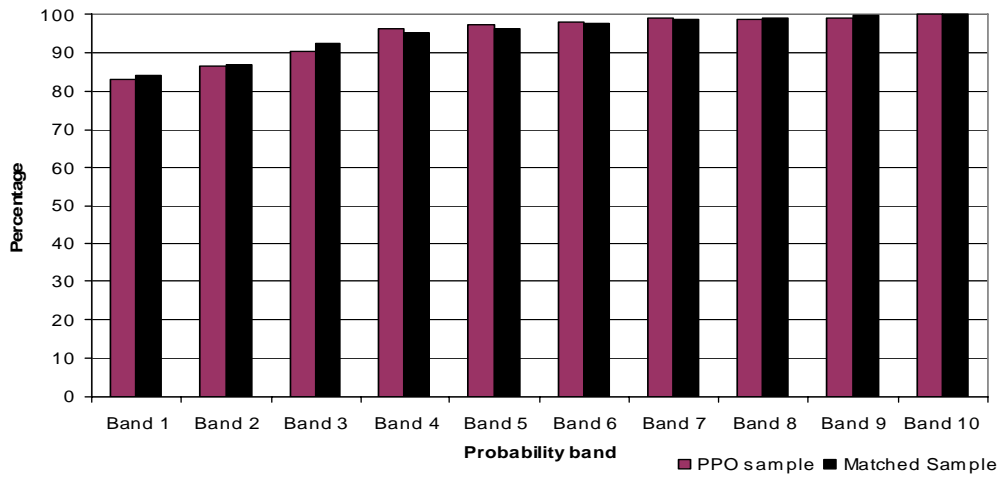


Figure J: Comparing the probability bands by the average number of previous offences

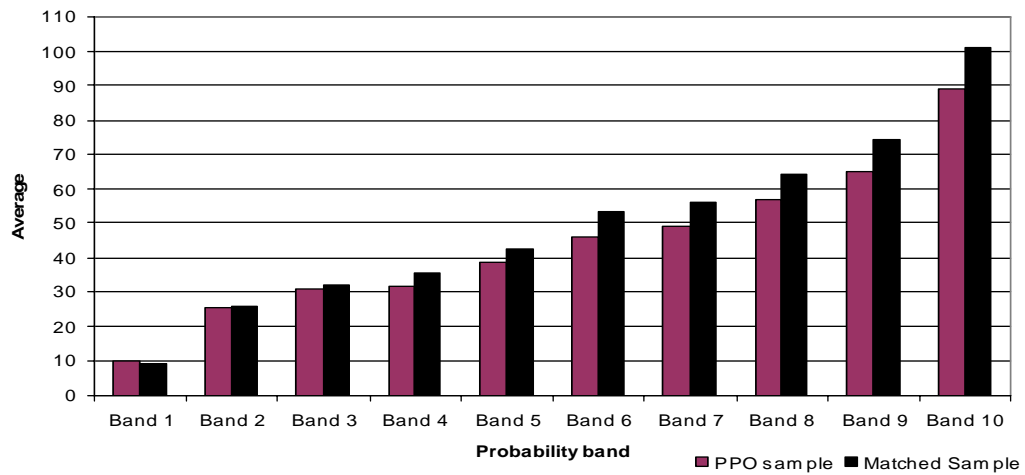
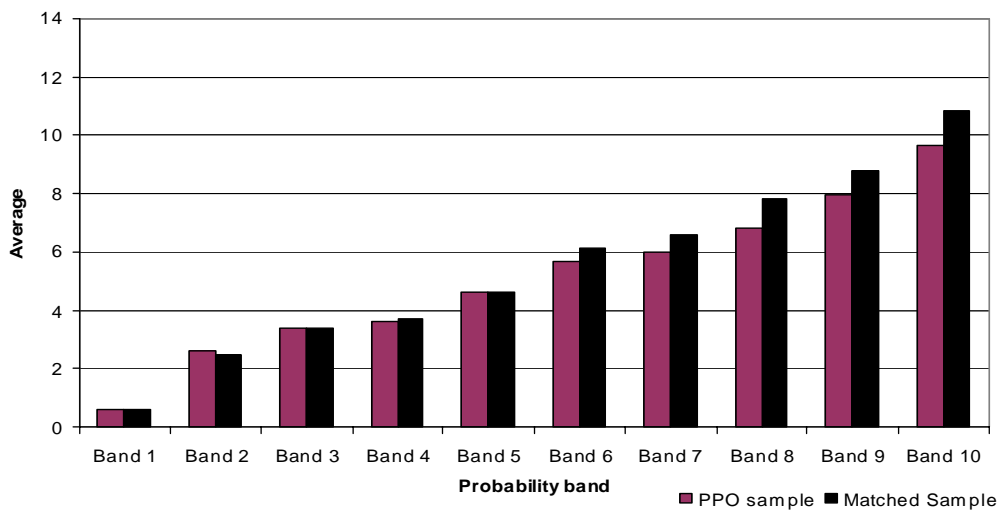
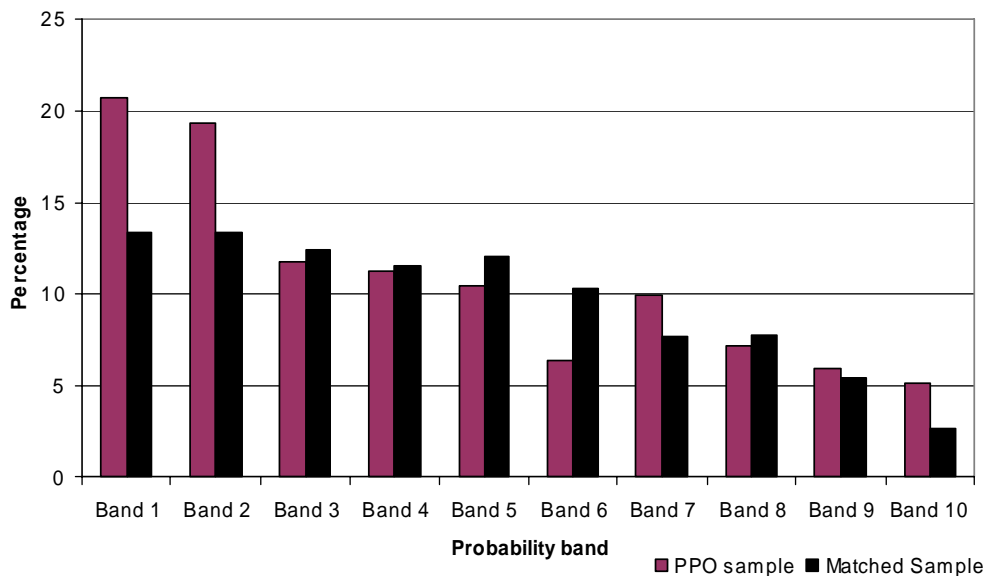


Figure K: Comparing the probability bands by the average number of previous custodial sentences



The only tested characteristic which did not show a similar pattern in the banding was ethnicity. This could suggest that ethnicity may have been used in the model, as it has a potential effect on the chance that an offender was selected as a PPO.

Figure L: Comparing the probability bands by percentage of offenders who are not White

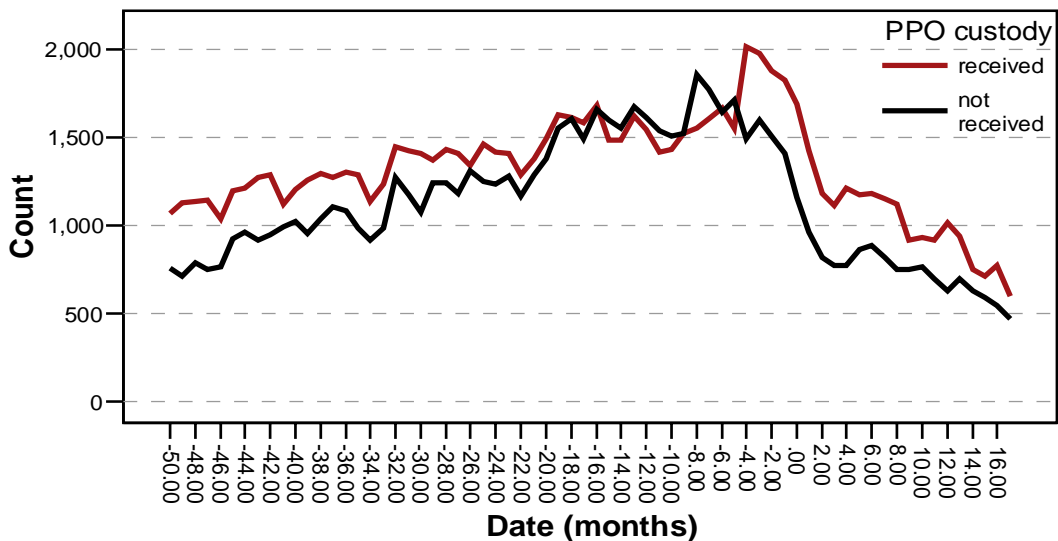


In conclusion, the PPO sample and the matched sample were tested within a number of characteristics and it was clear that the samples tended to have similar characteristics within each of the bands. These suggest that the match was apparently successful and can be used to evaluate the PPO programme.

The effect of custody on the PPO programme

It is worth noting here that the initial drop in recorded convictions following entry onto the PPO programme has not been caused by a sudden rise in custodial sentences. To assess the impact of custodial sentences on the analysis, the PPO cohort was divided into those who had received and those who had not received a custodial sentence whilst on the programme. As can be seen from the graph below both groups displayed the sharp reduction in convictions previously identified. As a result it is unlikely that the increase in custodial sentences explains the overall decrease in PPO convictions.

Figure M: PPOs with and without custodial sentences



Proofs of the theorems on which PSM is based

Below are informal intuitive sketched proofs of the two key results on which Propensity Score Matching is based.

If z is the treatment selection variable, r_0, r_1 are the outcome variables under $z=0$ and $z=1$, $e(x)$ is the propensity score, and $b(x)$ a balancing score (in the sense that $f(b(x)) = e(x)$ for some function f) then

$$\Pr(z=1 / b(x)) = E [\Pr(z=1 / x) / b(x)] = E [e(x) / b(x)] = E [f(b(x)) / b(x)] = f(b(x)) = e(x) \\ = \Pr(z=1 / x) = \Pr(z=1 / x, b(x))$$

Hence z is independent of x given $b(x)$

$$\Pr(z=1 / r_0, r_1, b(x)) = E [\Pr(z=1 / r_0, r_1, x) / r_0, r_1, b(x)] = E [\Pr(z=1 / x) / r_0, r_1, b(x)] \text{ if } z \\ \text{is independent of } r_0, r_1 \text{ given } x$$

$$= E [e(x) / r_0, r_1, b(x)] = E [f(b(x)) / r_0, r_1, b(x)] = f(b(x)) = e(x) = \Pr(z=1 / b(x)) \text{ from the} \\ \text{first theorem.}$$

Hence z is independent of r_0, r_1 given $b(x)$

Both proofs are large sample results and hence, in practice, balancing tests are needed to check the balance achieved. In addition, the second result depends on the assumption that z is independent of r_0, r_1 given x which is a non-trivial assumption. This assumption is referred to in the literature as the assumption of 'strong ignorability', or the assumption of conditional independence (depending on the author). Basically, one needs the vector of covariates x to include all of the covariates which explain z and all of the covariates which explain r_0, r_1 .

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