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Evaluating Continuous Training Programs Using the Generalized Propensity Score

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Jochen Kluge, Hilmar Schneider,
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#35



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Evaluating Continuous Training Programs Using the Generalized Propensity Score

Abstract

This paper assesses the dynamics of treatment effects arising from variation in the duration of training. We use German administrative data that have the extraordinary feature that the amount of treatment varies continuously from 10 days to 395 days (i.e. 13 months). This feature allows us to estimate a continuous dose-response function that relates each value of the dose, i.e. days of training, to the individual post-treatment employment probability (the response). The dose-response function is estimated after adjusting for covariate imbalance using the generalized propensity score, a recently developed method for covariate adjustment under continuous treatment regimes. Our data have the advantage that we can consider both the actual and planned training durations as treatment variables: If only actual durations are observed, treatment effect estimates may be biased because of endogenous exits. Our results indicate an increasing dose-response function for treatments of up to 100 days, which then flattens out. That is, longer training programs do not seem to add an additional treatment effect.

JEL Classification: C21, J68

Keywords: Training, program evaluation, continuous treatment, generalized propensity score

December 2007

* Jochen Kluge, RWI Essen and IZA Bonn; Hilmar Schneider, IZA Bonn; Arne Uhlendorff, IZA Bonn and DIW DC; Zhong Zhao, IZA Bonn. – The data used in this paper originate in the evaluation of continuous training programs as part of the evaluation of the so-called Hartz-Reforms. The corresponding report by IZA et al. 2007 (cf. references) contains details. We would like to thank Oscar Mitnik, Peter Mueser, Donald Parsons, Ulf Rinne, Gerard van den Berg, participants of the VfS Conference in Munich, the COST meeting in St. Gallen, and seminars at the George Washington University, the World Bank and the Washington Statistical Society for valuable discussions and helpful comments. Arne Uhlendorff also thanks DIW DC, where part of this research was pursued during his stay in fall 2007. The usual disclaimer applies. – Correspondence to kluge@rwi-essen.de, schneider@iza.org, uhlendorff@iza.org, zhao@iza.org.

1. Introduction

Over recent years there has been an increasing amount of research on the effectiveness of labor market training programs in many countries. Training programs represent the "classic" type of so-called active labor market programs, due to their objective of enhancing participants' employment prospects by increasing their human capital. While the evidence on early training programs in the 1970s and 1980s showed relatively optimistic results, the more recent research from the 1990s and 2000s – generally based on much better data and advanced econometric methods – points to the result that training programs seem to be modestly effective at best (Heckman et al. 1999, Kluge 2006). Adding to this general finding, one recent line of research shows that positive treatment effects may only materialize in the long run, and that program effectiveness can show a considerable dynamic ranging from often severe short-term locking-in effects to long-term gains in employment prospects (e.g. Lechner et al. 2004).

In this paper we contribute to the literature on training programs by focusing on the dynamics inherent to the provision of training, i.e. we study the treatment effects that arise from variation in the treatment duration. We implement this analysis on the basis of data on training programs in Germany. The key feature of the data is the fact that the treatment duration varies almost continuously from approximately 1 week duration up to approximately 13 months. We focus on programs in which no specific degree is acquired as part of the program requirements – this is the majority of training programs in Germany (about 70% in 2000, for instance). Training programs leading to the acquisition of a degree are not considered, since the degree requirement generates discontinuities in the distribution of treatment durations, and the objective of the analysis in this paper is to estimate the employment outcomes associated with each level of a continuous treatment.

The evaluation question that corresponds to the continuous administering of training is how effective (relative to each other) are training programs with different durations? This assessment of the dynamics of treatment duration essentially amounts to estimating a dose-response function. In this paper we therefore estimate the responses – i.e. the employment probability – that correspond to specific values of continuous doses – i.e. training of a particular length. In a setting in which doses are not administered under experimental conditions, estimation of a dose-response function is possible using the generalized propensity score (GPS). The GPS for continuous treatments is a straightforward extension of the well-established and widely used propensity score methodology for binary treatments (Rosenbaum

and Rubin 1983) and multi-valued treatments (Imbens 2000, Lechner 2001). The GPS methodology is developed in Hirano and Imbens (2004) and Imai and van Dyk (2004). Similar to the binary and multi-valued treatment propensity score methods it is assumed that – conditional on observable characteristics – the level of treatment received can be considered as random. Hirano and Imbens (2004) show that the GPS has a balancing property similar to the balancing property of the "classic" propensity score. This implies that individuals within the same strata of the GPS should look identical in terms of their observable characteristics, independent of their level of treatment. To our knowledge, our paper along with parallel work by Flores-Lagunes et al. (2007) constitutes the first application of the GPS in the context of evaluating active labor market policy.

In implementing the GPS approach, our data have the advantage that we can consider both the actual and planned training durations as treatment variables: If only actual durations are observed, treatment effect estimates may be biased because of endogenous exits. This could be the case, for instance, if observed durations are shorter than the initially planned durations, because people exit from the program early if they find a job. The bias could also point the other way, if a substantial fraction of program participants drops out early. We investigate these issues by taking into account both the actual and planned durations of individual program participants.

The paper is organized as follows. Section 2 describes the methodology of estimating a dose-response function to evaluate a continuous policy measure, adjusting for the generalized propensity score. Section 3 gives details on the data and the treatment we study. The fourth section contains the application and discusses the results of balancing the covariates as well as our estimates of the dose-response function. We also implement several robustness checks. Section 5 concludes.

2. Bias removal using the Generalized Propensity Score

Research in program evaluation in recent years has made comprehensive use of matching methods³. In the absence of experimental data, which is largely the case, the popularity of matching is due to its intuitively appealing technique of mimicking an experiment *ex post*.

³ Cf. *inter alia* the overview given in Augurzky and Kluve (2007) and articles in a recent symposium on the econometrics of matching in *The Review of Economics and Statistics* (2004, Vol. 86, No. 1, pp. 1-194), in particular the survey article by Imbens (2004).

The standard case, which is also appropriate for the majority of applications, considers a binary treatment. One of the key results that have made matching such an attractive empirical tool is developed in Rosenbaum and Rubin (1983), who show that, rather than conditioning on the full set of covariates, conditioning on the propensity score – i.e. the probability of receiving the treatment given the covariates – is sufficient to balance treatment and comparison groups.

Subsequently, the literature has extended propensity score methods to the cases of multi-valued treatments (Imbens 2000, Lechner 2001) and, more recently, continuous treatments (Imbens 2000, Behrmann, Cheng and Todd 2004, Hirano and Imbens 2004, Imai and van Dyk 2004). In this paper, we build on the approach developed by Hirano and Imbens (2004) who propose estimating the entire dose-response function (DRF) of a continuous treatment. This approach fits perfectly with the objective of our paper, since we are interested in the response – i.e. the post-treatment employment probability – associated with each value of the continuous dose, i.e. the days spent in training.

2.1 The GPS methodology

Hirano and Imbens (2004) develop the GPS methodology in the context of the potential outcomes model for estimation of causal effects of treatments. In what follows we closely follow their presentation. Suppose we have a random sample of units, indexed by $i=1, \dots, N$. For each unit i there exists a set of potential outcomes $Y_i(t)$ for $t \in \mathcal{T}$, referred to as the unit-level dose-response function. In the continuous case, \mathcal{T} is an interval $[t_0, t_1]$, whereas in the binary case it would be $\mathcal{T} = \{0,1\}$. Our objective is to estimate the average dose-response function (ADRF) $\sigma(t) = E[Y_i(t)]$. For each unit i , we observe a vector of covariates X_i , the level T_i of the treatment that unit i actually receives, with $T_i \in [t_0, t_1]$, and the potential outcome corresponding to the level of treatment received, $Y_i | Y_i(T_i)$. In the remainder of this section the subscript i will be omitted to simplify notation.

The key assumption of Hirano and Imbens (2004) generalizes the *unconfoundedness* assumption for binary treatments made by Rosenbaum and Rubin (1983) to the continuous case:

$$(1) \quad Y(t) \perp T | X \text{ for all } t \in \mathcal{T}.$$

Hirano and Imbens (2004) refer to this as *weak unconfoundedness*, since it only requires conditional independence to hold for each value of the treatment, rather than joint independence of all potential outcomes. Calling $r(t, x) | f_{T|X}(t | x)$ the conditional density of the treatment given the covariates, the *Generalized Propensity Score (GPS)* is defined as

$$(2) \quad R | r(T, X).$$

The GPS has a balancing property similar to the balancing property of the propensity score for binary treatments. Within strata with the same value of $r(t, X)$ the probability that $T=t$ does not depend on the value of X , i.e. the GPS has the property that $X \perp \mathbf{1}\{T = t\} | r(t, X)$. Hirano and Imbens (2004) emphasize that this is a mechanical implication of the definition of the GPS and does not require unconfoundedness. In combination with unconfoundedness, however, it implies that assignment to treatment is unconfounded given the GPS. That is, Hirano and Imbens (2004) prove that, if assignment to treatment is weakly unconfounded given covariates X , then it is also weakly unconfounded given the Generalized Propensity Score.

Given this result, it is possible to use the GPS to remove bias associated with differences in covariates in two steps. The first step is to estimate the conditional expectation of the outcome as a function of two scalar variables, the treatment level T and the GPS R , i.e.

$$(3) \quad \eta(t, r) | E[Y | T = t, R = r].$$

The second step is to estimate the DRF at each particular level of the treatment. This is implemented by averaging the conditional expectation function over the GPS at that particular level of the treatment,

$$(4) \quad \sigma(t) | E[\eta(t, r(t, X))].$$

The procedure does not average over the GPS $R=r(T, X)$, but instead it averages over the score evaluated at the treatment level of interest $r(t, X)$. Hirano and Imbens (2004) also emphasize that the regression function $\eta(t, r)$ does not have a causal interpretation, but that $\sigma(t)$ corresponds to the value of the DRF for treatment value t , which compared to another treatment level t' does have a causal interpretation.

2.2 Implementation

In the practical implementation of the methodology outlined in the previous section, we use a normal distribution for the treatment given the covariates

$$(5) \quad T_i | X_i \sim N(\eta_0 + \eta_1' X_i, \omega^2),$$

which we estimate by ordinary least squares regression (OLS).⁴ The estimated GPS is calculated as

$$(6) \quad \hat{R}_i | \frac{1}{\sqrt{2\phi\hat{\omega}^2}} \exp\left(-\frac{1}{2\hat{\omega}^2} (T_i - \eta_0 - \eta_1' X_i)^2\right).$$

In the second stage we calculate the conditional expectation function of Y_i given T_i and R_i as a flexible function of its two arguments. Our empirical approach uses the following approximation.

$$(7) \quad E[Y_i | T_i, R_i] \approx \zeta_0 + \zeta_1 T_i + \zeta_2 T_i^2 + \zeta_3 T_i^3 + \zeta_4 R_i + \zeta_5 R_i^2 + \zeta_6 R_i^3 + \zeta_7 T_i R_i + \zeta_8 T_i^2 R_i + \zeta_9 T_i R_i^2.$$

For each individual the observed T_i and estimated GPS \hat{R}_i is used, and the equation is estimated by OLS. Given the estimated parameters in the second stage, we estimate the average potential outcome at treatment level t as

$$(8) \quad E[Y(t)] \approx \frac{1}{N} \sum_{i=1}^N (\zeta_0 + \zeta_1 t + \zeta_2 t^2 + \zeta_3 t^3 + \zeta_4 \hat{r}(t, X_i) + \zeta_5 \hat{r}(t, X_i)^2 + \zeta_6 \hat{r}(t, X_i)^3 + \zeta_7 t \hat{r}(t, X_i) + \zeta_8 t^2 \hat{r}(t, X_i) + \zeta_9 t \hat{r}(t, X_i)^2).$$

The entire dose-response function can then be obtained by estimating this average potential outcome for each level of the treatment. In our application, we use bootstrap methods to obtain standard errors that take into account estimation of the GPS and the ζ parameters. In addition to the specification in equation (8) we also implement several other specifications in order to allow for sufficiently flexible functional forms.

⁴ It is possible to assume other distributions than the normal distribution, and estimate the GPS by other methods such as maximum likelihood. The key point here, however, is to make sure that the covariates are balanced after adjusting for the GPS: As long as sufficient covariate balance is achieved, the exact procedure of estimating the GPS is of secondary importance.

2.3 Testing for balancing of covariates and common support condition

Just as in the case of a binary treatment, in the continuous case it is crucial to evaluate how well adjustment for the GPS works in balancing the covariates, i.e. if the specification for estimation of expression (5) is adequate. Whereas in the binary case the typical approach is to compare the covariate means for the treated and control units before and after matching, testing for covariate balance is more difficult with continuous treatments.

Hirano and Imbens (2004) propose *blocking* on both the treatment variable, i.e. length of training in our case, and on the estimated GPS. We implement this by first dividing the sample into three groups according to the distribution of treatment length, cutting at the 30th and 70th percentile of the distribution. Within each group we evaluate the GPS at the median of the treatment variable. Then, in a second step we divide each group into five blocks by the quintiles of the GPS evaluated at the median, considering only the GPS distribution of individuals in that particular group.

Within each of these blocks we calculate the difference-in-means of covariates with respect to individuals that have a GPS such that they belong to that block, but have a treatment level different from the one being evaluated. This procedure tests if for each of these blocks the covariate means of individuals belonging to the particular treatment-level group are significantly different from those of individuals with a different treatment level, but similar GPS. A weighted average over the five blocks in each treatment-level group can be used to calculate the t-statistic of the differences-in-means between the particular treatment-level group and all other groups. The procedure needs to be repeated for each treatment-level group and for each covariate. If adjustment for the GPS properly balances the covariates, we would expect all those differences-in-means to not be statistically different from zero.

Similar to standard propensity matching methods, common support is also a concern in the GPS application. We propose to test the common support condition as follows⁵: First, following the procedure for testing for the balancing of covariates, we divide the sample into three groups according to the distribution of treatment length, cutting at the 30th and 70th percentile of the distribution. Then we evaluate the GPS at the group median of the treatment duration variable. For example, we evaluate the GPS for the whole sample at the median treatment duration of group 1, and after that we plot the distribution of the evaluated GPS for group 1 vs. the distribution of the GPS for the rest of the sample. Like in the case of binary

⁵ We thank Peter Mueser for suggesting this approach.

propensity score matching, by inspecting the overlap of these two distributions we are able to examine the common support condition graphically. In the same fashion, we can test the common support condition of groups 2 and 3 vs. the rest of the sample.

3. Data

In this paper we use a sample of a particularly rich administrative data set, the Integrated Employment Biographies (IEB) of the German Federal Employment Agency FEA (Bundesagentur für Arbeit). The data contain detailed daily information on employment subject to social security contributions, including occupational and sectoral information, receipt of transfer payments during periods of unemployment, job search activity, and participation in different programs of Active Labor Market Policy (ALMP). Furthermore, the IEB comprise a large variety of covariates like age, education, disability, nationality and regional indicators.

Training participants in the programs we consider learn specific skills required for a certain vocation (e.g. computer-aided design for a technician/tracer) or receive qualifications that are of general vocational use (e.g. MS Office, computer skills). Numerically, these program types constitute the most important ones among all publicly financed training programs: In 2000, roughly 70% of all participants in training programs were assigned to this type (Schneider and Uhlendorff 2006, IZA et al. 2007).

We focus on men only. Our sample of participants consists of about 265 unemployed persons per quarter entering the program during the years 2000, 2001, and 2002, i.e. we observe approximately 3180 program participants. The data allow us to draw conclusions on the average participant starting a program during this time period. The programs comprise both occupation-specific training programs ("berufsbezogene Weiterbildung") and general training programs ("berufsübergreifende Weiterbildung"). The core feature of these training programs is the fact that treatment provision is a continuous variable, since the elapsed duration of training varies from approx. 1 week up to 13 months. We exclusively focus on programs that do not lead to the acquisition of a degree, as the degree requirement would likely create discontinuities in the distribution of the treatment duration. For all participants we know the initial length of the treatment they were assigned to (i.e. the planned duration), as well as how long they actually stayed in the treatment (i.e. the actual duration).

We discard observations with treatment duration below 10 days, since such short durations arguably do not imply a serious attempt at finishing the program. Durations above 395 days are also discarded, since only very few observations are available. We do not consider durations of length zero, i.e. no non-treated individuals are included. Instead, we focus on the average responses of those individuals that did receive some treatment. Figure 1 shows the distribution of treatment durations, both for the actual and planned durations. We observe that the same two peaks exist in both distributions, at durations of 180 days and 360 days, respectively.

[Figure 1 about here]

The responses, i.e. the outcome variables of interest are (i) the employment probability at time 1 year after exit from the program, and (ii) the employment probability at time 2 years after entry into the program. Table 1 presents summary statistics of the two outcome variables and the covariates, for the full sample (columns 1 and 2) as well as for three sub-samples, “early exits” (i.e. actual duration < planned duration, columns 3 and 4), “late exits” (i.e. actual duration > planned duration, columns 5 and 6), and “exits as planned” (i.e. actual duration = planned duration, columns 7 and 8). The share of individuals who stayed in the program exactly as long as planned is quite high (68.7%). In the case in which actual and planned durations differ, early exits are much more common than late exits (22.1% and 9.2% of observations, respectively).

As Table 1 shows, the data contain a large number of covariates. In particular, we can use information on numerous variables that have been identified in the program evaluation literature to be important determinants of selection into a program: This comprises detailed data on citizenship and educational background, including vocational education. Moreover, we have detailed information on pre-treatment employment histories as well as regional indicators. Given the richness of the covariates along with the fact that we focus on participants only, rather than on a treatment vs. no-treatment comparison, the assumption of unconfoundedness seems entirely reasonable.

[Table 1 about here]

Table 1 also shows that the covariate distributions are very similar across all (sub-) samples. Looking at the full sample, the participants are on average 37 years old, around 9% of them

are handicapped and 12% do not have the German citizenship. The participants are on average relatively low-skilled: more than 60% did not get further than the first stage of secondary level education, around 35% do not have any vocational degree, and only a minority (7%) has obtained a university degree. Before entering a program the participants were on average unemployed for 9 months, and their previous employment lasted for about 21 months. The individuals for whom we observe a wage for their last employment earned around 50 Euros per day. For the previous employment history we construct eight variables describing the share of time spent in employment and unemployment, respectively, during each of the four years before entering the program. Looking at the outcomes, two years after program entry as well as one year after the program ended around 35% of the participants are employed.

Figure 2 contains six panels plotting unadjusted outcomes – i.e. employment probability two years after program entry as well as employment probability one year after program exit – against the three treatment variables, i.e. actual, planned, and actual=planned durations. The figures generally show an increasing trend: After an initial dip in employment probability during the first month in the program, employment rates seem to increase with the length of participation.

[Figure 2 about here]

4. Empirical results

4.1 Estimates from a Linear Probability Model

As mentioned in Section 3, in this paper we consider two outcome variables: one is the employment probability at the point in time 2 years after the participants entered into the program, and the second one is the employment probability at the point in time 1 year after the participants exited from the program. Before presenting results for the GPS, we explore first the relationship between post-treatment employment probability and the duration of treatment using a linear probability model (LPM). Table 2, parts a) and b), investigates the relationship between the employment probability at 2 years after entering into the program and 1 year after exit from the program, respectively, with the treatment duration.

[Table 2 about here]

From these tables, we have several observations. They show that there is a positive correlation

between employment probability and treatment duration, and a negative correlation between employment probability and the square of the treatment duration with or without controlling for additional variables. However, the estimated coefficients of the treatment duration are small, and the explanatory power of the treatment duration is low.⁶ These suggest that the impact of treatment duration on the employment probability is small or negligible.

However, it is worth noting that a regression type analysis such as the LPM models may rely on extrapolation, compare incomparable observations, and have greater risk of mis-specifying the model. All of these could potentially bias the estimates. Propensity score methods can alleviate these potential problems to some extent.

The key assumption for the GPS is the weak unconfoundedness assumption, also known as the assumption of selection on observables. As an identifying assumption, it is not statistically testable. One typical case of violating this assumption is the possibility that treatment duration is endogenous. In our data, besides the actual training duration, we also know the planned training duration. The planned duration is determined prior to the program, which is arguably exogenous. We can use the information on the planned duration to test the endogeneity of the actual treatment duration. Tables 3a and 3b are instrumental variables (IV) estimates using planned duration as IV. Comparing these IV estimates to the OLS estimates in Tables 2a and 2b, we find that they are not significantly different (see the results of the Hausman test in Tables 3a and 3b). This suggests that the actual training duration may not suffer strongly from endogeneity.

[Table 3 about here]

4.2 GPS Estimation, Covariate Balance, and Common Support

Our implementation of the generalized propensity score follows the procedure outlined in Hirano and Imbens (2004) and adapted to our context as presented in section 3 above. We first estimate the conditional distribution of the length of the training program (treatment) by applying OLS. Table 4 contains the results.

[Table 4 about here]

⁶ See low adjusted R-squared in Panel A of Tables 2a and 2b.

To assess the balancing property of the GPS (cf. section 2.3) we compare the distribution of covariates between three groups, which are defined by cutting the distribution of treatment duration at the 30th and 70th percentiles. We implement this for both the actual and planned durations. For actual durations, group 1 includes individuals with a treatment level between 11 and 137 days, group 2 ranges from 138 to 247 days and group 3 from 248 to 395 days. For planned durations, group 1 includes individuals with a treatment level between 11 and 167 days, group 2 ranges from 168 to 271 days and group 3 from 272 to 395 days. The groups therefore reflect the fact that on average actual durations are shorter than planned durations.

For each of the covariates we test whether the difference in means of one group compared to the other two groups is significantly different. In the left part of Tables 5 and 6 the corresponding t-statistics are reported. Without adjustment the clear majority of t-statistics are greater than 1.96, indicating a clearly unbalanced distribution of covariates.

[Tables 5, 6 about here]

In the second step, we calculate the corresponding t-statistics for the GPS-adjusted sample. To do this, we evaluate the GPS for each individual at the median of the three groups, i.e. at the lengths of 84 days, 180 days, and 332 days for the actual duration, and at the lengths of 117 days, 184 days, and 348 days for the planned duration. For each of the three groups, we discretize the GPS by using five blocks, evaluated by the quintiles of the GPS within each group. In other words, we calculate for the first group for the actual duration, consisting of individuals with an actual treatment ranging from 11 to 137 days, the GPS evaluated at the median of this group (84 days). The distribution of the GPS $r(84, X_i)$ is then discretized into five blocks using the quintiles of the distribution. For the first group, this leads to the intervals [0.00005, 0.0017], [0.0017, 0.0025], [0.0025, 0.0030], [0.0030, 0.0035] and [0.0035, 0.0045]. To assess the balancing of the adjusted sample, members of the first group with a GPS in the first range are compared with individuals who are not member of the first group, i.e. who have a different level of treatment, but who have a GPS $r(84, X_i)$ lying in the first interval as well. For each group, this implies five mean differences and five standard errors. The t-statistics reported on the right hand side of Tables 5, 6 correspond to the mean difference for each group. To calculate these mean t-statistics, the corresponding differences and standard errors of the five blocks are weighted by the number of observations.

In contrast to the unadjusted sample, we observe no t-statistics larger than 1.96 for the planned duration (Table 6) and only one t-statistic larger than 1.96 for the actual duration (Table 5). These results indicate that the balance of the covariates is clearly improved by adjustment for the GPS.

To test the common support condition for the actual duration, following the approach outlined in section 2.3, we divide the sample into three groups as we have done above when testing for covariate balance. Then we evaluate the GPS of the whole sample at the median treatment duration of group 1, i.e. 84 days. After that we plot the distribution of the evaluated GPS of group 1 and the same distribution of the rest of the sample in the same figure, which is the first panel of Figure 3. We repeat the same procedure for group 2 and group 3, and these give us the second and the third panels of Figure 3. These figures show that, with the exception of very few cases in the low tail of the second panel, the common support condition is satisfied. The last three panels of Figure 3 show results for the planned duration. These are very similar to the ones observed for the actual duration, i.e. common support is given.

[Figure 3 about here]

4.3 Results from estimating the dose-response function

The final step of our empirical analysis consists in estimating the GPS-adjusted dose-response function. Table 7 contains the estimation results for the dose-response function. Our main results for both outcome variables are presented in Figures 4 and 5, where each figure consists of three parts showing results for a) the actual duration, b) the planned duration, and c) for the subsample of individuals for which actual duration equals planned duration. The figures also include the non-participant employment probability baseline⁷, which indicates that training effects are generally positive. Standard errors are bootstrap standard errors from 2,000 replications.

[Table 7 about here]

[Figures 4, 5 about here]

As the figures show, the dose-response functions for both outcome variables considered have similar shapes for all specifications. They generally vary depending on the treatment variable considered: specifications based on the actual duration are rather flat, showing little variation

⁷ This is a covariate-adjusted baseline derived from standard binary matching methods.

of the outcome with respect to different durations. Specifications based on the planned durations show an increase in employment probability for the short durations of up to around 100 days, a slight dip for durations of about 200 to 250 days, and a final decrease for durations longer than 330 days (where confidence bands, however, are quite large). The subsample for which actual durations equals planned ones confirms this profile: while it is generally flatter for the long durations, it emphasizes the increase in the treatment effect for durations of up to 100 days.

4.4 Robustness

In this section, we carry out several sensitivity checks for our main estimation. The first check is that we further restrict our sample to the people who went through a training program exactly once. In the second check, we try different specifications for the dose-response functions, and also present estimates from LPM and probit models. Finally, we use planned duration as an instrumental variable for actual treatment duration, and estimate the local average treatment effect (LATE) as developed in Imbens and Angrist (1994).

Figures 4 and 5 also plot dose-response functions for a subsample of our data (labeled “dose-response for subsample” in the graphs). The original data contain information on whether a training participant, after having taken part in the course which we analyze here, participated in another training course at some point in time. These are about 7% of individuals in our sample. We therefore include results for the subsample of observations that participated in exactly the one course for which we have data on planned and actual durations. Regarding the shape of the dose-response functions, results for the subsample are very similar to the full sample. It is worth noting though, that the employment probabilities, and thus the treatment effects, are consistently larger for the subsample. In particular, the estimated average response is up to 3 percentage points higher (cf. Figure 5b).

Our main estimation is based on a cubic specification for the dose-response function. Figures 6 and 7 plot results for the dose-response function for the full sample for quadratic and 4th degree polynomial specifications as well. Like Figures 4 and 5, Figures 6 and 7 consider the two outcome variables and are structured in three parts reflecting actual, planned, and actual=planned durations. All six figures show that the general shapes and trends of the dose-response functions remain relatively unchanged under different specifications, though there are some differences in detail. Our central finding that the main body of the dose-response

functions is flat, i.e. longer training programs do not seem to add an additional treatment effect, is robust.

It is also interesting to compare the results from the GPS with the ones obtained directly from LPM and probit models. In Figure 6, both sets of results are quite similar, but in Figure 7, results from the GPS are rather different from the ones estimated using an LPM and a probit model. This suggests that in the case of Figure 7, a regression-type adjustment may not be sufficient to remove all observable bias, and the GPS provides a valuable alternative approach to control for differences in observables.

[Figures 6, 7 about here]

As we stated earlier, one of the paper's main findings is that longer training programs do not seem to add an additional treatment effect. We carry out another sensitivity check for this statement using an instrumental variable approach.

In our data, about 31% of participants' actual treatment durations differ from their planned duration. It is possible that the actual treatment duration could be endogenously determined by the participants. Fortunately, in our data, we also have information on the planned treatment duration, and this variable is decided prior the program, so we can use it as an instrumental variable to control for the possible endogeneity of the actual treatment duration.

We follow Imbens and Angrist (1994). First we discretize both actual and planned treatment duration variables into dummy variables according to the length of treatment. The indicator "1" means that the participants have a shorter duration (actual or planned), and "0" means otherwise. If the treatment duration has little impact on the outcome variables, the IV estimates should not significantly differ from zero, i.e. participants with shorter treatment durations have similar outcomes to the participants with longer treatment duration. In our empirical implementation, we use 5 different cutoff points, respectively, to define the two groups with the shorter vs. the longer treatment duration; i.e. we cut at the 15%, 30%, 50%, 70% and 85% percentiles of the distribution of the actual treatment duration.

[Table 8 about here]

Table 8 presents the results from this instrumental variable approach with or without controlling for additional variables. The different models 1 to 5 correspond to different cutoff points, from the 15% percentile to the 85% percentile. The majority of these estimates are insignificant, except for some cases in which the lower cutoff points are used.⁸ This provides additional evidence to support our finding from the GPS results that, if treatment duration has an impact at all, it is a weak impact during the first months, and longer durations seem to have no additional impact on the labor market outcomes of the participants.

5. Conclusions

In this paper, we study the effect of continuous training programs on the post-treatment employment probability, using a particular data set that contains information on training duration in days for a period of about 1 week to 13 months. In particular, we are interested in estimating the dose-response function at all possible treatment durations. We implement this using the recently developed generalized propensity score for continuous treatments. We are able to consider both the planned and actual durations as treatment variables, thus avoiding a potential bias in estimating the DRF from endogenous exits, which may play a role if only actual durations are observed. We conduct various robustness checks in order to further solidify our results.

Our findings indicate that the DRF has a relatively flat shape after an initial increase during the first 100 days of training. Indeed, the first three months of a training program appear to be the most effective period to improve the employment probability and bring about the generally positive effect relative to the non-participant baseline. After 100 days, however, further participation in the program does not seem to lead to an increase in the treatment effect. Whether the effect actually starts to decrease again for the very long durations (330 days +) cannot be said with certainty, as large confidence bands due to small number of observations exacerbate a precise estimation of this effect.

⁸ For these cases the estimates are negative, i.e. a shorter treatment duration relates to a lower outcome. This is also consistent with our GPS finding that the dose-responses are upward sloping in the lower treatment duration segment.

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Table 1. Summary Statistics

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|--|-------------|-------|-------------|-------|------------|-------|----------------|-------|
| | Full Sample | | Early Exits | | Late Exits | | Exits as plan. | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Age | 37.22 | 10.36 | 36.30 | 10.54 | 37.00 | 10.40 | 37.55 | 10.27 |
| <u>Disability</u> | | | | | | | | |
| Disability low degree | 0.07 | - | 0.09 | - | 0.04 | - | 0.07 | - |
| Disability medium degree | 0.01 | - | 0.00 | - | 0.00 | - | 0.01 | - |
| Disability high degree | 0.01 | - | 0.00 | - | 0.00 | - | 0.01 | - |
| <u>Citizenship</u> | | | | | | | | |
| Foreigner EU | 0.02 | - | 0.02 | - | 0.01 | - | 0.02 | - |
| Foreigner Non-EU | 0.10 | - | 0.11 | - | 0.14 | - | 0.10 | - |
| <u>Educational Attainment</u> | | | | | | | | |
| No graduation | 0.12 | - | 0.14 | - | 0.09 | - | 0.12 | - |
| First stage of secondary level | 0.48 | - | 0.53 | - | 0.48 | - | 0.47 | - |
| Second stage of secondary level | 0.26 | - | 0.23 | - | 0.29 | - | 0.26 | - |
| Advanced tech. college entrance qualification | 0.04 | - | 0.03 | - | 0.05 | - | 0.04 | - |
| General qualification for university entrance | 0.10 | - | 0.06 | - | 0.09 | - | 0.11 | - |
| <u>Vocational Attainment</u> | | | | | | | | |
| No vocational degree | 0.34 | - | 0.43 | - | 0.32 | - | 0.32 | - |
| In-plant training | 0.53 | - | 0.48 | - | 0.56 | - | 0.55 | - |
| Off-the-job training, voc. school, tech. school | 0.06 | - | 0.05 | - | 0.05 | - | 0.06 | - |
| University, advanced technical college | 0.07 | - | 0.04 | - | 0.07 | - | 0.07 | - |
| <u>Employment history</u> | | | | | | | | |
| Previous Unemployment Duration in months | 9.38 | 7.66 | 9.14 | 7.55 | 8.51 | 7.39 | 9.57 | 7.72 |
| Duration of last employment in months | 20.74 | 30.26 | 17.52 | 27.22 | 21.71 | 32.52 | 21.65 | 30.82 |
| Log(wage) of last employment | 3.61 | 1.17 | 3.59 | 1.12 | 3.47 | 1.32 | 3.63 | 1.16 |
| No last employment observed | 0.08 | - | 0.08 | - | 0.11 | - | 0.08 | - |
| Share of days in emp., 1 st year before program | 0.19 | - | 0.19 | - | 0.21 | - | 0.18 | - |
| Share of days in emp., 2 nd year before program | 0.38 | - | 0.36 | - | 0.40 | - | 0.38 | - |
| Share of days in emp., 3 rd year before program | 0.43 | - | 0.41 | - | 0.41 | - | 0.43 | - |
| Share of days in emp., 4 th year before program | 0.45 | - | 0.42 | - | 0.44 | - | 0.46 | - |
| Share of days in unemp., 1 st year before program | 0.67 | - | 0.68 | - | 0.64 | - | 0.67 | - |
| Share of days in unemp., 2 nd year before program | 0.39 | - | 0.43 | - | 0.36 | - | 0.39 | - |
| Share of days in unemp., 3 rd year before program | 0.34 | - | 0.37 | - | 0.33 | - | 0.33 | - |
| Share of days in unemp., 4 th year before program | 0.30 | - | 0.33 | - | 0.27 | - | 0.29 | - |
| <u>Outcome variables</u> | | | | | | | | |
| Employment two years after program entry | 0.35 | - | 0.35 | - | 0.33 | - | 0.38 | - |
| Employment one year after program exit | 0.34 | - | 0.35 | - | 0.34 | - | 0.33 | - |
| Number of Observations | 3162 | | 700 | | 291 | | 2171 | |

Table 2a. Estimated Effect of Treatment Duration on Employment Probability from Linear Probability Model

| Variables | (1) Coefficient | (2) Std. Error | (3) Coefficient | (4) Std. Error | (5) Coefficient | (6) Std. Error | (7) Coefficient | (8) Std. Error |
|--|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|
| Panel A: Only Control for Treatment Duration | | | | | | | | |
| Constant | 0.3354 | 0.0186 | 0.2989 | 0.0335 | 0.2948 | 0.0533 | 0.3052 | 0.0818 |
| Treatment Duration | 0.0001 | 0.0001 | 0.0005 | 0.0004 | 0.0006 | 0.0011 | 0.0002 | 0.0025 |
| Square of Treatment Duration | | | -1.11E-06 | 8.49E-07 | -1.71E-06 | 6.04E-06 | 2.18E-06 | 2.38E-05 |
| Cube of Treatment Duration | | | | | 9.89E-10 | 9.96E-09 | -1.38E-08 | 8.81E-08 |
| Fourth Power of Treatment Duration | | | | | | | 1.87E-11 | 1.10E-10 |
| Adjusted R Squared | -0.0002 | | 0.0001 | | -0.0002 | | -0.0005 | |
| Number of Observations | 3162 | | 3162 | | 3162 | | 3162 | |
| Panel B: Control for Treatment Duration and Other Variables | | | | | | | | |
| Constant | -0.1032 | 0.4742 | -0.1466 | 0.4746 | -0.1839 | 0.4759 | -0.1572 | 0.4791 |
| Treatment Duration | 3.72E-05 | 0.0001 | 0.0007 | 0.0003 | 0.0016 | 0.0010 | 0.0006 | 0.0023 |
| Square of Treatment Duration | | | -1.52E-06 | 8.19E-07 | -7.42E-06 | 5.71E-06 | 3.01E-06 | 2.24E-05 |
| Cube of Treatment Duration | | | | | 9.82E-09 | 9.40E-09 | -3.00E-08 | 8.30E-08 |
| Fourth Power of Treatment Duration | | | | | | | 5.02E-11 | 1.04E-10 |
| Other Control Variables: See Table 1 | | | | | | | | |
| Adjusted R Squared | 0.1371 | | 0.1378 | | 0.1378 | | 0.1376 | |
| Number of Observations | 3130 | | 3130 | | 3130 | | 3130 | |

Table 2b. Estimated Effect of Treatment Duration on Employment Probability from Linear Probability Model

| Variables | (1) Coefficient | (2) Std. Error | (3) Coefficient | (4) Std. Error | (5) Coefficient | (6) Std. Error | (7) Coefficient | (8) Std. Error |
|--|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|
| Panel A: Only Control for Treatment Duration | | | | | | | | |
| Constant | 0.3297 | 0.0186 | 0.3158 | 0.0334 | 0.3504 | 0.0532 | 0.3603 | 0.0816 |
| Treatment Duration | 0.00007 | 0.0001 | 0.0002 | 0.0004 | -0.0006 | 0.0011 | -0.0009 | 0.0025 |
| Square of Treatment Duration | | | -4.25E-07 | 8.46E-07 | 4.56E-06 | 6.03E-06 | 8.24E-06 | 2.37E-05 |
| Cube of Treatment Duration | | | | | -8.30E-09 | 9.93E-09 | -2.23E-08 | 8.79E-08 |
| Fourth Power of Treatment Duration | | | | | | | 1.77E-11 | 1.10E-10 |
| Adjusted R Squared | -0.0001 | | -0.0003 | | -0.0004 | | -0.0007 | |
| Number of Observations | 3162 | | 3162 | | 3162 | | 3162 | |
| Panel B: Control for Treatment Duration and Other Variables | | | | | | | | |
| Constant | -0.0821 | 0.4774 | -0.1036 | 0.4780 | -0.1056 | 0.4794 | -0.0765 | 0.4827 |
| Treatment Duration | 0.00006 | 0.0001 | 0.0004 | 0.0003 | 0.0004 | 0.0010 | -0.0007 | 0.0024 |
| Square of Treatment Duration | | | -7.53E-07 | 8.25E-07 | -1.06E-06 | 5.75E-06 | 1.03E-05 | 2.25E-05 |
| Cube of Treatment Duration | | | | | 5.17E-10 | 9.47E-09 | -4.30E-08 | 8.36E-08 |
| Fourth Power of Treatment Duration | | | | | | | 5.49E-11 | 1.05E-10 |
| Other Control Variables: See Table 1 | | | | | | | | |
| Adjusted R Squared | 0.1200 | | 0.12 | | 0.1197 | | 0.1195 | |
| Number of Observations | 3130 | | 3130 | | 3130 | | 3130 | |

Table 3a. IV Estimation of Effect of Treatment Duration on Employment Probability from Linear Probability Model

| Variables | (1) Coefficient | (2) Std. Error | (3) Coefficient | (4) Std. Error | (5) Coefficient | (6) Std. Error | (7) Coefficient | (8) Std. Error |
|--|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|
| Panel A: Only Control for Treatment Duration | | | | | | | | |
| Constant | 0.3433 | 0.0236 | 0.3246 | 0.0602 | 0.3426 | 0.1123 | 0.0080 | 0.1887 |
| Treatment Duration | 0.0000 | 0.0001 | 0.0002 | 0.0006 | -0.0001 | 0.0020 | 0.0104 | 0.0051 |
| Square of Treatment Duration | | | -4.93E-07 | 1.40E-06 | 1.57E-06 | 1.05E-05 | -9.80E-05 | 4.47E-05 |
| Cube of Treatment Duration | | | | | -3.27E-09 | 1.63E-08 | 3.57E-07 | 1.56E-07 |
| Fourth Power of Treatment Duration | | | | | | | -4.40E-10 | 1.88E-10 |
| Adjusted R Squared | -0.0002 | | -0.0001 | | -0.0006 | | 0 | |
| Number of Observations | 3162 | | 3162 | | 3162 | | 3162 | |
| Hausman Test: Chi-Squared | 0.3000 | | 0.3200 | | 0.2600 | | 9.7100 | |
| Probability>Chi-Squared | 0.5829 | | 0.8523 | | 0.8766 | | 0.0078 | |
| Panel B: Control for Treatment Duration and Other Variables | | | | | | | | |
| Constant | -0.0992 | 0.4746 | -0.1995 | 0.4772 | -0.2855 | 0.4850 | -0.5157 | 0.5051 |
| Treatment Duration | 1.87E-05 | 0.0001 | 0.0012 | 0.0006 | 0.0032 | 0.0019 | 0.0108 | 0.0048 |
| Square of Treatment Duration | | | -2.82E-06 | 1.32E-06 | -1.33E-05 | 9.97E-06 | -8.57E-05 | 4.22E-05 |
| Cube of Treatment Duration | | | | | 1.67E-08 | 1.55E-08 | 2.79E-07 | 1.48E-07 |
| Fourth Power of Treatment Duration | | | | | | | -3.21E-10 | 1.78E-10 |
| Other Control Variables: See Table 1 | | | | | | | | |
| Adjusted R Squared | 0.1371 | | 0.1369 | | 0.1359 | | 0.1299 | |
| Number of Observations | 3130 | | 3130 | | 3130 | | 3130 | |
| Hausman Test: Chi-Squared | 0.0400 | | 1.5700 | | 2.4300 | | 7.3300 | |
| Probability>Chi-Squared | 1.0000 | | 1.0000 | | 1.0000 | | 1.0000 | |

Table 3b. IV Estimation of Effect of Treatment Duration on Employment Probability from Linear Probability Model

| Variables | (1) Coefficient | (2) Std. Error | (3) Coefficient | (4) Std. Error | (5) Coefficient | (6) Std. Error | (7) Coefficient | (8) Std. Error |
|--|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|--------------------|-------------------|
| Panel A: Only Control for Treatment Duration | | | | | | | | |
| Constant | 0.3232 | 0.0235 | 0.2993 | 0.0600 | 0.3603 | 0.1120 | 0.2232 | 0.1878 |
| Treatment Duration | 0.00010 | 0.0001 | 0.0004 | 0.0006 | -0.0009 | 0.0020 | 0.0034 | 0.0051 |
| Square of Treatment Duration | | | -6.27E-07 | 1.40E-06 | 6.36E-06 | 1.05E-05 | -3.44E-05 | 4.44E-05 |
| Cube of Treatment Duration | | | | | -1.11E-08 | 1.63E-08 | 1.37E-07 | 1.56E-07 |
| Fourth Power of Treatment Duration | | | | | | | -1.80E-10 | 1.87E-10 |
| Adjusted R Squared | -0.0002 | | -0.0005 | | -0.0005 | | 0 | |
| Number of Observations | 3162 | | 3162 | | 3162 | | 3162 | |
| Hausman Test: Chi-Squared | 0.2000 | | 0.4200 | | 0.1600 | | 1.4500 | |
| Probability>Chi-Squared | 0.6508 | | 0.8120 | | 0.9249 | | 0.4834 | |
| Panel B: Control for Treatment Duration and Other Variables | | | | | | | | |
| Constant | -0.1007 | 0.4779 | -0.1940 | 0.4811 | -0.2227 | 0.4888 | -0.2637046 | 0.5076307 |
| Treatment Duration | 0.00014 | 0.0001 | 0.0013 | 0.0006 | 0.0019 | 0.0019 | 0.0033 | 0.0048 |
| Square of Treatment Duration | | | -2.62E-06 | 1.34E-06 | -6.13E-06 | 1.00E-05 | -1.90E-05 | 4.24E-05 |
| Cube of Treatment Duration | | | | | 5.58E-09 | 1.57E-08 | 5.23E-08 | 1.49E-07 |
| Fourth Power of Treatment Duration | | | | | | | -5.71E-11 | 1.79E-10 |
| Other Control Variables: See Table 1 | | | | | | | | |
| Adjusted R Squared | 0.1198 | | 0.1175 | | 0.1167 | | 0.1158 | |
| Number of Observations | 3130 | | 3130 | | 3130 | | 3130 | |
| Hausman Test: Chi-Squared | 0.8200 | | 3.5200 | | 3.8800 | | 3.7200 | |
| Probability>Chi-Squared | 1.0000 | | 1.0000 | | 1.0000 | | 1.0000 | |

Table 4. Estimated GPS: Linear Regression of treatment level on covariates

| | (1) | (2) | (3) | (4) |
|--|-----------------|------------|------------------|------------|
| | Actual Duration | | Planned Duration | |
| | Coeff. | Std. Error | Coeff. | Std. Error |
| Previous unemployment duration in months | 0.7636 | 0.3451 | 0.2429 | 0.3170 |
| Age | -2.1639 | 7.4060 | -8.7657 | 6.8028 |
| Age squared | -0.0025 | 0.1912 | 0.1927 | 0.1757 |
| Age cubic | 0.0006 | 0.0017 | -0.0014 | 0.0016 |
| Duration of last employment | 0.0023 | 0.0021 | 0.0006 | 0.0019 |
| No information about last employment | -11.0729 | 18.4469 | 4.3886 | 16.9444 |
| No wage of last employment observed | 34.2926 | 23.4434 | 1.8158 | 21.5339 |
| Log(wage) of last employment | 4.3508 | 3.4744 | 1.4269 | 3.1914 |
| Educational Attainment 2 | -189.4403 | 73.3736 | -111.4210 | 67.3971 |
| Educational Attainment 3 | -209.7043 | 82.7537 | -164.1688 | 76.0132 |
| Educational Attainment 4 | -371.8883 | 143.9889 | -401.1327 | 132.2606 |
| Educational Attainment 5 | -472.2201 | 148.2782 | -334.0777 | 136.2005 |
| Vocational Attainment 2 | 63.5927 | 51.9122 | 59.1829 | 47.6838 |
| Vocational Attainment 3 | 59.4316 | 91.8876 | 65.4984 | 84.4031 |
| Vocational Attainment 4 | 583.0145 | 186.1424 | 428.7167 | 170.9806 |
| Foreigner EU | -6.0217 | 13.0374 | -4.2181 | 11.9755 |
| Foreigner Non-EU | 6.3966 | 5.9281 | 1.4674 | 5.4452 |
| Share of days in emp., 1 st year before program | -5.2568 | 2.4743 | -3.7461 | 2.2727 |
| Share of days in emp., 2 nd year before program | -1.3409 | 1.9019 | -2.9754 | 1.7470 |
| Share of days in emp., 3 rd year before program | -1.0017 | 1.9274 | 0.5746 | 1.7704 |
| Share of days in emp., 4 th year before program | -2.0666 | 1.6206 | -3.1272 | 1.4886 |
| Share of days in unemp., 1 st year before | -1.5590 | 2.5644 | 1.0997 | 2.3555 |
| Share of days in unemp., 2 nd year before | -5.0441 | 1.8696 | -4.1941 | 1.7173 |
| Share of days in unemp., 3 rd year before | -0.8236 | 1.8962 | -0.7127 | 1.7418 |
| Share of days in unemp., 4 th year before | -5.4048 | 1.7663 | -4.3744 | 1.6225 |
| Disability low degree | 44.5817 | 21.5007 | 28.8693 | 19.7494 |
| Disability medium degree | 20.1793 | 20.5201 | 4.6797 | 18.8487 |
| Disability high degree | -27.3114 | 6.2610 | -42.4251 | 5.7510 |

Table 4. Estimated GPS (Cont.)

| | (1) | | (2) | | (3) | | (4) | |
|--|-----------------|------------|------------------|------------|------------------|------------|------------------|------------|
| | Actual Duration | | Planned Duration | | Planned Duration | | Planned Duration | |
| | Coeff. | Std. Error | Coeff. | Std. Error | Coeff. | Std. Error | Coeff. | Std. Error |
| Number of children | -7.1170 | 3.2875 | -5.5518 | 3.0197 | | | | |
| Youngest Child < 4 years | 5.6853 | 9.3889 | 8.0336 | 8.6242 | | | | |
| Youngest Child < 14 years | 1.1432 | 7.0381 | 4.1765 | 6.4648 | | | | |
| Regional unemployment rate | 433.1507 | 56.5878 | 387.5052 | 51.9786 | | | | |
| Regional type 2 | 0.9976 | 5.7695 | -2.7450 | 5.2996 | | | | |
| Regional type 3 | -15.7442 | 7.0030 | -20.5547 | 6.4326 | | | | |
| Regional type 4 | 15.2312 | 10.5725 | 21.1639 | 9.7113 | | | | |
| Regional type 5 | -10.3845 | 8.7881 | -2.5635 | 8.0723 | | | | |
| Educational Attainment 2 * age | 9.9967 | 4.2355 | 5.2211 | 3.8905 | | | | |
| Educational Attainment 3 * age | 10.6215 | 4.7983 | 7.8531 | 4.4074 | | | | |
| Educational Attainment 4 * age | 21.9266 | 7.9930 | 23.6488 | 7.3419 | | | | |
| Educational Attainment 5 * age | 28.8547 | 8.0434 | 19.5861 | 7.3883 | | | | |
| Educational Attainment 2 * age squared | -0.1259 | 0.0582 | -0.0600 | 0.0534 | | | | |
| Educational Attainment 3 * age squared | -0.1230 | 0.0659 | -0.0846 | 0.0605 | | | | |
| Educational Attainment 4 * age squared | -0.2846 | 0.1058 | -0.3097 | 0.0972 | | | | |
| Educational Attainment 5 * age squared | -0.3853 | 0.1055 | -0.2496 | 0.0969 | | | | |
| Vocational Attainment 2 * age | -2.7761 | 2.9808 | -3.1187 | 2.7380 | | | | |
| Vocational education 3 * age | -2.3590 | 5.2393 | -3.0691 | 4.8125 | | | | |
| Vocational education 4 * age | -28.0278 | 9.5537 | -19.4233 | 8.7755 | | | | |
| Vocational Attainment 2 * age squared | 0.0320 | 0.0404 | 0.0402 | 0.0371 | | | | |
| Vocational education 3 * age squared | 0.0381 | 0.0700 | 0.0459 | 0.0643 | | | | |
| Vocational education 4 * age squared | 0.3515 | 0.1191 | 0.2392 | 0.1094 | | | | |
| Constant | 220.4666 | 95.3657 | 353.6884 | 87.5979 | | | | |
| Adjusted R Squared | 0.1966 | | 0.1999 | | | | | |
| Number of Observations | 3130 | | 3130 | | | | | |

Table 5. Balance in Covariates with and without Adjustment Based on Actual Duration: t-statistics for Equality of Means

| Covariate | (1) | (2) | (3) | (4) | (5) | (6) |
|---|--------------|--------------|---------------|-----------|-------------|-----------|
| | [11, 137] | [138,247] | [248,395] | [11, 137] | [138,247] | [248,395] |
| Age | 4.37 | 0.13 | -4.53 | 0.94 | -0.14 | 0.00 |
| Disability | | | | | | |
| No disability | -2.42 | -1.39 | 3.92 | -0.46 | -0.57 | -0.80 |
| Disability low degree | 1.70 | 0.94 | -2.71 | 0.82 | 0.48 | -0.86 |
| Disability medium degree | 2.38 | 0.75 | -3.19 | 0.82 | -0.09 | 0.09 |
| Disability high degree | 0.64 | 1.07 | -1.79 | -0.03 | 0.48 | -0.19 |
| Citizenship | | | | | | |
| German | 0.76 | 1.25 | -2.11 | -0.31 | 0.42 | -0.42 |
| Foreigner EU | -2.48 | 0.89 | 1.53 | -0.40 | 0.35 | -0.57 |
| Foreigner Non-EU | 0.20 | -1.69 | -1.61 | 0.50 | -0.59 | 0.65 |
| Educational Attainment | | | | | | |
| No graduation (1) | -2.38 | -1.05 | 3.51 | -0.11 | 0.02 | -0.14 |
| First stage of secondary level (2) | -4.35 | 5.83 | 10.76 | 0.16 | -1.63 | 0.83 |
| Second stage of secondary level (3) | 2.52 | 2.12 | -4.82 | -0.42 | 0.52 | -0.65 |
| Advanced technical college entrance qualification (4) | 2.00 | 1.65 | -3.78 | -0.02 | 0.32 | -0.05 |
| General qualification for university entrance (5) | 4.95 | 6.82 | -12.51 | 0.56 | 1.97 | -0.10 |
| Vocational Attainment | | | | | | |
| No vocational degree (1) | -5.60 | -3.39 | 9.35 | -0.30 | -0.74 | 0.72 |
| In-plant training (2) | 1.52 | -1.44 | 0.02 | -0.20 | -0.61 | -0.25 |
| Off-the-job training, vocational school, technical school (3) | 1.79 | 3.04 | -5.07 | -0.25 | 1.12 | 0.19 |
| University, advanced technical college (4) | 5.95 | 6.58 | -13.29 | 1.36 | 1.89 | -0.48 |

Bold numbers indicate significance at the 5% level

Table 5. Balance in Covariates with and without Adjustment Based on Actual Duration: t-statistics for Equality of Means (Cont.)

| Covariate | (1) | (2) | (3) | (4) | (5) | (6) |
|--|--------------|--------------|---------------|-----------|-----------|-----------|
| | [11, 137] | [138,247] | [248,395] | [11, 137] | [138,247] | [248,395] |
| Employment History | | | | | | |
| Previous Unemployment Duration | 2.26 | -3.42 | 1.39 | 1.14 | -1.33 | 1.12 |
| Duration of last employment | 3.00 | -0.92 | -2.02 | 0.64 | -0.50 | -0.05 |
| Log(wage) of last employment | -0.59 | -1.17 | 1.84 | -0.19 | -0.56 | -0.12 |
| No last employment observed | 2.04 | 1.27 | -3.42 | 0.56 | 0.55 | 0.07 |
| Share of days in emp., 1 st year before program | -2.79 | 1.56 | 1.12 | -1.23 | 0.55 | -0.52 |
| Share of days in emp., 2 nd year before program | -2.08 | 2.56 | -0.66 | -1.21 | 1.01 | -0.41 |
| Share of days in emp., 3 rd year before program | -0.48 | 0.82 | -0.40 | -0.57 | 0.34 | -0.24 |
| Share of days in emp., 4 th year before program | 1.38 | -0.30 | -1.06 | 0.02 | -0.31 | -0.23 |
| Share of days in unemp., 1 st year before program | 1.58 | -2.62 | 1.22 | 1.09 | -1.04 | 0.66 |
| Share of days in unemp., 2 nd year before program | -0.14 | -3.97 | 4.40 | 0.78 | -1.47 | 0.76 |
| Share of days in unemp., 3 rd year before program | -0.31 | -3.75 | 4.33 | 0.80 | -1.38 | 0.74 |
| Share of days in unemp., 4 th year before program | -2.75 | -1.96 | 4.87 | -0.07 | -0.45 | 0.65 |
| Regional indicators | | | | | | |
| Regional type 1 | 6.22 | 4.74 | -11.49 | -0.38 | 1.04 | -0.43 |
| Regional type 2 | 4.22 | 2.48 | -6.93 | 0.86 | 0.86 | -0.93 |
| Regional type 3 | -6.00 | -4.53 | 11.02 | -0.18 | -1.19 | 0.98 |
| Regional type 4 | 1.12 | 1.22 | -2.43 | 0.01 | 0.56 | -0.06 |
| Regional type 5 | -4.75 | -3.14 | 8.18 | -0.34 | -0.90 | -0.90 |
| Regional unemployment rate | 8.92 | 6.75 | -16.70 | 0.48 | 1.49 | -0.89 |

Bold numbers indicate significance at the 5% level

Table 6. Balance in Covariates with and without Adjustment Based on Planned Duration: t-statistics for Equality of Means

| Covariate | (1) | (2) | (3) | (4) | (5) | (6) |
|---|--------------|--------------|---------------|-----------|------------|------------|
| | [11, 167] | [168, 271] | [272, 395] | [11, 167] | [168, 271] | [272, 395] |
| Age | 2.99 | 0.40 | -3.85 | 0.70 | -0.09 | -0.12 |
| Disability | | | | | | |
| No disability | -3.36 | 1.22 | 2.47 | 0.01 | 0.95 | -0.52 |
| Disability low degree | 2.22 | -1.47 | -0.90 | -0.42 | -0.97 | 0.70 |
| Disability medium degree | 3.11 | -0.14 | 3.39 | 1.10 | -0.36 | 0.01 |
| Disability high degree | 1.53 | 0.65 | 2.46 | 0.33 | 0.19 | -0.40 |
| Citizenship | | | | | | |
| German | -0.53 | -1.21 | 1.95 | 0.40 | -0.40 | 0.75 |
| Foreigner EU | 1.28 | 0.95 | -2.51 | -0.29 | 0.25 | -0.67 |
| Foreigner Non-EU | -2.03 | 0.50 | 1.76 | -0.22 | 0.34 | -0.13 |
| Educational Attainment | | | | | | |
| No graduation (1) | -2.66 | -0.85 | 3.98 | -0.47 | -0.17 | 0.59 |
| First stage of secondary level (2) | -5.69 | -2.94 | 9.84 | -0.09 | -0.61 | 0.70 |
| Second stage of secondary level (3) | 2.37 | 0.89 | -3.69 | -0.60 | 0.06 | -0.54 |
| Advanced technical college entrance qualification (4) | 2.96 | 0.35 | -3.76 | 0.46 | -0.12 | -0.31 |
| General qualification for university entrance (5) | 7.12 | 4.40 | -13.27 | 1.47 | 1.29 | -0.65 |
| Vocational Attainment | | | | | | |
| No vocational degree (1) | -6.24 | -2.00 | 9.40 | -0.87 | -0.34 | 1.34 |
| In-plant training (2) | 0.91 | -0.90 | -0.04 | -0.04 | -0.35 | -0.65 |
| Off-the-job training, vocational school, technical school (3) | 2.84 | 1.24 | -4.63 | 0.27 | 0.25 | -0.59 |
| University, advanced technical college (4) | 7.44 | 4.48 | -13.74 | 1.81 | 1.28 | -0.45 |

Bold numbers indicate significance at the 5% level

Table 6. Balance in Covariates with and without Adjustment Based on Planned Duration: t-statistics for Equality of Means (Cont.)

| Covariate | (1) | (2) | (3) | (4) | (5) | (6) |
|--|--------------|-------------------------|---------------|-----------|-----------------------|-----------|
| | [11, 167] | Unadjusted [168,271] | [272,395] | [11, 167] | Adjusted [168,271] | [272,395] |
| Employment History | | | | | | |
| Previous Unemployment Duration | 2.28 | -3.40 | 1.18 | 1.46 | -1.49 | 1.20 |
| Duration of last employment | 2.42 | -0.95 | -1.69 | 0.95 | -0.50 | -0.36 |
| Log(wage) of last employment | -1.51 | 0.41 | 1.26 | -0.26 | 0.23 | -0.45 |
| No last employment observed | 2.57 | -0.50 | 2.37 | 0.74 | -0.32 | 0.36 |
| Share of days in emp., 1 st year before program | -1.33 | -0.11 | 1.64 | -0.31 | 0.06 | -0.38 |
| Share of days in emp., 2 nd year before program | 0.16 | 0.85 | 0.77 | 0.04 | 0.37 | -0.96 |
| Share of days in emp., 3 rd year before program | 0.40 | -0.07 | -0.38 | 0.07 | -0.06 | -0.46 |
| Share of days in emp., 4 th year before program | 1.45 | -0.58 | -1.01 | 0.39 | -0.37 | -0.70 |
| Share of days in unemp., 1 st year before program | 0.31 | -1.45 | 1.25 | 0.49 | -0.70 | 0.92 |
| Share of days in unemp., 2 nd year before program | -2.06 | -1.67 | 4.21 | -0.03 | -0.52 | 1.18 |
| Share of days in unemp., 3 rd year before program | -2.11 | -1.93 | 4.56 | 0.11 | -0.64 | 1.29 |
| Share of days in unemp., 4 th year before program | -3.81 | -0.10 | 4.45 | -0.53 | 0.24 | 1.08 |
| Regional indicators | | | | | | |
| Regional type 1 | 7.71 | 2.54 | -11.76 | -0.31 | 0.77 | -0.57 |
| Regional type 2 | 3.54 | 1.69 | -5.93 | 0.67 | 0.43 | -1.51 |
| Regional type 3 | -6.07 | -3.74 | 11.21 | 0.81 | 0.94 | 1.32 |
| Regional type 4 | 1.20 | 0.71 | -2.16 | -0.29 | 0.18 | -0.05 |
| Regional type 5 | -5.68 | -0.50 | 7.04 | -1.15 | 0.25 | 0.99 |
| Regional unemployment rate | 11.46 | 2.43 | -16.09 | 1.16 | -0.24 | -1.22 |

Bold numbers indicate significance at the 5% level

Table 7. Estimated Dose Response Functions

| | (1) | (2) | (3) | (4) |
|--|-----------------|--------------|------------------|---------------|
| | Actual Duration | | Planned Duration | |
| | Coeff. | Std. Error | Coeff. | Std. Error |
| Panel A: Outcome Variable: Employment status at time 2 years after entry into the program | | | | |
| GPS | -198.9665 | 119.7742 | -91.8408 | 107.6389 |
| GPS ² | 60057.2100 | 46972.1400 | 60457.1900 | 39749.1900 |
| GPS ³ | -4442237.0000 | 5712302.0000 | -4925847.0000 | -4925847.0000 |
| Program Duration | 0.0015 | 0.0015 | 0.0038 | 1.9801E-03 |
| Program Duration ² | -5.56E-06 | 7.99E-06 | -4.22E-06 | 9.97E-06 |
| Program Duration ³ | 2.59E-09 | 1.30E-08 | -1.30E-08 | 1.67E-08 |
| GPS*Program Duration | 0.2792 | 0.5618 | -1.4210 | 0.5881 |
| GPS ² *Program Duration | -109.3040 | 63.0600 | -23.6346 | 56.5314 |
| GPS*Program Duration ² | 0.0006 | 0.0012 | 0.0035 | 0.0013 |
| Constant | 0.4127 | 0.1063 | 0.2268 | 0.1010 |
| Adjusted R Squared | -0.0002 | | 0.0013 | |
| Number of Observations | 3130 | | 3130 | |
| Panel B: Outcome Variable: Employment status at time 1 year after exit from the program | | | | |
| GPS | -20.4268 | 119.5165 | -102.1634 | 107.3369 |
| GPS ² | 9059.1920 | 46871.0700 | 50623.5700 | 39637.6800 |
| GPS ³ | -732274.6000 | 5700010.0000 | -2130617.0000 | 4313976.0000 |
| Program Duration | -0.0001 | 0.0017 | 0.0020 | 0.0020 |
| Program Duration ² | 3.49E-06 | 7.98E-06 | 4.06E-06 | 9.94E-06 |
| Program Duration ³ | -9.01E-09 | 1.30E-08 | -2.34E-08 | 1.66E-08 |
| GPS*Program Duration | -0.0346 | 0.5606 | -1.2096 | 0.5864 |
| GPS ² *Program Duration | -25.7458 | 62.9243 | -51.5993 | 56.3728 |
| GPS*Program Duration ² | 0.0003 | 0.0012 | 0.0032 | 0.0013 |
| Constant | 0.3421 | 0.1060 | 0.3114 | 0.1007 |
| Adjusted R Squared | -0.0020 | | 0.0009 | |
| Number of Observations | 3130 | | 3130 | |

Table 8. Instrumental Variable Estimations

| | (1) | (2) | (3) | (4) |
|--|--------------------------|------------|------------------|------------|
| | Linear Probability Model | | Probit Model | |
| | Treatment Effect | Std. Error | Treatment Effect | Std. Error |
| Panel A: Outcome Variable: Employment status at time 2 years after entry into the program | | | | |
| Model 1 | -0.0429 | 0.0456 | -0.1192 | 0.1252 |
| Model 2 | 0.0293 | 0.0290 | 0.0789 | 0.0778 |
| Model 3 | -0.0266 | 0.0224 | -0.0721 | 0.0606 |
| Model 4 | -0.0150 | 0.0224 | -0.0406 | 0.0606 |
| Model 5 | 0.0099 | 0.0281 | 0.0269 | 0.0763 |
| (Without Other Control Variables) | | | | |
| Panel B: Outcome Variable: Employment status at time 1 year after exit from the program | | | | |
| Model 1 | 0.0026 | 0.0455 | 0.0069 | 0.1237 |
| Model 2 | -0.0101 | 0.0289 | -0.0276 | 0.0787 |
| Model 3 | -0.0371 | 0.0223 | -0.1010 | 0.0607 |
| Model 4 | -0.0210 | 0.0224 | -0.0570 | 0.0606 |
| Model 5 | -0.0019 | 0.0281 | -0.0051 | 0.0763 |
| (Without Other Control Variables) | | | | |
| Panel C: Outcome Variable: Employment status at time 2 years after entry into the program | | | | |
| Model 1 | -0.1172 | 0.0440 | -0.4060 | 0.1393 |
| Model 2 | -0.0170 | 0.0289 | -0.0680 | 0.0895 |
| Model 3 | -0.0095 | 0.0237 | -0.0400 | 0.0730 |
| Model 4 | -0.0062 | 0.0249 | -0.0334 | 0.0763 |
| Model 5 | 0.0303 | 0.0300 | 0.0861 | 0.0918 |
| (With Other Control Variables: See Table 1) | | | | |
| Panel D: Outcome Variable: Employment status at time 1 year after exit from the program | | | | |
| Model 1 | -0.0614 | 0.0444 | -0.2033 | 0.1364 |
| Model 2 | -0.0535 | 0.0291 | -0.1808 | 0.0893 |
| Model 3 | -0.0262 | 0.0238 | -0.0867 | 0.0725 |
| Model 4 | -0.0150 | 0.0250 | -0.0509 | 0.0760 |
| Model 5 | 0.0133 | 0.0302 | 0.0460 | 0.0917 |
| (With Other Control Variables: See Table 1) | | | | |

Bold numbers indicate significance at the 5% level

Note: we use 5 different cutoff points, respectively, to define the two groups with the shorter vs. the longer treatment duration. The different models 1 to 5 correspond to different cutoff points, from the 15% percentile to the 85% percentile

Figure 1. Distributions of Actual and Planned Training Durations

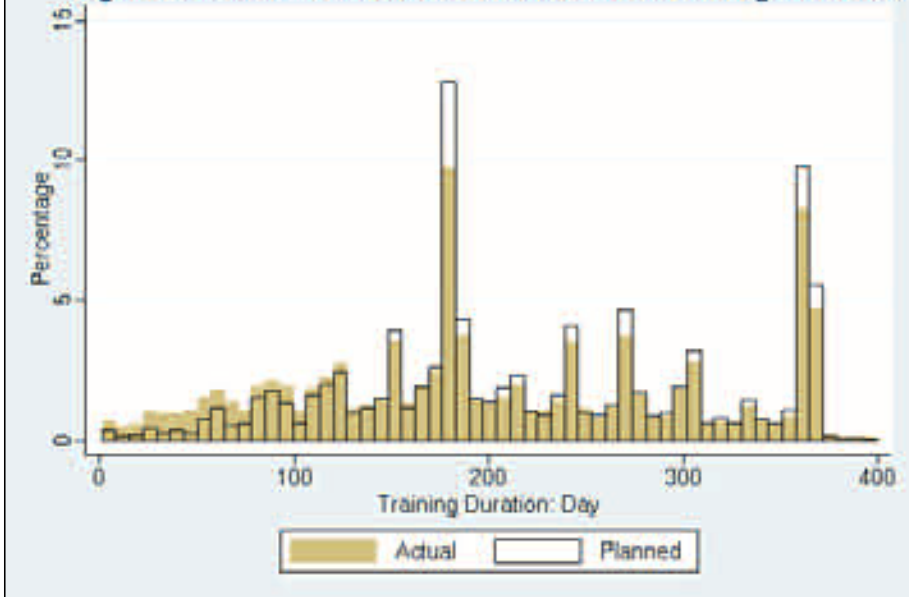


Figure 2a. Unadjusted Employment Probability at Time 2 Years after Entry into the Program Based on Actual Training Duration

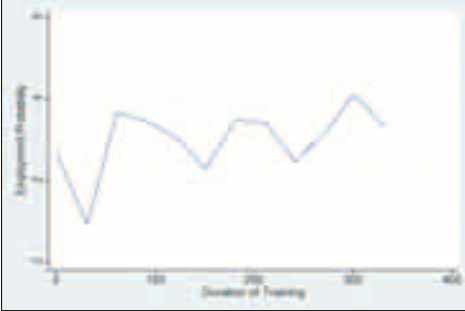
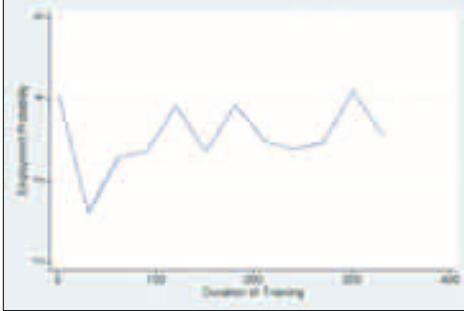


Figure 2c. Unadjusted Employment Probability at Time 2 Years after Entry into the Program Based on Subsample with Actual Training Duration Equal to Planned Duration

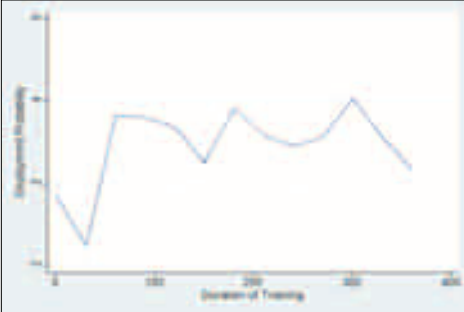


Figure 2d. Unadjusted Employment Probability at Time 1 Years after Exit from the Program Based on Actual Training Duration

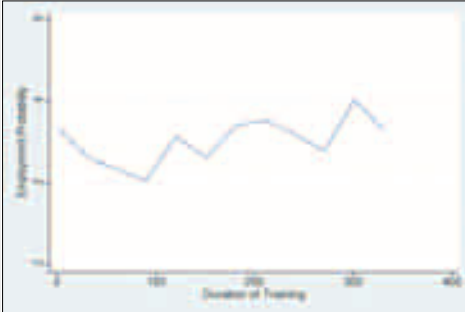


Figure 2e. Unadjusted Employment Probability at Time 1 Years after Exit from the Program Based on Planned Training Duration

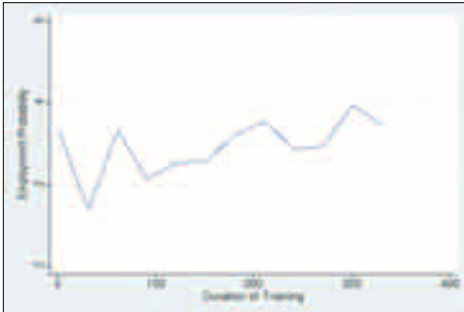


Figure 2f. Unadjusted Employment Probability at Time 1 Years after Exit from the Program Based on Subsample with Actual Training Duration Equal to Planned Duration

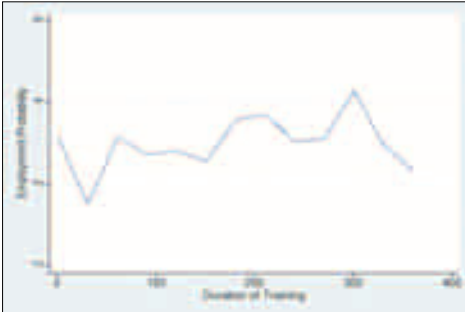
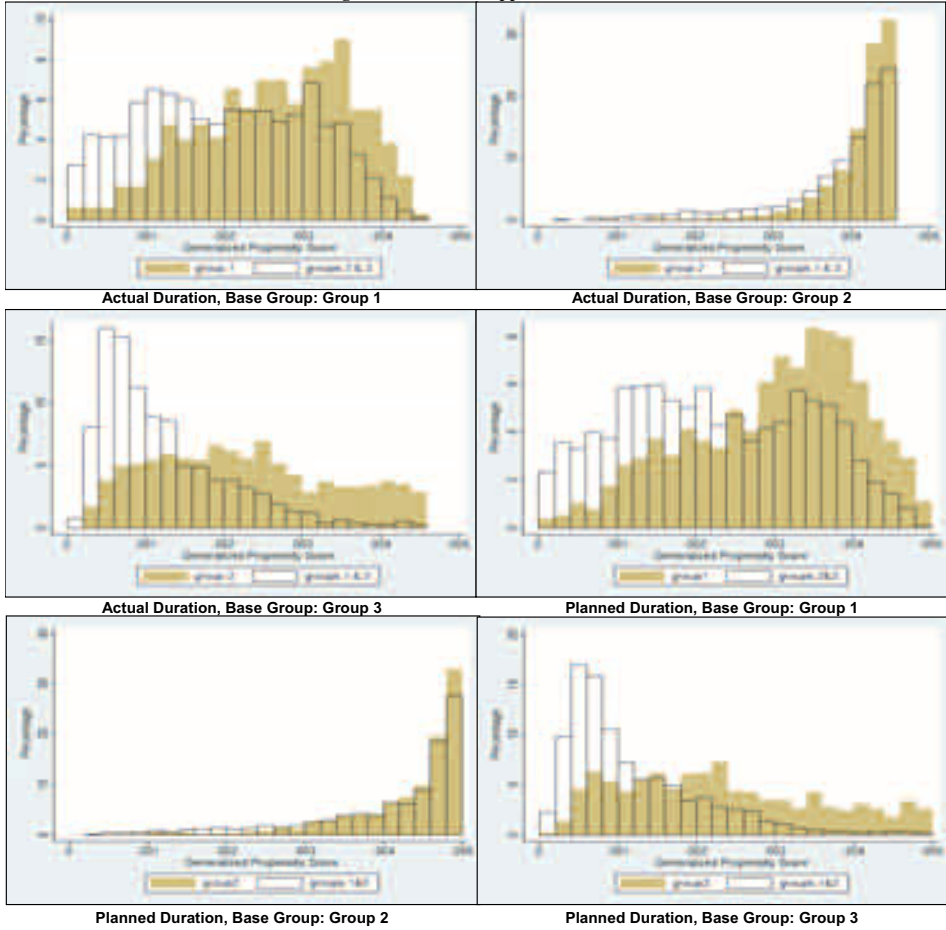
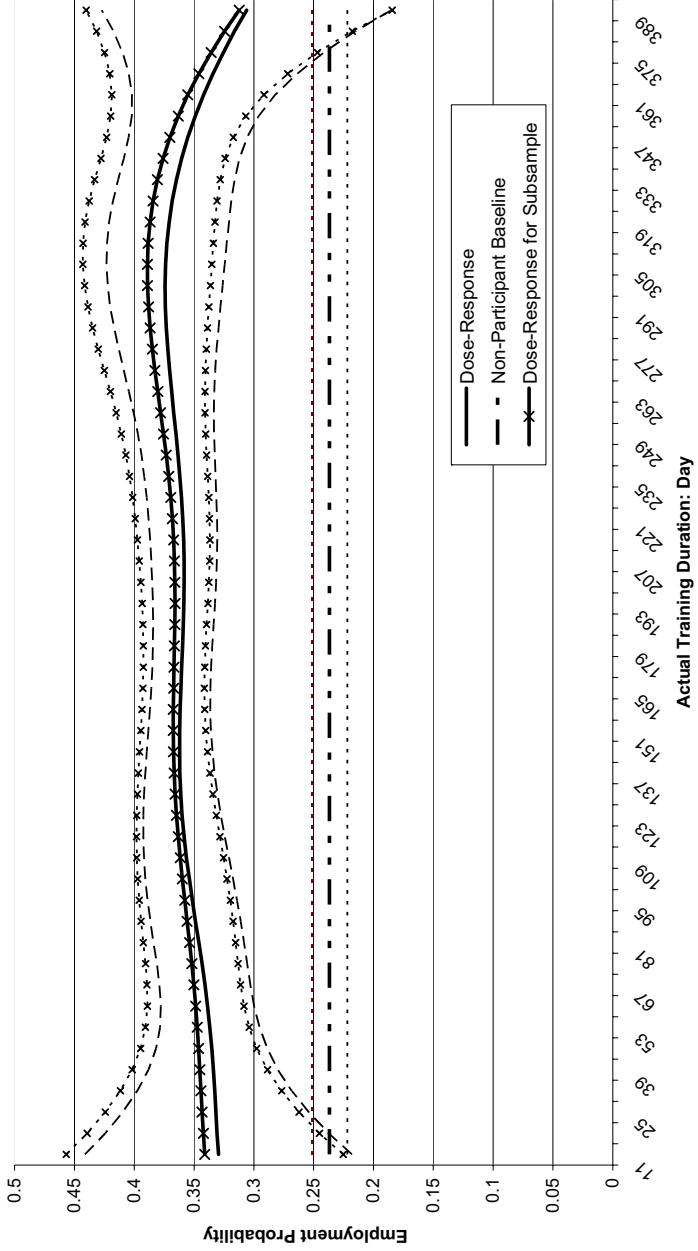


Figure 3. Common Support Condition

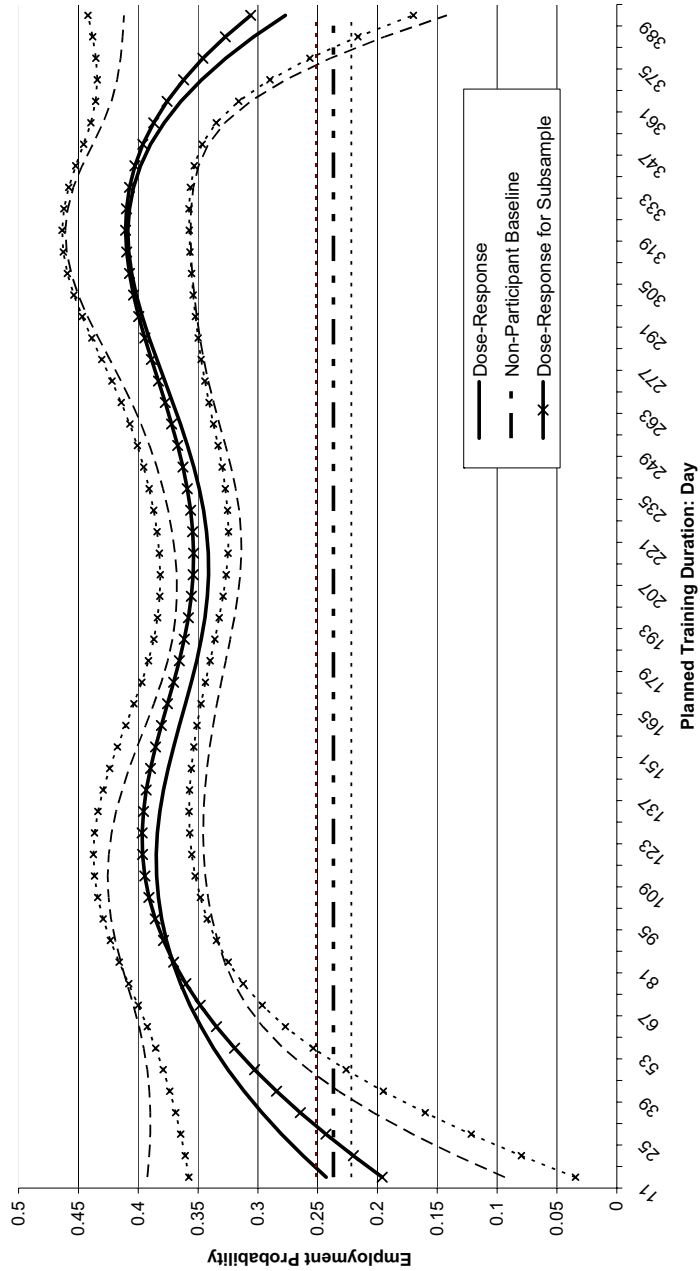


**Figure 4a. Employment Probability at Time 2 Years after Entry into the Program
Based on Actual Training Duration**



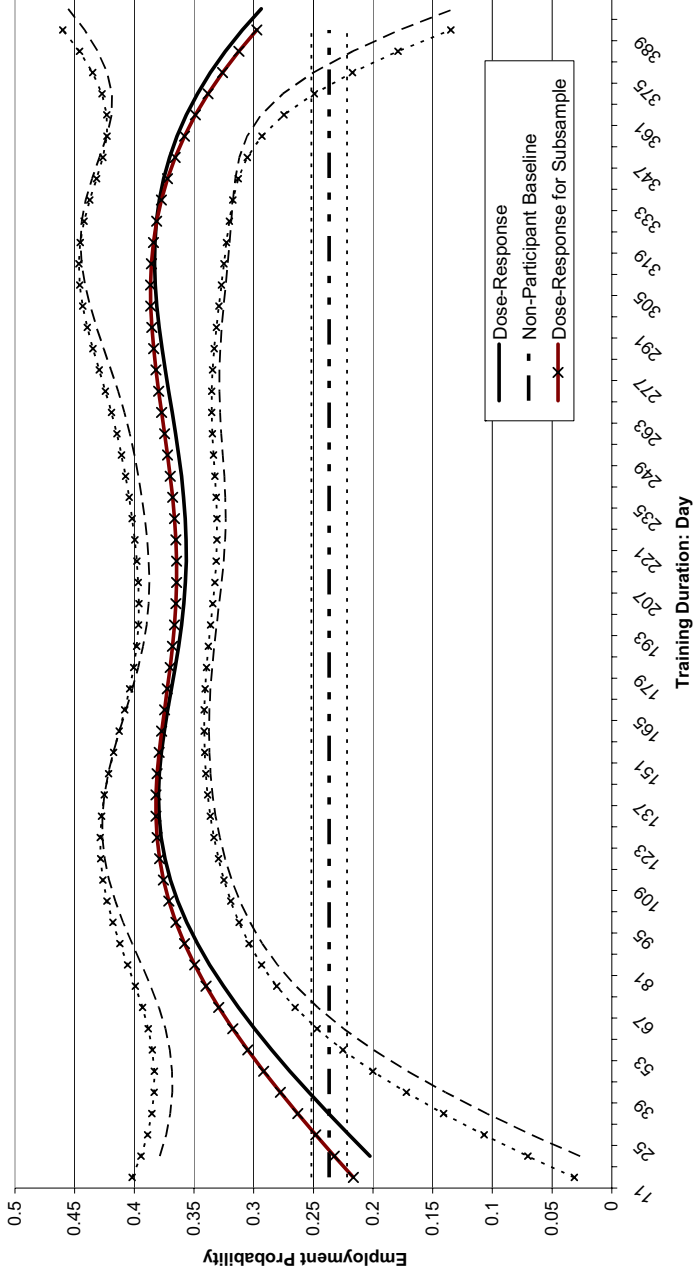
Dashed lines are bounds for 95% confidence intervals. These intervals are based on bootstrap standard errors from 2,000 replications

**Figure 4b. Employment Probability at Time 2 Years after Entry into the Program
Based on Planned Training Duration**



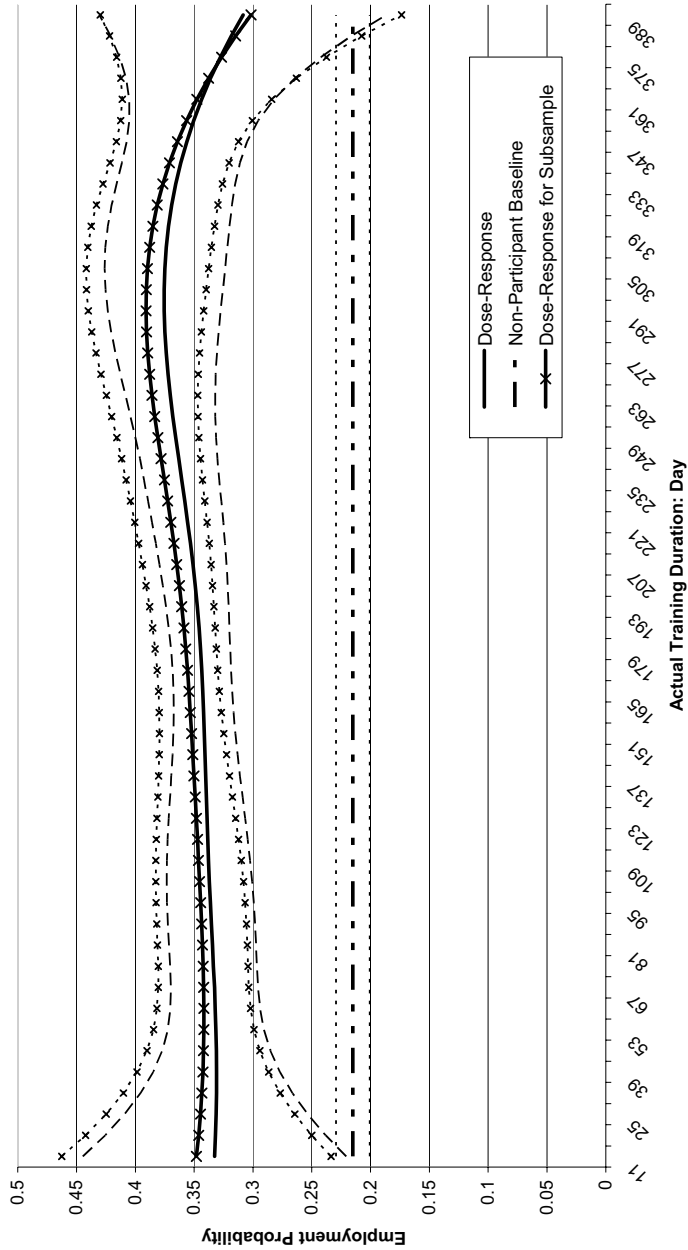
Dashed lines are bounds for 95% confidence intervals. These intervals are based on bootstrap standard errors from 2,000 replications

Figure 4c. Employment Probability at Time 2 Years after Entry into the Program Based on Subsample with Actual Training Duration Equal to Planned Duration



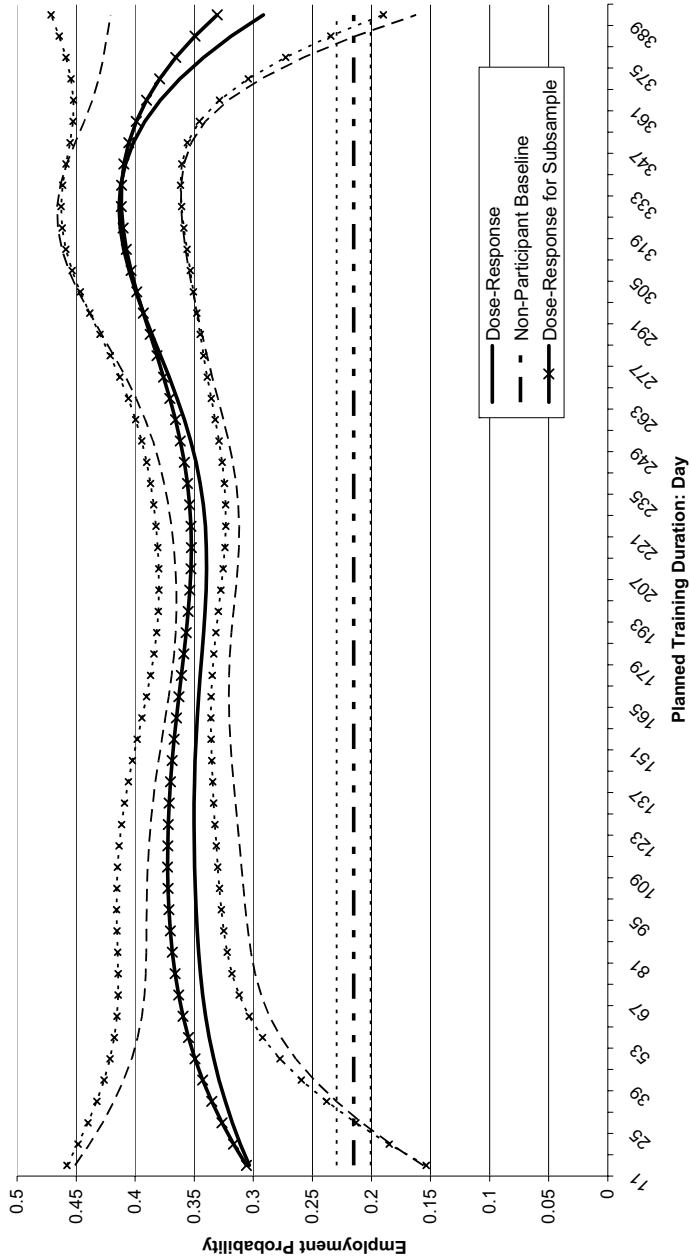
Dashed lines are bounds for 95% confidence intervals. These intervals are based on bootstrap standard errors from 2,000 replications

Figure 5a. Employment Probability at Time 1 Year after Exit from the Program Based on Actual Training Duration



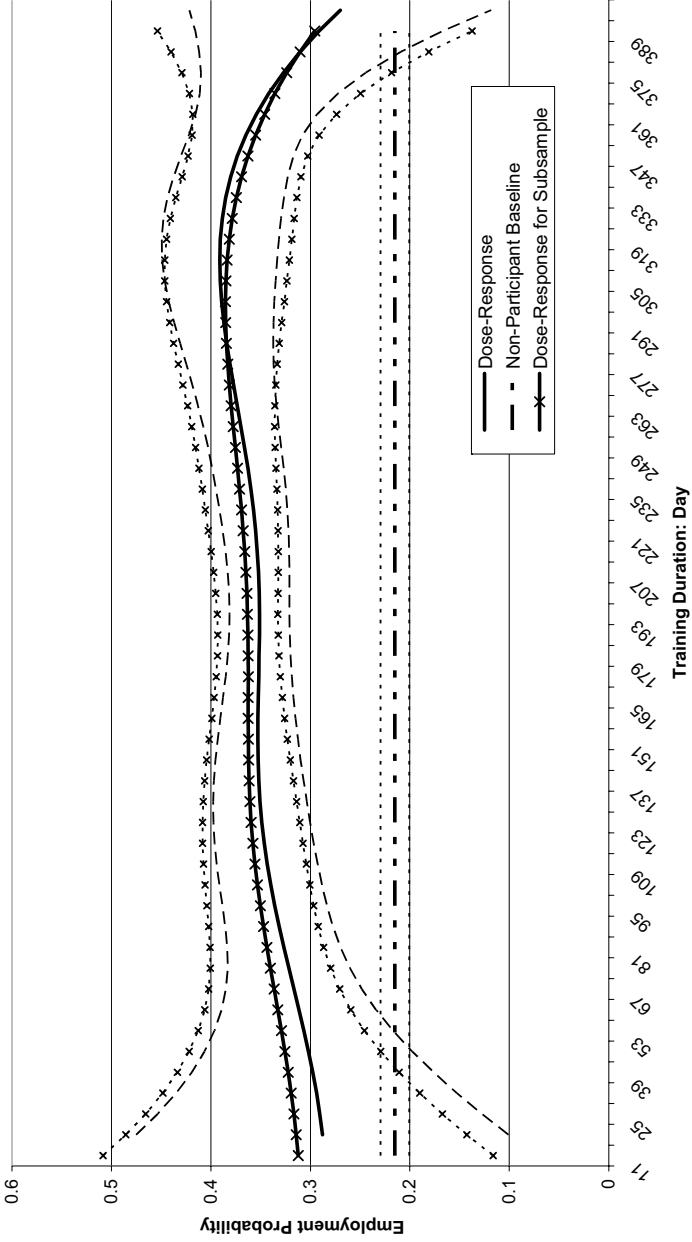
Dashed lines are bounds for 95% confidence intervals. These intervals are based on bootstrap standard errors from 2,000 replications

**Figure 5b. Employment Probability at Time 1 Year after Exit from the Program
Based on Planned Training Duration**



Dashed lines are bounds for 95% confidence intervals. These intervals are based on bootstrap standard errors from 2,000 replications

**Figure 5c. Employment Probability at Time 1 Year after Exit from the Program
Based on Subsample with Actual Training Duration Equal to Planned Duration**



Dashed lines are bounds for 95% confidence intervals. These intervals are based on bootstrap standard errors from 2,000 replications

Figure 6a. Estimated Employment Probability at Time 2 Years after Entry into the Program Based on Actual Duration

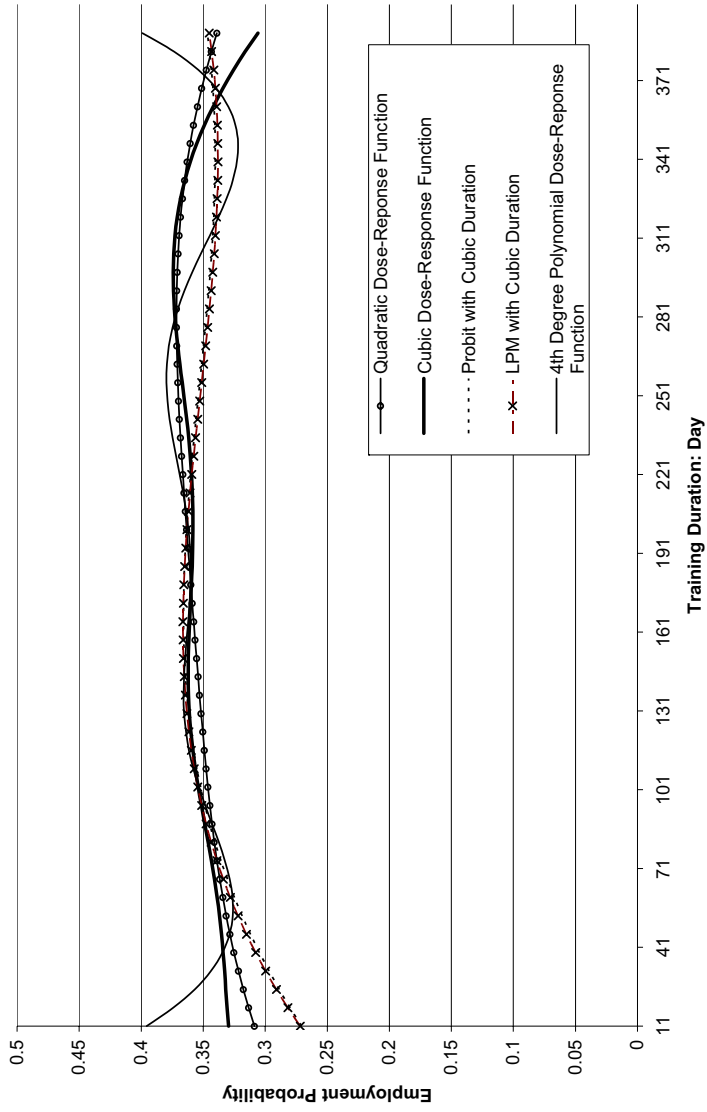


Figure 6b. Estimated Employment Probability at Time 2 Years after Entry into the Program Based on Planned Duration

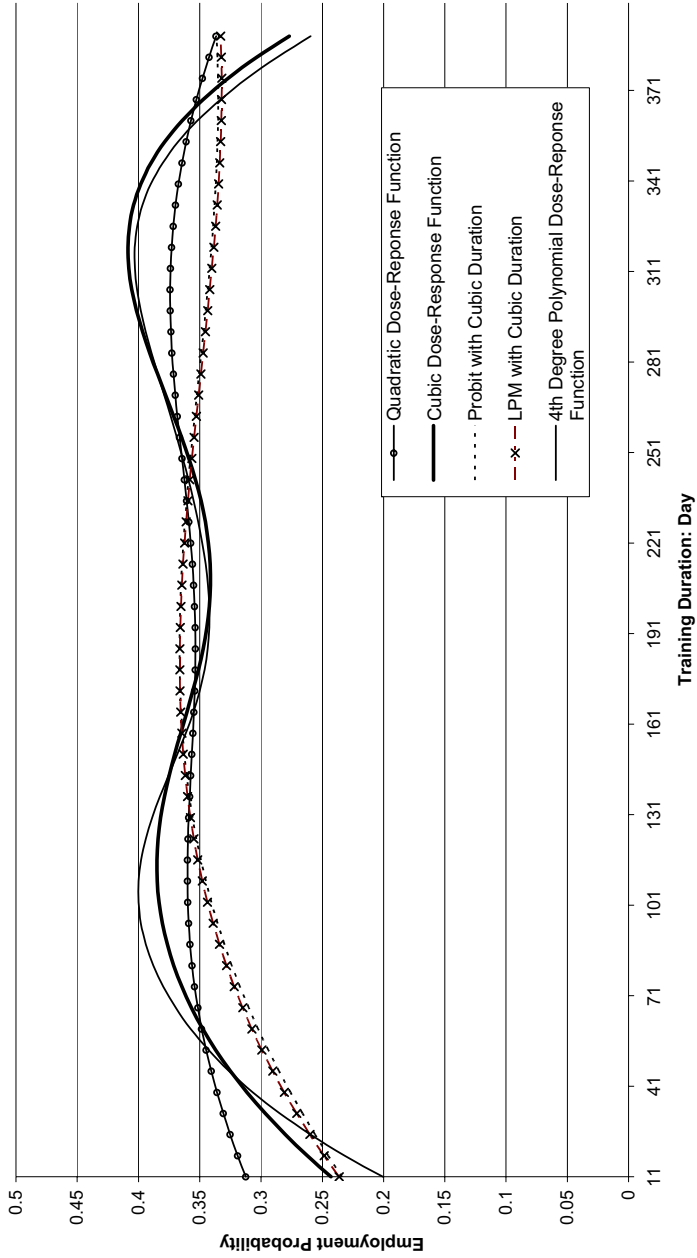


Figure 6c. Estimated Employment Probability at Time 2 Years after Entry into the Program Based on Subsample with Actual Training Duration Equal to Planned Duration

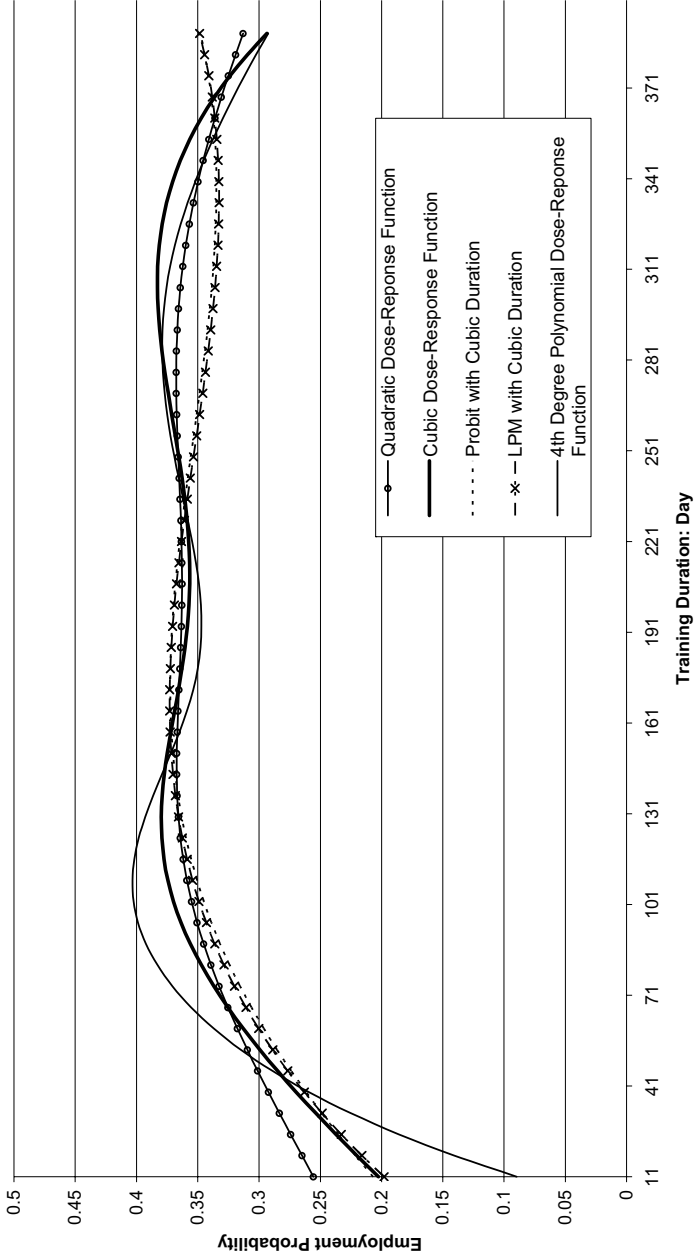


Figure 7a. Estimated Employment Probability at Time 1 Year after Exit from the Program Based on Actual Duration

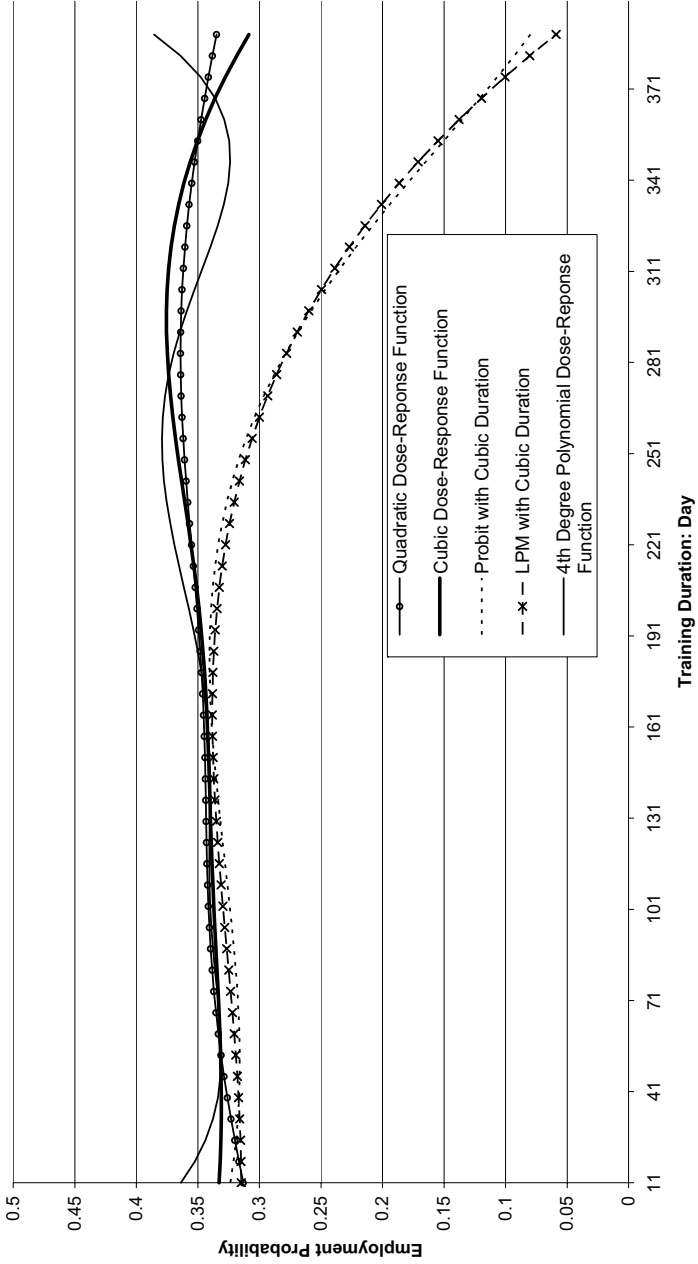


Figure 7b. Estimated Employment Probability at Time 1 Year after Exit from the Program Based on Planned Duration

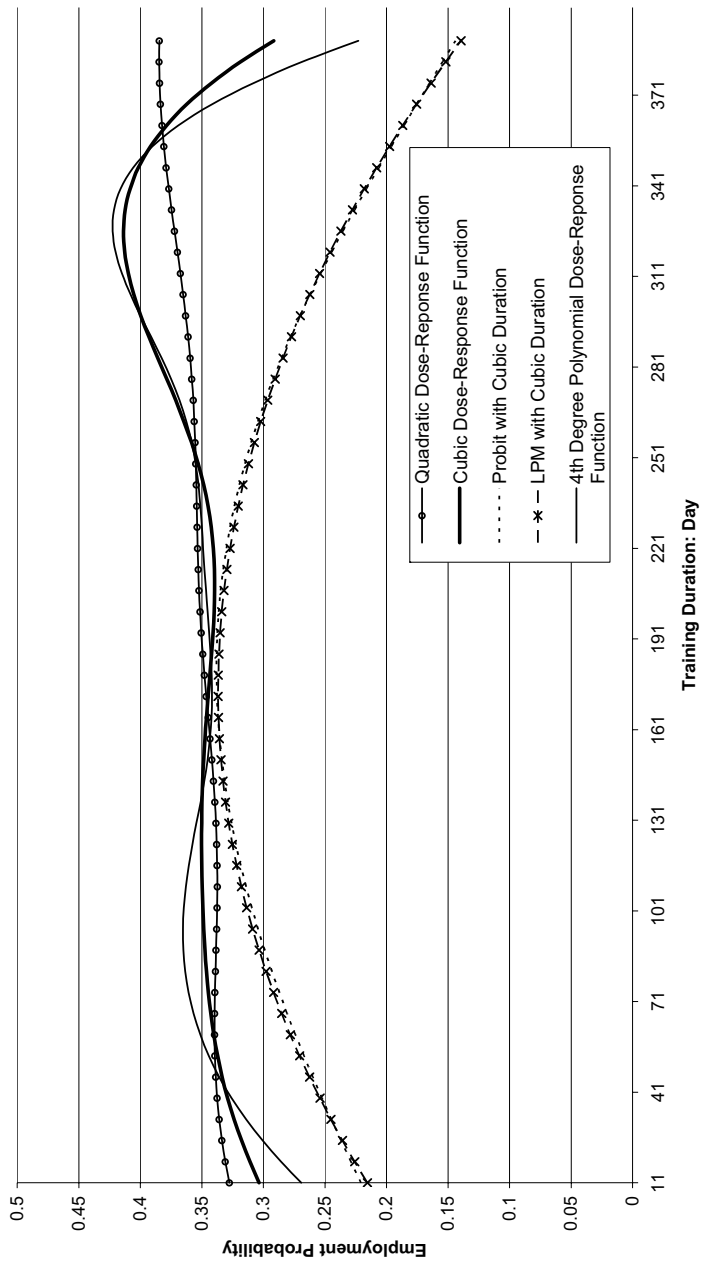


Figure 7c. Estimated Employment Probability at Time 1 Year after Exit from the Program Based on Subsample with Actual Training Duration Equal to Planned Duration

