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ABSTRACT

The Impact of Dual Apprenticeship Programs on Early Labour Market Outcomes: A Dynamic Approach*

This study examines the impact of enrolling into dual apprenticeship programs in secondary education on six early employment outcomes. Our contribution to the literature is threefold. First, we estimate – within the same, Belgian secondary education framework – the effects of two distinct types of dual programs that combine part-time school- or training centre-based instruction with an apprenticeship in a firm. Second, these effects are identified by estimating a dynamic model capturing subsequent educational and labour market outcomes to control for the dynamic selection of students into dual programs. Third, this approach enables us to distinguish between the programs' direct effects (conditional on educational achievement) and indirect effects (via educational achievement). We find evidence for short-term labour market advantages but only for the program with the most days of in-field training. With these findings we contribute to the international discussion on the optimal design of vocational programs.

JEL Classification: I21, I26, J21

Keywords: vocational education, transitions in youth, dynamic selection, education, labour

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1 Introduction

Worldwide, youth unemployment rates greatly exceed the unemployment rates of non-youths.[1] For example, Figure 1 clearly shows that the youth unemployment rates in the US, EU-28, and Belgium (the country from which our data samples were taken) are consistently higher. This is in particular the case for individuals who enter the labour market without a higher education degree, as seen in Figure 2, which shows substantially higher unemployment rates for jobseekers without an upper secondary or tertiary education degree in OECD countries. These imbalances indicate a rather poor transition from secondary education to the regular labour market in these economies. Not surprisingly, smoothing this transition is a key ambition of many OECD countries (van de Werfhorst, 2014).

< Figure 1 about here >

< Figure 2 about here >

One potential way of pursuing this is by more closely linking secondary education to the labour market, for example by encouraging students to enrol in dual apprenticeship and other vocational programs (Ryan, 2001; Zimmerman et al., 2013). By completing vocational education and, in particular, participating in work-based learning through apprenticeship training, students gain ready-to-use skills that immediately increase their employability when they enter the labour market (Hanushek, Schwerdt, Woessman, & Zhang, 2017). Moreover, apprenticeships may even provide immediate access to a job if employers use them as a

[1] The youth unemployment rate is calculated as the ratio between the unemployed in the age group of 15 to 24 years old and the total labour force (employed and unemployed, i.e. youth in education excluded) for that age group. The non-youth unemployment rate is measured as the ratio between the unemployed in the age group 25 to 74 years old and the total labour force (employed and unemployed) for that age group.

screening device (Wolter & Ryan, 2011). But for three main reasons, this advantage when first entering the labour market might decrease (and even turn into a disadvantage) over time. First, the occupation-specific skills gathered in vocational education may quickly become obsolete ('external depreciation of human capital'; Weber, 2014). This might be especially true today with automation and digitalisation leading to rapid technological change (Krueger & Kumar, 2004; Hampf & Woessmann, 2017). Second, occupation-specific skills are highly sensitive to changes in labour demand, so that their premiums might not be robust to these changes (Golsteyn & Stenberg, 2014). Third, vocational education comes at the cost of less general education, which focuses more on cognitive skills, problem solving, and critical thinking. Less development of these skills is expected to decrease students' potential for lifelong learning and learning on the job, so that students in vocational education are expected to be less capable of adapting to changing labour market conditions and, therefore, less employable in the long run (Weber, 2014; Hanushek et al., 2017).

Several recent studies have indeed found that the effect of vocational secondary education (in comparison to more general secondary education) on the probability of finding a job is initially positive, but declines over time (Parey, 2016; Brunello & Rocco, 2017) and ultimately may even turn negative (Forster, Bol, & van de Werfhorst, 2016; Hampf & Woessmann, 2017; Hanushek et al., 2017; Lavrijsen & Nicaise, 2017). Furthermore, a number of studies found a similar initially positive but declining relative effect of vocational education on earnings (Cörvers, Heijke, Kriechel, & Pfeifer, 2011; Golsteyn & Stenberg, 2014; Laurijssen & Glorieux, 2017; Lavrijsen & Nicaise, 2017) and on the quality of the match in terms of attained and required skills (Verhaest, Lavrijsen, Van Trier, Nicaise, & Omey, 2018). Finally, some of these studies also concluded that both the initial advantage and the extent to which this advantage diminishes over time is more pronounced in countries like Germany or

Denmark, which are characterised by a dual system in which students combine one or two weekdays of school-based learning with an apprenticeship of three or four weekdays at a firm (Forster et al., 2016; Hampf & Woessmann, 2017; Hanushek et al., 2017; Verhaest et al., 2018).

The present study adds to this previous literature examining the (longitudinal) effects of vocational education in three ways. *First*, in the present study, we directly compare (i.e. in the same institutional setting) the effectiveness of two distinct vocational education programs that combine part-time school-based instruction with an apprenticeship in a firm. In most of the previous studies, a comparison between different vocational education programs was done only by comparing the effect of vocational education between countries with different vocational education systems (Forster et al., 2016; Hampf & Woessmann, 2017; Hanushek et al., 2017; Verhaest et al., 2018). As a consequence, it cannot be ruled out that the diverging effects of the programs might be driven by other forms of heterogeneity between these countries.[2]

In contrast, in the present study, we compare the effect of two types of formal dual apprenticeship programs (relative to non-apprenticeship secondary education programs) in terms of obtaining a secondary education qualification and the chances to obtain (stable) employment three months, one year, and five years after leaving the formal education and training system. While the first program includes more hours of workplace learning and, as in traditional dual system countries like in Germany, gives a more profound role to employers

[2] One other study indirectly evaluated the labour market effects of alternative types of apprenticeship programs. By evaluating a reform of the Italian apprenticeship system, Albanese, Cappellari, and Leonardi (2017) recently concluded that bringing the system closer to the German system – mainly by increasing the importance of on-the-job training – improved employment chances and wages in the first few years after the expiration of the apprenticeship contract. However, in contrast with our study, they did not test whether this new apprenticeship program fares better than other, non-apprenticeship programs.

in the organisation and design of the program, the second program is much more school-led and also allows students to participate as a part-time student in case they do not manage to find a workplace for their apprenticeship. As such, our study also contributes to the discussion on the optimal design of vocational programs in general and dual apprenticeship programs in particular.

Second, we are one of the first to estimate a dynamic model that corrects for the dynamic selection of students into dual programs. Earlier, Adda, Dustmann, Meghir, and Robin (2010) estimated a dynamic model to investigate the effect of apprenticeship training on later wages in the German education system. They examined this for a very particular group of students – those who were in the vocational track at age 10 and chose whether or not to follow apprenticeship training at age 16 – finding a positive effect of apprenticeship training on wages. Other previous studies examining the relative labour market effects of vocational and apprenticeship programs have not or have to a lesser extent attempted to control for this selection bias. While several cross-sectional studies controlled for detailed cognitive skill test scores (Forster et al., 2016; Hampf & Woessmann, 2017; Hanushek et al., 2017; Lavrijsen & Nicaise, 2017; Verhaest et al., 2018), this is unlikely to be sufficient to capture all selectivity. Other studies relied on longitudinal labour market data to account for unmeasured changes in the selectivity of vocational programs over time (Cörvers et al., 2011; Golsteyn & Stenberg, 2014; Brunello & Rocco, 2017). Still, this does not allow one to address the problem of more systematic and time-invariant unobserved selectivity in vocational programs.

Just a few studies have addressed these problems in a more in-depth manner by means of quasi-experimental identification strategies. Relying on a regression discontinuity design (RDD), Malamud and Pop-Eleches (2010) did not find evidence for differences in labour

market outcomes between vocationally and generally educated medium-aged workers. While this conclusion is consistent with an initially positive but declining effect of vocational programs, they did not assess initial labour market effects. Based on an instrumental variable (IV) analysis, Parey (2016) meanwhile assessed labour market outcomes at ages 23 and 26 and found that the initial advantage of dual apprenticeship programs over other vocational programs in terms of employment chances vanished over time.[3]

In the present study, we also compare the relative labour market effects of apprenticeship programs at several stages in the early career. But differently from Parey (2016) and Malamud and Pop-Eleches (2010), we exploit unique longitudinal data and make different identifying assumptions to estimate a dynamic discrete choice model in which subsequent educational and early labour market outcomes are explained, based on observed and unobserved characteristics. Consequently, while IV and RDD methods only estimate a local average treatment effect (LATE) (Angrist, Graddy, & Imbens, 2000), this allows us to identify a more general average treatment effect (ATE).

Third, we are novel in distinguishing between the direct and indirect effect of dual apprenticeship programs with respect to labour market outcomes. While the former effect is conditional on student academic achievement, the latter one goes via the effect of enrolling into dual programs on educational attainment. This distinction is an important one given that the practical focus in vocational programs may motivate certain students who would

[3] A few other studies on the effects of vocational education adopted quasi-experimental designs as well, but are less relevant in the context of our paper. Both Oosterbeek and Webbink (2007) and Fersterer, Pischke, and Winter-Ebmer (2008) assessed the labour market effects of additional years of vocational education and apprenticeship training (i.e. in comparison to no additional years of education), while our focus is rather on the effects of vocational and apprenticeship programs relative to other programs that are similar in terms of curriculum length. Further, Verhaest and Baert (2018) focused on higher education, while the focus of the present study and most of the literature in this respect is on vocational education in secondary education.

otherwise have dropped out to obtain a qualification in secondary education (Bishop & Mane, 2004; Grubb & Lazerson, 2005; Eichhorst, Rodríguez-Planas, Schmidl, & Zimmerman, 2012; Hanushek et al., 2017).

The remainder of this study is organised as follows. In Section 2, we discuss the investigated dual programs within the context of secondary education in Flanders (the Northern, Dutch-speaking region of Belgium). Next, in Sections 3 and 4, we discuss, respectively, the data and econometric model that we use to estimate the relationship between dual programs and first labour market outcomes. In Section 5, the results of our analyses are presented. We end this article with a brief conclusion including policy recommendations and suggestions for future research.

2 Institutional Setting

In this section, we discuss some crucial characteristics of the education system in Flanders (the Northern, Dutch-speaking region of Belgium), as this is the region from where we obtained our data. In Flanders, there is compulsory education starting from September 1st of the year in which the child turns 6 until their 18th birthday or until June 30th of the year in which the child turns 18, whichever comes first. Full-time school-based education is compulsory until the age of 16 or until the age of 15 if a student has already completed the first two years of secondary education. From that moment on, they are allowed to start dual programs, which consist of learning on a part-time basis at a school or training centre that may be combined with a part-time apprenticeship in a firm or organisation.

There are two types of dual programs that are part of the formal secondary education

and training system in Flanders. First, students can enrol in so-called *Deeltijds BeroepsSecundair Onderwijs*, which is part-time vocational education organised by the Centres for Part-time Education (CPE).[4] In this program, students follow classes in a CPE for two days a week. The remaining three days they are either employed as an apprentice or follow a preliminary phase in a Centre for Part-time Training (PTE) to develop their attitudes and skills before starting an apprenticeship. Based on whether students combine classes with an actual apprenticeship, we label this dual program *school-based dual program with apprenticeship* or *school-based dual program without apprenticeship*.

Second, students can choose to start the so-called *leertijd* (literally translated "Training Time"), an apprenticeship-based program that is organised by the Flemish Agency for Entrepreneurial Training (SYNTRA) and is recognised by the Flemish government. In these programs, students follow theoretical training in a SYNTRA training centre for one day a week, consisting of four hours of general education and four hours of vocational training. The four remaining days they follow practical training with an employer. Having an employer that is willing to instruct them is therefore a necessary condition that should be met before students can start the program. Consequently, this dual program always has an apprenticeship component. Therefore, for brevity, we label this program simply as *training centre-based dual program*, instead of the longer *training centre-based dual program with apprenticeship*.

The main differences between students enrolled in school-based and training centre-based dual programs (both with apprenticeships) are that in the latter, the practical training is more intensive and employer organisations take relatively more the lead in the organisation and design of the programs. Moreover, unlike the school-based dual programs, enrolment is

[4] The CPEs are often affiliated to a secondary education school and are governed by one of the educational providers that also govern standard schools.

only allowed for students who manage to secure an apprenticeship at a firm.

Students who complete full-time school-based education are unconditionally allowed to start tertiary education. In contrast, students who complete dual programs receive a secondary education qualification but are not allowed to enrol in tertiary education programs.

3 Data

3.1 Sample

Our analyses are based on the SONAR data, which contains exceptionally rich data on education and labour market outcomes for Flemish youth. More concretely, SONAR includes data on three cohorts of about 3,000 individuals born in 1976, 1978, and 1980. These individuals were interviewed at ages 23, 26, and 29. In this study, we use data on the last two cohorts, as for these individuals uniform information on their education career and labour market outcomes was available. To have a sample of pupils with a homogeneous education background, we excluded students who (i) already experienced more than one year of retention at the start of primary education, (ii) needed special help and were therefore in special schools,[5] and (iii) enrolled in a dual program for the first time after the end of compulsory education. Additionally, we excluded students with erroneous or inconsistent data. The final sample consists of 5,541 individuals.

[5] E.g. due to physical and/or mental disability, serious behavioural and/or emotional problems, or serious learning difficulties.

3.2 Exogenous Variables

In our econometric model, which we discuss in detail in Section 4, we use six strictly exogenous background characteristics of the students: (i) gender, (ii) migration background,[6] (iii) number of siblings, (iv and v) maternal and paternal education level (in years of education after primary education), and (vi) day of birth within the calendar year. The first five variables are standard and have also been included by other researchers (Cameron & Heckman, 2001; Belzil & Poinas, 2010; Baert & Cockx, 2013). The day of birth is included to control for relative age within the birth cohort, which is found to positively affect cognitive and non-cognitive achievements in both the short- and long-term (Angrist & Krueger, 1991; Bedard & Dhuey, 2006; Baert & Cockx, 2013; Fumarco & Baert, 2017). The summary statistics for these variables can be found in Panel A of Table 1. When we compare students with full-time school-based education to students who enrolled in a dual program, we see that males, students with a migration background, students with a higher number of siblings, and students with less-educated parents are overrepresented in the latter sample.[7]

< Table 1 about here >

Additional to these background characteristics, we include the unemployment rate at the district level, in the year of the modelled outcomes (source: Public Employment Agency of Flanders). This way, we aim to control for time-varying labour market conditions and (to some extent) for the economic differences by region (and, thereby, family wealth).

[6] This was measured as a dummy capturing a foreign nationality of the maternal grandmother.

[7] Given the substantial overrepresentation of male students in a dual program, we examine in Section 5 whether the effect of a dual program is heterogeneous by gender. Although also students with a migration background are overrepresented in a dual program, we do not pursue the heterogeneity between students with and without a migration background, as the number of students in the former group is too small to model this heterogeneity.

3.3 Endogenous Variables

In our econometric model, we jointly model twelve outcomes: students' (i) delay at the start of primary education, (ii) delay at the start of secondary education, (iii) track choice at the start of the second year of secondary education (either general track, technical or arts track, or vocational track),[8] (iv) secondary education experience (in terms of whether students experience study delay and/or downgrade)[9] at the end of compulsory full-time school-based education, (v) enrolment in a dual program, and if so, (vi-vii) the kind of dual program (training centre-based versus school-based (with or without apprenticeship in case of a school-based dual program)). Additionally, we model whether students (viii) obtained a secondary education qualification, (ix) enrolled in tertiary education, and (x-xii) were employed three months, one year, and five years after leaving the formal education and training system.[10] In an alternative approach with respect to the labour market outcomes, we model whether students secured a permanent contract after leaving formal education and training (in comparison to being either not employed or employed without a permanent contract).

Descriptive statistics of these endogenous variables are given in Panel B of Table 1. Comparing students in full-time school-based education with students in a dual program, we see indications that students in the latter group performed worse in school by the end of

[8] Students have to make their track choice after successful completion of the first year of secondary education.

[9] At the end of each academic year during secondary education, students receive an A, B, or C evaluation. Those getting an A are promoted to the next education year. However, if they wish, they can downgrade tracks. In the present article, we define a downgrade as a transition from general secondary education to another track or from technical or arts secondary education to vocational secondary education. Transitions in the opposite direction are hardly observed. Students obtaining a C must repeat the education year and, if they wish, can downgrade tracks. Students with a B evaluation are forced to downgrade in case they want to be promoted to the next education year (Cockx, Picchio, & Baert, in press).

[10] Dual programs are considered to be part of one's educational and not one's (regular) labour market career. Therefore, these labour market outcome variables only pertain to regular jobs and not to apprenticeship jobs conducted during one's participation in a dual program.

compulsory full-time school-based education. Indeed, they more often had a delay at the start of primary and secondary education, were more delayed, and downgraded more.

Among the 5,541 students observed in our full sample, 332 left full-time school-based education for a dual program. Of the latter group, 37.7% (i.e. 125/332) opted for a training centre-based dual program, while the remaining 62.3% opted for the school-based dual program. These students in dual programs less often obtained a secondary education qualification. When we look at the transition to the regular labour market, students in dual programs more often had a job three months after leaving education. Contrarily, they were less often employed one year or five years after leaving education. This pattern is also observed when looking at the alternative labour market outcome 'permanent contract after leaving education'. These observations are in line with the theoretical arguments outlined in Section 1 for dual programs offering short-term advantages at the cost of long-term disadvantages.

3.4 Endogeneity Problem

By simply comparing the descriptive statistics for students in and out of dual programs, we are, however, unable to deduce the causal impact of these programs on regular labour market outcomes. Indeed, the observed association may also be driven by observable or unobservable differences between students in and out of dual programs.

The biggest barrier to estimating the causal relationship between dual programs and transition to work success is the presence of unobservable differences between students in and out of dual programs (Ryan, 2001). Indeed – and in line with our discussion of Panel B.1 of Table 1 – several studies report that these programs are mostly attended by students with lower ability and motivation (Malamud & Pop-Eleches, 2010; Altonji, Blom, & Meghir, 2012;

Eichhorst et al., 2012). This unobserved heterogeneity may yield a classic omitted variable problem: as unobserved characteristics may also impact labour market outcomes, naively estimated effects are unable to distinguish between the effect of these unobservables and the effect of dual programs. In addition, bias may be introduced by the dynamic sorting that takes place in the educational progression. Cameron and Heckman (1998) show this formally. Intuitively, the dynamic bias is brought about by the progressively growing negative correlation between observed characteristics such as parental educational attainment and unobserved characteristics, because students with adverse observables realise successful outcomes only if their unobserved endowments are sufficiently favourable. This biases the coefficients of observables negatively and more so as one proceeds to higher grades (Baert & Cockx, 2013; Cockx et al., in press).

In this study, we simultaneously model educational outcomes up to the end of compulsory full-time school-based education, enrolment into dual programs, and regular labour market outcomes and control for the unobservable differences between students. We outline this approach in more detail in the next section.

4 Method

In this section, we present the econometric model used to estimate the causal impact of leaving full-time school-based education for one of the two discussed dual programs on the later transition from education to regular work. The added value of this approach is twofold. First, it enables us to control for unobservable factors that influence both the enrolment of students in dual programs and later employment outcomes. Second, this model allows us to

make a distinction between the direct effect of these dual programs (conditional on their effect on the probability of obtaining a secondary education qualification, tertiary education enrolment, and earlier labour market outcomes) and their indirect effect (through these earlier outcomes).

4.1 Dynamic Discrete Choice Model

We build on previous studies that estimated dynamic discrete choice models (Cameron & Heckman, 1998, 2001; Baert & Cockx, 2013; Baert, Neyt, Omey, & Verhaest, 2017; Cockx et al., in press). In line with this literature, our model is a sequence of binary and multinomial probabilities. More concretely, in our benchmark model, we jointly estimate the twelve outcomes mentioned in Subsection 3.3. See Figure 3 for a schematic overview of this model.[11]

< Figure 3 about here >

The choice set for a specific outcome, denoted by C^O, is a set of multinomial numbers: $C^O = \{0,1,...,n^O\}$, where n^O defines the number of choices that can be made for outcome O minus 1. With respect to outcome (iii), three outcome values are possible: general track (outcome value 0), technical or arts track (outcome value 1), and vocational track (outcome value 2). With respect to outcome (iv), four outcome values are possible: no retention and no downgrade (outcome value 0), retention but no downgrade (outcome value 1), no retention but downgrade (outcome value 2), and retention and downgrade (outcome value 3). All other outcomes are binary in nature.

[11] As mentioned in Subsection 3.3, in an alternative model we investigate the impact of dual programs on the chances of securing a permanent contract. The last three outcomes then become whether students had a permanent contract three months, one year, and five years after leaving education.

The optimal choice $\hat{c}_i^O$ of an individual *i* with respect to outcome *O* is the following:

$$\hat{c}_i^O = c \in C^O \quad if \quad \omega_c^O < U_{i,c}^O \leq \omega_{c+1}^O , \tag{1}$$

where $U_{i,c}^O$ is the latent utility of choice *c* for outcome *O,* and ω_c^O and ω_{c+1}^O are threshold utilities ('cut-off values') that determine the ordered choice ($\omega_0^O \equiv -\infty$ and $\omega_{n^O+1}^O \equiv +\infty$). In line with the literature, we approximate this $U_{i,c}^O$ by a linear index:

$$U_{i,c}^O = Z_i \alpha^O + R_i^O \beta^O + V_i^O \gamma^O + \nu_{i,c}^O . \tag{2}$$

In this equation, Z_i is a vector representing the exogenous variables as observed for individual *i*, and R_i^O captures the unemployment rate at the district level at the moment of outcome *O*, both of which are described in Subsection 3.2. V_i^O is the vector of endogenous outcomes that are realised before outcome *O*, which are described in Subsection 3.3. The vectors α^O, β^O, and γ^O are vectors of associated parameters and $\nu_{i,c}^O$ is unobservable from the researcher's point of view.

We follow Cameron and Heckman (2001) by assuming that $\nu_{i,c}^O$ is characterised by a factor structure. However, in line with the more recent literature (Carneiro, Hansen, & Heckman, 2003; Heckman & Navarro, 2007; Fruehwirth, Navarro, & Takahashi, 2016; Cockx et al., in press), we generalise by allowing the factor "loadings" to depend on our main treatment status (whether students enrolled in a dual program) P_i:

$$\nu_{i,c}^O = \delta^O \eta + \varphi^O P_i \, \eta + \varepsilon_{i,c}^O , \tag{3}$$

in which η is a random effect, independent of $\varepsilon_{i,c}^O$, and independent across individual students, which captures unobserved determinants of the outcomes in the model. The

outcome-specific coefficients δ^O and φ^O are normalised to 1 for the first modelled outcome. The error term $\varepsilon_{i,c}^O$ is i.i.d. and assumed to be logistically distributed.

As a consequence, we can write the probability of a particular outcome value as:

$$\Pr(\hat{c}_i^O = c \mid \mathrm{Z_i}, R_i^O, V_i^O, \eta; \vartheta) = \frac{\exp(\omega_{c+1}^O - \mathrm{Z_i}\alpha^{\mathrm{O}} - R_i^O\beta^{\mathrm{O}} - V_i^O\gamma^O - \delta^O\eta - \varphi^O P_i\,\eta - \varepsilon_{i,c}^O)}{1+\exp(\omega_{c+1}^O - \mathrm{Z_i}\alpha^{\mathrm{O}} - R_i^O\beta^{\mathrm{O}} - V_i^O\gamma^O - \delta^O\eta - \varepsilon_{i,c}^O)} - \frac{\exp(\omega_c^O - \mathrm{Z_i}\alpha^{\mathrm{O}} - R_i^O\beta^{\mathrm{O}} - V_i^O\gamma^O - \delta^O\eta - \varphi^O P_i\,\eta - \varepsilon_{i,c}^O)}{1+\exp(\omega_c^O - \mathrm{Z_i}\alpha^{\mathrm{O}} - R_i^O\beta^{\mathrm{O}} - V_i^O\gamma^O - \delta^O\eta - \varepsilon_{i,c}^O)}, \quad (4)$$

in which we denote the vector of unknown parameters by ϑ. The likelihood contribution $\ell_i(Z_i, R_i^O, V_i^O, \eta; \vartheta)$ for any sampled individual, conditional on the unobservable η, is then constructed by the product of the probabilities of the choices realised in the data for the twelve modelled outcomes.

Following the literature, we adopt a non-parametric discrete distribution for the unobserved random variable η. We assume that this distribution is characterised by an *a priori* unknown number of *K* points of support η_k to which are assigned probabilities $p_k(q)$ specified as logistic transforms:

$$p_k(q) = \frac{exp(q_k)}{\sum_{j=1}^{K} exp(q_j)} \quad with \quad k = 1,2,...K; q \equiv [q_1, q_2, ..., q_K]' \; and \; q_1 = 0 \qquad (5)$$

.

Hence, the unconditional individual likelihood contribution for individual *i* is:

$$\ell_i(Z_i, R_i^O, V_i^O; \vartheta, q) = \sum_{k=1}^{K} p_k(q)\,\ell_i(Z_i, R_i^O, V_i^O, \eta_k; \vartheta) \qquad (6)$$

.

As Cameron and Heckman (1998; 2001) show, identification of the random effect is proven if our initial condition, i.e. delay at the start of primary education, is free of selection. This means that η should be independent of Z_i and R_i^O.

4.2 Model Selection

We estimated the coefficients for the model presented in the previous subsection with a maximum likelihood estimation following Gaure, Røed, and Zhang (2007). Heterogeneity types were gradually added until the log-likelihood value of the model failed to increase.

Table A–1 in Appendix A reports the number of parameters, the log-likelihood, and the Akaike Information Criterion (AIC)[12] values of the model according to the number of heterogeneity types *K* included. The lowest AIC was obtained for K = 6. The coefficient estimates for this model are displayed in Table A–2. Unless otherwise stated, the simulations below are based on these parameter estimates.

The coefficient estimates in Table A–2 provide further evidence that controlling for unobserved heterogeneity is important. First, the proportion of each of the six heterogeneity types is substantial (p_1 = 40.1%, p_2 = 6.0%, p_3 = 35.4%, p_4 = 16.5%, p_5 = 0.9%, and p_6 = 1.2%).[13] Second, almost all (other) parameters of the unobserved heterogeneity distribution (i.e. all η_k's and most δ^O's) are highly significantly different from 0.

4.3 Simulation Strategy

Based on the estimated parameters for our preferred model, we simulate student education careers (among which their enrolment in dual programs) and early regular labour market outcomes. To answer our research questions, we run these simulations under different

[12] Following the argument in Gaure et al. (2007), we believe that the AIC is the preferable criterion for our sample size.

[13] For instance, following Equation (5), p_2 = exp(-1.899) / (exp(0) + exp(-1.899) + exp(-0.124) + exp(-0.887) + exp(-3.787) + exp(-3.538)).

scenarios with respect to student enrolment in dual programs.

For each analysis, we randomly draw 999 vectors from the asymptotic normal distribution of the preferred model's parameters. Subsequently, in each of the 999 draws, the parameters are used to calculate the probabilities associated with each heterogeneity type. These probabilities are then used to randomly assign a heterogeneity type to each pupil in the sample. Thereafter, based on these randomly drawn parameters and the assignment of individuals to a heterogeneity type, the full sequence of education and labour market outcomes is simulated for each student in the sample (for each draw).

More concretely, each outcome is simulated sequentially based on its (multinomial) logit specification, reported in Subsection 4.1. These specifications yield, for each individual in each draw, a probability for each potential outcome value. These probabilities are then translated to segments on the unit interval. To determine the particular outcome value for each individual in each draw, a random number is generated from the standard uniform distribution. The outcome value assigned to the individual depends on the segment in which this random number falls. Once an outcome is assigned, it is saved and conditioned upon for subsequent outcomes. In the sequel, the model prediction of a particular outcome refers to the average of these 999 replications. The 95% confidence intervals are constructed by choosing the appropriate percentiles of the 999 simulated probabilities.

4.4 Goodness of Fit

To determine the benchmark model's goodness of fit, for each endogenous variable we compared the actual probability (as observed in our data) with the simulated probability (as estimated by our model). As can be seen from Figure 4 and Table A–3, the simulated probabilities are closely distributed around the actual probabilities. Only for the outcome

'Employed five years after leaving education' does the simulated probability deviates significantly (at the 5% confidence level) from the actual probability. Nonetheless, also for this outcome the simulated probability approaches the actual probability quite well in economic terms (i.e. the probabilities are 0.923 and 0.906, respectively).

< Figure 4 about here >

4.5 Average Treatment Effects

To answer our research questions, we simulated, following the strategy presented in the previous subsection, two series of average treatment effects (ATEs): one for the treatment 'training centre-based dual program' and one for the treatment 'school-based dual program with apprenticeship'. Since in a school-based dual program without apprenticeship there is no real work component (supra, Section 2), we do not report the ATEs for this program. The ATEs for this treatment are available on request.

The ATEs are a combination of average treatment effects on the treated (ATTs) and average treatment effects on the non-treated (ATNTs). ATTs were based on the simulated outcomes of individuals ('ind.' in the following equations) who were assigned to the treatment of a certain dual program given a particular parameter draw. Similarly, we calculated the ATNTs for individuals who were assigned to no treatment. First, the ATT for a certain treatment is calculated for each outcome of interest (and for each of the 999 parameter draws) as follows:

$$ATT = \frac{average\ outcome\ across\ treated\ ind.}{average\ outcome\ across\ treated\ ind.,\ in\ the\ counterfacutal\ of\ no\ treatment} \quad (7)$$

The counterfactual outcomes were realised by forcing all indicator variables for treatment (i.e. participation in dual program, school-based dual program, and apprenticeship during

school-based dual program) to 0 for each treated individual. Second, the ATNT is calculated for each outcome of interest as follows:

$$ATNT = \frac{average\ outcome\ across\ untreated\ ind.,in\ the\ counterfacutal\ of\ treatment}{average\ outcome\ across\ untreated\ ind.}. (8)$$

In this case, the counterfactual outcomes in case of treatment were realised by forcing the indicator variables for treatment to the appropriate status. More concretely, in the counterfactual situation of a training centre-based dual program only, the variable 'participation in dual program' was forced to 1, while in the counterfactual situation of a school-based dual program with apprenticeship, also 'school-based dual program' and 'apprenticeship during school-based dual program' were forced to 1 for each untreated individual. Third, the ATE is realised by combining both strategies and calculated as follows:

$$ATE = \frac{average\ outcome\ across\ treated\ ind.}{average\ outcome\ across\ untreated\ ind.}. \quad (9)$$

For each parameter draw, the numerator is the average outcome in case of treatment for all individuals (so the factual simulated outcome for the individuals assigned to the treatment or the counterfactual simulated outcome in case of no such assignment), while the denominator is the average outcome in case of no treatment for all the individuals (so the counterfactual simulated outcome for the individuals assigned to the treatment or the factual simulated outcome in case of no such assignment). If the ATE is above (below) 1, this means there is a positive (negative) effect of the treatment on the outcome of interest. Below, we discuss the distribution of this ATE, i.e. its average over the 999 draws and its 95% confidence intervals.

4.6 Total and Direct Effects

For outcomes realised after the decision (not) to enrol in a dual program, we make a

distinction between total effects and direct effects. For the total effects, we do not condition the denominator of Equation (9) on earlier outcomes, as would be realised in the scenario of no treatment (not enrolling in a certain dual program). Consequently, the treatment impacts these outcomes both directly (via the model's coefficients capturing the direct effect of a dual program) and indirectly (via the model's coefficients capturing the effects of earlier outcomes, which in turn were (potentially) affected by enrolling into a dual program). In contrast, for the direct effects, we do condition the denominator of Equation (9) on earlier outcomes as realised in the scenario of no treatment. Consequently, the treatment impacts the analysed outcomes only directly (via the model's coefficients capturing the direct effect of a dual program on these outcomes).

5 Results

In this section we present the results of our analyses. We start with a brief discussion of the coefficient estimates of our benchmark model and three alternative models (to inspect whether the effect of the dual programs is heterogeneous by observed early labour market outcome and by gender). Next, we discuss our ATEs and contrast the total effects of enrolling into a dual program with its direct effects. All these analyses are based on our preferred model, i.e. the model with six heterogeneity types.

Table 2 shows the main coefficient estimates for several specifications of our model – the full estimation results of our benchmark model are presented in Table A–2. The models for which the main results are presented in the first two columns of Table 2 use 'employed after leaving education' as the labour market outcome, while the other models use

'permanent contract after leaving education'. Column (1) and (3) show the results for models without an interaction effect between participation in a dual program and female gender, while column (2) and (4) provide the estimation results for an extended version of the model in which this interaction is added. The coefficients should be interpreted relative to 0. If the coefficients are above (below) 0, there is a positive (negative) effect of enrolling into a dual program compared to enrolling into full-time school-based education. The effect of enrolling into a training centre-based dual program is measured by the coefficient of 'participation in dual program'. For students in a school-based dual program without apprenticeship (with apprenticeship), this coefficient should be increased with the coefficient of 'school-based dual program' (with the coefficients of 'school-based dual program' and 'apprenticeship during school-based dual program').

< Table 2 about here >

We first focus on the results in column (1) and (3). Panel A of Table 2 clearly shows a highly significantly negative effect of enrolling in any dual program on the probability of obtaining a secondary education qualification. We cannot reject that this effect is homogeneous by whether one enrols into a training centre-based or school-based dual program (i.e. 'school-based dual program' is not significant) or by whether one is employed during one's school-based dual program (i.e. 'apprenticeship during school-based dual program' is not significant).

Regarding work status (employment and having a permanent contract) three months after leaving formal education and training (Panel B), we observe a highly significantly positive effect for students doing a training centre-based dual program (conditional on the included education outcomes). For students with an experience of a school-based dual program, we cannot reject the null hypothesis of no effect (i.e. the sum of the coefficients of 'participation

in dual program' and 'school-based dual program' was not statistically significantly different from 0). Further, no significant effects of the dual programs were found with respect to the later labour market outcomes (conditional on earlier education and labour market outcomes).

Concerning heterogeneous effects by gender, we find a negative effect of the interaction term 'participation in dual program × female gender' on the probability of being employed three months after leaving formal education and training but not on the probability of having a permanent contract after three months. So, the premium of a dual program is found to be lower for females, *ceteris paribus*.

The abovementioned results based on parameter estimates are direct effects, i.e. they are conditional on all earlier outcomes. Moreover, their magnitude is difficult to interpret. Therefore, in Table 3 and 4, we present various ATEs of the dual programs. The treatment is a particular dual program. The counterfactual is the scenario where the same individuals do not follow any dual program (i.e. they are enrolled in full-time school-based education).[14] The ATEs should be interpreted relative to 1. If the ratio is above (below) 1, there is a positive (negative) effect of the dual program compared to full-time school-based education.

Column (1) of Table 3 shows the total effects of dual programs on obtaining a secondary education qualification and employment three months, one year, and five years after leaving education. In line with our discussion of Panel A of Table 2, we find that students doing a training centre-based dual program (Panel A of Table 3) are 5.5% less likely to obtain a secondary education qualification compared to students in full-time school-based education. Additionally, students in a school-based dual program with apprenticeship (Panel B of Table

[14] Results do not substantially differ when estimating ATTs or ATNTs (see Table A–4 in Appendix A).

3) are 3.9% less likely to obtain this qualification (compared to students who did not enrol in a dual program). However, the latter effect is not statistically significantly different from 0. Concerning the labour market outcomes, we find that students in training centre-based dual programs are 29.7% more likely to have a job three months after leaving formal education and training, but that this effect fades over time; that is, there is no effect on the probability of having a job one year and five years after leaving education. For students doing a school-based dual program with apprenticeship we see the same pattern, although we do not find a statistically significant effect. In economic terms, the ATEs for these students are lower too (compared to those for a training centre-based dual program).

< Table 3 about here >

Column (2) of Table 3 presents the direct effects of the two dual programs.[15] These effects capture the same empirical pattern as that presented in column (1) of Table 2, since the coefficient estimates also measure direct effects. For students doing a training centre-based dual program, the direct effect on finding a job three months after leaving education (30.6%) is slightly bigger than the total effect (29.7%). This means that the direct effect overcompensates for a very small negative indirect effect, via the negative effect of doing a training centre-based dual program on obtaining a secondary education qualification, which in turn has a positive effect on finding work (Panel M of Table A–2).[16]

Table 4 compares the total effects on the labour market outcome 'employed after leaving education' with the alternative labour market outcome 'permanent contract after

[15] Given that for the outcome 'secondary education qualification obtained' we do not condition on prior endogenous outcome variables, the direct effects equal the total effects and are therefore not reported.

[16] When using the outcome 'permanent contract after leaving education', the differences between total effects and direct effects are similar. These additional results are available on request.

leaving education'. For this alternative outcome the results are somewhat more pronounced. Students doing a training centre-based dual program have a 78.9% higher probability of having a permanent contract three months after leaving education and a 26.7% higher probability of having a permanent contract one year after leaving education. The fact that a significant total effect on having a permanent contract one year after leaving education is found while column (3) of Table 2 points in the direction of no direct effect can be explained by the significant effect of having a contract three months after leaving education on having such a contract one year after leaving formal education and training. Again, for students in the school-based dual program with apprenticeship (Panel B), no statistically significant treatment effects are found.

< Table 4 about here >

6 Conclusion

In this study we examined the effect of participation in training centre-based and school-based dual programs within the context of the Belgian secondary education system on educational achievement and subsequent regular labour market outcomes. We found that students doing a training centre-based dual program less often obtain a secondary education qualification compared to students in full-time school-based education, whereas this effect was not significant for students in a school-based dual program. In addition, students doing a training centre-based dual program had an increased probability of finding a job when entering the regular labour market but this impact diminished over time. This advantage was not found for students in the school-based dual program, suggesting that the positive effect

of doing a training centre-based dual program is due to its closer ties to the labour market. The finding that the advantage of training centre-based dual programs in the short run fades over time is consistent with previous literature that also found evidence for a positive effect of vocational education on employment outcomes only in the short run (Forster et al., 2016; Brunello & Rocco, 2017; Hampf & Woessmann, 2017; Hanushek et al., 2017; Lavrijsen & Nicaise, 2017).

Our results have several implications for policy makers. First, our evaluation of the Flemish dual programs in secondary education is rather positive overall. Although students enrolling into this system face a slightly higher unqualified drop-out rate, they have a substantially higher probability of a smooth transition to regular work (especially with respect to getting a permanent contract) compared to students with the same endowments who did not enrol into a dual program. Second, and in line with Albanese et al. (2017), our results suggest that this advantage may be enforced by increasing the importance of in-field training. Third, our results also suggest that policy makers face a trade-off when designing dual programs, since programs with more in-field training also seem to result in more unqualified drop-outs, with potential negative effects beyond early labour market outcomes (Weber, 2014; Hanushek et al., 2017).

Finally, we recommend several directions for future research. First, we suggest investigating the effect of dual programs (in Belgium and abroad) on other labour market outcomes than those considered in this study. In particular, it would be interesting to see what the direct and indirect causal effects of the studied programs on later wages and other indicators of job match quality are. Second, due to data constraints, we were unable to investigate the mechanisms underlying the smoother transition to the regular labour market after a (training centre-based) dual program in secondary education. In particular, our data

did not allow us to examine the extent to which students enrolled in such a program start their regular labour market career with the employer that they worked for during these programs. Finding evidence for this screening channel could support the idea that programs with more in-field training are more effective due to the realised stronger ties with the labour market. Third, since we only observed the first five years after entering the regular labour market, we were not able to assess whether the declining advantage of dual programs in terms of labour market outcomes ultimately turns into a disadvantage, as found in some other studies. Relying on a similar type of modelling to investigate whether this is the case is another interesting avenue for further research.

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Appendix A

< Table A–1 about here >

< Table A–2 about here >

< Table A–3 about here >

< Table A–4 about here >

Table 1. Summary statistics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	I. Whole sample (N = 5,541)		II. Sample with full-time school-based education (N = 5,209)		III. Sample with dual program (N = 332)		IV. Sample with training centre-based dual program (N = 125)		V. Sample with school-based dual program without apprenticeship (N = 97)		VI. Sample with school-based dual program with apprenticeship (N = 110)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
A. Exogenous variables												
Female gender	0.495	-	0.506	-	0.331	-	0.317	-	0.485	-	0.211	-
Migration background	0.062	-	0.057	-	0.142	-	0.071	-	0.247	-	0.128	-
Number of siblings	1.642	1.403	1.606	1.351	2.208	1.966	1.706	1.345	2.763	2.482	2.294	1.921
Mother's education after primary education (years)	5.441	3.209	5.585	3.164	3.181	3.058	3.508	2.950	2.742	3.046	3.193	3.170
Father's education after primary education (years)	5.869	3.472	6.016	3.442	3.563	3.103	3.659	2.860	3.134	3.319	3.835	3.164
Day of birth within calendar year	180.316	103.336	180.358	103.334	179.654	103.517	165.365	104.101	207.536	105.434	171.358	97.016
B. Endogenous variables												
B.1. Educational outcomes before choice related to dual program												
Delay at start PE	0.017	-	0.016	-	0.033	-	0.032	-	0.021	-	0.046	-
Delay at start SE	0.106	-	0.096	-	0.268	-	0.246	-	0.278	-	0.284	-
Track choice at start second year of SE												
General track	0.605	-	0.634	-	0.157	-	0.206	-	0.124	-	0.128	-
Technical or arts track	0.260	-	0.257	-	0.307	-	0.246	-	0.351	-	0.339	-
Vocational track	0.135	-	0.109	-	0.536	-	0.548	-	0.526	-	0.532	-
SE experience at end of CFTSBE												
No retention and no downgrade	0.812	-	0.820	-	0.681	-	0.738	-	0.670	-	0.624	-
Retention and no downgrade	0.074	-	0.069	-	0.160	-	0.103	-	0.175	-	0.211	-
No retention and downgrade	0.104	-	0.102	-	0.139	-	0.127	-	0.134	-	0.156	-
Retention and downgrade	0.010	-	0.009	-	0.021	-	0.032	-	0.021	-	0.009	-
B.2. Choice related to dual program												
Participation in dual program	0.060	-	0.000	-	1.000	-	1.000	-	1.000	-	1.000	-
Training centre-based dual program	0.023	-	0.000	-	0.377	-	1.000	-	0.000	-	0.000	-
School-based dual program	0.037	-	0.000	-	0.623	-	0.000	-	1.000	-	1.000	-
Apprenticeship during school-based dual program	0.020	-	0.000	-	0.328	-	0.000	-	0.000	-	1.000	-

Table 1. *Continued.*

B.3. Later educational and labour market outcomes												
SE qualification obtained	0.924	-	0.942	-	0.633	-	0.770	-	0.546	-	0.550	-
TE enrolment	0.636	-	0.677	-	0.000	-	0.000	-	0.000	-	0.000	-
Employed three months after leaving education	0.615	-	0.613	-	0.646	-	0.795	-	0.495	-	0.619	-
Employed one year after leaving education	0.834	-	0.842	-	0.723	-	0.819	-	0.608	-	0.724	-
Employed five years after leaving education	0.906	-	0.920	-	0.780	-	0.900	-	0.627	-	0.788	-
Permanent contract three months after leaving education	0.311	-	0.305	-	0.407	-	0.569	-	0.258	-	0.365	-
Permanent contract one year after leaving education	0.504	-	0.505	-	0.497	-	0.637	-	0.371	-	0.462	-
Permanent contract five years after leaving education	0.768	-	0.780	-	0.643	-	0.758	-	0.494	-	0.655	-

Notes. See Section 3 for a description of the listed variables. The following abbreviations are used: CFTSBE (compulsory full-time school-based education), PE (primary education), SE (secondary education), and TE (tertiary education). For binary variables no standard deviations are presented.

Table 2. Main estimated coefficients.

	(1)	(2)	(3)	(4)
	Model			
	Labour market outcome: employed after leaving education		Labour market outcome: permanent contract after leaving education	
	Dual program effect homogeneous by gender (benchmark model)	Dual program effect heterogeneous by gender	Dual program effect homogeneous by gender	Dual program effect heterogeneous by gender
A. Outcome: SE qualification obtained				
Participation in dual program	−1.941*** (0.729)	−1.996*** (0.754)	−2.333*** (0.794)	−2.387*** (0.837)
Participation in dual program × female gender		0.293 (0.923)		0.871 (0.971)
School-based dual program	−0.271 (0.941)	−0.207 (1.028)	−0.045 (0.975)	−0.083 (1.118)
Apprenticeship during school-based dual program	0.840 (1.128)	0.981 (1.272)	0.875 (1.217)	1.167 (1.393)
B. Outcome: work status three months after leaving education				
Participation in dual program	0.930*** (0.312)	1.194*** (0.343)	1.111*** (0.261)	1.269*** (0.281)
Participation in dual program × female gender		−0.641** (0.323)		−0.471 (0.347)
School-based dual program	−1.055*** (0.389)	−0.995** (0.392)	−1.118*** (0.383)	−1.082*** (0.388)
Apprenticeship during school-based dual program	0.448 (0.358)	0.272 (0.368)	0.363 (0.371)	0.255 (0.390)
C. Outcome: work status one year after leaving education				
Participation in dual program	−0.382 (0.381)	−0.153 (0.430)	−0.048 (0.416)	−0.042 (0.441)
Participation in dual program × female gender		−0.489 (0.440)		−0.010 (0.460)
School-based dual program	−0.048 (0.439)	0.023 (0.452)	−0.134 (0.518)	−0.120 (0.530)
Apprenticeship during school-based dual program	0.335 (0.460)	0.222 (0.492)	0.045 (0.532)	0.055 (0.556)
D. Outcome: work status five years after leaving education				
Participation in dual program	0.174 (0.471)	0.387 (0.537)	−0.370 (0.303)	−0.233 (0.346)
Participation in dual program × female gender		−0.393 (0.438)		−0.311 (0.359)
School-based dual program	−0.939* (0.528)	−0.941* (0.530)	−0.586 (0.431)	−0.566 (0.432)
Apprenticeship during school-based dual program	0.608 (0.502)	0.522 (0.506)	0.447 (0.431)	0.360 (0.438)
N	5,541	5,541	5,541	5,541
# heterogeneity types (K)	6	6[a]	6	6
# parameters	239	243	239	243
Log-likelihood	−19,441.101	−19,436.983	−20,562.977	−20,561.153
Akaike Information Criterion (AIC)	39,360.203	39,359.965	41,603.953	41,608.305

Notes. The presented statistics are estimated coefficients and standard errors between parentheses. * (**) ((***)) indicates significance at the 10% (5%) ((1%)) significance level. The following abbreviation is used: SE (secondary education).

[a] The AIC is slightly lower for the model with seven heterogeneity types, i.e. AIC=39,358.177. However, for consistency, we used the model with six heterogeneity types throughout all our analyses. Using a model with seven heterogeneity types for this specification does not substantially change our results.

Table 3. ATEs on educational and labour market outcomes: participation in a dual program versus full-time school-based education.

	(1)	(2)
	Total effect	**Direct effect**
A. Treatment: training centre-based dual program		
SE qualification obtained	0.945*** [0.893, 0.989]	
Employed three months after leaving education	1.297*** [1.117, 1.449]	1.306*** [1.129, 1.456]
Employed one year after leaving education	1.011 [0.914, 1.093]	0.943 [0.826, 1.044]
Employed five years after leaving education	1.009 [0.943, 1.051]	1.007 [0.943, 1.050]
B. Treatment: school-based dual program with apprenticeship		
SE qualification obtained	0.961 [0.891, 1.009]	
Employed three months after leaving education	1.129 [0.872, 1.344]	1.136 [0.885, 1.349]
Employed one year after leaving education	1.003 [0.859, 1.111]	0.980 [0.847, 1.084]
Employed five years after leaving education	0.985 [0.884, 1.047]	0.984 [0.890, 1.044]

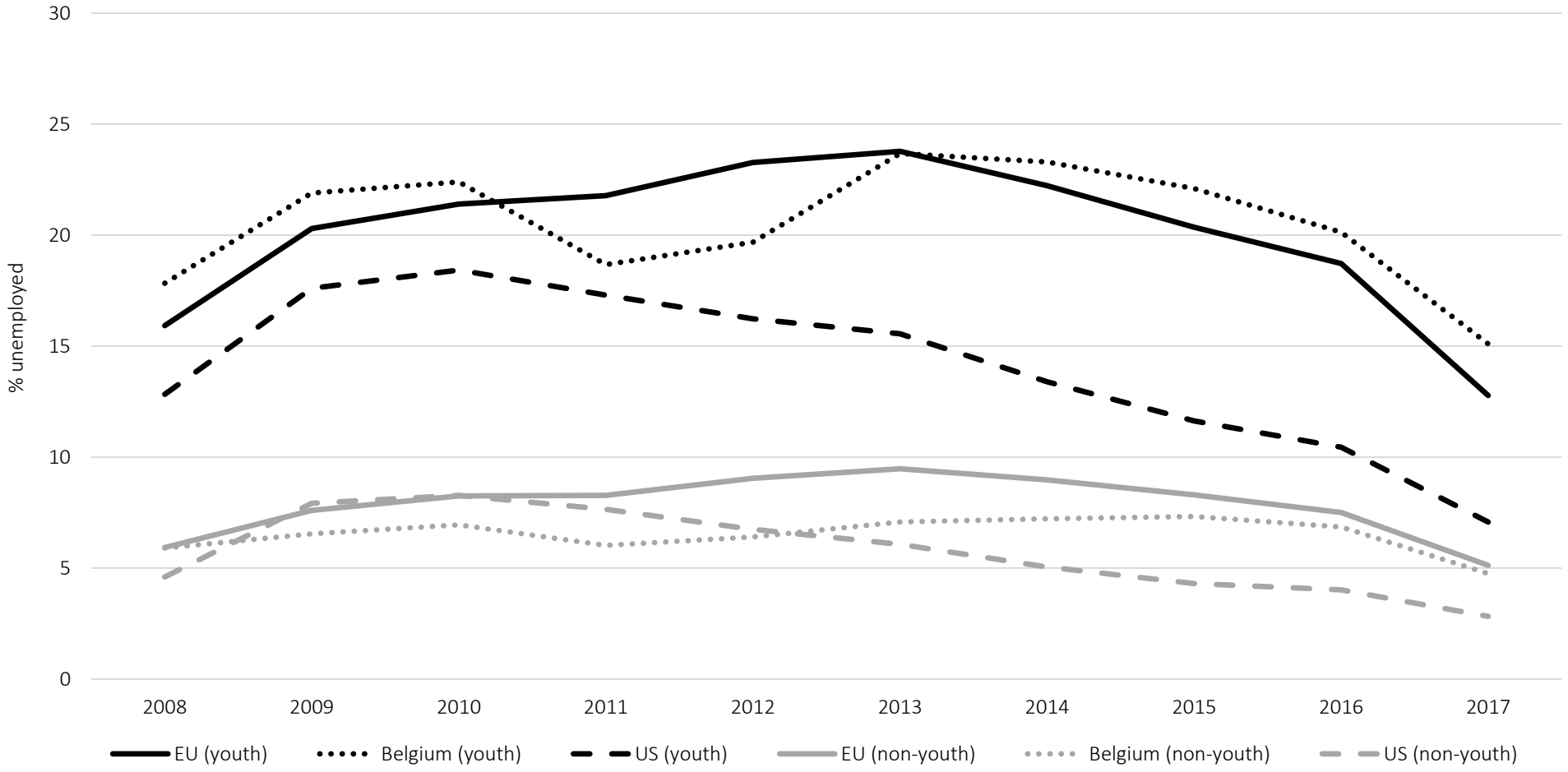
Notes. The presented statistics are simulated average treatment effects (ATEs) and 95% confidence intervals are given between brackets. * (**) ((***)) indicates significance at the 10% (5%) ((1%)) significance level. The following abbreviation is used: SE (secondary education). The direct effects are not presented with respect to the outcome 'SE qualification obtained', as these effects are equal to the total effects.

Table 4. ATEs on labour market outcomes: participation in a dual program versus full-time school-based education.

	(1)	(2)
	Total effect	
	Employed	Permanent contract
A. Treatment: training centre-based dual program		
Work status three months after leaving education	1.297*** [1.117, 1.449]	1.789*** [1.383, 2.216]
Work status one year after leaving education	1.011 [0.914, 1.093]	1.267** [1.038, 1.482]
Work status five years after leaving education	1.009 [0.943, 1.051]	0.979 [0.847, 1.090]
B. Treatment: school-based dual program with apprenticeship		
Work status three months after leaving education	1.129 [0.872, 1.344]	1.248 [0.811, 1.726]
Work status one year after leaving education	1.003 [0.859, 1.111]	1.046 [0.749, 1.343]
Work status five years after leaving education	0.985 [0.884, 1.047]	0.905 [0.693, 1.078]

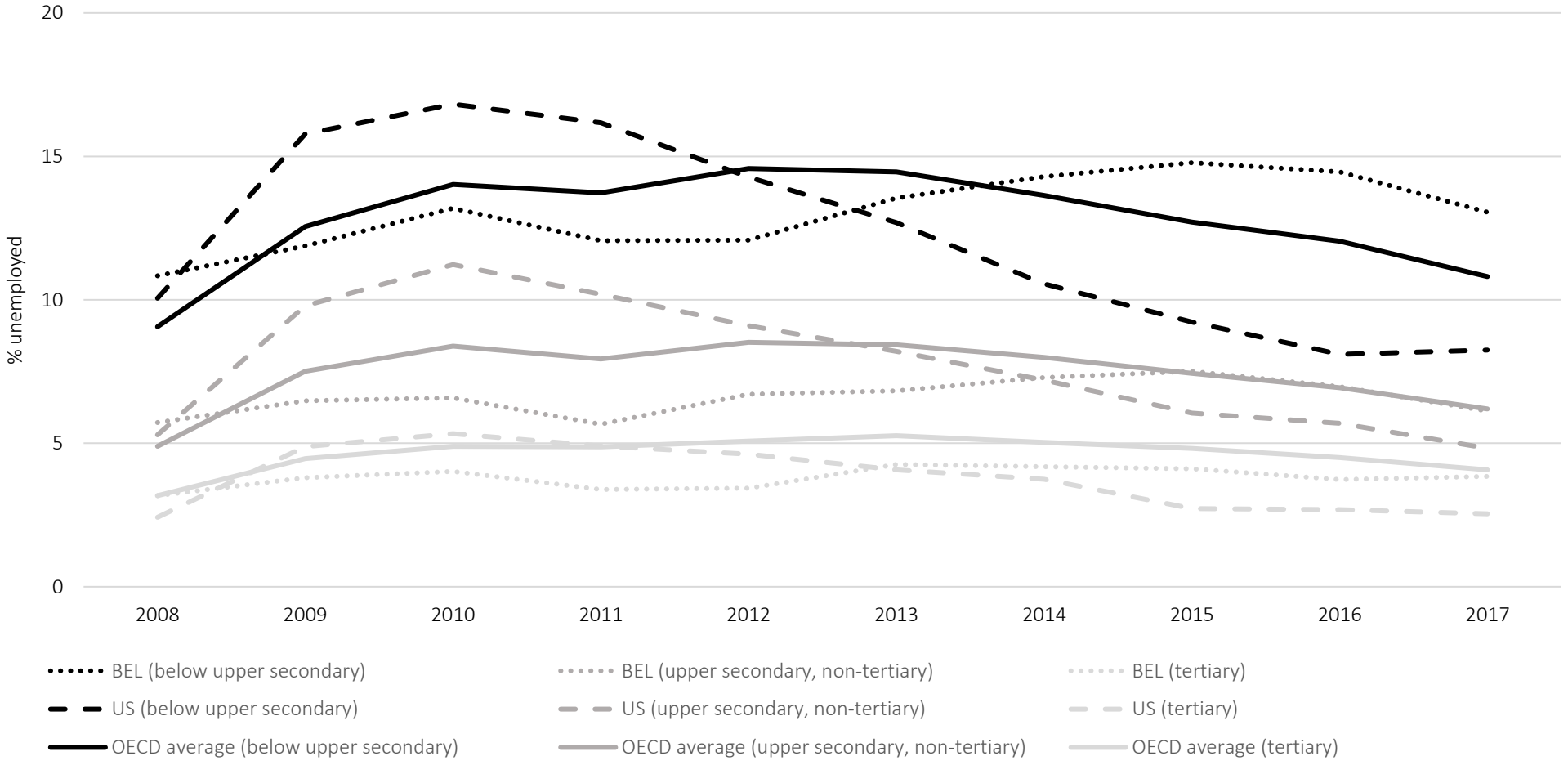
Notes. The presented statistics are simulated average treatment effects (ATEs) and 95% confidence intervals are given between brackets. * (**) ((***)) indicates significance at the 10% (5%) ((1%)) significance level. The effects are not presented with respect to the outcome 'SE qualification obtained', as these effects are equal to the total effects in the previous table.

Figure 1. Youth and non-youth unemployment rates.



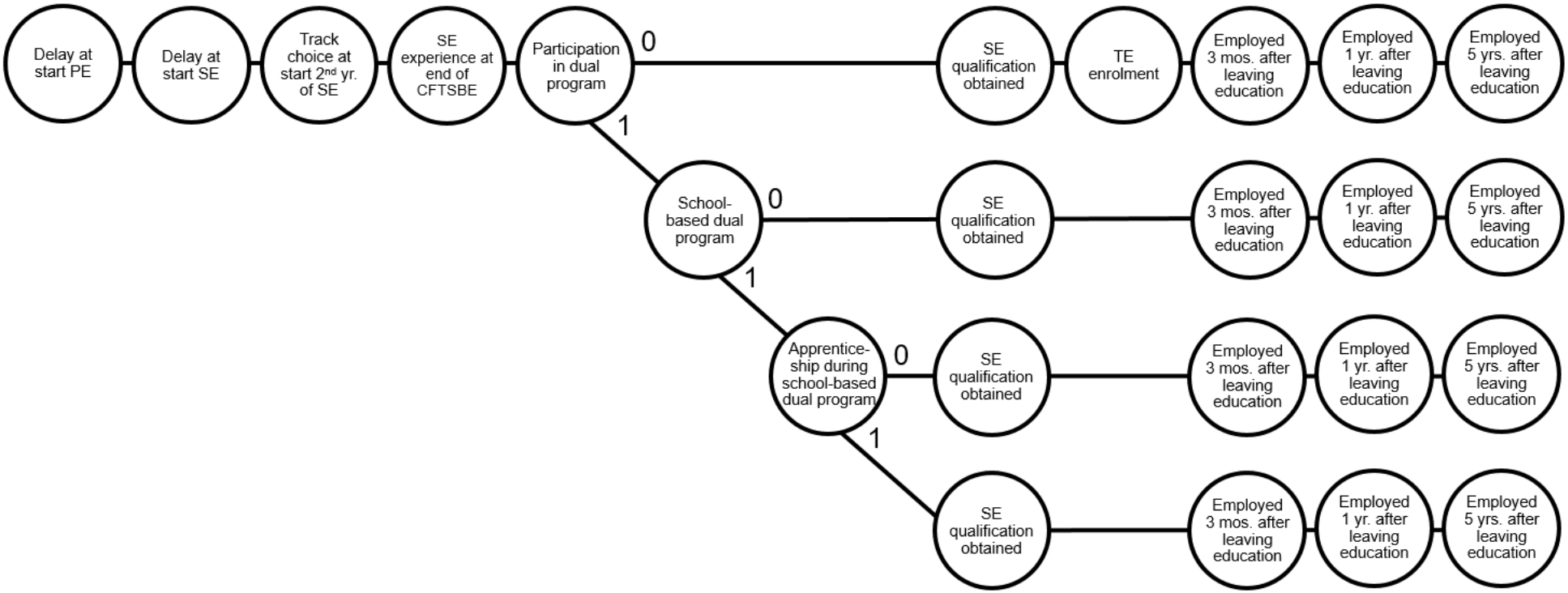
Source: Eurostat. Youth: between 15 and 24 years old. Non-youth: between 25 and 74 years old.

Figure 2. Unemployment rates by highest obtained education level.



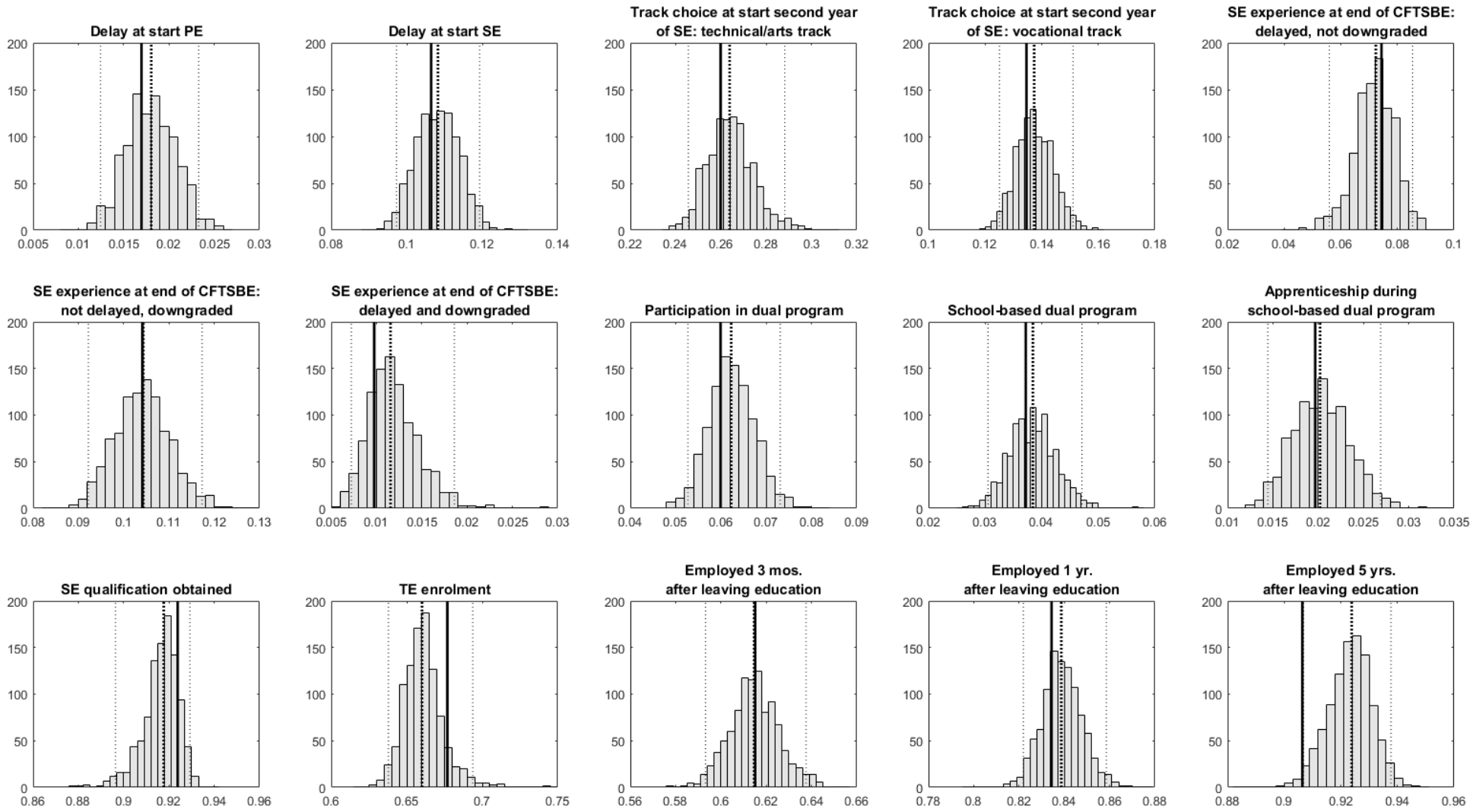
Source: OECD (2018).

Figure 3. Schematic overview of the econometric model.



Notes. The following abbreviations are used: CFTSBE (compulsory full-time school-based education), PE (primary education), SE (secondary education), TE (tertiary education), mos. (months), yr. (year), and yrs. (years).

Figure 4. Goodness of fit for the simulated probabilities.



Notes. The y-axis indicates how many times (on a total of 999) a particular probability (x-axis) was simulated. The full line indicates the actual probability, the dotted lines indicate the median and the 95% confidence interval of the simulated probabilities. The following abbreviations are used: CFTSBE (compulsory full-time school-based education), PE (primary education), SE (secondary education), TE (tertiary education), mos. (months), yr. (year), and yrs. (years).

Table A–1. Benchmark model: model selection.

(1) # heterogeneity types (K)	(2) # parameters	(3) Log-likelihood	(4) Akaike Information Criterion
1	212	−19,602.013	39,628.027
2	231	−19,501.459	39,464.917
3	233	−19,455.369	39,376.737
4	235	−19,452.384	39,374.768
5	237	−19,447.588	39,369.175
6	**239**	**−19,441.101**	**39,360.203**
7	241	−19,439.929	39,361.859
8	243	−19,439.051	39,364.103

Table A–2. Benchmark model: full estimation results.

	Coefficient (SE)
A. Outcome: Delay at start primary education	
Female gender	−0.048 (0.243)
Migration background	1.281*** (0.390)
Number of siblings	0.019 (0.089)
Mother's education after PE (years)	−0.031 (0.050)
Father's education after PE (years)	0.032 (0.046)
Day of birth within calendar year	0.005*** (0.001)
Unemployment rate	0.017 (0.056)
Intercept	−5.854*** (0.990)
B. Outcome: Delay at start SE	
Female gender	−0.285*** (0.099)
Migration background	0.525*** (0.162)
Number of siblings	0.096*** (0.032)
Mother's education after PE (years)	−0.139*** (0.019)
Father's education after PE (years)	−0.081*** (0.018)
Day of birth within calendar year	0.003*** (0.000)
Unemployment rate	0.011 (0.017)
Delay at start primary education	3.473*** (0.283)
Intercept	−1.828*** (0.292)
C. Outcome: Track choice at start second year of SE: technical or arts track	
Female gender	−0.628*** (0.089)
Migration background	−0.352* (0.195)
Number of siblings	0.080** (0.035)
Mother's education after PE (years)	−0.194*** (0,020)
Father's education after PE (years)	−0.187*** (0.018)
Day of birth within calendar year	0.001*** (0,000)
Unemployment rate	0.043*** (0,014)
Delay at start primary education	−0.252 (0.365)
Delay at start secondary education	1.857*** (0.202)
Intercept	1.603*** (0.321)
D. Outcome: Track choice at start second year of SE: vocational track	
Female gender	−0.704*** (0.138)
Migration background	−0.375 (0.269)
Number of siblings	0.238*** (0.048)
Mother's education after PE (years)	−0.355*** (0.031)
Father's education after PE (years)	−0.295*** (0.028)
Day of birth within calendar year	0.002*** (0.001)
Unemployment rate	0.096*** (0.021)
Delay at start primary education	−0.176 (0.555)
Delay at start secondary education	3.252*** (0.263)
Intercept	1.071** (0.446)
E. Outcome: SE experience at end of CFTSBE: delayed, not downgraded	
Female gender	−0.434*** (0.135)
Migration background	0.493** (0.240)
Number of siblings	0.055 (0.043)
Mother's education after PE (years)	0.009 (0.027)
Father's education after PE (years)	0.061*** (0.024)

Table A–2. *Continued*.

	Coefficient (SE)
Day of birth within calendar year	0.000 (0.001)
Unemployment rate	−0.012 (0.022)
Delay at start primary education	−0.624 (0.638)
Delay at start secondary education	−1.113*** (0.238)
Track choice at start second year of SE: technical or arts track	2.973*** (0.383)
Track choice at start second year of SE: vocational track	3.691*** (0.530)
Intercept	−6.115*** (0.652)
F. Outcome: SE experience at end of CFTSBE: not delayed, downgraded	
Female gender	−0.113 (0.094)
Migration background	−0.365 (0.251)
Number of siblings	0.021 (0.038)
Mother's education after PE (years)	−0.095*** (0.020)
Father's education after PE (years)	−0.078*** (0.019)
Day of birth within calendar year	0.000 (0.000)
Unemployment rate	0.027* (0.015)
Delay at start primary education	−1.309 (1.143)
Delay at start secondary education	−4.053*** (1.124)
Track choice at start second year of SE: technical or arts track	−0.155 (0.169)
Track choice at start second year of SE: vocational track	−50[a]
Intercept	−1.333*** (0.352)
G. Outcome: SE experience at end of CFTSBE: delayed and downgraded	
Female gender	−0.414 (0.347)
Migration background	−0.454 (0.884)
Number of siblings	0.094 (0.122)
Mother's education after PE (years)	−0.052 (0.066)
Father's education after PE (years)	−0.158*** (0.059)
Day of birth within calendar year	−0.001 (0.002)
Unemployment rate	0.015 (0.054)
Delay at start primary education	0.345 (1.821)
Delay at start secondary education	−0.388 (1.162)
Track choice at start second year of SE: technical or arts track	−1.206* (0.710)
Track choice at start second year of SE: vocational track	−50[a]
Intercept	−2.785*** (1.030)
H. Outcome: Participation in dual program	
Female gender	−0.716*** (0.148)
Migration background	0.058 (0.231)
Number of siblings	0.071 (0.043)
Mother's education after PE (years)	−0.039 (0.029)
Father's education after PE (years)	−0.031 (0.027)
Day of birth within calendar year	−0.001 (0.001)
Unemployment rate	−0.11*** (0.023)
Delay at start primary education	0.258 (0.482)
Delay at start secondary education	0.026 (0.185)
Track choice at start second year of SE: technical or arts track	2.244*** (0.373)
Track choice at start second year of SE: vocational track	4.304*** (0.526)
SE experience at end of CFTSBE: delayed, not downgraded	0.157 (0.274)
SE experience at end of CFTSBE: not delayed, downgraded	1.416*** (0.236)

Table A–2. *Continued*.

	Coefficient (SE)
SE experience at end of CFTSBE: delayed and downgraded	2.270*** (0.560)
Intercept	−3.665*** (0.617)
I. Outcome: School-based dual program	
Female gender	−0.115 (0.320)
Migration background	0.828 (0.552)
Number of siblings	0.221** (0.108)
Mother's education after PE (years)	−0.007 (0.058)
Father's education after PE (years)	0.044 (0.058)
Day of birth within calendar year	0.002* (0.001)
Unemployment rate	−0.006 (0.044)
Delay at start primary education	0.051 (0.903)
Delay at start secondary education	−0.207 (0.374)
Track choice at start second year of SE: technical or arts track	2.560*** (0.890)
Track choice at start second year of SE: vocational track	2.859** (1.120)
SE experience at end of CFTSBE: delayed, not downgraded	0.112 (0.555)
SE experience at end of CFTSBE: not delayed, downgraded	0.518 (0.531)
SE experience at end of CFTSBE: delayed and downgraded	0.410 (1.705)
Intercept	−3.750*** (1.323)
J. Outcome: Apprenticeship during school-based dual program	
Female gender	−1.179*** (0.392)
Migration background	−0.460 (0.519)
Number of siblings	−0.021 (0.097)
Mother's education after PE (years)	0.002 (0.074)
Father's education after PE (years)	0.029 (0.064)
Day of birth within calendar year	−0.003* (0.002)
Unemployment rate	−0.009 (0.057)
Delay at start primary education	0.902 (1.214)
Delay at start secondary education	0.199 (0.458)
Track choice at start second year of SE: technical or arts track	0.091 (0.961)
Track choice at start second year of SE: vocational track	0.607 (1.260)
SE experience at end of CFTSBE: delayed, not downgraded	0.235 (0.595)
SE experience at end of CFTSBE: not delayed, downgraded	0.557 (0.596)
SE experience at end of CFTSBE: delayed and downgraded	−0.887 (2.210)
Intercept	0.602 (1.592)
K. Outcome: SE qualification obtained	
Female gender	1.687*** (0.448)
Migration background	−2.279*** (0.597)
Number of siblings	−0.075 (0.092)
Mother's education after PE (years)	−0.163** (0.068)
Father's education after PE (years)	−0.007 (0.055)
Day of birth within calendar year	0.005*** (0.002)
Unemployment rate	0.150** (0.064)
Delay at start primary education	0.080 (1.475)
Delay at start secondary education	0.430 (0.561)
Track choice at start second year of SE: technical or arts track	−12.245*** (2.479)
Track choice at start second year of SE: vocational track	−20.440*** (3.995)
SE experience at end of CFTSBE: delayed, not downgraded	2.786*** (0.984)

Table A–2. *Continued*.

	Coefficient (SE)
SE experience at end of CFTSBE: not delayed, downgraded	−1.047 (0.805)
SE experience at end of CFTSBE: delayed and downgraded	−6.914* (3.661)
Participation in dual program	−1.941*** (0.729)
School-based dual program	−0.271 (0.941)
Apprenticeship during school-based dual program	0.840 (1.128)
Intercept	21.674*** (4.035)
L. Outcome: TE enrolment	
Female gender	1.304*** (0.328)
Migration background	−0.636 (0.528)
Number of siblings	0.152 (0.101)
Mother's education after PE (years)	−0.056 (0.052)
Father's education after PE (years)	0.132*** (0.050)
Day of birth within calendar year	0.006*** (0.002)
Unemployment rate	0.461*** (0.079)
Delay at start primary education	3.195*** (1.003)
Delay at start secondary education	−0.031 (0.524)
Track choice at start second year of SE: technical or arts track	−12.044*** (1.730)
Track choice at start second year of SE: vocational track	−18.462*** (2.537)
SE experience at end of CFTSBE: delayed, not downgraded	3.666*** (0.737)
SE experience at end of CFTSBE: not delayed, downgraded	−4.901*** (0.750)
SE experience at end of CFTSBE: delayed and downgraded	−8.170*** (2.179)
Intercept	7.716*** (1.319)
M. Outcome: Employed three months after leaving education	
Female gender	−0.225*** (0.061)
Migration background	−0.744*** (0.140)
Number of siblings	−0.048** (0.023)
Mother's education after PE (years)	−0.008 (0.013)
Father's education after PE (years)	−0.026** (0.011)
Day of birth within calendar year	0.000 (0.000)
Unemployment rate	−0.105*** (0.015)
Delay at start primary education	−0.196 (0.264)
Delay at start secondary education	−0.061 (0.114)
Track choice at start second year of SE: technical or arts track	0.073 (0.195)
Track choice at start second year of SE: vocational track	0.069 (0.344)
SE experience at end of CFTSBE: delayed, not downgraded	−0.077 (0.151)
SE experience at end of CFTSBE: not delayed, downgraded	0.147 (0.110)
SE experience at end of CFTSBE: delayed and downgraded	0.205 (0.355)
Participation in dual program	0.930*** (0.312)
School-based dual program	−1.055*** (0.389)
Apprenticeship during school-based dual program	0.448 (0.358)
SE qualification obtained	0.577*** (0.178)
TE enrolment	−0.175 (0.174)
Intercept	1.436*** (0.458)
N. Outcome: Employed one year after leaving education	
Female gender	−0.379*** (0.098)
Migration background	−0.570*** (0.196)
Number of siblings	−0.060* (0.032)

Table A–2. *Continued*.

	Coefficient (SE)
Mother's education after PE (years)	−0.024 (0.020)
Father's education after PE (years)	−0.017 (0.018)
Day of birth within calendar year	−0.001* (0.000)
Unemployment rate	−0.111*** (0.021)
Delay at start primary education	−0.549 (0.376)
Delay at start secondary education	0.075 (0.160)
Track choice at start second year of SE: technical or arts track	−0.910** (0.353)
Track choice at start second year of SE: vocational track	−1.657*** (0.605)
SE experience at end of CFTSBE: delayed, not downgraded	0.382* (0.231)
SE experience at end of CFTSBE: not delayed, downgraded	−0.263 (0.184)
SE experience at end of CFTSBE: delayed and downgraded	−0.791 (0.568)
Participation in dual program	−0.382 (0.381)
School-based dual program	−0.048 (0.439)
Apprenticeship during school-based dual program	0.335 (0.460)
SE qualification obtained	0.338 (0.258)
TE enrolment	−0.178 (0.284)
Employed three months after leaving education	2.319*** (0.109)
Intercept	3.226*** (0.778)
O. Outcome: Employed five years after leaving education	
Female gender	−0.669*** (0.168)
Migration background	−0.618** (0.271)
Number of siblings	−0.138*** (0.041)
Mother's education after PE (years)	0.021 (0.033)
Father's education after PE (years)	−0.007 (0.030)
Day of birth within calendar year	0.001 (0.001)
Unemployment rate	−0.038 (0.047)
Delay at start primary education	0.145 (0.655)
Delay at start secondary education	0.010 (0.225)
Track choice at start second year of SE: technical or arts track	−0.936 (0.672)
Track choice at start second year of SE: vocational track	−2.386** (1.082)
SE experience at end of CFTSBE: delayed, not downgraded	0.339 (0.356)
SE experience at end of CFTSBE: not delayed, downgraded	−0.192 (0.304)
SE experience at end of CFTSBE: delayed and downgraded	−1.580** (0.729)
Participation in dual program	0.174 (0.471)
School-based dual program	−0.939* (0.528)
Apprenticeship during school-based dual program	0.608 (0.502)
SE qualification obtained	0.064 (0.395)
TE enrolment	−0.188 (0.501)
Employed three months after leaving education	0.153 (0.182)
Employed one year after leaving education	1.197*** (0.187)
Intercept	3.988*** (1.415)
P. Unobserved heterogeneity distribution	
q_2	−1.899*** (0.124)
q_3	−0.124 (0.113)
q_4	−0.887*** (0.194)
q_5	−3.787*** (0.313)
q_6	−3.538*** (0.552)

Table A–2. *Continued*.

	Coefficient (SE)
η_2	1.115*** (0.203)
η_3	0.387*** (0.074)
η_4	0.693*** (0.128)
η_5	1.425*** (0.255)
η_6	−0.411*** (0.115)
δ: delay at start SE	−0.564** (0.254)
δ: track choice at start second year of SE: technical or arts track	3.722*** (0.865)
δ: track choice at start second year of SE: vocational track	7.823*** (1.654)
δ: SE experience at end of CFTSBE: delayed, not downgraded	−4.555*** (1.095)
δ: SE experience at end of CFTSBE: not delayed, downgraded	−0.558 (0.405)
δ: SE experience at end of CFTSBE: delayed and downgraded	−0.173 (0.921)
δ: participation in dual program	2.212*** (0.710)
δ: school-based dual program	3.167** (1.414)
δ: apprenticeship during school-based dual program	0.353 (1.269)
δ: SE qualification obtained	−20[b]
δ: TE enrolment	−16.348*** (3.744)
δ: employed three months after leaving education	−0.185 (0.374)
δ: employed one year after leaving education	−1.755** (0.706)
δ: employed five years after leaving education	−2.056* (1.137)
η_i × participation in dual program × SE qualification obtained	0.675 (1.130)
η_i × participation in dual program × employed three months after leaving education	0.059 (0.543)
η_i × participation in dual program × employed one year after leaving education	0.148 (0.665)
η_i × participation in dual program × employed five years after leaving education	−0.062 (0.678)
N	5541
# heterogeneity types (K)	6
# parameters	239
Log-likelihood	−19,441.101
Akaike Information Criterion	39,360.203

Notes. The presented statistics are estimated coefficients and standard errors between parentheses. * (**) ((***)) indicates significance at the 10% (5%) ((1%)) significance level. The following abbreviations are used: CFTSBE (compulsory full-time school-based education), PE (primary education), SE (secondary education), and TE (tertiary education).

[a] As the outcome 'downgraded' is not possible for students in the vocational track (the lowest track), these parameters were estimated with a large negative number (−50), causing a 0 probability with respect to this outcome for students in the vocational track.

[b] One parameter of the unobserved heterogeneity distribution is estimated as a very large negative number causing a 0 or 1 probability with respect to secondary education qualification for some heterogeneity types. This is numerically problematic; therefore, in the spirit of Gaure et al. (2007), we stack it to −20, and kept it out of further estimation.

Table A–3. Goodness of fit for the simulated probabilities.

	(1)	(2)
	Actual probability	Simulated probability [95% CI]
Delay at start PE	0.017	0.018 [0.013, 0.023]
Delay at start SE	0.106	0.108 [0.097, 0.119]
Track choice at start second year of SE		
General track (reference)	0.605	0.598
Technical or arts track	0.260	0.264 [0.246, 0.288]
Vocational track	0.135	0.138 [0.125, 0.151]
SE experience at the end of CFTSBE		
No retention and no downgrade (reference)	0.812	0.812
Retention and no downgrade	0.074	0.072 [0.056, 0.085]
No retention and downgrade	0.104	0.104 [0.092, 0.117]
Retention and downgrade	0.010	0.012 [0.007, 0.019]
Participation in dual program	0.060	0.063 [0.053, 0.073]
School-based dual program	0.037	0.038 [0.031, 0.047]
Apprenticeship during school-based dual program	0.020	0.020 [0.014, 0.027]
SE qualification obtained	0.924	0.916 [0.896, 0.929]
TE enrolment	0.636	0.661 [0.638, 0.694]
Employed three months after leaving education	0.615	0.615 [0.593, 0.638]
Employed one year after leaving education	0.834	0.839 [0.822, 0.859]
Employed five years after leaving education	0.906	0.923** [0.907, 0.938]

Notes. We do not provide confidence intervals for the two reference categories, as these probabilities are not simulated. The probabilities here are calculated by subtracting the simulated probabilities of the non-reference categories from 1. * (**) ((***)) indicates a significant difference between the actual and simulated probabilities at the 10% (5%) ((1%)) significance level. The following abbreviations are used: CFTSBE (compulsory full-time school-based education), PE (primary education), SE (secondary education), and TE (tertiary education).

Table A–4. ATTs and ATNTs on labour market outcomes: the two dual program programs versus full-time school-based education.

	Total effect	
	ATTs	**ATNTs**
A. Treatment: training centre-based dual program		
SE qualification obtained	0.870** [0.744, 0.980]	0.949*** [0.900, 0.987]
Employed three months after leaving education	1.198* [0.991, 1.434]	1.300*** [1.128, 1.454]
Employed one year after leaving education	1.001 [0.864, 1.150]	1.008 [0.904, 1.087]
Employed five years after leaving education	1.015 [0.899, 1.131]	1.008 [0.950, 1.048]
B. Treatment: school-based dual program		
SE qualification obtained	0.855 [0.591, 1.098]	0.965 [0.898, 1.009]
Employed three months after leaving education	1.052 [0.747, 1.361]	1.123 [0.883, 1.327]
Employed one year after leaving education	0.987 [0.775, 1.226]	1.003 [0.876, 1.105]
Employed five years after leaving education	0.970 [0.750, 1.174]	0.985 [0.889, 1.044]

Notes. The presented statistics are simulated average treatment effects on the treated (ATTs) and average treatment effects on the non-treated (ATNTs) and 95% confidence intervals are given between brackets. * (**) ((***)) indicates significance at the 10% (5%) ((1%)) significance level. The following abbreviation is used: SE (secondary education).