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Graduate migration and early-career labor market outcomes: Do education programs and qualification levels matter?

[**Running title:** Graduate migration and labor market outcomes]

Timo Mitze* and **Nino Javakhishvili-Larsen****

* Department of Business and Economics, University of Southern Denmark, Email: tmitze@sam.sdu.dk

** Centre for Regional and Tourism Research, Copenhagen, Email: nino.javakhishvili@crt.dk

Abstract: This paper investigates the role that spatial mobility plays for early-career labor market outcomes across education programs and qualification levels. We use data for the full population of Danish graduates from upper (post-)secondary and tertiary education programs to estimate the labor market returns from migrating after graduation. Benchmark OLS estimates find positive correlations between migration, the employment probability and entry wages. We further apply IV estimation with instruments constructed from exogenous push factors into migration at the individual, education institution and local labor market level. Results confirm a mobility premium for graduates from tertiary but not from vocational education programs.

JEL-Codes: C23, I23, I26, J61, R23

Keywords: Graduate migration, labor market returns, tertiary education, vocational education and training, endogenous treatment model, Denmark

1. Introduction

A central aim of vocational education and training (VET) and higher education policy is to ensure the employability of graduates by optimally matching graduate skills with local labor market requirements. In this paper, we analyze the education-to-work transition of Danish graduates with a focus on the role played by geographic mobility (internal migration) for early-career labor market outcomes. From the perspective of the individual graduate, we investigate

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under which circumstances geographic mobility is an effective means to increase individual labor market returns. From an aggregate labor market perspective, shedding new light on the size of graduate mobility premia across education programs and qualification levels may provide policy makers with relevant information on the relevance of spatial frictions in different segments of the labor market and help to assess the scope of instruments that either support graduate mobility or enhance labor market efficiency through other means, e.g. improve the quality of local matches.¹

While there is a growing body of research studying the size of a geographical mobility premium for graduates from tertiary education programs, particularly universities (e.g., Yankow, 2003; Di Cintio and Grassi, 2013; Crivellaro, 2014; Venhorst and Cörvers, 2018), very little evidence is available on spatial job search processes and associated labor market effects for “European” type upper (post-)secondary education programs that emphasize the creation of local job networks during the education phase (Böckerman et al., 2019). In this paper, we aim at closing this research gap by estimating micro-econometric models for the employment and wage effects of mobile versus immobile graduates, thereby making use of detailed register data on all Danish graduates from vocational upper (post-) secondary and tertiary education programs that entered the Danish labor market in 2006-2011. This setup allows us to identify the overall returns to geographical mobility in the education-to-job transition and to differentiate between the returns from different education programs and qualification levels (e.g., bachelor and master levels) to comprehensively assess the role played by qualification, spatial mismatch, and local job networks for the size of this premium.

Whereas the human capital theory of migration generally argues that geographic mobility allows individuals to take advantage of skill-specific wage differences across alternative locations (Sjaastad, 1962), there are good reasons to assume that the size of the mobility premium varies across education programs and qualification levels: On the one hand, graduates with higher qualification levels can be expected to face a wider range of available labor market

¹ As an alternative to mobility support, a recent policy reform in Denmark has fostered the regionalization of tertiary education through the establishment of new higher education units in towns with no or very limited prior supply (Eurydice Network, 2019). Thus, rather than supporting the mobility of labor market entrants after graduation, the reform operates through an increase in the spatial mobility of higher education institutions. Although this is more costly than mobility support schemes, it may also give rise to add-on effects of creating local job networks to support the matching efficiency in local labor markets.

choices and higher opportunity costs of imperfect job matching given their higher investment in education. This should naturally raise the incentives to be spatially mobile and increase the potential returns to migration (Venhorst et al., 2010 & 2011). On the other hand, graduates with on-the-job experience during education and established local labor market ties at the time of graduation may face higher opportunity costs of migrating, as this would imply a loss of social capital built up as part of the informal qualification process in a VET program.

From an econometric point of view, it is not easy to identify the returns to graduate migration since the migration decision is likely to be simultaneous to observed labor market outcomes (i.e., migrants move to a specific job rather than move speculatively). We use endogenous treatment models to minimize the size of this endogeneity bias. In a first step, we link individual graduation records with data on the graduates' subsequent labor market performance. We then add (non-labor market) individual characteristics and aggregate information on the educational institution and local labor market conditions at the point in time of graduation. The goal is to select instruments that are related with the graduates' migration decision but not directly with the post-graduation labor market outcome. Our instrumental variable (IV) strategy mainly builds on instruments measured at three different levels of aggregation: 1) changes in individual characteristics that are uncorrelated with the individual's labor market outcome (e.g., changes in family status, birth of child, migration before/at start of education), 2) peer signals that explore cohort-specific trends in the migration-to-work decision from a specific education institution, and 3) exogenous differences in local labor market conditions measured at the graduate's place of residence prior to/at graduation.² Although, we carefully try to select instruments that are uncorrelated with the individual graduate's labor market outcome, obviously our identification strategy is less strict compared to quasi-randomized identification approaches such as in Anelli (2020) on the returns to education. When we interpret our empirical results, this limitation is taken into account.

Foreshadowing some key results, our benchmark OLS estimates generally indicate that geographic mobility after graduation is associated with a 0.5%-point higher probability of

² Since our sample period coincides with the timing of the global economic crisis of 2007/08, the crisis shock with widening local labor market disparities in Denmark may be regarded as an exogenous source of variation in determining individual migration decisions. As Haaland (2018) points out, a young population typically faces the greatest risk to be negatively affected by business cycle downturns in terms of their employment prospects.

being employed and approximately 7% higher (full-time) entry wages. Migration-related differences in labor market outcomes are found to be higher for graduates from tertiary education programs compared to upper and post-secondary vocational education programs. We also find evidence that this correlation is subject to business cycle movements, as the results show that spatially mobile graduates cannot increase their employment probability in a period of a weak labor market (i.e., during the global economic crisis). However, the ability of graduates to earn higher wages from internal migration increases during the crisis. This indicates that business cycle downturns amplify spatial frictions on the labor market.

When we control for the simultaneity between the migration decision and labor market outcome by means of IV estimation, we find robust evidence of a mobility premium for graduates from tertiary education programs but not upper and post-secondary VET programs. This may relate to the predictions of the neoclassical migration model that graduates with higher qualification levels face higher returns from spatial search processes. Another explanation for the obtained difference in the mobility returns might be that the institutional design of VET programs effectively creates job networks that allow individual graduates and local firms to mutually benefit from building up localized social capital during the education period. Our estimated insignificant or negative returns to graduate migration for graduates from VET programs may thus reflect the loss of such social capital investments.

2. Institutional Settings, Data, and Variables

2.1. The Danish Education System

Studying the education-to-work transition in the Danish education system offers several attractive features. A distinct novelty of our empirical approach is that we do not need to rely on survey data but can use the full population of Danish graduates that entered the national labor market during the period 2006-2011. This allows us to identify differences in the mobility premium for different groups of graduates. Throughout the empirical analysis we especially distinguish between two types of graduates from different education programs, namely 1) academic graduates (i.e., all persons in Denmark who have graduated from a tertiary education program), and 2) professional graduates (i.e., all persons in Denmark who have graduated from a vocational (upper- and post-secondary non-tertiary) education program). The main reason for choosing these two groups of students is that they constitute the final knowledge attainment steps from different tracks of the Danish (higher) education system before entering the labor

market.³ Additionally, we also distinguish between the mobility returns for different qualification levels obtained within both types of education programs (e.g., bachelor, master, etc.).

Academic graduates include all persons who have graduated (as the final education step) from a short-cycle (1-2 years, or ISCED 5), medium-cycle (3 years, or ISCED 6) or long-cycle (3+2 years, or ISCED 7) education program.⁴ In the Danish higher education system, an academic degree can primarily be obtained from universities. However, university colleges (polytechnics) also offer medium-cycle education programs at ISCED levels 5 and 6, which qualify students for ISCED level 7 education programs exclusively offered at Danish universities. In the following section, we therefore include all persons who graduate from a university or university college in the group of academic graduates. As outlined above, we also estimate the mobility returns for qualification levels ISCED 5/6 and ISCED 7 separately.

The group of professional graduates includes all persons who have graduated from VET programs and who are equipped with the skills that many non-academic jobs require. These education programs include upper secondary vocational education (ISCED 3) and post-secondary (non-tertiary) vocational education (ISCED 4). VET programs are specifically planned to fit local labor market requirements.⁵ Similar to the case of academic graduates, we additionally estimate separate mobility premiums for professional graduates from ISCED 3 and ISCED 4 education programs. A specific feature of VET programs is that they are divided into school-based learning and workplace-based traineeships. These practical internships typically take place in geographical proximity to the vocational education institutions and often reflect

³ The Danish (higher) education system is based on the egalitarian principles of the welfare state. It is free and accessible to everyone who wishes to pursue it (Jørgensen, 2017). VET educational institutions are located in nearly every municipality in Denmark. Tertiary education institutions (universities and university colleges) are mostly located in urban areas. However, due to the principle of making higher education (at ISCED levels 5 and 6) accessible to everyone, university campuses and colleges have since the late 1990s also been located outside large urban areas. This makes make education available to those students who cannot afford to move to the big cities for receiving an academic education (see Figure A1 for an overview of the spatial distribution of universities, colleges, and VET educational institutions).

⁴ See UNESCO Institute of Statistics (2011) for a classification of ISCED levels.

⁵ Even though the vocational education institutions are financed and managed by the state, their Board of Directors often have representation from employer organizations and labor unions, which ensures that the VET programs provide education and training in employment-specific skills (Jørgensen, 2013, 2017).

specific local labor market needs. Because of the traineeships, professional graduates are well acquainted with local labor market demands in their profession and have better access to local job networks. If they move to other municipalities after, they risk losing the benefits of the local labor market networks as well as the on-the-job experience received during education.

2.2. Data, Variables, and Stylized Facts

The main input for estimation is administrative register data retrieved from Statistics Denmark for the sample period 2006 to 2011 (annual observations for November in each year). We link different registers⁶ to arrive at a database that covers data on all graduates entering the national labor market during this period and include information on their age, sex, family status, educational attainments, graduation periods, job-specific information, migration and commuting experience, employment status, and wages as well as current geographical information on the workplace and the location of residence (measured on the small-scale LAU Level 1; i.e., Danish municipalities).⁷ In order to ensure that we identify of the transition from education to labor market participation, we only count the individuals' final graduation record in cases where they enter the labor market without starting a consecutive educational program during the sample period. This creates an (unbalanced) panel data set covering 405,559 graduates and 1,278,899 (person-time) observations.

The structure of our panel data is illustrated in Figure 1. As shown in panel (a) of Figure 1, out of the 405,559 registered graduates 53% are graduates from tertiary education programs (academic graduates), while 47% have graduated from an upper- or post-secondary VET program (professional graduates). Exact information on the graduation year is used to construct a binary treatment variable of becoming a “graduate mover” in the following manner: first, for

⁶ These are: 1) BEF (*Befolkningen*), which contains basic population information at the time of reference, including birth, death, and migration; 2) RAS (*Registerbaseret Arbejdsstyrkestatistik*), which determines the population's primary connection to the labor market and provides variables on labor market outcomes (wages, etc.) and changes in labor market status (e.g., employment and unemployment, job mobility); 3) UDDA (*Uddannelser*), which contains information about the education and graduation of each individual; and 4) STORHED (*Bystørrelse*) represents population measures of towns in Denmark below the LAU1 administrative level.

For further information see <https://www.dst.dk/da/TilSalg/Forskningsservice/Dokumentation>.

⁷ The Local Administrative Units (LAU) level 1 (formerly NUTS4 Level) comprises the municipalities and communes of the European Union. In Denmark, this is equivalent to the municipality level (*Kommune*, 98 entities).

each graduate (i), the time period of graduation ($t_{1(i)}$) is identified within the sample period. Next, we link migration activities measured as registered movements across Danish municipalities (LAU1 level) to graduation if migration takes place between $t_{1(i)}$ and $(t_{1(i)} + 2)$. In this case, the graduate is classified as a graduate (grad) mover (see panel (b) of Figure 1 for a graphical visualization) and we associate this migration activity with the transition from education to employment.

Accordingly, we find that 31% of all graduates are graduate movers (i.e., migrate within the first two years after graduation). This share comes close to findings from Dutch register data reported in Middeldorp et al. (2016).⁸ The identification of graduate movers makes it possible to compare their labor market outcome *vis-à-vis* graduate stayers (i.e., those graduates that do not change their place of residence while taking up a job after graduation). We compare the labor market performance of movers and stayers during the time period between $t \geq t_1$ and T with $T=2011$. Panel (c) in Figure 1 shows this comparison of entry wages for graduate movers who graduates in t_1 and who is employed in the period between t_2 and T (after migrating).

<< Figure 1 about here >>

Labor market outcomes are measured in terms of the employment status of the individual graduate (binary: 0 = unemployed, 1 = employed) and the nominal annual wage level in Danish kroner (DKK). While assessing the early-career wage effects of migration, we find that the sample is restricted to full-time employees in order to avoid estimation bias in the wages received in part time jobs and other types of employments (like seasonal, temporary).

Individual characteristics and data for education institutions (EI) are extracted (and aggregated) from individual register data; local labor market variables are obtained at the aggregate level from the STATBANK database of Statistics Denmark. Table A1 in the supplementary materials presents summary statistics for individual characteristics classified by graduate movers and stayers, and Table A2 provides information on EI-specific and local labor market variables used as instruments in the estimation of a first-stage migration equation (see Section 4 for details on model specification and estimation including a description of our multi-level

⁸ The authors use up to five years after graduation and report a share of grad movers of 35% among all Dutch graduates.

instrument set). We also include dummies for town size below the LAU1 level as control factors for agglomeration economies and price differences in local labor markets (Glaeser and Maré, 2001).⁹

3. Related Empirical Literature

Our approach links itself to different strands of the empirical literature on the labor market returns to education (e.g., Card, 1999; Buonanno and Pozzoli, 2009, Aakvik et al., 2010; Fan, 2012, Böckerman et al., 2019, Anelli, 2020) and migration (e.g., Nakosteen and Zimmer, 1980; Borjas et al., 1992; Böheim and Taylor, 2007; Rodríguez-Pose and Tselios, 2010). We also draw links to recent studies that have investigated the effects of labor market entry conditions on earnings (e.g., Brunner and Kuhn, 2014, Kondo, 2015, Haaland, 2018). Although these strands of literature have grown considerably in recent years, still only few studies deal explicitly with labor market differences between migrants and non-migrants in the early-career stage after graduation – especially in the context of “European”-type dual education systems (Crivellaro, 2014).¹⁰ Notable studies on graduates from tertiary education programs are Lehmer and Ludsteck (2011), Di Cintio and Grassi (2013) as well as Venhorst and Cörvers (2018), who investigate the mobility premium for graduates from university and university colleges in Germany, Italy, and the Netherlands, respectively.

Di Cintio and Grassi (2013) quantify early-career wage effects arising from a two-stage migration process for university graduates three years after graduation. The authors additionally decompose migration patterns into a (potential) first migratory move from the origin to the university region and a second migratory move from the university region to the first employment location. Their findings suggest that graduate migrants generally receive a wage premium compared to stayers. The highest premium is observed for late movers (those who start tertiary education in their home region but move for employment afterwards). Lehmer and Ludsteck (2011) similarly find that

⁹ While space restrictions limit the length of our description of key trends in the data, for the interested reader we illustrate stylized facts of the mobility and employment/wage behavior of Danish graduates in Figures A2-A4 in the supplementary materials.

¹⁰ The literature on wage differences among mobile and immobile U.S. graduates and entrants in the labor force is somewhat richer; see, for instance, Gabriel and Schmitz (1995), Card and Lemieux (2001), Yankow (2003), Wheeler (2006), Wozniak (2010), Lkhagvasuren (2014), and Wang (2016).

wage effects of internal mobility in Germany are most profound for young workers (with less than 10 years of job experience) compared to other worker cohorts.

Different from the above studies, Venhorst and Cörvers (2018) find only modest positive returns to migration after graduation from tertiary education programs in the Netherlands, which mostly turn out to be insignificant once the authors control for the self-selection of migrants by means of an IV approach. The authors use a sample of graduates from universities and university colleges and find that the underlying job matching processes are different for these two types of education programs: While spatial mobility is associated with better outcomes on alternative job match indicators for university graduates, this is less so the case for college graduates.

Almost no empirical evidence is available for the mobility returns in upper and post-secondary vocational education programs. Different from tertiary education programs, students enrolled in VET programs are typically required to carry out firm-based traineeships to guarantee that – upon graduation – they have acquired both theoretical and practical knowledge. VET graduates may thus continue to work in the same firm where they received on-the-job training. For instance, Fitzenberger et al. (2015) find based on German data that the retention rate is often quite high (around 60-75%). When investigating the associated labor market returns to job changes after graduation from an apprenticeship, Fitzenberger et al. (2015) report a negative short-run wage effect for VET graduates who switch firms after the on-the-job training period, compared to those who stay within the firm and keep their occupations. A job change within the training firm is, however, accompanied by a positive wage effect. The authors take the estimated positive wage effect of about 12% for the identified occupational changes within the training firm as an indication of career progression through job mobility.

Taken together, the findings from the empirical literature review emphasize the importance of accounting for potentially different labor market returns to migration for academic and professional graduates. We will incorporate these differences in the specification and estimation of our empirical labor market model (see Section 4.1).

A common methodological problem in empirical studies on mobility returns is that the (geographical and job) mobility decision is typically endogenous with respect to the observed labor market outcome. A growing number of studies have tried to come up with a solution to this problem. Fitzenberger et al. (2015), for instance, control for selection into job mobility by estimating a first-stage probability model, which specifies the individual's probability of switching firms or occupations as a function of regional labor market characteristics. The

causal identification strategy thereby assumes that the latter can be considered as exogenous with respect to the individual's labor market outcome. Venhorst and Cörvers (2018) likewise estimate a first-stage migration probability equation to cope with the potential endogeneity of the migration decision when estimating the labor market returns to mobility.

Applied to the case of graduate migration, positive selection effects are likely to occur if graduates choose to change location as a form of career advancement. In this case, migration is more likely to occur if it leads to higher wages compare to the wages available in the location of educational institution after graduation. On the other hand, if mobility is a compensation criterion for poor labor market opportunities after graduation, then selection effects conditional on the individual's underlying personal characteristics and talents can be negative (Wachter and Bender, 2006). The empirical analysis conducted in this paper follows the approach taken by Fitzenberger et al. (2015) allowing for both negative and positive selection effects in the specification of an endogenous treatment model. In line with the above authors, we also consider differences in local labor markets at the students' location of residence when they are enrolled in an education program as a potential source of exogenous variation for the analysis of causal effects of graduate migration.¹¹

4. Empirical Model: Specification and Estimation

4.1 Model Specification

This section outlines a stylized theoretical model framework to illustrate challenges involved with the identification of labor market effects of migration for academic and professional graduates. Specifically, it presents a model of the returns to migration after graduation, which accounts for difference in returns across education programs and qualification levels. It also incorporates the endogeneity of the migration decision with regard to labor market outcomes when comparing the early-career performance of movers and stayers. Starting point is the human capital theory of migration (Sjaastad, 1962). According to the latter, a prospective

¹¹ This approach thus differs from the majority of available studies on the returns to migration, which predominantly rely on individual-specific information in the first-stage migration models. For instance, Böheim and Taylor (2007, p. 109) focus on “*the individuals' age, highest qualification, region of residence, marital status, type of employment contract, industry, occupation and sector of employment, and whether or not he liked his neighbourhood*” when estimating the first-stage migration equation.

migrant i (after graduating from education program d) maximizes the net benefit of a spatial job search process. The individual's objective function reflects the expected income differential between a destination and origin location as well as the cost of migration as

$$\text{net benefit of migration for individual } i = \sum_0^{T_{i(d)}} \left[\frac{(Y_m(t) - Y_n(t))_{i(d)}}{(1 + \rho)^t} \right] - C_{i(d)}, \quad (1)$$

where Y_m and Y_n denote (expected) income levels (Y) in location m and n at time t , C covers the direct and indirect cost of moving from region n to region m , ρ is the implicit discount rate, and T describes the working life period. If the net benefit of migration in eq.(1) is positive, the optimal choice for maximizing lifetime income is to migrate from n to m , while no migration occurs otherwise (see, e.g., Borjas et al., 1992, for an extension of this two-location setup to the case of multiple locations). We expect that the choice of education program, d , influences individual i 's net benefit of migration in three possible ways:

- 1) The expected income difference $(Y_m(t) - Y_n(t))_{i(d)}$ for individual i varies by education program, d . It is larger in tertiary vis-à-vis upper (post) secondary vocational education programs and increases with higher qualification levels reflecting a growing spatial mismatch of labor market outcomes for human capital-intense specialized jobs.¹² In tendency, this relationship should result in higher returns to migration for graduates from tertiary vis-à-vis upper (post) secondary vocational education programs and for graduates with increasing qualification levels.
- 2) The cost of migration, for individual i , $C_{i(d)}$, is specific to education program d in the sense that graduates from VET programs face higher opportunity costs of migration, as this may imply a potential loss of social capital when established local job networks have to be given up.¹³ This should result in higher net benefits of migration for graduates from tertiary vis-à-vis upper (post) secondary vocational education programs as shown in eq.(1).

¹² See Lkhagvasuren (2014) for a similar argumentation on the link between qualification levels and labor market thickness.

¹³ Social capital can broadly be defined as an individual's resources that are embedded in the relationship with specific others. Its role as hampering factor for the likelihood of moving has been found in several studies (see Clark and Lisowski, 2019, for an overview). See also Gardner and Hendrickson (2018) for a general modeling approach that links the higher fixed cost of moving to a reduction in the migration incentive of individuals.

3) Individual i 's working life period, $T_{i(d)}$, is lower when education takes more time. This reduces the net benefit of migration for individuals graduating from tertiary vis-à-vis upper (post) secondary education programs and for graduates with higher qualification levels. Whether 1) + 3) or 2) dominates the overall net calculation depends on the distribution of income differences and migration costs relative to working life period.

When modeling the simultaneous determination of income and migration in a structural labor market model, Nakosteen and Zimmer (1980) simplify the lifetime income maximization approach outlined in eq.(1) to a static decision making process, where individual i decides at any point in time to migrate if the (expected) income gain from moving, as $[(Y_m - Y_n)/Y_n]_{i(d)} \approx (y_m - y_n)_{i(d)}$ exceeds the associated total costs for individual i ,¹⁴

$$(y_m - y_n)_{i(d)} > C_{i(d)}, \quad (2)$$

where lower case letters indicate logarithmic transformations. This simplification of the individual's decision-making process to a static case implies that we can formulate the following two research hypotheses regarding the net benefit of migration of individual i as a function of education program d (since it excludes argument 3) from the above sketched net benefit considerations):

H1: The returns to mobility (migration) are higher for graduates from tertiary vis-à-vis upper (post) secondary education programs.

H2: The returns to mobility (migration) increase with higher qualification levels.

To empirically test for differences in the returns to graduate migration across education programs/qualification levels, we estimate structural labor market models for the two different education programs (tertiary and upper (post) secondary vocational education) and for different types of qualification levels (ISCED 3, ISCED 4, ISCED 5/6, and ISCED 7). For the remainder of this section, which provides an operationalization of the structural labor market model, we drop the subscript d for the ease of presentation.

¹⁴ While Nakosteen and Zimmer (1980) refer to an income gain measured in percentage terms, eq.(1) bases the migration decision on absolute differences in income levels.

Nakosteen and Zimmer (1980) specify the cost of migration for individual i as a function of the individual's personal characteristics (\mathbf{x}_i) as well as aggregate attributes describing the origin location n of individual i (\mathbf{z}_n) and a random disturbance term (ϵ_i) as

$$C_i = g(\mathbf{x}_i, \mathbf{z}_n) + \epsilon_i. \quad (3)$$

The authors motivate the inclusion of location-specific attributes in eq.(3) as to reflect indirect costs of moving from areas which offer attractive labor market conditions (e.g. local labor market ties) potentially affecting the individual's employment and income position. Eq.(2) and eq.(3) can then be used to define a selection criterion into migration (I_i^*) as a function of differences in income levels along with regional and personal characteristics

$$I_i^* = \alpha_0 + \alpha_1(y_{m,i} - y_{n,i}) + \alpha_2\mathbf{x}_i + \alpha_3\mathbf{z}_n + \epsilon_i. \quad (4)$$

Individuals decide to migrate if I_i^* exceeds a certain threshold ϕ and stays in the origin location otherwise. The model is completed by specifying income equations for the two groups of migrants and non-migrants, which depend on individual attributes such as¹⁵

$$y_{m,i} = \beta_{m0} + \beta_{m1}\mathbf{x}_i + \epsilon_{m,i} \quad (5)$$

$$y_{n,i} = \beta_{n0} + \beta_{n1}\mathbf{x}_i + \epsilon_{n,i}. \quad (6)$$

4.2 Model Estimation

Benchmark Estimator for Treatment Effects

The estimation of the model framework sketched above can be regarded as a treatment effects approach in the logic of switching regressions (Quandt, 1958, 1972) with two regimes for i) graduate movers (the treatment group) and ii) graduate stayers (the comparison group). We start by considering the estimation of a treatment effects model for eq.(5) and eq.(6) under the assumption that the migration decision is exogenous with regard to the labor market outcomes of graduates. For this case, the two equations in eq.(5) and eq.(6) can be transformed to a single equation switching regression of the form

$$y_i = d_i(\beta_{m0} + \beta_{m1}\mathbf{x}_i + \epsilon_{m,i}) + (1 - \Psi_i)(\beta_{n0} + \beta_{n1}\mathbf{x}_i + \epsilon_{n,i}) \quad (7)$$

¹⁵ We will also include locational attributes as an extension to the benchmark case shown in eqs. (5) and (6).

$$\Leftrightarrow y_i = \beta_{n0} + \beta_{n1}\mathbf{x}_i + (\beta_{m0} - \beta_{n0})\Psi_i + (\beta_{m1}\mathbf{x}_i - \beta_{n1}\mathbf{x}_i)\Psi_i + \varepsilon_{n,i} + (\varepsilon_{m,i} - \varepsilon_{n,i})\Psi_i,$$

where Ψ_i is a binary treatment indicator which takes a value of 1 for treated individuals and is zero otherwise. If we further assume that the variation in \mathbf{x}_i alters $y_{n,i}$ and $y_{m,i}$ in exactly the same way (see Proposition 18.1 in Wooldridge, 2002) and further that conditional mean independence holds as $E(y_i | \mathbf{x}_i, \Psi_i) = E(y_{n,i} | \mathbf{x}_i)$ and $E(y_i | \mathbf{x}_i, \Psi_i) = E(y_{m,i} | \mathbf{x}_i)$, then eq.(7) can be simplified to

$$y_i = \gamma_0 + \gamma_1\mathbf{x}_i + \delta\Psi_i + u_i, \quad (8)$$

with $\gamma_0 = \beta_{n0}$, $\gamma_1 = \beta_{n1}$, $\delta = (\beta_{m0} - \beta_{n0})$, and u_i as error term. The coefficient of the treatment dummy δ presents the average treatment effect on the treated (δ_{ATT}^{OLS}). Under the validity of the above assumptions, eq.(8) can be estimated by OLS and the inclusion of \mathbf{x}_i can be interpreted as a rudimental control mechanism for self-selection into treatment.

For our longitudinal sample of Danish graduates, we extend the cross-sectional setup shown in eq.(8) to panel data with variations across cross-sections i (with $i=1, \dots, N$) and over time t (with $t=1, \dots, T$) as

$$y_{it} = \beta_0 + \beta_1\mathbf{x}_{it} + \delta\Psi_i + \lambda_t + \mu_m + u_{it}. \quad (9)$$

In eq.(9) we additionally include time- (λ_t) and location-specific destination-fixed effects (μ_m) for the set of Danish municipalities (LAU1 level). Including proxies for location-specific labor market characteristics and further amenities is important as wages have been shown to contain compensating differential components (e.g., Roback, 1982). Combes et al. (2008) point out that the inclusion of location-fixed effects may further account for spatial sorting effects when analyzing labor market outcomes. As default estimator we apply pooled OLS with two-way clustered standard errors at the individual and location levels (destination) to control for the interdependence of errors.

With regard to the treatment indicator Ψ_i , we restrict our analysis to a comparison of the labor market outcomes between graduate movers and stayers in the years following the graduation of individual i as $t_{(i)} \geq t_{1(i)}$, where $t_{1(i)}$ is the graduation period for individual i . For this setting, the treatment indicator Ψ_i can be defined as

$$\Psi_i = 1 \text{ if individual } i \text{ becomes a graduate mover after graduating in } t_{1(i)}$$

$\Psi_i = 0$ otherwise.

As already outlined in Section 2, we only allow the treatment variable Ψ_i to take values 0 or 1 over the time period $(t_{(i)}, T_{(i)})$. In other words, we only compare the average labor market performance between graduate migrants and non-migrants in the treatment period between the time of graduation and the last sample observation $(T_{(i)})$ for individual i .

Our main reason for restricting the analysis to the post-graduation period (compared to a full difference-in-differences approach, which also compares differences across groups in the pre-treatment period) is that we expect labor market outcomes to be significantly different in the post-graduation period compared to the pre-treatment education period, which would potentially bias the estimation results. A similar empirical approach as proposed here is taken by Fitzenberger et al. (2015). While this restriction thus refines the comparison of labor market outcomes across treatment and comparison groups, as a drawback it also implies that we cannot include individual-fixed effects for the estimation of eq.(9) since Ψ_i may be time invariant (i.e., may contain only for those individuals who become a graduate mover directly in $t_{1(i)}$). Eq.(9) will be estimated for the full sample of graduates as well as subsamples of academic and professional graduates (and for subsamples of different qualification levels). As outlined above, this disaggregation allows us to test for differences in the returns to migration in the presence of spatial frictions in the labor market.

As a sensitivity check, we also investigate whether treatment effects are heterogeneously distributed over time and re-estimate eq.(9) as

$$y_{it} = \beta_0 + \beta_1 \mathbf{x}_{it} + \sum_{t=1}^T \delta_t (\lambda_t \times \Psi_i) + \lambda_t + \mu_m + u_{it}, \quad (10)$$

which allows us to disaggregate the observed migration premium by individual sample years. This disaggregation can provide further insights into the role of migration for early-career labor market effects in the aftermath of the global economic crisis of 2007/08. The role of temporal changes in local labor market characteristics, for example, measured through an increase in volatility for individual migration incentives has recently been addressed by Gardner and Hendrickson (2018). The authors find that increases in the volatility of labor market quality significantly reduce the likelihood of migration.

Endogenous Treatment Model

A drawback of the above sketched switching regression approach is that it does not account for the potential endogeneity of the migration decision with regard to labor market outcomes and may thus result in biased estimates of the returns to migration for Danish graduates (δ_{ATT}^{OLS}). As a solution to this estimation problem, we apply an endogenous treatment model (Heckman, 1978, Wooldridge, 2002).¹⁶ To do so, we make use of a reduced form version of eq.(4) (when inserting eq.(5) and eq.(6) into eq.(4)), which models selection into migration as a function of individual characteristics \mathbf{x}_i and location-specific characteristics \mathbf{z}_n at the time period of graduation ($t_{1(i)}$) as

$$I_i^* = \theta_0 + \theta_1 \mathbf{x}_i + \theta_2 \mathbf{z}_n + \epsilon_i, \quad (11)$$

with $\theta_0 = (\alpha_0 + \alpha_1 \beta_{m0} - \alpha_1 \beta_{n0})$, $\theta_1 = (\alpha_2 + \alpha_1 \beta_{m1} - \alpha_1 \beta_{n1})$ and $\theta_2 = \alpha_3$. Although I_i^* is a latent variable, we may infer I_i^* to be positive and larger than ϕ when a graduate is observed to migrate ($\Psi_i = 1$). We can thus estimate eq.(11) as a linear probability model (LPM) or probit specification with $Prob(I_i^* > \phi) = Prob(\Psi_i = 1)$.

Accordingly, eq.(9) and eq.(11) will be jointly estimated using a linearized 2SLS estimator with a first-stage LPM as suggested by Angrist and Pischke (2009). As an alternative to this linearized version, we also estimate eq.(9) and eq.(11) by means of a Probit-2SLS, which replaces the linear probability model in the first-stage estimation by a non-linear probit model (Cerulli, 2012). As Cerulli points out, the latter specification increases the estimation efficiency vis-à-vis the linearized 2SLS benchmark approach.¹⁷

In both cases, the estimation strategy requires the use of valid exclusion restrictions. Here we rely on a multi-level IV strategy on the basis of 1) individual, 2) education institution (EI), and 3) location-specific characteristics that can be expected to be directly correlated with the

¹⁶ The model is also referred to as the endogenous dummy variable model in the econometric literature.

¹⁷ We thank an anonymous referee for pointing out that the Probit-2SLS estimator relies on stronger functional form assumptions than the linearized 2SLS approach. This may complicate the interpretation of estimated effects. We will accordingly use the Probit-2SLS estimator as a robustness check to compare coefficient sign and magnitude with the benchmark linearized 2SLS estimator.

migration decision of graduates but not with their labor market outcomes. The instrument set includes the following variables:

- 1) IV candidates at the level of the individual graduate are potentially most powerful in explaining individual migration decisions but are also most likely to suffer from selection effects. In first place, we have chosen to focus on variables that measure changes in family status in the year of graduation, namely i) contract a marriage or registered partnership¹⁸ and ii) birth of a child. Both events can be expected to affect the individual's mobility behavior without directly influencing the observed post-graduation labor market outcome (Clark, 2013). This consideration also applies to iii) individual migratory movements before/at the start of the education, which may affect the probability of migrating after graduation (Di Cintio and Grassi, 2013). The latter is measured as change in residence 2-3 years prior to graduation.
- 2) With regard to push factors at the level of the educational institution, we use an instrument for institutional peer pressure as proposed by Shi (2015): The instrument is constructed as the percentage share of graduate migrants in the total number of graduates for each education institution h (averaged over two consecutive time periods). The assumption behind this instrument is that individuals are more likely to migrate to work after graduation if there is a common trend of migration to work in the respective educational institution where the individual was enrolled. It can be assumed that this peer effect partly influences the migration decision of individual graduates without affecting the individual's labor market outcome (e.g., entry wage).
- 3) Finally, we also consider the role played by local labor market conditions in place of residence (municipality m) at the time period of graduation (and in the year before) as alternative push factors for graduate out-migration as predicted by push-pull theories of migration (Carlsen et al., 2013, O'Reilly, 2015). Specifically, we use the average disposable income level per municipality (LAU1 level) as a general measure for the relative economic performance of regions. As outlined above, the local labor market status can be related to the direct and indirect costs of migration after graduating. A similar estimation approach has been used in Fitzenberger et al. (2015), who argue that local labor market signals can be

¹⁸ In Denmark, a registered partnership has almost the same qualities as a marriage comprising all legal and fiscal rights and obligations with very few exceptions. For further details, see: <https://www.borger.dk/familie-og-boern/Aegteskab-og-parforhold/Registreret-partnerskab>.

regarded as exogenous to individual decisions as, for instance, aggregate income levels are subject to collective wage bargaining (see Venhorst and Cörvers, 2018, for a similar argumentation).

Although IV selection follows the common practice in the related empirical literature and is mainly based on theoretically grounded arguments, we also report tests for endogeneity of the treatment variable (graduate mobility) and instrument relevance (i.e., a sufficiently high correlation between the exogenous instruments and the endogenous treatment dummy). Specifically, we compute the Durbin-Wu-Hausman (DWH) test to compare OLS and IV estimates and the Cragg-Donald (1993) Wald F statistic as a means to detect potentially weak instruments. The null hypothesis of the DWH test is that both estimators, OLS and IV, are consistent, but OLS estimation is more efficient. A rejection of the null may hint at the inconsistency of the estimated OLS coefficients. Hence, for the case that 1) the DWH tests rejects the consistency of our benchmark OLS estimates and 2) the Cragg-Donald test further rejects the null hypothesis of weak instruments, we take this as indication in favor of our proposed IV approach summarized in Figure 2. The figure also stresses that our identification strategy rests on the validity of the assumption that no direct link between the exogenous instruments and the outcome variables is present. As outlined above, it may though be very difficult to precisely isolate such effect channels in the absence of (quasi-)randomized data. This has to be considered when interpreting the empirical results to be presented next.

<< Figure 2 about here >>

5. Empirical Results

As the starting point of the empirical analysis, we report the results of t -tests for mean differences in the employment probability and (log) entry wage levels between graduate movers and stayers. Table 1 shows that the employment probability is about 6.4 percentage points higher for graduate movers compared to stayers after graduation. However, the difference in the employment probability is conditional on the chosen education program: While the difference is positive for graduates from tertiary education programs, it is actually negative for graduates from VET programs. As shown in greater detail in Table 2 for ISCED qualification levels, this negative mean difference is thereby mainly in order for graduates from upper secondary vocational (ISECD 3) programs, for which the results show a roughly 3%

lower employment probability for graduate mover. In terms of entry wages, Tables 1 and 2 generally show a positive and statistically significant wage difference for graduate movers compared to stayers. Entry wage differences between movers and stayers are generally higher for graduates from tertiary education programs with the largest wage premium being observed for short- and medium-cycle tertiary education programs (ISCED 5/6).

<< Table 1 about here >>

<< Table 2 about here >>

An essential limitation of t -tests as shown in Tables 1 and 2 is, however, that they only measure unconditional labor market outcomes. In other words, the results do not account for systematic differences across sectors, and occupational types as well as spatial price differences across municipalities. In order to control for these factors, Tables 3 and 4 report the estimation results for a pooled OLS specification of eq.(9) both for the employment probability and the entry wage level as outcome variable. As before, we distinguish between education programs and qualification levels. The results show that the positive overall outcome difference for both labor market variables remains intact once we include individual-specific and aggregate controls and time-fixed as well as location-fixed effects. As shown in Table 3, accounting for these influencing factors of an individual's observed labor market outcome reduces the size of the treatment effect: That is, the estimates for the overall sample show that graduate migration is correlated with a 0.4 percentage point higher employment probability and 6.9% higher entry wages.

If we look at the estimated effects across education programs, we now also observe a positive correlation between graduate mobility and the employment probability for professional graduates (compared to the negative t -test results from Table 1). However, both with regard to the employment probability and the average wage level, the observed positive correlation with the treatment dummy is generally higher for academic graduates (from tertiary education programs) compared to graduates from VET programs (0.6% versus 0.2 percentage points in the case of the employment probability and 8.5% versus 5.4% in the case of (log) wages). The results in Table 4 additionally show that the highest mobility premium in terms of entry wages is found for graduates from long-cycle education programs (ISCED 7). Thus, the results provide empirical support to our research hypotheses, **H1** and **H2**, that labor market returns to graduate migration significantly differ by education programs and increase with obtained

qualification levels. Interestingly, the smallest mobility premium on wages is found for graduates from post-secondary vocational education programs (ISCED 4), which supports our supposition that the opportunity costs of migration are generally higher for VET graduates and increase for higher degrees of job specialization.

<< Table 3 about here >>

<< Table 4 about here >>

As a sensitivity check, Figure 3 reports the estimation results for annualized treatment effects during the period (November) 2006–2011. As the figure shows, the possibility of increasing the individual's employment probability after graduation through a migratory move falls after 2007 and becomes insignificant during the midst of the global economic crisis in 2009 (see, e.g., Andersen, 2011, for a description of the timing of labor market effects in Denmark during the global economic crisis). In comparison, the possibility of obtaining a wage premium through migration in the transition from education to work significantly increases during the crisis. This result links itself to earlier work on the growing importance of spatial wage and income disparities across local labor markets as a driver of migration during the global economic crisis (Mitze, 2018). Although the magnitude and timing of the estimated yearly employment and wage effects of graduate migration differ between academic and professional graduates, Figure 3 also shows that the direction of change is similar for both groups.¹⁹

<< Figure 3 about here >>

As outlined above, the identified outcome differences from reduced-form OLS regressions may be biased given that unobservable factors simultaneously influence both the treatment and outcome variables. In order to account for this endogeneity problem, Tables 5 and 6 present the estimation results for an endogenous treatment model on the basis of the structural labor market model from eq.(9) and eq.(11). As outlined above, we estimate the first stage (i.e., the individual's probability of becoming a graduate mover), both as LPM and Probit specifications. As a general indicator for the relevance of our IV approach, Tables 5 and 6 report the results

¹⁹ Disaggregate results by qualification level can be obtained from the authors upon request.

of the DWH test and the Cragg-Donald Wald F statistic for detecting weak instruments. While the DWH test largely rejects the consistency of OLS estimation (except for the wage regression of the ISCED 7 subsample), the Cragg-Donald test results do not report weak instruments.²⁰ With regard to differences due to differences in the chosen functional form of the estimation equation, we find that, with very few exceptions, the estimation results from the LPM-2SLS and Probit-2SLS specification are very similar in terms of coefficient sign and magnitude, which we take as an indication for the robustness of our regression output. Finally, although instrument validity is essentially an untestable assumption, in Table A3 in the supplementary materials we approach this issue by reporting the results from Hansen J and difference-in-Hansen overidentification tests to assess the correlation between the instruments and the residuals from the second-stage IV estimation. Although the test results give some indication that the overidentifying restrictions do not hold in all cases, e.g. for the subsample of academic graduates, a decision has been made here to evaluate the effects of graduate mobility on labor market outcomes on the same instrument set for both outcome variables and across all subsamples to ensure the interpretability of and comparability across the different specifications. However, this implies that our results from both OLS and IV estimation should only be interpreted cautiously in a cause-effect manner.²¹

<< Table 5 about here >>

<< Table 6 about here >>

Conditional on the above discussed statistical properties of our estimation approach, the results of the endogenous treatment model show the following picture: For graduates from VET

²⁰ To evaluate the problem of weak identification stemming from a non-zero but small correlation between the instruments and the endogenous treatment variables, we use critical values proposed by Stock and Yogo (2005) for one endogenous variable and six instruments. The test results in Table 5 do not indicate any form of weak instrumentation for the critical values applied (i.e., 5% maximum IV relative bias and 10% maximum IV size). That is, in all cases, the first-stage F values are significantly larger than the reported critical values, so that we can reject the null hypothesis of a significant relative IV bias compared to OLS estimation.

²¹ As pointed out by an anonymous reviewer, one should note, though, that overidentification tests are only valid under certain assumptions. For instance, a possible reason for a rejection of the null in the case of Hansen's J statistic may also be that slope coefficients vary over time (Sato and Söderbom, 2017).

programs, we find that migration can positively influence the individual's employment probability but that becoming a graduate mover is not associated with a mobility wage premium. The estimated increase in the employment probability is statistically significant but small in economic terms (i.e., about 0.5-0.9 percentage points). In comparison, for graduates from tertiary education programs the IV estimates show that becoming a graduate mover is a positive and statistically significant influencing factor for the individual's entry wage level (i.e., graduate movers are observed to have a 4-6% higher wage level compared to graduate stayers). These results highlight two aspects: First, migration can enhance the labor market efficiency in terms of increasing the employment rate for relatively standardized jobs. Second, for more specialized jobs from tertiary education, individuals can maximize monetary labor market returns through a spatial job search. This indicates that the labor market for jobs from tertiary education programs is subject to spatial wage frictions.²²

If we zoom in on the ISCED level, the empirical picture shown in Table 6 becomes even clearer: That is, we find that the highest wage premium is received by graduate movers from ISCED 7 education programs, followed by graduate movers from ISCED 5/6. This lends strong support to our research hypothesis that the wage returns to migration differ by education programs and increase with obtained qualification levels. Another striking finding from Table 6 is that graduate movers from post-secondary vocational education programs (ISCED 4) have both a lower employment probability and earn lower entry wages compared to graduated stayers – the results in terms of entry wages vary between -3.7% (Probit-SLS) and -7.2% (LPM-SLS). For graduates from upper secondary education programs (ISCED 3) no wage premium is found.

As mentioned above, professional graduates from VET programs have completed compulsory, practical internships and are embedded in the local labor market prior to graduation; therefore, spatial mobility decisions may reflect negative selection effects and accordingly translate into a negative impact on the observed labor market outcomes. This may point to the fact that these graduates risk losing their acquired social capital once they migrate, particularly those with higher specialization levels (ISCED 4). Related to this, Venhorst and Cörvers (2018) offer the explanation that negative effects of graduate migration may reflect forced migration: Specific

²² Detailed estimation outputs for all covariates in the second-stage IV estimation are given in Table A4 in the supplementary materials.

groups of graduates fail to find a local match and are therefore forced to move to other regions with, at least initially, a relatively poor job match as a consequence.

Finally, the underlying results for the first-stage probability model of migrating after graduating in Table 6 indicate that the multi-level instrument set works as expected: With regard to the institutional peer effect, we find that the higher the share of graduate movers in the total number of graduates per higher education institution is, the more likely is it that individual i will choose to migrate as well. We further find that graduates who have migrated before/at the start of the education are also more likely to become graduate movers after finalizing the education (Di Cintio and Grassi, 2013). Changes in the individual's family status also affect the likelihood of migration significantly: While the life event of having a child negatively influences the individual's migration propensity, the effect of a marriage/registered partnership is mixed (i.e., it negatively affects the migration propensity of professional graduates but positively affects the migration propensity of academic graduates). Finally, local labor market conditions work as a signaling factor as predicted by the neoclassical migration model. That is, the more average income level increases (across Danish municipalities), the less likely is the individual to move away from this economically successful region (this link is only statistically significant for academic graduates).

<< Table 7 about here >>

6. Conclusion

We have investigated the role that graduate migration plays for early-career labor market outcomes of graduates that entered the Danish labor market during the period 2006-2011. We have defined graduate movers as those labor market entrants who have migrated between Danish municipalities (LAU1 level) within the first two years after graduation. Given that we use a rich register-based data set covering the full population of 405,559 graduates, we were able to distinguish between the effects of migration for different education programs (upper and post-secondary vocational education, tertiary education) and qualification levels. Such a comprehensive analysis of the mobility-related labor market returns in the education-to-job transmission has not previously been published in the empirical literature on this matter and thus helps to enhance our understanding on the role of mobility in the education-to-work transition.

Our benchmark OLS results indicate a positive correlation between graduate migration and individual labor market outcomes, which is particularly strong for entry wages. The results show that the estimated outcome differences between movers and stayers are larger for graduates from tertiary education programs than for those from VET programs. The reduced-form OLS results also provide evidence that the estimated labor market effects vary over the business cycle: While the possibility of a higher employment probability through graduate migration shrinks significantly during the midst of the global economic crisis, spatial wage differences and therefore the associated wage premium for mobile graduates, increase significantly.

To better identify the causal effects of migration on the employment probability and entry wages in the education-to-job transition, we have also estimated endogenous treatment models that account for the simultaneity between migration and observed labor market outcomes. The IV estimates indicate that graduates from VET programs have a slightly higher employment probability (estimates range between 0.5 and 0.9 percentage points), but we do not find evidence for a positive mobility wage premium. In comparison, for graduates from tertiary education programs the IV estimates reveal that post-graduation migration is a positive and statistically significant influencing factor for the individual's entry wage (i.e., graduate movers are observed to have a 4-6% higher wage level compared to graduate stayers). These results are even more pronounced if we split the sample by ISCED qualification levels and basically highlight two aspects: First, migration can enhance the labor market efficiency in terms of increasing the employment rate for relatively standardized jobs. Second, for more specialized jobs from tertiary education, individuals can maximize monetary labor market returns through a spatial job search.

Likely reasons for this observed heterogeneity are differences in spatial labor market frictions for specific labor market segments, which increase with higher qualification levels and more specialized jobs. They also point to the role played by differences in the institutional setup of both types of education programs in the Danish education system: As VET graduates have typically completed practical traineeships and are already embedded in the local labor market prior to graduation, migration decisions that do not reflect unobserved individual talents may exhibit negative signaling effects on the labor market as they imply a loss of social capital.²³ This explanation is in line with our finding that graduate movers from post-secondary

²³ An alternative explanation is offered by Venhorst and Cörvers (2018). The authors take the empirical evidence of negative mobility effects for certain graduate groups as an indication for forced migration processes resulting in a poor job match.

vocational education programs (ISCED 4) have the relatively poorest job market performance vis-à-vis stayers, as the loss in social capital is likely to be the largest for this group of mobile graduates. In comparison, academic graduates facing spatial frictions in the job search process may benefit from migration as a means to maximize labor market outcomes in the early-career stage. We find the largest mobility wage premium for tertiary graduates from long-cycle education programs (ISCED 7). Our results can thus be seen in line with earlier findings provided by Lkhagvasuren (2014) arguing that labor market thickness decreases with education levels: for professional graduates from VET programs opportunities do not vary much across different local markets, whereas for academic graduates' different market segments offer the opportunity to exploit spatial wage differences.

Obviously, the obtained empirical results should only be interpreted with caution from a causal perspective as we cannot fully rule out selection effects in comparison to quasi-randomized identification approaches such as in Anelli (2020) on the returns to education. While the use of register data offers the advantage of providing a comprehensive empirical picture of different groups of graduates in the Danish education system, the availability of instrument candidates is limited (compared to other data sources, such as detailed graduate surveys). We have tried to bypass this problem by constructing a multi-level instrument set that exploits information relevant for the migration decision at the level of the individual graduate, the education institution, and the local labor market. Although we have carefully tried to select instruments that are likely unrelated to the individual graduate's observed labor market outcome, complex life decisions of individuals can hardly be decomposed into single causes and often reach far into the individual's future. This is also reflected in our data. Nonetheless, we hope that our findings on the role of spatial mobility for individual and aggregate labor market outcomes are of relevance for the academic and political debate – even if they have to be read *cum grano salis*.

Taken together, the estimation results underline the importance of spatial mobility for job market matching in the transition from education to employment. One of our key findings is that the migration premium differs across education programs and obtained qualification levels. As such, from a policy perspective we find that geographical mobility after graduation can be seen as a viable tool for increasing labor market returns in different contexts – either to increase the employment rate of relatively standardized jobs or through the exploitation of spatial wage differences for specialized jobs. However, our results also show that in job market segments that build up strong local job networks and associated social capital during the education,

mobility support may not lead to increased labor market efficiency. Here, policies that support job matching through the creation of local labor market ties should be strengthened.

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TABLES

Table 1: *t*-tests for differences in labor market outcomes between graduate movers and stayers (overall; by education program)

Variable	Indicator	Graduate Stayer (0)	Graduate Mover (1)	Graduate Stayer (0)	Graduate Mover (1)	Graduate Stayer (0)	Graduate Mover (1)
		Overall		Academic		Professional	
<i>Pr</i> (Emp)	Mean	0.796	0.860	0.752	0.884	0.847	0.836
	Difference (1-0)	0.064***	(0.00)	0.132***	(0.00)	-0.012***	(0.00)
<i>log</i> (Wage) [§]	Mean	11.858	12.042	12.225	12.430	11.805	11.94
	Difference (1-0)	0.184***	(0.00)	0.206***	(0.00)	0.179***	(0.00)

Notes: H_0 : $\text{mean}(1) - \text{mean}(0) = 0$, H_a : $\text{mean}(1) - \text{mean}(0) \neq 0$. [§] = only full-time employment. ***, ** denote statistical significance at the 1% and 5% levels. *P*-values for *t*-tests are given in brackets. Academic = Graduates from tertiary education programs; Professional = Graduates from upper (post) secondary vocational education programs.

Table 2: *t*-tests for differences in labor market outcomes between graduate movers and stayers (by ISCED qualification level)

Variable	Indicator	Graduate Stayer (0)	Graduate Mover (1)	Graduate Stayer (0)	Graduate Mover (1)	Graduate Stayer (0)	Graduate Mover (1)	Graduate Stayer (0)	Graduate Mover (1)
		ISCED 3		ISCED 4		ISCED 5/6		ISCED 7	
<i>Pr</i> (Emp)	Mean	0.858	0.830	0.796	0.869	0.752	0.882	0.752	0.887
	Difference (1-0)	-0.028***	(0.00)	0.074***	(0.00)	0.130***	(0.00)	0.135***	(0.00)
<i>log</i> (Wage) [§]	Mean	11.762	11.966	12.240	12.336	12.095	12.360	12.400	12.512
	Difference (1-0)	0.203***	(0.00)	0.096***	(0.00)	0.265***	(0.00)	0.116***	(0.00)

Notes: H_0 : $\text{mean}(1) - \text{mean}(0) = 0$, H_a : $\text{mean}(1) - \text{mean}(0) \neq 0$. [§] = only full-time employment. ***, ** denote statistical significance at the 1% and 5% levels. *P*-values for *t*-tests are given in brackets. For a definition of ISCED levels, see main text.

**Table 3: Benchmark OLS estimates for labor market returns to graduate migration
(overall; by education program)**

<i>Dep. Var.:</i>	<i>Pr(Emp)</i>			<i>log(Wage)[§]</i>		
<i>Sample:</i>	Overall	Academic	Professional	Overall	Academic	Professional
Graduate Mover	0.004***	0.006***	0.002***	0.069***	0.085***	0.054***
(S.E.)	(0.0004)	(0.0005)	(0.0006)	(0.0017)	(0.0023)	(0.0024)
Observations	1,279,899	662,784	617,115	871,453	466,281	405,172
Individual controls	✓	✓	✓	✓	✓	✓
Time-fixed effects	✓	✓	✓	✓	✓	✓
Location-fixed effects	✓	✓	✓	✓	✓	✓

Notes: § = only full-time employment. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance levels, respectively. Academic = Graduates from tertiary education programs; Professional = Graduates from upper (post) secondary vocational education programs. Results reported for pooled OLS specification with two-way clustered standard errors (S.E.) at the individual and municipality levels. Individual-specific controls include age, sex, dummies for sector of employment, occupational types, educational level, and a binary dummy indicating if the person commutes to work or not (see Table A1 in the supplementary materials). Full estimation outputs including the coefficients from control variables can be found in Table A4 in the supplementary materials.

**Table 4: Benchmark OLS estimates for labor market returns to graduate migration
(by qualification level)**

<i>Dep. Var.:</i>	<i>Pr(Emp)</i>				<i>log(Wage)[§]</i>			
<i>Sample:</i>	ISCED 3	ISCED 4	ISCED 5	ISCED 6	ISCED 3	ISCED 4	ISCED 5/6	ISCED 7
Graduate Mover	0.002***	0.003**	0.006***	0.005***	0.061***	0.029***	0.083***	0.085***
(S.E.)	(0.0006)	(0.0014)	(0.0006)	(0.0008)	(0.0026)	(0.056)	(0.0029)	(0.0034)
Observations	518,069	99,046	377,526	285,258	405,172	72,369	256,682	209,599
Individual controls	✓	✓	✓	✓	✓	✓	✓	✓
Time-fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Location-fixed effects	✓	✓	✓	✓	✓	✓	✓	✓

Notes: § = only full-time employment. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance levels, respectively. For a definition of ISCED levels, see main text. Results reported for pooled OLS specification with two-way clustered standard errors (S.E.) at the individual and municipality levels. Individual-specific controls include age, sex, dummies for sector of employment, occupational types, educational level, and a binary dummy indicating if the person commutes to work or not (see Table A1 in the supplementary materials). Full estimation outputs can be obtained from the authors upon request.

Table 5: Endogenous treatment model estimates for labor market returns to graduate migration (overall; by education program)

<i>Dep. Var.</i>	<i>Pr(Emp)</i>			<i>log(Wage)[§]</i>		
<i>Sample:</i>	Overall	Academic	Professional	Overall	Academic	Professional
(a) Linearized 2SLS						
Graduate Mover	0.005***	-0.002	0.006***	-0.002	0.043***	-0.013*
(S.E.)	(0.0009)	(0.0013)	(0.0015)	(0.0054)	(0.0071)	(0.0076)
(b) Probit 2SLS						
Graduate Mover	0.009***	0.001	0.009***	0.007	0.061***	-0.011
(S.E.)	(0.0009)	(0.0013)	(0.0015)	(0.0062)	(0.0069)	(0.0082)
Observations	1,075,984	555,823	518,869	707,378	383,188	325,549
Durbin-Wu-Hausman	67.83***	62.89***	24.69***	212.97***	27.66***	54.59***
Cragg-Donald Wald <i>F</i>	15782.6	6815.1	8185.7	9257.4	5132.5	4903.1
5% max. IV relative bias [#]	19.28	19.28	19.28	19.28	19.28	19.28
10% max. IV size [#]	29.18	29.18	29.18	29.18	29.18	29.18
Individual controls	✓	✓	✓	✓	✓	✓
Time-fixed effects	✓	✓	✓	✓	✓	✓
Location-fixed effects	✓	✓	✓	✓	✓	✓

Notes: § = only full-time employment. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance levels, respectively. [#] = Critical values taken from Stock and Yogo (2005). Academic = Graduates from tertiary education programs; Professional = Graduates from upper (post) secondary vocational education programs. Results reported for (a) Linearized 2SLS specification with robust standard errors (S.E.), (b) Probit 2SLS specification with robust standard errors. Individual-specific controls in the second-stage regression include age, sex, dummies for sector of employment, occupational types, educational level, and a binary dummy indicating if the person commutes to work or not (see Table A1 in the supplementary materials). Full estimation outputs can be obtained from the authors upon request. First-stage regression results for the LPM and Probit specification are shown in Table 7.

**Table 6: Endogenous treatment model estimates for labor market returns to graduate migration
(by qualification level)**

<i>Dep. Var.:</i>	<i>Pr(Emp)</i>				<i>log(Wage)[§]</i>			
	ISCED 3	ISCED 4	ISCED 5/6	ISCED 7	ISCED 3	ISCED 4	ISCED 5/6	ISCED 7
(a) Linearized 2SLS								
Graduate Mover	0.013***	-0.013***	-0.001	0.006***	0.008	-0.072***	0.038***	0.062***
(S.E.)	(0.0017)	(0.0033)	(0.0017)	(0.0019)	(0.0087)	(0.0153)	(0.0094)	(0.0099)
(b) Probit 2SLS								
Graduate Mover	0.017***	-0.012***	0.001	0.008***	-0.003	-0.037**	0.032***	0.073***
(S.E.)	(0.0016)	(0.0033)	(0.0016)	(0.0018)	(0.0092)	(0.0146)	(0.0089)	(0.0096)
Observations	436,205	82,664	316,263	239,568	265,706	59,843	207,992	175,202
Durbin-Wu-Hausman	137.88***	18.91***	50.59***	9.32***	19.37***	35.60***	199.40***	0.27
Cragg-Donald Wald <i>F</i>	6678.2	1564.9	3858.4	3410.1	3807.1	1130.3	2764.4	2659.5
5% max. IV relative bias [#]	19.28	19.28	19.28	19.28	19.28	19.28	19.28	19.28
10% max. IV size [#]	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18
Individual controls	✓	✓	✓	✓	✓	✓	✓	✓
Time-fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Location-fixed effects	✓	✓	✓	✓	✓	✓	✓	✓

Notes: § = only full-time employment. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance levels, respectively. For a definition of ISCED levels, see main text. Results reported for (a) Linearized 2SLS specification with robust standard errors (S.E.), (b) Probit 2SLS specification with robust standard errors. Individual-specific controls in the second-stage regression include age, sex, dummies for sector of employment, occupational types, educational level, and a binary dummy indicating if the person commutes to work or not (see Table A1 in the supplementary materials). Full estimation outputs and first-stage regression results can be obtained from the authors upon request.

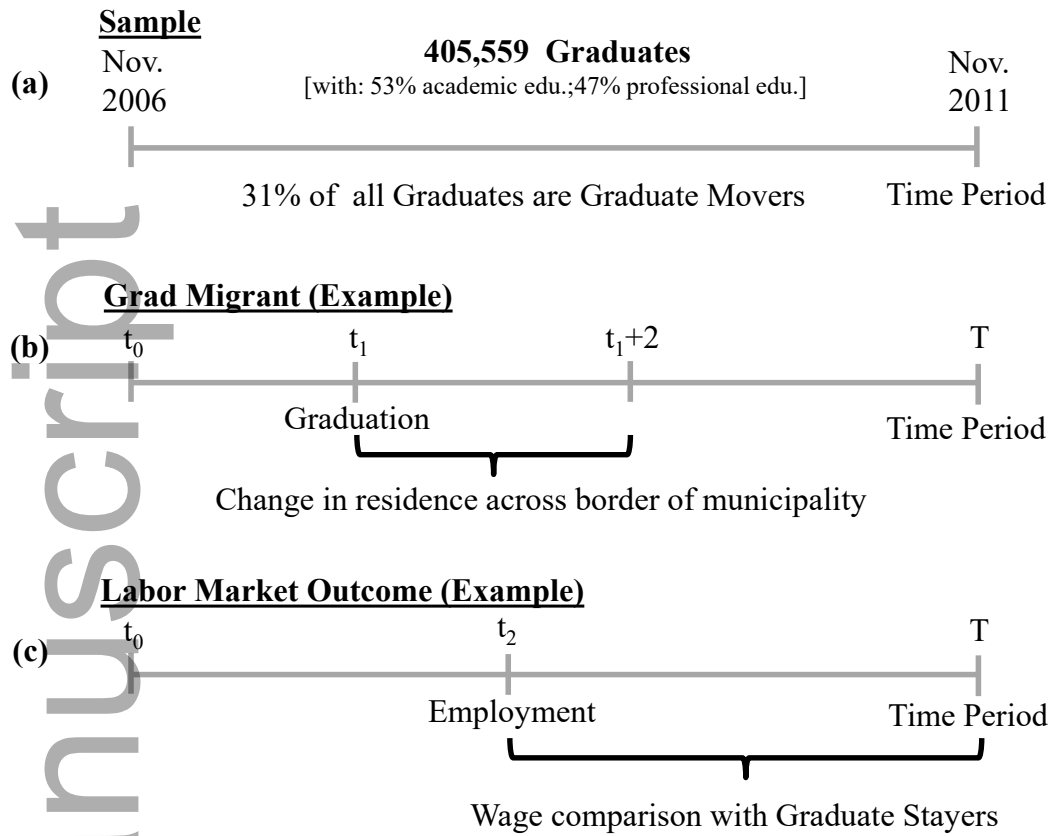
**Table 7: First stage LPM and Probit estimates for first-stage migration equation
(Probability of becoming a graduate mover)**

Econometric specification	LPM			Probit		
	Overall	Academic	Professional	Overall	Academic	Professional
<i>Dep. Var.: Pr($\Psi_i = 1$)</i>						
Share of graduate migrants in EI <i>h</i>	0.228***	0.218***	0.258***	0.794***	0.819***	0.833***
(S.E.)	(0.0019)	(0.0024)	(0.0031)	(0.0078)	(0.0116)	(0.0109)
Disposable income in municipality <i>m</i>	-0.033***	-0.044***	-0.011	-0.096***	-0.128***	-0.033
(S.E.)	(0.0121)	(0.0156)	(0.0192)	(0.0339)	(0.0433)	(0.0556)
Lagged disposable income in municipality <i>m</i>	-0.122***	-0.162***	-0.045***	-0.331***	-0.438***	-0.121**
(S.E.)	(0.0099)	(0.0127)	(0.0159)	(0.0275)	(0.0348)	(0.0456)
Δ Family status: marriage/partnership	-0.041***	0.027***	-0.089***	-0.118***	0.069***	-0.254***
(S.E.)	(0.0016)	(0.0026)	(0.0022)	(0.0047)	(0.0074)	(0.0062)
Δ Family status: birth of child	-0.113***	-0.133***	-0.096***	-0.367***	-0.433***	-0.304***
(S.E.)	(0.0017)	(0.0024)	(0.0024)	(0.0064)	(0.0094)	(0.0090)
Migration before/at start of education	0.280***	0.275***	0.285***	0.778***	0.751***	0.812***
(S.E.)	(0.0009)	(0.0014)	(0.0014)	(0.0030)	(0.0042)	(0.0044)
No. of graduates	405,559	214,946	190,613	405,559	214,946	190,613
Individual controls	✓	✓	✓	✓	✓	✓
Time-fixed effects	✓	✓	✓	✓	✓	✓
Dummies for city type (Origin location)	✓	✓	✓	✓	✓	✓

Notes: $Pr(\Psi_i = 1)$ is the probability of becoming a graduate mover after graduating. ***, **, * denote statistical significance at the 1%, 5%, and 10% significance levels, respectively. Δ denotes change in family status in the year of graduation. LPM = Linear probability model. Academic = Graduates from tertiary education programs; Professional = Graduates from upper (post) secondary vocational education programs; EI = Educational Institution. Full estimation outputs can be obtained from the authors upon request.

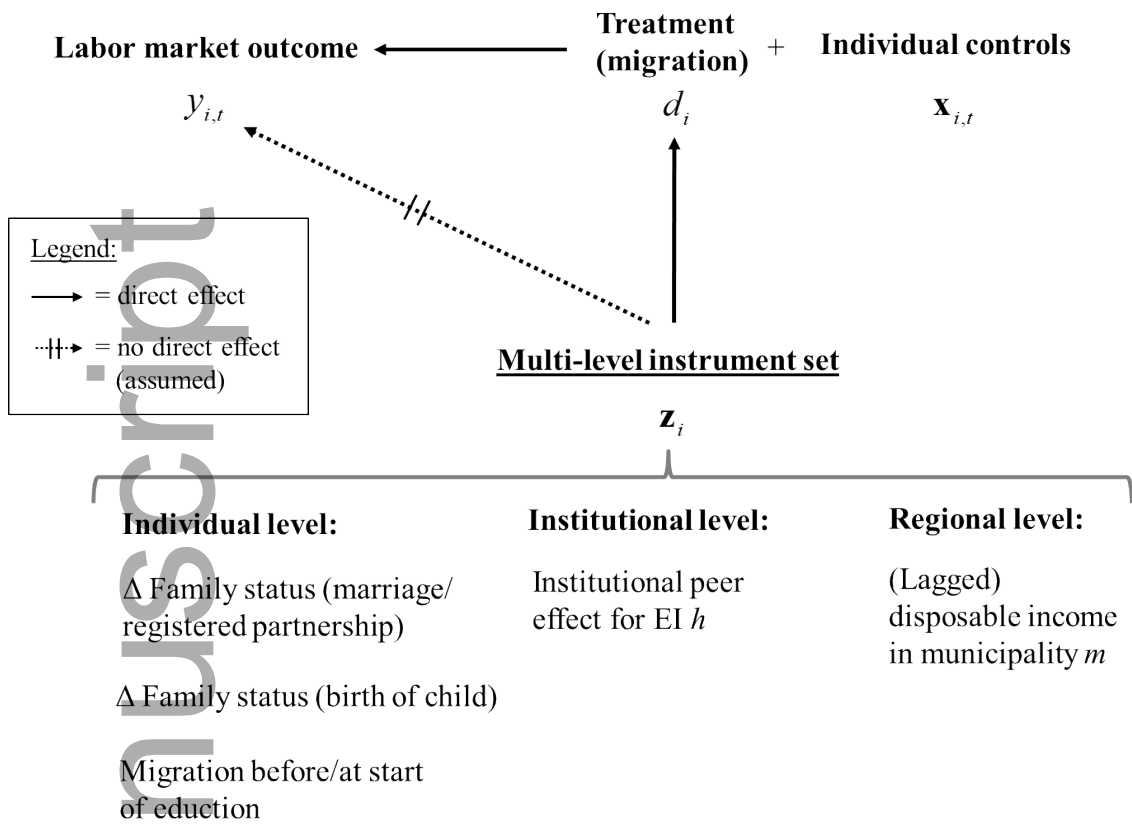
FIGURES

Figure 1: Identification of treatment group (graduate migrants) and labor market outcomes



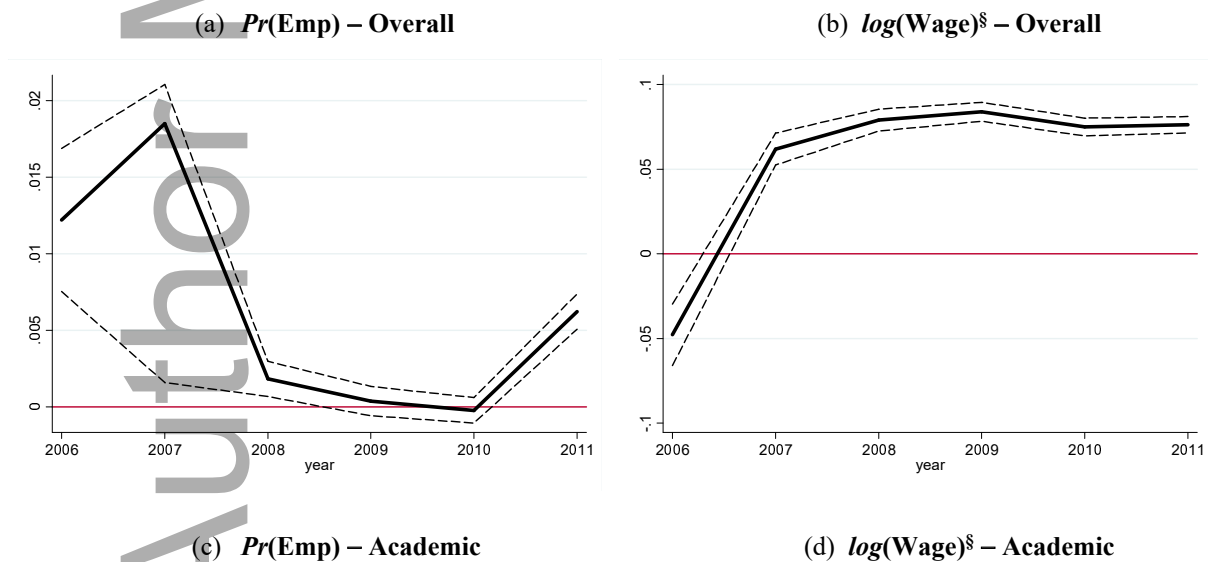
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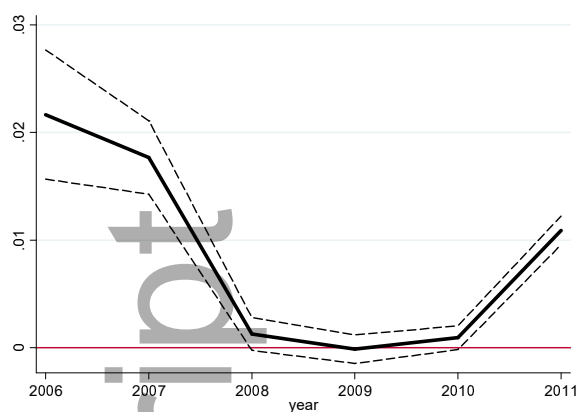
Figure 2: Summary of multi-level IV set for endogenous treatment model estimation



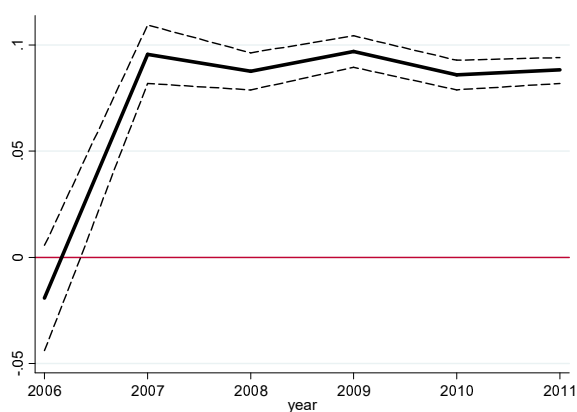
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Figure 3: Estimated treatment effects of graduate migration by sample year

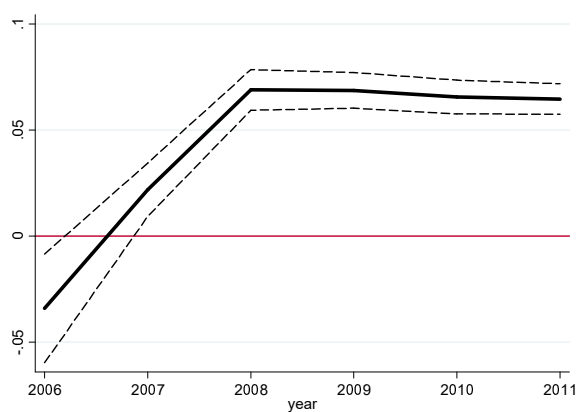
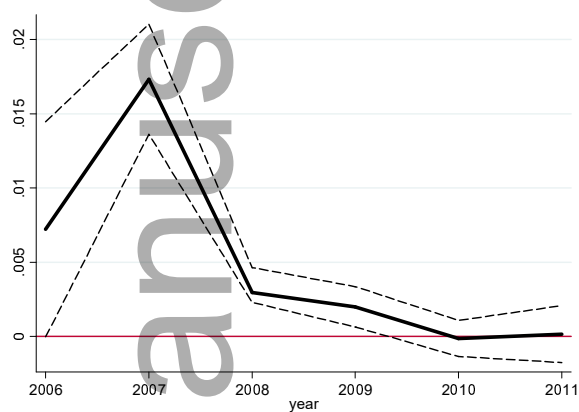




(d) $Pr(Emp) - Professional$



(b) $\log(Wage)^{\S} - Professional$



Notes: \S = only full-time employment. Solid lines show estimated treatment effects for individual years; dashed lines indicate the 95% confidence interval. Academic = Graduates from tertiary education programs; Professional = Graduates from upper (post) secondary vocational education programs. Estimates are based on OLS specification with two-way clustered standard errors at the individual and municipality levels.