International Migration:

a Destination Country and Migrant Perspective

PhD dissertation by

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Acknowledgements

My interest in the Economics of Migration started when I gathered valuable experience working as a research assistant for Martin Munk, Panu Poutvaara and Martin Junge. I am thankful to them for introducing me to migration as a research field and for letting me use their novel survey data on "Danes Abroad" in the first chapter.

I spent January to May 2012 at the Centre for Research and Analysis of Migration, University College London. I learned a tremendous amount during that stay and I would like to thank Christian Dustmann for hosting me and giving me that opportunity. Following his course on the Economics of Migration and getting feedback from him on my own work gave me insights that I build on today. The excellent group of young scholars at CReAM was a further inspiration for me. I appreciate very much their well-coming attitudes and enjoyed interacting with them during my stay and at conferences and workshops.

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Summary

This dissertation is comprised of three self-contained chapters in the Economics of Migration. The two first take the perspective of the migrant and analyze the decision to migrate and its consequences for labor market outcomes. The last chapter consider the impact immigration has on natives in the destination country.

Chapter 1 "*International Return Migration and the Effects on Earnings*" investigates the economic incentives for international return migration from a high wage country, more specifically Denmark. I follow the migrants abroad and link labor market outcomes to reasons behind emigrating and work-activities abroad. The impacts on earnings and employment are negative the first one-two years after return. Male migrants overtake their peers who did not go abroad within a few years, while women experience long-lasting negative returns to their international experience. This seem to reflect gender differences in reasons behind emigrating and consequently differences in the labor-market value of the international experience. Men migrate for job-related reasons, the majority due to a job-transfer, and most women are accompanying their partner in the migration decision. Similarly, men possess very high skilled jobs abroad and women take low skilled jobs or stay at home looking after the children. This is surprising because Denmark is a highly gender-equal country by international standards and all individuals were in the labor force prior to migrating. The next chapter sets out to understand these gender-patterns among international migrants.

Chapter 2 "*Family Migration and Relative Earnings Potentials*" considers the mobility of dual-earner households. I show that couples are more likely to migrate if household earnings are disproportionately due to one partner. Furthermore, families react equally strong to an increase in the male or the female relative earnings advantage within the household. This is evidence in favor of the human-capital model of family migration, that is completely gender-neutral and symmetric in the private gains to husbands and wives. It contradicts another prevalent hypothesis, namely that migration is husband-centered and biased towards husbands' private gains from mobility. The seemingly lower weight on wives' private gains in the literature can (at least partly) be attributed to two facts: household earnings are lower among female headed households and highly educated women more often than highly educated men find highly educated partners. The results hold for relocations between commuting zones in Denmark as well as for international migration of Danish couples.

Chapter 3 "*Immigration and Native Workers: New Analysis Using Longitudinal Employer-Employee*

Data" is coauthored with Giovanni Peri from University of California, Davis. This chapter makes progress on a central question in the Economics of Migration: the impacts of immigration on the labor market outcomes of native workers. We use the inflow of non-EU immigrants to Denmark, beginning in 1995 and driven by a sequence of international crises. The immigrants were very low skilled relative to the native population in Denmark and took mainly manual jobs. We find that the increased supply of low-skilled foreign workers pushed natives to pursue more complex and less manual-intensive occupations. The reallocation took place mainly through movement of individuals across firms and resulted in higher or unchanged wages for the native workers. Thus, immigration increased the mobility but we also find that it did not increase their probability of unemployment.

Resumé (Summary in Danish)

Denne afhandling består af tre selvstændige kapitler om de økonomiske determinanter og effekter af migration. De første to kapitler er nært beslægtede og analyserer henholdsvis, hvilke par der kan blive enige om at migrere internationalt eller indenfor Danmark (Kapitel 2) og hvilke konsekvenser den internationale mobilitet har for migranternes beskæftigelse og indkomst (Kapitel 1). Det sidste kapitel analyserer de effekter indvandring har for lønmodtagere i modtagerlandet, i dette tilfælde Danmark.

Kapitel 1 "*International Return Migration and the Effects on Earnings*" undersøger de økonomiske incitamenter for international migration fra et høj-indkomst land, nærmere bestemt Danmark. Det danske register data kombineret med unikt survey-baseret data gør det muligt at følge migranter i udlandet og linke deres løn og beskæftigelse efter opholdet i udlandet til årsagen til udvandringen og arbejdsaktiviteter under udlandsopholdet. Jeg finder signifikante negative effekter for alle migranter de første 1-2 år efter genindvandring til Danmark. Derefter overhaler de mobile mænd, dem der blev hjemme, mens kvinderne har langvarige negative effekter af deres internationale mobilitet. Det ser ud til at afspejle kønsforskelle i udrejseårsagen. Mænd migrerer på grund af deres arbejde, flertalet grundet udstationering, mens de fleste kvinder følger deres partner i den internationale vandring. Mændene har krævende job i udlandet som ledere eller i højt specialiserede jobs. Kvinderne derimod er oftest hjemmegående eller tager mindre kompetance-krævende eller helt ufaglærte jobs, mens de er i udlandet. Dette er overraskenede, givet at Danmark i international sammenhæng har relativ stor lighed mellem kønnene og alle individer i undersøgelsen var på arbejdsmarkedet inden udvandringen fra Danmark. Det næste kapitel giver en forklaring på disse tilsyneladende stærke kønsmønstrer blandt internationale migranter.

Kapitel 2 "*Family Migration and Relative Earnings Potentials*" tager udgangspunkt i husholdninger, hvor begge partnere er på arbejdsmarkedet. Jeg viser, at migration er mere udbredt blandt familier, hvor den ene partner tjener størstedelen af husholdningsindkomsten. Stigningen i migrationssandsynligheden ved en stigning i indkomstuligheden indenfor husholdningen afhænger ikke af om indkomstudligheden er til mandens eller kvindens fordel. Dette resultat er konsistent med humankapital teorien for mobilitet, som er fuldstændig kønsneutral og tilsiger at migrationssandsynligheden er symmetrisk i de to partners forventede gevinster ved mobilitet. Det modsiger en anden fremherskende hypotese om, at familie-migration følger mandens jobmuligheder på grund af faste kønsnormer. Den tilsyneladende højere vægt på mandens karriere, når betydningen af manden og kvindens karakter-

istika analyseres, kan forklares af to vigtige faktorer der ikke i tilstrækkelig grad har været kontroleret for i literaturen: Familier hvor kvinden tjener mest har lavere indkomst, end familier hvor manden tjener mest, og de højt uddannede kvinder er oftere end højtuddannede mænd sammen med en ligeså højtuddannede partner. Det gør dem mindre mobile. Resultaterne holder for interne flytninger mellem pendlingsoplande i Danmark såvel som for international migration af danske par.

Kapitel 3 "*Immigration and Native Workers: New Analysis Using Longitudinal Employer-Employee Data*" tager fat på et af de store spørgsmål om indvandring, nemlig betydningen af indvandring for de enkelte lønmodtagere. Dette kapitel er skrevet i samarbejde med Giovanni Peri fra University of California, Davis. Vi kigger indvandringen fra ikke EU-lande, primært den store tilstrømning af flygtninge og familiesammenførte, der startede midt i 1990erne drevet af en serie af internationale kriser såsom den bosniske, somaliske og irakiske. Denne indvandring var lavtuddannet sammenlignet med den danske befolkning og indvandrene tog primært manuelle og ufaglærte jobs. Vi finder, at det øgede udbud af lavtuddannet arbejdskraft grundet indvandring skubbede de indfødte lønmodtagere mod mere komplekse jobs, som typisk kræver flere kommunikative og færre manuelle færdigheder. Tilpasningen fandt primært sted gennem flytning af arbejdskraft på tværs af virksomheder. Således stimulerede indvandringen mobiliteten til nye jobs og nye virksomheder, men indvandringen skubbede ikke de indfødte ud i arbejdsløshed og pressede ikke deres lønninger i period 1995-2008.

Contents

Chapter 1

International Return Migration and the Effects on Earnings

International Return Migration and the Effects on Earnings

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Abstract

This paper investigates the economic incentives for international migration from a high wage country by estimating the wage and employment effects abroad as well as after return migration. Positive wage effects are found for men. Women, on the contrary, do not gain from international migration on average. This seems to be a tied mover effect. Men migrate for job-related reasons, the majority due to a job-transfer, while most women report that they are accompanying their partner abroad. Consistent with this, male migrants work more and female migrants work less abroad than their peers in the home country and this is also reflected in their earnings. For all migrants, I find strong negative employment and earnings effects immediately after return migration. In terms of earnings, men recover fast and are rewarded for their international experience but women experience long-lasting negative labor market effects. The results are estimated using full population register data and survey data on Danish return migrants.

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1 Introduction

The term brain drain was initially introduced to describe human capital flight from developing countries, but emigration of human capital is a potential cost for all countries. Outflow of skills and knowledge is not least a concern for a redistributive welfare state facing global competition for highly skilled labor and at the same time sponsoring education for its citizens. Recent research shows that European countries experience net losses of highly educated to the rest of the world. Docquier and Rapoport (2012) show that up to 2 percent of Danish college graduates and 5 percent of British college graduates currently live in the US.[1] In the Danish case 80 percent of emigrants return, and more educated are more likely to return.

This paper estimates what these return migrants earn abroad compared to what they would have earned in the home country and what they earn upon return migration compared to what they would have earned had they not been abroad. It is the first empirical investigation of wage effects of international migration using data where individuals can be followed abroad, and the paper contributes with new knowledge on wage effects for returned migrants. The results can be used to evaluate the idea that migration flows are driven by returns to human capital and to better understand skill flows between developed countries. Most of the literature on international migration deals with migration from low wage to high wage countries (South-North migration). The migration flows considered here are from a high wage country, more specifically Denmark. The migrants are relatively high skilled and the mobility is often related to transfers within multinational corporations; 37 percent of the Danish labor migrants are sent abroad by their employer.

The human capital approach to migration, i.e. the idea that migrants relocate to improve lifetime earnings, goes back to Sjaastad (1962) who described the costs and returns to migration. For return migrants, improvements to lifetime income can come through higher earnings while abroad and higher earnings upon returning home. If migration is motivated by higher expected earnings and expectations are realized on average it should be possible to identify wage effects empirically at some point in the wage profile of migrants. The challenge is that it is difficult to construct a proper comparison group for migrants. Most data sources are split by country leaving the migrants and non-migrants in distinct data sources. Furthermore, migrants are likely to be a self-selected group.

[1] For PhD holders the numbers are 5 and 6 percent for Denmark and United Kingdom respectively, and for researchers within science and technology the corresponding numbers are 9 and 29 percent (Docquier and Rapoport, 2012).

Borjas (1987) was the first to apply Roy's model of self-selection to international migration (Roy, 1951). Based on the income distributions in the sending and the receiving countries, he showed that migrants from countries with a relatively narrow income distribution will be drawn from the upper end of the income distribution, provided that earnings are sufficiently correlated across countries. Borjas and Bronars (1991) show that family migration dilutes the selection pattern found in Borjas (1987) and predict that single migrants have higher returns from migration than persons who migrate as part of a family. Borjas and Bratsberg (1996) developed the Roy framework to encompass return migration. In their model, return migration can become optimal for the marginal migrant due to disappointment about actual earnings abroad or due to a wage premium to international experience in the home country. Return migration has also been explained in theoretical models by Hill (1986) and Dustmann and Weiss (2007). Hill (1986) studies circular migration between the United States and Mexico in a model where migrants are driven forth and back by higher earnings abroad and a preference for home country consumption. A wish to smooth consumption over time leads the migrant to divide the optimal duration abroad into shorter stays in this model. Dustmann and Weiss (2007) set up a model where return migration can be triggered by a preference for home country residence, purchasing power considerations, or a wage premium to international experience. Mincer (1978) developes a model of migration where families are the economic units and migration occurs if there is a positive net gain to the family as a whole. If a family member on its own would find it suboptimal to move that individual is called a tied mover. Foged (2014) expands on Mincer's work and shows that migration propensities of couples are increasing in the intra-household earnings dissimilarity.

Wage effects abroad as well as over a period of four years after return migration are estimated in order to shed light on the timing and the composition of the effects that cumulate into the change in lifetime earnings for migrants. Information on reasons behind emigrating and work-activities abroad, stemming from new unique survey data on Danish return migrants, are used to better understand the heterogenous effects. The remaining data come from Danish registers. The empirical strategy combines matching with difference-in-differences techniques to avoid arbitrary functional form assumptions and reduce bias from non-overlaping covariate distributions between migrants and non-migrants. I consider individuals who entered the labor market at least two years prior to treatment and test that the pre-trends in earnings are statistically similar between migrants and non-migrants.

I find that men have positive payoffs in terms of higher earnings, while married women experience

negative earnings effects abroad as well as after return migration. The gender differences in average returns to international migration are in line with the related literature on internal migration and results by Barrett and O'Connell (2001) for returned Irish migrants. I find strong negative effects for all migrants the first 1-2 years after return migrating. The estimated impacts are smaller for shorter emigration spells.

Section 2 reviews the related empirical literature on wage effects of internal migration and wage effects of international experience for returned migrants. Sections 3 describes the data and section 4 motivates the choice of covariates based on empirical literature and theory. Descriptive statistics on the reasons behind emigrating and the characteristics of Danish emigrants are provided in section 5. The empirical stratgy is explained in section 6. Results are presented in section 7 and discussed in section 8. The final section concludes.

2 Review of the empirical literature

Few papers exist that examine individual wage effects associated with international migration. International migration has more often been analyzed from the perspective of the host countries, and migrant wages have therefore been compared to wages of natives. Co, Gang, and Yun (2000), Barrett and O'Connell (2001) and de Coulon and Piracha (2005) are exceptions. They compare earnings of people who have been abroad in the past with earnings of people who stayed in the home country. de Coulon and Piracha (2005) look at return migrants to Albania and find evidence that a stay abroad increases hourly wages. Barrett and O'Connell (2001) and Co, Gang, and Yun (2000) estimate wage effects for returned migrants to Ireland and Hungary, respectively. Barrett and O'Connell (2001) find a positive wage gain for men and no significant effect for women. Co, Gang, and Yun (2000) conversely find positive returns to women and no effects for men.

Negative labor market outcomes for married women and positive labor market outcomes for married men following migration are well documented in the internal migration literature.[2] Sandell (1977) is an early paper on American data documenting negative returns to married women and positive effects for married men, large enough to compensate the losses of the wives. Cooke (2003) confirms that the returns at the household-level are positive but finds that the gains are concentrated in households

[2]Examples are Sandell (1977); Grant and Vanderkamp (1980); Lichter (1980, 1983); Spitze (1984); Shihadeh (1991); Cooke (2003).

with high male earnings. Grant and Vanderkamp (1980) use Canadian data and find wage penalties to married women and positive returns for single women of smaller magnitude than the returns accruing to single men.

It is a general perception that women most often accompany their partner in migration decisions.[3] A series of papers therefore study the returns to geographic mobility within countries looking only at men. This literature has illustrated heterogeneity in returns to mobility with respect to education and illustrated that the returns are not constant over the post-migration period. Ham, Li, and Reagan (2005) find a positive wage growth premium for college graduates, negative effects for high school dropouts, and no returns to other education groups of internal mobility in the United States. Yankow (2003) looks at internal migration in United States, too. He finds that migrants with a higher education receive a stream of positive wage growth effects with a lag of nearly two years. Whereas migrants with less education do not experience significant impacts on their earnings profile after migration but have a significant drop in earnings before migration. Yankow (1999) also finds positive increasing returns to migration for a high education group looking at American data. Böheim and Taylor (2007) find a positive hourly wage growth premium looking at the first three years after internal migration in Great Britain. Bartel (1979) looks into the combined and isolated effects of migration and job separation. She finds that a majority of migrations within the United States are associated with job change. The largest robust wage effects are found for the men who were transferred by their employer. 52 percent of male and 13 percent of female labor migrants from Denmark report job transfer as the main reason behind emigrating, according to the survey data employed in this paper

To sum up the literature on wage effects of internal migration shows strong gender differences, heterogeneity across education levels and illustrates that it is important when the wage effects are estimated. The papers on international return migration estimated a constant wage effect in the post-migration period. In this paper the effects of return migration are allowed to differ over the post-migration period, and effects are estimated separately for different durations abroad.

[3]This is rational for the household if the husband is the breadwinner (Mincer, 1978) and some papers argue that husbands' private returns to relocating may take precedence even when the wife has higher earnings potentials because women are more likely to place the family before private gains (Shihadeh, 1991; Bielby and Bielby, 1992; Cooke, 2003).

3 Data

Full population Danish register data from 1985 to 2009 and survey data on a random sample of migrants are used to analyze the earnings abroad and the earnings after return for international migrants from Denmark. Let t denote the year of migration and d the duration of stay abroad. The change in the earnings profile of migrants is estimated the last year before the return year, $t+d-1$, and four years after the migration spell, $[t+d+s]_{s=2}^{5}$, for durations up to seven years, $d \in [1-6]$.[4] The first year after return is left out since it is affected by the Danish vacation pay system and possible measurement error in the exact return date.

The effect of international experience is estimated using all emigrants in the years $t \in [1987, 2002]$, while earnings abroad are analyzed for the subsample available in the survey. The survey sampled randomly within duration groups those who migrated in 1987, 1988, 1992, 1993, 1997, 1998, 2001 and 2002. It contains 3065 persons who emigrated in the survey years and had returned to Denmark by 2007. Contact information was obtained from Danish registers and the survey was conducted in 2008 with a response rate of 67 percent.[5]

Danish citizens aged 20-49 in year $t-1$ are selected for the analysis. Non-Danish citizens may temporarily leave Denmark to visit their country of origin, and the definition of foreign and home country seems ambiguous for this group. The age restriction is required to ensure that all individuals are still of working age when their earnings are examined. A higher minimum age was considered in order to be able to use more labor marked history. Most people, however, emigrate early in their career, so that would have resulted in a large loss of observations. To minimize the risk that people have not yet entered the labor market and to be able to use some labor market history the sample is restricted to wage earners who completed their education at least two years prior to emigrating and have not received any study grants since. Danish citizens enrolled in the Danish educational system are eligible for public study grants from the age 18 (for further education there is a maximum of six full years). Migrants to Greenland and the Faroe Islands have been eliminated from data because Greenland and the Faroe Islands are autonomous parts of Denmark.

The restrictions implies that 421 survey respondents can be used in the analysis. More than half of the respondents were excluded because the individuals were not wage earners prior to migration.

[4] Wages abroad of people who emigrate and return the same year where measured in that year but these individuals ($d = 0$) are excluded from the analysis, as well as individuals returning seven years after the emigration year or later.

[5] A further description of the survey design and sampling process can be found in Munk, Poutvaara, and Foged (2011).

The age restriction and elimination of migrants to Greenland and the Faroe Islands stand for another large reduction in observations.

Earnings abroad are only available in survey data. The definition of the earnings variable in the survey is the same as the earnings variable taken from the Danish income register.[6] It is a potential problem that the data source for the outcome variable is not the same for the control group and the treatment group in the analysis of earnings abroad. The register data variable is reported to the Danish Tax Authority by employers whereas the survey variable is self-reported by the respondents. There is a risk that the survey respondents systematically remember wrong when asked about their earnings years ago. Any bias in the survey variable will in that case go right through to the estimated effect of working abroad. The results, however, are in line with the register based analysis, and I did not find reasons to believe that the survey variable is flawed. Finally, combining two data sources is the only possibility one has if the aim is to compare migrants abroad to people who stayed in the home country, since countries normally do not have access to data on earnings of their emigrated citizens.

As an alternative outcome variable I consider also the employment of an individual. This variable is equal to one for individuals who have been full-time employed throughout the year and takes a fractional value if the individual was only employed part of the year and/or worked part-time.[7] While the log-earnings specifications capture the earnings change of those who did some paid work during the year, this alternative outcome variable allows me to check the clean employment response. Explanatory variables are constructed using data from year $t-1$ and $t-2$, i.e before emigration.[8] These variables are carefully described in the next section.

4 The choice of covariates

The empirical strategy, described in section 6, rely on selection on observables using panel data methods to eliminate time-invariant unobervable differences between migrants and non-migrants, and a non-parametric matching technique to avoid functional form assumptions and eliminate bias stemming from differences in the covariate distribution between migrants and non-migrants. Hence, the choice

[6] Yearly gross labor earnings measured in DKR. The respondents reported their earnings in the currency they were paid. This is converted to DKR using the average exchange rate in the relevant year. All earnings are deflated using the Danish consumer price index.

[7] In the survey, this variable is simply an indicator for whether the primary occupation was a paid job.

[8] This structure implies that 1985-1986 are used only for the construction of control variables and only outcome variables are extracted from 2002-2009. The intervening years are pre-treatment for some individuals and post treatment for others.

of covariates is crucial. In choosing the covariate set, I rely on theoretical models of migration and the empirical literature on the determinants of mobility. Theory suggests that it is very important to control for initial earnings capacity (Borjas, 1987; Borjas and Bronars, 1991; Borjas and Bratsberg, 1996), family ties (Mincer, 1978) and relative earnings within the household (Foged, 2014). I will motivate the choice of each control variable below and illustrate that the chosen variables are important determinants of migration in section 5.

Borjas (1987) shows that emigrants from countries with relative narrow income distributions are likely to come from the upper end of the income distribution. According to this theory, the high marginal tax rate will work as a push factor for high income earners in Denmark. At the same time, the welfare system and public transfers increase living standards relatively more in the bottom of the income distribution. Thus, the initial wage is an important determinant of international migration. I use earnings two years up to the migration and control for both the *level* and *trend* in earnings. Together with the difference-in-differences strategy I believe this is a major advantage compared to the exisiting studies. Earnings in a given year is a noisy measure of the true earnings potential of an individual and earnings profiles may differ by education and occupation. Migration propensities also differ by education and occupation. Some occupations are more geographically transferable than others, and education influences the costs and returns to migrating, for example through language skills. Detailed education and occupation groups are therefore included in the set of controls.

Personal employment and unemployment rates are important controls because earnings are less noisy contingent on these variables, and people who have not worked a full year or have experienced unemployment are more prone to migrating either as a tied mover or to find employment elsewhere, since their opportunity costs of moving are lower (Saben, 1964).

Experience and age are negatively correlated with the propensity to migrate because the migrant should invest in international experience in the beginning of his/her working life to reap the full return to the investment (Sjaastad, 1962). Job tenure may favor no-migration since people with long tenure in their current job are likely to possess a relatively large amount of job-specific human capital. On the other hand, a large fraction of Danish labor migrants are transferred by their employer, and the employer may prefer to send a senior employee to represent the firm or the Danish state abroad.

Borjas and Bronars (1991) show that family migrants are less strongly selected than single migrants due to the accompanying family members. The selection pattern and expected income gain in

their model collapse to that of single migrants, if partners come from the same place in the income distribution. The model implies that more similar partners are more likely to agree on migrating which is at odds with the empirical finding in Foged (2014). Appendix B discusses how colocation problems can be incorporated in the Roy-Borjas framework to reverse the prediction that migration is increasing in the earnings similarity of the spouses. Selection of more asymmetric couples into migrating can be derived from a simple extension of the Mincer (1978) model where gains are functions of earnings potentials in the absence of migration (Foged, 2014). Foged (2014) shows that colocation problems intensify the initial earnings asymmetries within families and the asymmetry of the intra-household earnings is therefore a crucial covariate. I use the two-year average earnings of each partner to calculate the contribution of the individual to total household earnings. This is likely to be a better proxy for the long-term contributions compared to the contribution in a single year. The variable is one for singles. The trailing spouse might experience an earnings decline due a to poor job match abroad and lower earnings after return due to depreciation of human capital abroad while the dominating spouse presumably gathered valueable experience abroad.

Singles, cohabiting and married are distinguished in the empirical analysis. Migration costs increase with family size and especially school age children are found to exert an inhibiting effect on the mobility of families (Long, 1974; Mincer, 1978). I categorize the presence of children into three age groups, 0-2, 3-6 and 7-17 years old. Schools are free and daycare is subsidized in Denmark whereas many migrants will have to pay for these services abroad. In addition, parents may prefer to raise their children in their home country. Thus, the deterence effect of children may be stronger for international migration.

It is a concern that return migration is potentially endogenous. 70 percent of Danish labor migrants return within seven years. It does not seem to be the marginal migrants who returns (as predicted by Borjas and Bratsberg, 1996). The probability of migration is increasing in earnings, whereas the stay abroad rate decrease with earnings. Education reveals the same pattern. Section 5 shows that individuals with short or medium higher education (community college) and especially individuals with a university degree are highly overrepresented among the emigrants, and Figure 1 shows that they are also more likely to return. Singles and individuals with no post-secondary education are most likely to stay abroad. This may suggest that meeting a partner is an important reason for staying abroad, rather than economic incentives. The estimation strategy assumes that the variation in earnings growth are unrelated to the return decisions (and the emigration decisions) once the rich

set of observable characteristics have been controled for.

5 Descriptive statistics

Men emigrate to a large extent for reasons related to job, whereas the majority of women state that they migrate for reasons related to family and partner (Poutvaara, Munk, and Junge, 2009).[9] Table 1 shows the stated main reasons for men and women in my sample. 82 percent of male migrants report to have emigrated for reasons related to their job compared to 23 percent for women. More than half of the female migrants state that they emigrated for family, even though everyone was in the labor force in Denmark prior to emigrating.

This pattern is also reflected in the primary occupation of the migrants just before returning to Denmark. The majority of men had very high skilled jobs abroad (17 percent in top management and 40 percent as higher grade professionals) while the majority of women did low-skilled work or stayed at home looking after children (24 percent in skilled or unskilled jobs and 36 percent staying home taking care of the children). The gender differences in emigration motives and employment abroad can to a large extent be attributed to the intra-household earnings distribution; the median male migrant in a relationship earns 68 percent of total household earnings while the median female migrant with a partner earns 40 percent of family income.

Table 3 shows variable means for migrants and non-migrants and two-sample t-tests. The large difference between the number of male and female migrants is partly because of the underlying gender difference in migration propensities and partly because the sample is restricted to wage earners. Table 3 shows that migrants are younger than non-migrants; less likely to have older children, especially school age children; and more likely to be singles, as expected.

Migrants are on average better educated than the part of the population staying in the home country. Fewer migrants than non-migrants have left the education system after basic school (reference) and more migrants have a university degree. This is also reflected in the primary occupations. Unskilled work (reference) and skilled work are less frequent among migrants compared to non-migrants. Most male migrants are higher grade professionals and most female migrants are intermediate professionals. Migrants have less job tenure and labor market experience; of course, this correlates with

[9] Using survey data on inter-province migration in Canada Shihadeh (1991) finds that three fourths of women and only one in twenty men report that they accompanied their partner in the migration decision.

age. Consistent with Borjas (1987), migrants earn more than non-migrants. Interestingly, they are also on a much steeper career path. Hence, it is a major advantage that I can match on (level and) trend in earnings before migration. Together with the large set of other controls it greatly improves the identification.

Metropolitan areas offer different job types and lifestyles than rural areas. Thus, a dummy for residence in the capital (Copenhagen) is included to control for unobservables affecting wage growth and mobility.[10] Different specialization of migrants and non-migrants is evident from the last controls listed in Table 3. Migrants are more likely to have tertiary education within natural and social sciences or health, but less likely to have a technical education. Technical education includes a lot of vocational trained who tend to have more local labor markets.

To summarize, Table 3 shows that migrants are statistically different from non-migrants in terms of almost all the covariates. Thus, migrants are a highly selected group. The next section explains how these differences are eliminated.

6 Method

The individual treatment effects are estimated non-parametrically using matching difference-in-differences. The relationship between (log) wage growth $\Delta y_i = y_{i,after} - y_{i,before}$, and migrant status T_i given the set of observable covariates X_i can without loss of generality be written

$$\Delta y_i = \alpha(X_i) + \beta(X_i)T_i + \gamma_i T_i + \varepsilon_i \tag{1}$$

Where α and β are functions of the explanatory variables affecting wage growth, and ε_i is the standard residual. The specification in (1) is more flexible than the common homogenous returns model where the treatment effect is assumed to equal the same constant for all individuals; hence, $\beta(X_i)T_i$ drops out and $\gamma_i = \gamma \; \forall i$. Misspecification of the no-treatment outcome $\alpha(X_i)$ and the heterogeneous returns $\beta(X_i)$ could lead to biased estimates of ATT in the linear regression model. While matching estimators control for observables in a flexible way and allow for general treatment effect heterogeneity in terms of all the observables. In that way matching is always more robust than OLS, but OLS would be more

[10] Grant and Vanderkamp (1980); Yankow (1999, 2003) and Ham, Li, and Reagan (2005) distinguish between rural and urban residence when estimating wage effects of internal migration. Co, Gang, and Yun (2000) use a dummy for residence in the capital prior to migration when estimating wage effects for return migrants to Hungary.

precise if the specification is warranted. Matching and OLS both assume selection on observables

$$\Delta y^0 \perp T|X \tag{2}$$

This assumption states that the change in the outcome if the individual do not migrate Δy^0 is independent of the actual migrant status T conditional on the observables X. Individuals may select into migration based on their idiosyncratic gain γ_i as long as γ_i does not correlate with the no-migration outcome. Time-constant effects of unobservables on wage levels cancels out due to the specification in changes. Thus, unobservables like abilities are controlled for to the extent that they only affect the levels and not the changes. Conditional on a large set of observables characteristics including earnings level, earnings growth and intra-household earnings dissimilarity prior to migrating, the identifying assumption is that unobservables correlating with migrating do not affect the post-treatment wage growth.

Matching imposes a common support requirement which ensures that for each treated a similar person can be found among the untreated. This is only possible if no combination of variables predicts migration perfectly

$$\Pr\left(T = 1|X\right) < 1 \tag{3}$$

Only observations within the common support are used, and differences in the distribution of the observables over the common support are accounted for by the weighting of observations within the common support. In other words, matching uses only comparable untreated, and the chosen controls are weighted to reproduce the distribution of observables among the treated. OLS to the contrary, generally extrapolates outside the area of common support and does not ensure comparable distributions of covariates. Extrapolation over areas that lack common support can be an advantage when data are scarce, but thanks to full population register data I can match on a large set of covariates and still have common support.

The *ATT* is estimated non-parametrically using Mahalanobis metric matching. Mahalanobis metric matching matches directly on all the covariates, and the distance is made unit-free by Mahalanobis distance metric which is the inverse of the covariance matrix. Estimates of *ATT* based on the linear heterogeneous effect model and propensity score matching have been explored as well. Mahalanobis metric matching was more effective than the propensity score matching estimators in terms of re-

ducing observable differences between treated and controls.[11] It also provided systematically smaller estimates than the other estimators, which is taken as evidence that the non-parametric approach was superior in terms of reducing bias stemming from observables. Thus, Mahalanobis metric matching is chosen as the preferred estimator and compared to the semi- (matching on the propensity score) and fully parametric approach (fully interacted linear regression) it tend to provide a lower bound for the estimated effects.

The average treatment effect on the treated for all types of difference-in-differences matching estimators (Heckman, Ichimura, and Todd, 1997) can be written

$$ATT = \sum_{i \in (T=1 \cap C^*)} \left(\Delta y_i - \sum_{j \in (T=0 \cap C^*)} w_{ij} \Delta y_j \right) \frac{1}{N_T^*} \text{ for } \sum_{j \in (T=1 \cap C^*)} w_{ij} = 1 \tag{4}$$

N_T^* is the number of treated falling within the common support C^*, and w_{ij} is the weight that is placed on untreated individual j when forming a counterfactual for treated i. Matching is performed using one nearest neighbor, and controls are selected with replacement. This minimizes the risk of bias. The drawback is loss of precision.

7 Results

Migrants are matched to non-migrants over the same period, and non-migrants are allowed as possible controls in more than one strata as long as they are available in relevant years of the panel. First I consider the overall wage and employment effects for men and women and the effect for singles and individuals in a relationship (section 7.2). The survey data revealed that a large share of those who migrate for work were transferred by their employer in Denmark. Using the subsample available in the survey, I am able to estimate the impact of international migration on labor market outcomes abroad as well and after return and link the treatment effects to the reasons behind emigrating (section 7.3).

7.1 Covariate balancing

Matching variables are all the variables listed in Table 3 as well as year dummies. Year dummies are included to account for business cycle effects in wages and migration decisions. Table A.1 and A.3 in

[11] Matching on the propensity score is known to have poor small sample properties and problems in distinguishing between points in the tails of the propensity score distribution. Since the pool of possible controls is large compared to the number of migrants the later may have been a problem here.

Appendix A show balancing indicators in the unmatched sample as well as after Mahalanobis metric matching. The gradual reduction in observations over duration abroad can be attributed to the fact that for the most recent emigration years (t) only shorter durations (d) can be investigated before the panel ends in 2009. For treated the gradual decline is also due to the fact that most migrants stay abroad for shorter periods of time.

The number of matched controls shows that only few of the untreated are used as controls more than once within each strata. Hence, the matching procedure identifies different best matches for most of the migrants even though migrants are much selected in terms of observable pre-migration characteristics. Table A.1 and A.3 also report the median and mean of the absolute standardized bias (Rosenbaum and Rubin, 1985) as well as a χ^2 test of all covariates in a probit of treatment. The median bias is zero in most subgroups, and the mean bias is reduced to around one percent after matching. This means that treated and controls are identical on average for more than half of the variables. Small differences persist after matching for the remaining variables.[12]

The test for overall significance of all covariates is known to be sensitive to the number of observations and should therefore be interpreted with caution. Not surprisingly, I find that the included covariates are strong predictors of treatment in all subsamples before matching. After matching, to the contrary, I find no significant differences between treated and controls in most samples. Only few significant differences remain for the largest groups, which is not surprising given the large set of variables.[13]

The tendency that median bias and mean bias before matching are increasing in duration abroad shows that migrants are more selected in terms of pre-treatment characteristics the longer the duration abroad. This highlights the importance of matching within strata, and the covariate balancing indicators clearly show that the employed matching procedure is successful in accounting for the increased selectivity of the longer term migrants.

Table A.2 and A.4 report the pre-trend in earnings for migrants and non-migrants before and after Mahalanobis metric matching for each strata in the matching procedure. Migrants have much steeper earnings trends than the pool of potential controls, especially married men. No statistical differences

[12]The absolute standardized difference is far below the recommended 20-percent tolerance level (Rosenbaum and Rubin, 1985) for all variables.

[13]Reducing the number of control variables, e.g. by excluding field of education from the controls, eliminates the statistical differences. Removing controls that most likely affect earnings would however lead to bias in the estimated treatment effect.

in earnings trends persist after matching. This is reassuring since at makes it more likely that any differential trend in earnings after treatment can be attributed to the migration decisions.[14]

7.2 International migration, family status and labor market outcomes

Table 4 shows the estimated average treatment effect on the treated (ATT) for men and women, summarized for short and long stays abroad. As explained in section 3, I leave out the first year after return since this is affected by the accuracy of the self-reported return dates and the Danish vacation pay system. The estimated earnings effects are larger in absolute value for migrants who have been abroad longer and increasing over the post-migration period. International experience leads to lower earnings in the early years after return but also a steeper career path. Male migrants overtake their counterparts in Denmark in the third year after return, while married females never seem to catch up with their peers who stayed at home.

Men who returned within the first to third year after the year they migrated ($d \in [1, 3]$) settle on 3-4 percentage points larger earnings, while the married men who stayed longer ($d \in [4, 6]$) abroad had earnings gains of 8-9 percentage points after the initial reduction in earnings had been recovered. The differences across durations are consistent with the model by Dustmann and Weiss (2007), where the wage premium to international experience is increasing in time spent abroad. Most of the wage effects for single women are insignificant while married women experience considerable earnings penalties upon return. This is likely to stem from the more dispersed migration motives among women. 23 percent migrate for work and 58 percent migrate to be with their partner or other family considerations. Those who follow their partner cannot expect to gain from migrating and may even experience a wage penalty upon return migration if they did not have relevant employment abroad. Moreover, the initial

Married and singles are distinguished in Table 4 based on marital status prior to migrating.[15] Some singles may move to a partner abroad, and some couples may dissolve when emigrating, so this only gives a rough idea of how tied movers have influenced the overall effect. I find little differences across marital status for men. Women in a relationship experience large wage penalties the first year and the significant wage penalties persist, especially for the long durations abroad. This indicates that women in a relationship compromise with their own career when migrating. A poor job match abroad

[14]The small, insignificant differences tend to be positive. Hence, we could expect a small positive bias for both men and women if we believe this difference still can influence the results.

[15]The married group consists of married or cohabiting.

is likely to carry over to the post-migration period in terms of a penalty arising from deterioration of the human capital abroad. Table A.5 in the Appendix shows that husbands gain, wifes lose and household earnings are unaffected (excluding the initial dip in earnings upon return), considering only stable couples who migrate and return together and both fulfill the sampling criteria (Danish citizens, aged 20-49, in the labor force two years prior to migrating). Thus, international migration also leads to a clear increase in mens' intra-household earnings advantage as predicted in (Foged, 2014).

Table 5 reveals a general negative employment effect for international migrants, though statistically insignificant for single men and women who spent more than three years abroad. Hence, a proportion of the international migrants seem to struggle finding relevant employment once returned home, or they become self-employed or withdraw from the labor force. Employment among male migrants is three to five percentage points higher than among non-migrating males. The negative employment effects are largest for married women who stayed abroad longer. Employment decreased as much as ten percentage points for this group.

7.3 Labor market outcomes and reasons behind emigrating

Earnings and employment abroad as well as after return are investigated in Table 6 and 7 for the individuals in the survey. Hence, we can relate the labor market outcomes of migrants to their reasons behind emigrating. Those who emigrated for reasons related to work have positive or insignificant changes to their earnings and employment, while those who emigrated for other reasons significantly worsened their labor market outcomes abroad as well as after return relative to non-migrants.

Migrants experienced a 25 percent drop in earnings abroad relative to their counterfactual in the home country when migration was driven by "adventure", partner or family considerations. The reduction in annual earnings persisted several years into the post-migration period. Two and three years after return they still had lower earnings by respectively 13 and 4 percent. Employment shows a similar pattern. Employment fell by 16 percentage points abroad, was initially 11 percentage points lower upon return migration and remain about 5 percentage points lower than non-migrants.

Positive and statistically significant earnings effects after return are found for individuals who were transferred by their employer to the job they undertook abroad. Not surprisingly, they also significantly improve their employment abroad relative to had they stayed at home. Estimates for men and women follow very closely estimates for those who migrate for work and family, respectively.

So a lot of the gender gab in returns to international migration is likely due to the diverse reasons behind emigrating.

The empirical analysis shows that men to a greater extent than women pursue their own career interests when migrating and gain both abroad and after return migration (with a possible drop in earnings and employment immediately following return). Female labor migrants are fewer in numbers and have more diverse motives for emigrating. This leads to a worsening of their labor market outcomes. Positive returns to international experience accrue to wage earners who emigrated for work, especially those who were sent abroad by their employer get significant positive returns abroad and after return migration.

8 Discussion

This paper has not looked into the tax effects associated with emigration. Denmark is one of the world's most redistributive welfare states, so the effect on net earnings is likely larger than the effect on gross labor market earnings estimated here. The effect on standards of living is more ambiguous because emigrating from Denmark generally means higher expenses for health care, child care, schooling, and other services that are provided by the welfare state in Denmark. Furthermore, people in a relationship should earn more than enough to compensate the accompanying partner if migration is to be viewed as a net economic gain to the family.

The income variable is yearly gross earnings and therefore contains a productivity effect as well as an hours-worked effect. Hence, it is possible that migrants are rewarded with a higher wage because they work more hours after having been exposed to another work culture abroad. If migrants were more hard-working even before emigration, this is not an effect and this is netted out in the difference-in-differences matching framework under the assumption that working hours affect only the level of earnings or any differences in trend can be captured by the pre-trend in earnings and the remaining controls.

Gross earnings can be viewed as reflecting the human capital value of the individual. From this perspective, a wage premium abroad shows that the skills of Danish migrants are valued more in the foreign labor market compared to in the home country labor market. A wage premium after return migration can be interpreted as evidence that international migrants bring back knowledge and competencies that are valued by employers in the home country. An alternative explanation

is that international migration helps the migrant signal ambition and diligence. The employers are therefore willing to pay the migrants a higher wage. A wage premium in the home country labor market encourages return migration and is therefore positive to the source country in either case. The fact that a large fraction have been transferred by their employer indicates that firms operating in Denmark are sending employees abroad to export markets or subcontractors. The wage premium they acquire may reflect valuable work abroad for a specific firm and possible valuable working experience that is brought back. The firm, however, would only pay the worker a higher salary if the outside option of the worker has changed so we should expect that the estimated wage gains reflect working experience that is of more general value in the labor market.

Those who are sent abroad by firms operating in Denmark are part of the high skilled migration flows. This kind of brain circulation is potentially valuable to both countries because knowledge is transferred between countries and a better understanding of foreign markets, habits and language is likely to be important in a world of increased economic integration between countries.

9 Conclusion

Economists like to view migration as an investment in higher returns to human capital. This paper followed this idea and looked for wage effects to international return migration from a developed country. The paper is the first to analyze wage effects of working abroad using data where the individuals are followed abroad and after return migration. Moreover, the considered migrant flow is that of relatively skilled individuals from a high wage country and thereby differs from the focus on emigration from poor to rich countries in the literature.

Considerable heterogeneity is found in the estimated returns; by gender and more interestingly related to the reason behind emigrating. Men gain abroad as well as after return migration, but women do not gain on average. These results are consistent with the stated emigration motives: 52 percent of male and 13 percent of female migrants in the labor force report as their main motivation for emigrating that they were sent abroad by their employer. One reason for these gender differences is that it is easier for couples with asymmetric contributions to household earnings to agree on migration (Foged, 2014) and women still earn relative little compared to their partners and thus often follow their partners in migration decisions.

It is a robust finding of the paper, that earnings and employment initially drop upon return

migration. Previous papers on international migration have estimated a constant wage effect over the post-migration period (using an indicator for whether the person has ever lived abroad to determine treatment). Hence, they missed the timing and composition of the effects. The (insignificant) higher earnings abroad and significant positive earnings effect after return migration, apart from the initial dip in earnings, suggest that economic incentives for international mobility from a high wage country exist for those who migrate for work.

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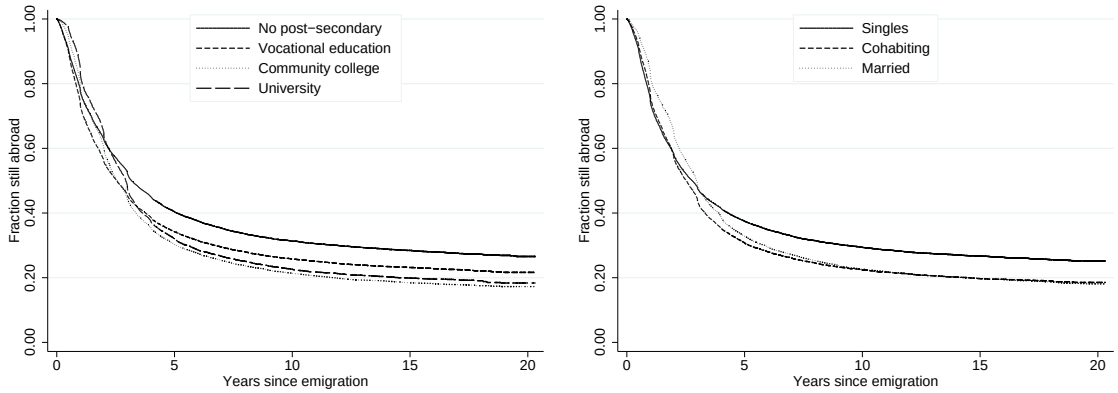
Figure 1: Stay abroad rates by education and family status



Notes: All individuals who migrate between 1987-2002 and are non-censored at time t contribute to the estimate of the stay-abroad rate in period t (Kaplan-Meier survival estimate). Duration is measured as the actual difference between the emigration and return date.

Table 1: Main reason behind emigrating

	Men	Women	All
Job-related	81.6	23.1	59.4
Job transfer	51.7	12.5	36.8
Partner and family	3.8	58.1	24.5
Other reasons	14.6	18.8	16.2
Observations	261	160	421

Notes: Survey data. Table entries are in percent of the column total.

Table 2: Primary occupation abroad

	Men	Women	All
Self-employed	4.6	0.6	3.1
Management	16.5	3.1	11.4
Higher grade professional	39.9	8.8	28.0
Intermediate professional	23.0	24.4	23.5
Skilled worker	10.7	21.3	14.9
Unskilled worker	0.4	3.1	1.4
No paid job	5.0	38.8	18.1
Taking care of the children	0.8	35.6	14.0
Observations	261	160	421

Notes: Survey data. Respondents were asked: *"What was your primary occupation just before your return migration"*. Table entries are in percent of the column total.

Table 3: Variable means for migrants and non-migrants

	Men				Women			
	Migrants	Non-migrants		t	Migrants	Non-migrants		t
Age	32.451	36.215	***	-61.67	32.635	37.113	***	-57.57
Children aged 0-2	0.166	0.152	***	4.52	0.169	0.133	***	9.03
Children aged 3-6	0.160	0.186	***	-8.63	0.176	0.185	*	-2.10
Children aged 7-17	0.195	0.362	***	-50.78	0.240	0.447	***	-45.76
Married	0.390	0.533	***	-35.54	0.429	0.612	***	-34.89
Cohabiting	0.213	0.202	***	3.34	0.215	0.179	***	8.32
Earnings contribution	0.821	0.752	***	43.28	0.635	0.587	***	14.53
ln(earnings)	12.592	12.451	***	32.22	12.234	12.132	***	19.89
Dif. ln(earnings)	0.107	0.048	***	17.92	0.103	0.060	***	9.91
Upper secondary	0.055	0.028	***	14.52	0.053	0.026	***	11.31
Vocational upper secondary	0.032	0.013	***	13.02	0.044	0.017	***	12.22
Vocational education	0.318	0.498	***	-46.85	0.283	0.403	***	-25.04
Short higher	0.049	0.044	**	3.11	0.066	0.044	***	8.21
Medium higher	0.171	0.096	***	24.26	0.274	0.185	***	18.80
Bachelor	0.017	0.005	***	11.52	0.020	0.005	***	10.52
Master	0.211	0.055	***	46.57	0.133	0.035	***	27.31
Doctoral	0.014	0.003	***	12.01	0.005	0.001	***	5.64
Tenure	3.319	4.934	***	-68.63	3.562	5.132	***	-49.55
Experience	10.107	15.035	***	-94.85	9.257	12.927	***	-58.38
Unemployment rate	0.020	0.021		-1.20	0.025	0.025		0.27
Employment rate	0.934	0.941	***	-4.84	0.881	0.866	***	6.62
Management	0.023	0.018	***	4.17	0.005	0.005		-0.59
Higher grade professional	0.354	0.137	***	55.17	0.181	0.078	***	25.48
Intermediate professional	0.289	0.277	**	3.11	0.592	0.537	***	10.66
Skilled worker	0.180	0.332	***	-47.75	0.106	0.163	***	-17.51
Copenhagen	0.193	0.087	***	32.56	0.215	0.092	***	28.29
Humanities	0.049	0.054	**	-2.79	0.207	0.153	***	12.56
Natural sciences	0.020	0.006	***	11.91	0.008	0.002	***	6.16
Social sciences	0.129	0.036	***	33.76	0.085	0.023	***	21.07
Technical sciences	0.520	0.581	***	-14.91	0.298	0.359	***	-12.53
Health	0.036	0.012	***	15.55	0.181	0.134	***	11.42
Defense	0.028	0.012	***	12.19	0.002	0.001		1.50
Observations	14914	975042			9012	817613		

Notes: * p<0.05, ** p<0.01, *** p<0.001. Each row shows mean values and t-tests of equality of means between migrants and non-migrants.

Table 4: Earnings effect after return migration by family status

	Men						Women					
s	All		Married		Single		All		Married		Single	
					Short stays abroad ($d \in [1,3]$)							
2	-0.046	***	-0.051	***	-0.045	***	-0.155	***	-0.165	***	-0.114	***
	(-6.260)		(-5.743)		(-3.5104)		(-14.527)		(-13.275)		(-5.740)	
3	0.021	**	0.014		0.026	*	-0.046	***	-0.053	***	-0.015	
	(2.895)		(1.693)		(1.998)		(-4.790)		(-4.606)		(-0.846)	
4	0.042	***	0.031	***	0.045	***	-0.034	***	-0.034	**	-0.018	
	(5.638)		(3.543)		(3.475)		(-3.350)		(-2.895)		(-0.997)	
5	0.026	**	0.022	*	0.027		-0.033	**	-0.032	**	-0.017	
	(3.196)		(2.3471)		(1.833)		(-3.100)		(-2.631)		(-0.853)	
Treated	10735		6568		4167		6166		3986		2180	
					Long stays abroad ($d \in [4,6]$)							
2	-0.039	*	-0.025		-0.051		-0.206	***	-0.245	***	-0.122	**
	(-2.146)		(-1.205)		(-1.435)		(-8.005)		(-8.365)		(-2.456)	
3	0.038	*	0.049	*	0.033		-0.110	***	-0.134	***	-0.045	
	(2.083)		(2.446)		(0.886)		(-4.699)		(-4.713)		(-1.056)	
4	0.066	***	0.068	***	0.076	*	-0.074	***	-0.105	***	0.017	
	(3.822)		(3.463)		(2.202)		(-3.542)		(-4.421)		(0.403)	
5	0.064	**	0.078	**	0.059		-0.092	***	-0.101	**	-0.044	
	(3.102)		(3.205)		(1.468)		(-3.555)		(-3.188)		(-0.899)	
Treated	2018		1326		692		1164		758		406	

Notes: * p<0.05, ** p<0.01, *** p<0.001. Standard errors do not account for the matching quality, t-tests are reported in parenthesis below the ATT.

Table 5: Employment effect after return migration by family status

	Men						Women					
s	All		Married		Single		All		Married		Single	
					Short stays abroad ($d \in [1,3]$)							
2	-0.059	***	-0.049	***	-0.073	***	-0.113	***	-0.123	***	-0.095	***
	(-15.017)		(-10.150)		(-10.844)		(-20.679)		(-18.512)		(-9.963)	
3	-0.036	***	-0.027	***	-0.046	***	-0.062	***	-0.065	***	-0.057	***
	(-8.886)		(-5.568)		(-6.736)		(-11.307)		(-9.732)		(-6.018)	
4	-0.032	***	-0.027	***	-0.036	***	-0.052	***	-0.054	***	-0.048	***
	(-7.854)		(-5.297)		(-5.281)		(-9.513)		(-8.160)		(-4.931)	
5	-0.034	***	-0.029	***	-0.037	***	-0.053	***	-0.056	***	-0.049	***
	(-8.170)		(-5.659)		(-5.232)		(-9.467)		(-8.297)		(-4.959)	
Treated	12486		7425		5061		7506		4824		2682	
					Long stays abroad ($d \in [4,6]$)							
2	-0.074	***	-0.079	***	-0.070	***	-0.149	***	-0.160	***	-0.126	***
	(-7.669)		(-6.871)		(-4.036)		(-11.186)		(-9.859)		(-5.400)	
3	-0.042	***	-0.046	***	-0.041	*	-0.093	***	-0.106	***	-0.074	**
	(-4.298)		(-4.011)		(-2.293)		(-6.957)		(-6.475)		(-3.139)	
4	-0.030	**	-0.033	**	-0.028		-0.079	***	-0.097	***	-0.046	
	(-3.083)		(-2.861)		(-1.598)		(-5.784)		(-5.851)		(-1.913)	
5	-0.041	***	-0.050	***	-0.034		-0.050	***	-0.072	***	-0.016	
	(-4.082)		(-4.245)		(-1.882)		(-3.679)		(-4.283)		(-0.659)	
Treated	2428		1570		858		1506		980		526	

Notes: * p<0.05, ** p<0.01, *** p<0.001. Standard errors do not account for the matching quality, t-tests are reported in parenthesis below the ATT.

Table 6: Earnings effect abroad and after return migration

	Job-related	Job-transfer	Other reasons	Men	Women
Abroad	0.024	0.032	-0.244 *	0.076	-0.464 *
	(0.969)	(1.078)	(-2.290)	(1.043)	(-2.331)
Treated	161	103	41	162	40
			After return		
$s = 2$	-0.053	-0.049	-0.134 ***	-0.036	-0.166 **
	(-0.587)	(-1.085)	(-3.649)	(-1.179)	(-3.159)
$s = 3$	0.022	0.026	-0.039 **	0.034	-0.062 **
	(0.104)	(1.524)	(-2.877)	(0.574)	(-2.870)
$s = 4$	0.043	0.046	-0.017 **	0.056	-0.041 *
	(0.864)	(1.685)	(-2.650)	(0.447)	(-1.974)
$s = 5$	0.038	0.039 *	-0.024	0.049	-0.045
	(1.439)	1.973	(-1.276)	(0.994)	(-0.756)
Treated	227	143	130	230	127

Notes: * p<0.05, ** p<0.01, *** p<0.001. Standard errors do not account for the matching quality, t-test are reported in parenthesis below the ATT. Earnings abroad and reason behind emigrating stem from survey data. Job-transfer is a subgroup among the job-related reasons.

Table 7: Employment effect abroad and after return migration

	Job-related	Job-transfer	Other reasons	Men	Women
Abroad	0.040 ***	0.039 **	-0.158 ***	0.080 ***	-0.240 ***
	(4.227)	(2.902)	(-4.571)	(3.373)	(-4.628)
Treated	194	123	118	200	112
			After return		
$s = 2$	-0.070	-0.066	-0.111 ***	-0.062 *	-0.127 **
	(-1.034)	(-0.278)	(-4.289)	(-2.155)	(-3.201)
$s = 3$	-0.040	-0.037	-0.064 ***	-0.035	-0.074 **
	(-0.063)	(-0.844)	(-3.786)	(-1.225)	(-2.590)
$s = 4$	-0.031	-0.028	-0.054	-0.027	-0.063 **
	(0.68)2	(0.585)	(-3.740)	(-0.542)	(-2.694)
$s = 5$	-0.037	-0.034	-0.050 ***	-0.034	-0.055
	(-1.132)	(-0.637)	(-3.068)	(-0.286)	(-1.775)
Treated	250	155	171	261	160

Notes: * p<0.05, ** p<0.01, *** p<0.001. Standard errors do not account for the matching quality, t-test are reported in parenthesis below the ATT. Employment abroad and reason behind emigrating stem from survey data. Job-transfer is a subgroup among the job-related reasons.

Appendix A: Additional material

Table A.1: Covariate balancing indicators for men

			Before			After matching			
d	Treated	Untreated	Median bias	Mean bias	χ^2 p-value	Matched controls	Median bias	Mean bias	χ^2 p-value
					Married				
1	2899	659550	8.90	17.63	0.000	2858	0.15	1.23	0.002
2	2073	652846	11.03	18.85	0.000	2047	0.00	1.33	0.005
3	1596	607390	11.41	20.33	0.000	1577	0.22	1.47	0.071
4	763	563097	13.12	20.24	0.000	753	0.00	1.48	0.600
5	367	518822	15.59	21.42	0.000	366	0.00	1.98	0.995
6	196	472677	11.62	23.24	0.000	196	0.00	2.44	0.998
					Single				
1	2341	223243	6.12	11.05	0.000	2310	0.00	0.82	0.999
2	1117	220525	7.01	14.30	0.000	1100	0.00	0.79	1.000
3	709	203976	9.25	15.18	0.000	702	0.00	0.79	1.000
4	370	187847	10.07	14.87	0.000	369	0.00	0.81	1.000
5	196	171958	7.46	15.12	0.000	196	0.00	0.87	1.000
6	126	155994	11.92	15.94	0.000	126	0.00	1.58	1.000

Notes: Median and mean absolute standardized bias (Rosenbaum and Rubin, 1985) as well as the p-value from a χ^2 test of all covariates in a probit of treatment are reported for the raw and the matched samples.

Table A.2: Pre-trend in earnings for men

	Before				After matching	
d	Treated	Untreated	t		Controls	t
			Married			
1	0.084	0.040	9.76	***	0.073	1.34
2	0.082	0.039	7.98	***	0.075	0.71
3	0.084	0.039	7.51	***	0.076	0.90
4	0.087	0.039	5.57	***	0.070	1.37
5	0.084	0.039	3.57	***	0.068	0.87
6	0.143	0.038	6.07	***	0.095	1.35
			Single			
1	0.138	0.080	8.01	***	0.132	0.47
2	0.169	0.080	8.56	***	0.160	0.51
3	0.134	0.080	4.13	***	0.140	-0.23
4	0.119	0.080	2.13	*	0.134	-0.44
5	0.123	0.081	1.71		0.114	0.28
6	0.157	0.081	2.46	*	0.121	0.67

Notes: * p<0.05, ** p<0.01, *** p<0.001. Each row shows trend in earnings for treated, untreated and matched controls as well as a t-test for equality of the trends between treated and untreated and treated and controls, respectively.

Table A.3: Covariate balancing indicators for women

			Before			After matching			
d	Treated	Untreated	Median bias	Mean bias	χ^2 p-value	Matched controls	Median bias	Mean bias	χ^2 p-value
					Married				
1	1794	576016	10.23	16.04	0.000	1777	0.22	1.20	0.988
2	1300	570309	11.67	16.20	0.000	1289	0.16	1.28	0.791
3	892	529334	11.90	15.67	0.000	889	0.00	1.04	0.980
4	440	489483	11.43	16.90	0.000	440	0.00	1.43	0.999
5	192	450859	9.47	16.01	0.000	192	0.00	1.28	1.000
6	126	410056	12.01	18.67	0.000	125	0.00	2.19	1.000
					Single				
1	1235	145743	5.17	11.54	0.000	1212	0.27	0.83	1.000
2	572	143810	5.77	13.92	0.000	566	0.00	1.05	1.000
3	373	133000	8.95	16.71	0.000	369	0.00	0.91	1.000
4	207	122486	7.59	14.77	0.000	207	0.00	0.81	1.000
5	131	112501	9.03	14.44	0.000	130	0.00	2.11	1.000
6	68	102602	12.13	18.70	0.000	68	0.00	1.14	1.000

Notes: Median and mean absolute standardized bias (Rosenbaum and Rubin, 1985) as well as the p-value from a χ^2 test of all covariates in a probit of treatment are reported for the raw and the matched samples.

Table A.4: Pre-trend in earnings for women

	Before				After matching	
d	Treated	Untreated	t		Controls	t
			Married			
1	0.092	0.056	4.79	***	0.074	1.70
2	0.099	0.559	4.86	***	0.076	1.93
3	0.084	0.056	2.66	**	0.078	0.38
4	0.114	0.056	3.83	***	0.083	1.24
5	0.056	0.055	0.03		0.041	0.54
6	0.161	0.054	3.73	***	0.135	0.50
			Single			
1	0.124	0.081	4.48	***	0.119	0.30
2	0.151	0.081	4.93	***	0.143	0.32
3	0.110	0.081	1.68	***	0.102	0.25
4	0.101	0.081	0.83		0.100	0.01
5	0.052	0.082	-1.00		0.072	-0.40
6	0.153	0.082	1.73		0.119	0.41

Notes: * p<0.05, ** p<0.01, *** p<0.001. Each row shows trend in earnings for treated, untreated and matched controls as well as a t-test for equality of the trends between treated and untreated and treated and controls, respectively.

Table A.5: Earnings effect after return migration for stable couples

s	Husband		Wife		Household		Contribution	
2	-0.004		-0.096	***	-0.040	***	0.019	***
	(-0.393)		(-6.916)		(-5.581)		(5.964)	
3	0.030	*	-0.064	***	-0.004		0.018	***
	(2.503)		(-4.543)		(-0.586)		(5.722)	
4	0.047	***	-0.038	**	0.009		0.017	***
	(3.854)		(-2.804)		(1.143)		(5.245)	
5	0.047	***	-0.035	*	0.016		0.016	***
	(3.356)		(-2.364)		(1.919)		(4.581)	
Treated	1998		1998		1998		1998	

Notes: * p<0.05, ** p<0.01, *** p<0.001. Standard errors do not account for the matching quality, t-test are reported in parenthesis below the ATT. Contribution refers to husband's contribution to total household earnings.

Appendix B: Colocation problems in the Roy-Borjas framework

B.1 The basic framework

Let y_{0k} denote the lifetime earnings of individual k in the home country and y_{1k} the lifetime earnings in case of international mobility. Assume that the distribution of lifetime earnings in the home country and of the same population if everybody where to migrate can be described by the following equations

$$\log(y_{0k}) = \mu_0 + \eta v_k \tag{B.1}$$

$$\log(y_{1k}) = \mu_1 + v_k \tag{B.2}$$

where μ_0 and μ_1 are constants and represent, respectively, the population mean of the distribution of lifetime earnings in the home country and in the hypothetical scenario where the entire population migrates. v_k can be interpreted as the skill of individual k and is assumed normally distributed with mean zero and standard deviation σ. The relative skill price in the home country is captured by the parameter $\eta > 0$. Hence, skills are effectively one-dimensional,[16] and the perfectly positive correlation of earnings across locations means that skills are transferable across countries. This basic framework follows the influential work by Borjas (1987) with the slight modifications that: wage distributions are reinterpreted as lifetime earnings distributions, negative correlation in the value of skills across countries is ruled out and migration need not be permanent.[17] Since, η is the ratio of the standard deviations in the two income distributions and Denmark has a relatively narrow income distribution, the following calculations assume $\eta < 1$.[18]

Individual k migrates if it increases the stream of future earnings net of migration costs, M

$$I_k = (1-\eta)v_k - (\mu_0 - \mu_1) - M = (1-\eta)v_k - \Delta\mu > 0 \tag{B.3}$$

Defining λ as the inverse Mills ratio it can be shown that migrants from Denmark will be drawn from

[16] v_k could alternatively be viewed as a composite skill where the relative skill price is the same for each skill.

[17] The migration decision is irreversible in the classical presentation of the Roy-Borjas model. Borjas and Bratsberg (1996) incorporate the possibility of return migration due to either lower than expected earnings in the destination country or returns to international experience in the home country. Furthermore, the classical Roy-Borjas model assumes that the deviations from the mean incomes in equations B.1 and B.2 follow a bivariate normal distribution. This representation is more closely related to Borjas and Bronars (1991) and assumes perfectly linear dependence between the value of skills in the two countries. This rules out what Borjas (1987) terms refugee sorting referring to political refugees that may have been persecuted and excluded from economic activities in their home countries.

[18] Assuming $\eta > 1$ reverses the selection pattern, but results are similar to those showed here (opposite sign).

the upper end of the income distribution (Borjas, 1987)

$$\mathrm{E}(v_k|I_k > 0) = E\left(v_k \middle| v_k > \frac{\Delta\mu}{1-\eta}\right) = \sigma\lambda\left(\frac{\Delta\mu}{(1-\eta)\sigma}\right) \tag{B.4}$$

B.2 Introducing family migration

Borjas and Bronars (1991) extend the basic Roy-Borjas model in order to learn about chain migration. They show that family migration does not alter the type of selection characterizing single migrants, but it "dilutes" the extent of selection under the additional assumptions that families maximize total earnings and the correlation of earnings between spouses is given by ρ; hence, the marriage decision is given and family dissolution is ignored. Their model also implies that the probability of family migration is strictly increasing in ρ and for $\rho = 1$ the probability equals that of single migrants. It is at odds with the empirical finding in Foged (2014).

B.3 Family migration with colocation problems

Less than perfect, possitive correlation of net gains across locations leads to a coordination problem in dual-earner households (Mincer, 1978). The absence of coordination problems for partners coming from the same place in the income distribution in Borjas and Bronars (1991) arises from the one-dimensional sorting in the model. Multidimensional skills and differences in skill prices across countries would lead to different privately optimal locations for two partners, even if they have similar earnings. A lower job offer arrival rate abroad would also would also make it easier for more unequal couples to agree on migrating, because the expected future earnings stream of the trailing spouse would be lower abroad. The cost of forgone earnings for the trailing spouse is lower the lower his/her earnings and the cost will increase the acceptance wage offer of the dominating spouse, which naturally leads to migration of asymmetric couples in terms of earnings potentials.

A simple way to unite colocation problems and hierachical sorting into international migration is to assume that only one spouse is able go to his privately optimal location abroad (characterized by the lifetime earnings in equation B.2). The other spouse gets only a fractional value $(1-p)$ of her earnings potential if migrating due to the colocation problem.[19] This is a simple way of stating that the colocation problem forces one spouse below his/her potential private return. Without loss of

[19] $1-p$ could also be interpreted as the probability that j gets his/her earnings potential abroad and p is then the propability that he/she does not find a job.

generality let i be the dominating and j be the dominated spouse in the location decision

$$\log(y_{1j}(p)) = (1-p)(\mu_1 + v_j) \tag{B.5}$$

A couple then migrates if

$$X = I_i + I_j(p) = (1-\eta)v_i + (1-\eta-p)v_j - (2-p)\Delta\mu > 0 \tag{B.6}$$

and probability that a couple migrates becomes[20]

$$\mathrm{P}\left(X>0\right) = 1 - \Phi\left(\frac{(2-p)\Delta\mu}{\sigma\sqrt{[(1-\eta)^2 + (1-\eta-p)^2 + 2(1-\eta)(1-\eta-p)\rho}}\right) \tag{B.7}$$

Result 1: Whether more or less symmetric couples in terms of pre-migration earnings are most likely to migrate depends on the price of the colocation problem, i.e. the proportion of earnings forgone by the tied mover. More asymmetric couples are more likely to migrate for $p > 1-\eta$. If the colocation problem is negligible ($p < 1-\eta$), symmetric coupled will be the most likely to migrate.

The expected skill level of a dominating spouse (i)[21]

$$\begin{aligned}
\mathrm{E}[v_i|X>0] &= \textstyle\int_{-\infty}^{\infty} v_i \phi_{v_i}(v_i|X>0)\mathrm{d}v_i \\
&= \textstyle\int_{-\infty}^{\infty} v_i \frac{\int_0^{\infty} \phi_{v_i}(v_i|X=x)\phi_X(x)\mathrm{d}x}{P(X>0)}\mathrm{d}v_i \\
&= \textstyle\frac{1}{P(X>0)} \int_0^{\infty} \left(\int_{-\infty}^{\infty} v_i \phi_{v_i}(v_i|X=x)\mathrm{d}v_i\right)\phi_X(x)\mathrm{d}x \\
&= \textstyle\frac{1}{P(X>0)} \int_0^{\infty} \left(0 + (x+(2-p)\Delta\mu)\frac{(1-\eta)+(1-\eta-p)\rho}{s}\frac{\sigma}{\sigma s}\right)\phi_X(x)\mathrm{d}x \\
&= \textstyle\frac{(1-\eta)+(1-\eta-p)\rho}{s}\sigma\left(\frac{\int_0^{\infty}\frac{x+(2-p)\Delta\mu}{\sigma s}\phi_X(x)\mathrm{d}x}{P(X>0)}\right) \\
&= \textstyle\frac{(1-\eta)+(1-\eta-p)\rho}{s}\sigma\left(\frac{\int_0^{\infty}\frac{x+(2-p)\Delta\mu}{\sigma s}\frac{1}{\sqrt{2\pi}\sigma s}exp^{-\frac{1}{2}(\frac{x+(2-p)\Delta\mu}{\sigma s})^2}\mathrm{d}x}{P(X>0)}\right) \\
&= \textstyle\frac{(1-\eta)+(1-\eta-p)\rho}{s}\sigma\left(\frac{-\frac{1}{\sqrt{2\pi}}exp^{-\frac{1}{2}\frac{x+(2-p)\Delta\mu}{\sigma s}}\Big|_0^{\infty}}{P(\frac{X+(2-p)\Delta\mu}{\sigma s}>\frac{0+(2-p)\Delta\mu}{\sigma s})}\right) \\
&= \textstyle\frac{(1-\eta)+(1-\eta-p)\rho}{s}\sigma\lambda\left(\frac{(2-p)\Delta\mu}{\sigma s}\right)
\end{aligned} \tag{B.8}$$

[20] $\mathrm{Var}(X) = \sigma^2[(1-\eta)^2 + (1-\eta-p)^2 + 2(1-\eta)(1-\eta-p)\rho] = \sigma^2 s^2$ and $\mathrm{E}(X) = -(2-p)\Delta\mu$

[21] Consider the two-dimensional normal distribution of X and v_i with covariance $\sigma^2[(1-\eta)+(1-\eta-p)\rho]$

Likewise, for the dominated spouse (j):[22]

$$\mathrm{E}[v_j|X>0] = \frac{(1-\eta)\rho + (1-\eta-p)}{s}\sigma\lambda\left(\frac{(2-p)\Delta\mu}{\sigma s}\right) \tag{B.9}$$

Result 2: It follows immidiately from equation B.8 and B.9 ($1>\rho$) that spouses dominating migration decisions rank higher in the skill distribution - are more intensively selected - than spouses being dominated in the migration decision.

Finally, Mincer's (1978) famous result that family ties deter migration can be replicated within this extended version of the Roy-Borjas model by proving that the migration propensity of families is lower in the presence of the colocation problem given the parameter values of the model

$$\begin{aligned}
&\mathrm{P}\left(I_i + I_j > 0\right) > \mathrm{P}\left(I_i + I_j(p) > 0\right) \\
&\Phi\left(\tfrac{\Delta\mu}{(1-\eta)\sigma}\sqrt{\tfrac{2}{1+\rho}}\right) < \Phi\left(\frac{(2-p)\Delta\mu}{\sigma\sqrt{[(1-\eta)^2+(1-\eta-p)^2+2(1-\eta)(1-\eta-p)\rho}}\right) \\
&\frac{2}{\sqrt{2(1-\eta)^2(1+\rho)}} < \frac{(2-p)}{\sqrt{(1-\eta)^2+(1-\eta-p)^2+2(1-\eta)(1-\eta-p)\rho}} \\
&Q = \tfrac{1}{2}(2-p)^2(1-\eta)^2(1+\rho) - (1-\eta)^2 - (1-\eta-p)^2 - 2(1-\eta)(1-\eta-p)\rho > 0
\end{aligned}$$

$\frac{\partial Q}{\partial \rho} = \frac{1}{2}(2-p)^2(1-\eta)^2 - 2(1-\eta)(1-\eta-p) > 0$ for $p > 1-\eta$ and $\frac{\partial^2 Q}{\partial \rho^2} = 0$.

Hence, if $Q>0$ for $\rho=-1$ then $Q>0\ \forall\ -1\leq\rho\leq 1$.

Therefore we can just check whether $Q>0$ when $\rho=-1$

$$\begin{aligned}
Q|_{p=-1} &= -(1-\eta)^2 - (1-\eta-p)^2 + 2(1-\eta)(1-\eta-p) \\
&= \Big((1-\eta) - (1-\eta-p)\Big)\Big((1-\eta-p) + (1-\eta)\Big) \\
&= p^2 > 0
\end{aligned}$$

Result 3: The colocation problem deters migration of families.

[22] The covariance between X and v_j is $\sigma^2[(1-\eta)\rho + (1-\eta-p)]$

Chapter 2

Family Migration and Relative Earnings Potentials

Family Migration and Relative Earnings Potentials

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Abstract

I document that couples are more likely to migrate if household income is disproportionally due to one partner, and that families react equally strong to a male and a female relative earnings advantage. A stylized model of family migration in which gains to relocating are functions of earnings potentials is used to derive testable implications regarding the type of couples that select into migrating. The empirical tests show that gender-neutral family migration cannot be rejected against the alternative of husband-centered migration. The lower response of family migration to the human capital held wives than the human capital of husbands, documented in the literature, can (partly) be attributed to more intense colocation problems and lower income among female-headed households. The more severe colocation problem stems from stronger educational homogamy among highly educated women relative to highly educated men. The results hold for internal as well as international migration of couples and are not sensitive to the presence of children.

JEL Classification: F22, D19, J61.

Keywords: International migration, family migration, colocation problem, selection.

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1 Introduction

Female labor force participation rates have risen in most developed countries over the past decades (Browning, Chiappori, and Weiss, 2011), and the colocation problem of couples has worsened (Costa and Kahn, 2000). While single-earner households naturally follow the earnings prospects of one spouse, economic rationality prescribes that dual-earner couples consider the earnings potentials of both spouses in migration decisions. Different job prospects across locations represent a source of conflict of private interests when couples make joint location decisions (the colocation problem). Completely gender-neutral and rational family migration lacks empirical support. Wives' human capital characterisitics appear much less important than husbands' characteristics in family migration equations, in terms of significance and magnitude, and a series of papers have therefore concluded that migration is husband-centered.[1] In the sociological terminology, migration lies within the husbands' decision domain and women are socialized to place the family before private gains. Economists usually frame it as lower weight on wives' private gains in location decisions.

This paper shows why the horse race between husbands' and wives' characteristics does not disprove economic rationality and tests whether family migration is indeed husband-centered or rather completely egalitarian and symmetric in partners' private gains. The tests rely on measures of the relative earnings potential within the household. I also contribute to the family migration literature by providing novel evidence on international migration. The main contribution of the paper is to provide evidence in favor of gender-neutral family migration. I find that the human-capital model of family migration cannot be rejected against the alternative of husband-centered migration, neither for internal nor for international migration of couples. Thus, women become increasingly important in location decisions as their relative intra-household earnings potential increase. In turn, this feeds into the relative earnings of women in society.[2]

The theoretical framework of the paper re-casts the human-capital model of family migration (Mincer, 1978) as a selection model where the return to relocating is a function of the earnings potential of the individual, and the relative weight on wives' returns is possibly smaller than one.[3] Using equal weight on partners' private returns, as mandated by the human-capital model, it follows

[1] Examples are Duncan and Perrucci (1976); Lichter (1982); Shihadeh (1991); Bielby and Bielby (1992); Nivalainen (2004); Shauman (2010); Tenn (2010).

[2] Frank (1978) highlights family migration as one important determinant of the unexplained gender wage gap.

[3] Mincer (1978) shows how the relative distributions and correlation of net gains between spouses affect migration propensities of families.

immediately that couples with more dispersed intra-household earnings are more likely to migrate, and migration propensities are more skewed towards households with higher earnings of the husband the lower the relative weight on the returns of the wife.

The empirical analysis is based on husband-wife matched data on earnings and relocations from Danish registers. Denmark is an interesting case. First, it is a highly gender-equal country with female education level and labor force participation rate among the highest in developed countries and other developed countries show trends in this direction. Second, Danes are relatively unhindered in their international mobility and thus the kind of international migrants we would like to study not to confound self-selection with the impacts of migration policies. Denmark is also relative unique in having data on international migration of its citizens. This allows me to bring international migration into the family migration literature. The paper shows that the same type of selection characterizes internal and international migrants but international migrants are more intensively selected presumably due to higher cost in international migration.

Sometimes, dependents are prohibited to work by immigration policies.[4] This will tend to intensify the selection of asymmetric couples in terms of intra-household earnings. Whether that is beneficial to the destination country is a complicated question beyond the scope of this paper. But the high share of accompanied migrants in the international skill flows suggests that this is a relevant question for further research. More than 60 percent of international labor migrants from Denmark are in a relationship.[5] At the microeconomic level, this paper contributes to the literature on determinants of family migration and labor market effects of family migration; specifically, whether we should think that gains to relocation are functions of gender or rather relative earnings potentials. In fact, I show that the intra-household dispersion in earnings is an important determinant for migration, and migration propensities of families react equally strong to larger male and female earnings advantages.

Section 2 discusses the literature on family migration with special emphasis on its implications for the symmetry or asymmetry of family migration. Section 3 outlines the theoretical setup and derives the testable predictions regarding the families that agree on migrating. Section 4 describes the data and section 5 explains the empirical implementation of the tests and shows the results. The final section concludes.

[4]For example, family members accompanying the holder of a temporary work visa like H1B to the United States are often not entitled to work.

[5]Labor migrants are defined as those who have completed their education and been in the labor force at least two years prior to migrating.

2 The empirical literature

Research on family migration recognizes that relocation decisions are part of a household decision-making process. Hence, the composition of the household matters and (expected) gains and losses of husbands and wives are compared when deciding on a location. The literature has two main strands: one focusing on the determinants of family relocation and one focusing on the labor market outcomes of migrating husbands and wives (Appendix B provides a schematic overview).

Sandell (1977) and Cooke (2003) find that migration increases husbands' earnings and has little effect on wives' earnings such that the total effect on the household is positive.[6] Negative labor market effects for married women and positive effects for married men have been widely documented.[7] These findings are not surprising given the sex gap in earnings and the general presumption that gains to geographic mobility increase with earnings or education (e.g. Sandell, 1977). Husband-centered migration is inconsistent with economic rationality, insofar as the wife has higher earnings prospects than the husband.

Education and occupational characteristics have been used in the literature to shed light on the earnings potentials of husbands and wives. Duncan and Perrucci (1976) and Shauman (2010) show that family migration is positively related to the occupational prestige of the husband but is less responsive or unrelated to the wife's occupational migration potential or prestige.[8] Lichter (1982), Nivalainen (2004) and Swain and Garasky (2007) find that the effect of wife's education is small and insignificant controling also for husband's education. Tenn (2010) calculates the relative explanatory power of wives' and husbands' human capital characteristics using variance decomposition on five waves of the US decennal census and concludes that husbands' human capital is the most important determinant of family migration and this has been remarkably stable over a forty year period where the female labor force participation has risen. Junge, Munk, and Poutvaara (2013) find that the international mobility of couples is increasing in male earnings, but unrelated to the earnings of the female partner.

Bielby and Bielby (1992) find women express significantly higher reluctance to relocate for personal

[6] Axelsson and Westerlund (1998) and Rabe (2011) find evidence of zero or negative effects on household income.

[7] E.g. Grant and Vanderkamp (1980); Lichter (1980, 1983); Spitze (1984); Shihadeh (1991) for internal mobility and Foged (2014a) for international mobility.

[8] They also control for wife's percent of family income, but it has no significant effect on family migration. This is likely due to misspecification. A U-shaped relationship between family migration and contributions to total income should be expected provided that colocation problems are more severe for households with more equal intra-household earnings distributions, as shown in section 3.

career opportunities because of family considerations. Wallston, Foster, and Berger (1978) follow dual-career couples and find that the actual location decisions most often favored the man eventhough these couples expressed eligatarian views on location decisions before entering the job market and both posses relative high levels of human capital. Shihadeh (1991) reports that 74 percent of women and as little as 4 percent of men state they are accompanying their partner in the migration decision.

Hence, it is often concluded that families put lower weight on wives' private return in migration decisions (e.g. Duncan and Perrucci, 1976; Lichter, 1982; Shihadeh, 1991; Bielby and Bielby, 1992; Cooke, 2003; Nivalainen, 2004; Tenn, 2010). However, the inhibiting effect of working wives on family migration (e.g. Long, 1974; Sandell, 1977; Lichter, 1980, 1982; Nivalainen, 2004) suggests that husbands abstain from migrating not to hurt the career of the their wife placing them as tied stayers. Thus, at least the weight on wives' private return cannot be zero. Rabe (2011) calculates the potential private wage gains from geographic mobility for husbands and wives and finds that the wage gain of the wife has a positive and large effect on migration propensities of couples indicating that a positive weight is attached to both spouses in migration decisions.

The average earnings effects for married men and married women and the gender differences in reasons for migrating may reflect the gender gap in earnings, as already mentioned. The horse race between husbands' and wives' human capital characteristics in the migration equations estimated in the literature does not provide conclusive evidence either: educational attainment may not be an equally good indicator of earnings potentials for men and women, for instance due to differences in horizontal specialization, and the estimated effects of husbands' and wives' educational attainment are likely biased by omitted interaction effects.[9]

Lower responsiveness of migration propensities to wives' education may be compatible with egalitarianism and income-maximization at the household level given the higher earnings of men. 54 percent of university educated women and only 34 percent of university educated men in dual-earner households in Denmark have university educated partners, and we should expect two highly educated partners to be less mobile than more asymmetric couples (see section 3). Hence, the robust evidence that female education is a weaker predictor of family migration than male education may be attributed to the lower correlation of female education with potential gains and the stronger correlation of female

[9] Assortative mating poses an additional problem, but collinearity of husband's and wife's characteristics affects only the precision, not consistency. Nivalainen (2004) notes that insignificance of wives' education can be attributed to collinarity problems, but concludes that *"it continues to be the human capital of the husband that rules"* (page 170).

education with the omitted intensity of the colocation problem. This paper shows that the omitted colocation problem does bias the specifications in the existing literature and provides evidence in favor of the human-capital model using an approach that relies directly on relative earnings potentials as explained in the next section.

3 Theory

3.1 Existing work

The human-capital model of migration assumes, for families as for singles, that migration occurs when the change in lifetime earnings exceeds migration costs. Thus, migration is a human capital investment (Sjaastad, 1962; Sandell, 1977; Mincer, 1978). Migration costs include all monetary and non-monetary costs associated with the relocation. Direct and indirect moving costs as well as psychic costs of leaving familiar surroundings, family and friends, and differences in local amenities enter the calculation of the prospective migrants.[10]

Mincer (1978) describes how less-than-perfect correlation between net gains of family members creates tied movers and tied stayers where tied stayers and movers are those whose private optimum differs from the family optimum. The difference between the gain an individual would have at his/her privately optimal location and the gain he/she experiences when locating with the family is a measure of the private externalities in joint location problems. These negative private externalities are assumed to be internalized within marriage by transfers between the spouses (Coase Theorem), or family dissolution may become optimal if the gains from marriage (Becker, 1973) are smaller than the losses from privately suboptimal location decisions within the family.[11] It is possible that both spouses are tied if the location that maximizes family welfare is privately suboptimal for both spouses (Mont, 1989).

An alternative explanation of family migration is founded in gender-role theory and argues that women are socialized to forgo own career opportunities in location decisions, and the provider-role is allotted to the husband with no or little regard to the job opportunities of the wife (Shihadeh, 1991; Bielby and Bielby, 1992; Tenn, 2010). In a microeconomic model of family migration this means that

[10] Sjaastad (1962) provides an elaborate discussion of each component in the individual migration decision.

[11] Borjas and Bronars (1991) assume that the externalities can be internalized while Mincer (1978) discusses the possibility of family dissolution. Gemici (2011) builds a structural model in which location and marital status are jointly determined in a Nash-bargaining game.

families maximize husband's private returns or at least attach a lower relative weight to the returns of the wife.

3.2 Distinguishing egalitarian and husband-centered family migration

The theoretical model below is designed to encompass the human-capital theory and the gender-role theory of family migration in a unified framework and derive testable predictions about the types of couples who are more likely to agree on migrating. To simplify things assume that the marriage decision is given and ignore the possibility of family dissolution. Furthermore, the family behaves like a single unit, and we can abstract from the intra-household allocation of resources.[12]

Let Y_i denote the lifetime earnings of individual i at origin and suppose the returns to geographic mobility is a function of this earnings potential. The rate of return to migrating for i is given by r_i and the associated costs are C. It means that the absolute returns are higher for individuals with higher earnings consistent with the higher mobility among more educated and higher earning individuals.[13] Cultural and linguistic differences across countries may constitute extra costs for international compared to internal migration, and direct moving costs are most likely increasing with the distance moved. Hence, we can think of international migration as being characterized by higher costs compared to internal relocations. It implies that international migration propensities are shifted downwards compared to internal migration propensities. Table 1 confirms this. About one percent of couples migrate to another region in Denmark and 0.2 percent emigrate from Denmark every year.[14]

The potential private return to an individual, r_i, is a random variable. We can think of the distribution as being potential job-offers across multiple destinations or aggregate all potential destinations into one and think of the distribution as the distribution of potential job-offers at this alternative location. Individuals are in the beginning of their working life when job-offers are realized.

A single individual only migrates if $Y_i r_i - C > 0$, and $\mathrm{E}[Y_i r_i - C]$ must be negative since the majority do not migrate. It is also clear that international migrants must be more positively selected from the population since costs are higher. The more intense selection of international migrants is

[12] Browning, Chiappori, and Weiss (2011) provide a review of unitarian and non-unitarian approaches to modelling family behavior. The model of this paper falls within the unitarian framework. A collective model where bargaining power in location decisions is determined by income shares would give similar predictions.

[13] Larger geographic labor markets (Sandell, 1977) and better access to information in distant labor markets (Bowles, 1970) for high skilled have been offered as possible explanations for this.

[14] 70 percent have returned within 5 years from emigration and more than 80 percent have returned after 10 years (Figure A.1 in Appendix A).

confirmed in section 5 (Table 3).

In order to focus on selection based on the intra-household earnings asymmetry, define total household earnings at origin, $Y = Y_h + Y_w$, where subscripts h and w refer to the husband and the wife. The contribution of the husband to the total earnings is denoted $s = \frac{Y_h}{Y_h+Y_w}$. Costs of family migration are simply the sum of the individual costs (no economies of scale in moving). A family consisting of husband and wife then migrates if the net gain to the household is positive

$$X = Y s r_h + Y(1-s)\delta r_w - 2C > 0 \tag{1}$$

where $0 \leq \delta \leq 1$ is the relative weight attached to the returns of the wife. Families migrate whenever total net gains are positive, possibly discounting the returns of the wife (gender-role theory). The private return to one spouse may be negative, and he/she is then a tied spouse as defined by Mincer (1978). The likelihood that the return of the wife is negative increase as lower weight is put on her returns in the family migration decisions.

Assume that each individual draws a potential private return to geographic mobility, r_i, from a normal distribution with mean μ and variance σ and allow for a correlation between spouses' returns $-1 < \rho \leq 1$. The migration probability for a family with total income, Y, and husband's share, s, is given by

$$\Pr(X > 0) = 1 - \Phi\left(\frac{2C - \mu Y(s(1-\delta)+\delta)}{\sigma Y \tilde{z}_s}\right) \tag{2}$$

where Φ is the standard normal distribution function and $\tilde{z}_s = \sqrt{\delta^2 - s2(\delta^2 - \delta\rho) + s^2(1+\delta^2-2\delta\rho)}$.[15] Family migration is decreasing in the costs of migrating (C), increasing in the expected rate of return (μ) and the total earnings of the household (Y) as well as the dispersion of returns to migrating (σ) since more people pass the threshold where migration becomes optimal.

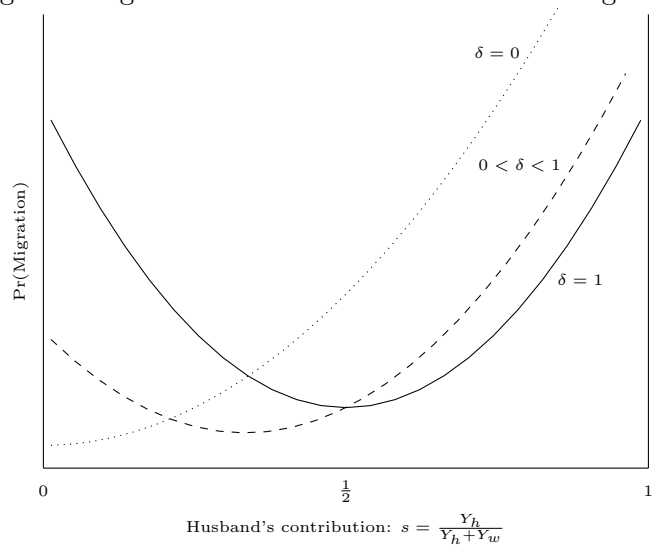
The purpose is to analyze how the probability of family migration relates to the intra-household earnings dissimilarity captured by the parameter s. To ease exposition define the mean net gain to households: $\mu_X \equiv \mu Y(s(1-\delta)+\delta) - 2C$.

$$\frac{\partial \Pr(X>0)}{\partial s} = \phi\left(\frac{-\mu_X}{\sigma Y \tilde{z}_s}\right) \frac{\mu Y(1-\delta)\tilde{z}_s^2 - \mu_X\left[s(1+\delta^2-2\delta\rho) - (\delta^2-\delta\rho)\right]}{\sigma Y \tilde{z}_s^3} \tag{3}$$

[15] Notice that $\delta^2 - s2(\delta^2-\delta\rho) + s^2(1+\delta^2-2\delta\rho)$ is always positive if ($\delta = 0$ or) ρ is larger than -1. This is because $\delta^2 - s2(\delta^2-\delta\rho) + s^2(1+\delta^2-2\delta\rho) > 0 \Rightarrow \frac{\delta^2(1-2s+s^2)+s^2}{2\delta(s^2-s)} < \rho$ and the left-hand side is concave and has -1 as its maximum value.

The numerator determines the sign in equation (3). It reduces to $(2C - \mu Y)(2s - 1)(1 - \rho)$ under gender-neutral family migration ($\delta = 1$).[16] Thus it follows immediately that the derivative is negative to the left of 1/2, zero at 1/2 and positive to the right of 1/2.[17] It means that the least migratory couples are those with equal earnings and the migration propensity is increasing in the intra-household earnings asymmetry. Family migration propensities are increasing functions of husbands' earnings and the correlation of gains within the household becomes irrelevant in the extreme case with zero weight on private returns to wives ($\delta = 0$).[18] Moderate husband-centered migration ($0 < \delta < 1$) places the least migratory family in between that of the human-capital model ($\delta = 1$) and the extreme case of gendered migration ($\delta = 0$), as illustrated in Figure 1 plotting the migration propensities against the relative earnings potential in the household.

Figure 1: Egalitarian versus husband-centered migration



The spouse who contributes the most to the total family income gains the most from migrating when migration is gender-neutral, whereas husband-centered migration favors the husband (see Appendix C for proof).

$$\mathrm{E}(r_h|X > 0) > \mathrm{E}(r_w|X > 0) \Leftrightarrow s > \frac{\delta}{1 - \delta} \tag{4}$$

Hence, family migration magnifies initial earnings asymmetries within the household, and the spouse who stands to gain the most rank higher than the trailing spouse in the income distribution at origin.

[16] Equation (3) becomes $\frac{\partial \Pr(X>0)}{\partial s} = \phi\left(\frac{2C-\mu Y}{\sigma Y\left(1-2(1-\rho)(s+s^2)\right)^{1/2}}\right)\frac{(2C-\mu Y)(2s-1)(1-\rho)}{\sigma Y\left(1-2(1-\rho)(s-s^2)\right)^{3/2}}$ if δ=1.

[17] Family migration is unrelated to earnings shares, $\frac{\partial \Pr(X>0)}{\partial s} = 0$, in the special case where $\delta = 1$ and $\rho = 1$.

[18] Equation (3) becomes $\frac{\partial \Pr(X>0)}{\partial s} = \phi\left(\frac{2C-\mu Y s}{\sigma Y s}\right)\frac{2C}{\sigma Y}s^{-2}$ if δ=0 and is positive for all s between zero and one.

The latter point links the model to those of the international migration literature where selection is framed in terms of positions in the income distribution of the sending country and the "quality" of arriving immigrants rather than the colocation problem is the focus.[19]

The first step of the empirical analysis is a non-parametric examination of the relationship between relative earnings prior to migrating and the probability of family migration (section 5.2). Then, family migration is specified as a function of the husband's contribution to test for gender-neutral versus husband-centered family migration (section 5.3). The proposed tests exploit that the human-capital model of family migration is completely symmetric while the gender-role model is asymmetric and skewed towards male dominance as shown above. The theoretical insights are based on the assumption that returns to geographic mobility are functions of earnings potentials at origin. In implementing the tests (section 5.4), I assume that relative earnings within the household prior to migration are good proxies for relative earnings potentials. Post-migration earnings are endogenous and should not be used in the tests. The employed data are described in the next section.

4 Data

The analysis requires husband-wife matched data for multiple periods, measures of the earnings and information on the geographic location of the couples. This information can be extracted from administrative registers in Denmark. The mobility of dual-earner couples is considered for the years 1987–2002 (t) using characteristics of the husbands and the wives for the two years preceding migration ($t-2$ and $t-1$).

I restrict my sample to couples were both spouses are Danish citizens to exclude international migration that is driven by the return migration of one or both spouses. Further restrictions are imposed to make sure the sample consist of prime-age workers. Each partner is between 25 and 39 years old,[20] and has made a permanent transition to the labor market in the sense that they are wage earners and have completed their highest level of education two years prior to entering the sample. These restrictions are important to exclude mobility associated with the completion of studies and to have at least two years of sound earnings information ($t-2$ and $t-1$). It also implies that I focus on dual-earner couples. Single-earner couples can be expected to behave as singles if migration is driven

[19] The seminal model is that of Borjas (1987).

[20] Costa and Kahn (2000) use the same age restriction on husbands to study trends in location decisions of college educated couples in the US.

by returns to human capital.

Couples are usually defined by marital status, only stable household constellations are included in the analysis, and family migration is defined as the joint migration of both spouses. Cohabitation, however, is widespread in Denmark. 69 percent of the selected couples are married and 95 percent of all couples are stable. I choose couples that had been together at least two years leading up to the migration year as my unit of analysis.

Earnings are the annual income from labor. This is the income that should matter in location decisions. Family earnings are simply the sum of the earnings of the two spouses and contributions sum to one and measure for each spouse his/her share of the total family earnings. The demographic controls include age of each spouse, highest completed education of each spouse (field of education and level), the presence of children in the household by age groups (0-2 years old children, 3-6 and 7-17 years old children).

International migrants are those who leave Denmark. Internal migrants are those who move across one of the 36 commuting areas in Denmark as defined by Andersen (2002). Results are not sensitive to migration to the Faroe Islands and Greenland. The Faroe Islands and Greenland are autonomous parts of the Danish Kingdom, but they represent relatively long-distance moves compared to internal migration or international migration to neighboring countries of Denmark. The results in the paper exclude migration to the Faroe Islands and Greenland and results including them are available upon request.

4.1 Descriptive evidence

We would like to capture the relationship between the true relative advantage in earnings in the household and family migration. We do not want to distort our measures by the endogenous realized earnings following migration. Figure 2 plots family migration against the intra-household earnings dissimilarity using different measures of relative earnings in the household prior to migrating. Migration is definitely increasing in the intra-household earnings asymmetry. Even more, migration is strikingly U-shaped.

Family migration in response to unemployment of one spouse could boost the U-shape in the Panel A that uses earnings the year just before the year of migration. Panel B therefore plots migration as a function of relative earnings two years prior to the year of relocation. If the concern is valid, we would

expect the relationship using the lagged income of the spouses to be flatter. But families with female primary earners actually seem slightly more migratory using the lagged measure. Panel C of Figure 2 uses average earnings of husbands and wives prior to migrating and this is the preferred measure of relative earnings potentials for the rest of the analysis since it is less noisy than the relative earnings in a single year.

Table 2 reports the relative shares of families in three categories of husband's contribution. As a percent of all families less than one percent are in 0-0.33, eighty percent of families are in 0.33-0.66, and more than twenty percent of families are in 0.66-1. When this distribution is shown by quintiles of family income we see that female earnings advantages are more prevalent among low income households. The two rightmost columns of Table 2 report the migration rates. There is a clear pattern, that migration rates increase with family income. International migration is 9 times more frequent in the top quintile compared to the bottom quintile of family earnings. This may explain the seemingly lower reponsiveness of international migration to female earnings advantages. As the theory in section 3 pointed out, we should observe mobility to increase in earnings asymmetry for a given income while the general possitive sorting may blur the raw correlation between migration and within household earnings dispersion.

International migrants have much higher household income than internal migrants, and migrating families with male primary-earners are richer than families with female primary-earners, as Table 3 shows. The table also shows that relative years of education within the family follows the relative earnings. The proportions with a university degree follow the same pattern, except for the proportion with a university degree among international migrating couples with a female earnings advantage. The age of wife and husband does not vary much across the family types. Internally (internationally) migrating wives and husbands are on average 31 (32) and 32 (33) years old, respectively, exluding husbands among male headed migrating families who are one year older.

4.2 Tests for symmetry

A simple parametric model is used to control for possible factors influencing the relationship between relative earnings potentials and migration propensities and test whether the response of the migration propensity is gender-neutral or skewed towards husband's advantage. Equation (6) relates family migration M to husband's contribution to household earnings s and variables contained in the vector

X. The calculation of husband's contribution is based on average earnings two years prior to migration to reduce noise in this measure of relative earnings potentials (similar to Panel C of Figure 2), and X is measured the year prior to migrating.

$$M = X'\beta_0 + \beta_1 s + \beta_2 s^2 + \varepsilon \tag{5}$$

The non-parametric analysis of section 5.2 verifies that we include a quadratic function of relative earnings potential and we expect $\beta_1 < 0$ and $\beta_2 > 0$. X contains a constant and possible confounding factors to be discussed below. The human-capital model of family migration ($\delta = 1$ in the theoretical model of section 3) predicts that the vertex of the convex parabola in husband's contribution is located in $s = \frac{1}{2}$. Husband-centered migration would imply that it is located to the left of $\frac{1}{2}$ ($\delta < 1$). Migration is simply an increasing function of s if the family attaches zero weight to the return of the wife ($\delta = 0$). This amounts to the following testable predictions:[21]

$$\begin{aligned}
\mathrm{H}_0 &: \beta_1 + \beta_2 = 0 \quad \text{(symmetry)} \\
\mathrm{H}_1 &: \beta_1 + \beta_2 \neq 0 \quad \text{(asymmetry)} \\
&\text{or} \\
\tilde{\mathrm{H}}_1 &: \beta_1 + \beta_2 > 0 \quad \text{(husband-centered)}
\end{aligned}$$

The quadratic function restricts slopes to be identical (in absolute value) around the axis of symmetry. Alternatively, we might ask whether the migration propensities respond equally strong to increasing male and female relative advantages by allowing for different changes in migration propensities for an increase in the intra-household earnings dissimilarity going towards higher female or male earnings share

$$M = X'\beta_0 + \beta_{1w} s \times \mathbb{1}(s < .5) + \beta_{1h} s \times \mathbb{1}(s \geq .5) + \varepsilon \tag{6}$$

[21] $\frac{-\beta_1}{2\beta_2} = \frac{1}{2} \Rightarrow \beta_1 + \beta_2 = 0$.

Hence, we test for symmetry of sensitivity to husband's and wive's earnings advantage as follows

$$\begin{aligned} \mathrm{H}_0 &: \beta_{1w} + \beta_{1h} = 0 \quad \text{(symmetry)} \\ \mathrm{H}_1 &: \beta_{1w} + \beta_{1h} \neq 0 \quad \text{(asymmetry)} \\ &\text{or} \\ \tilde{\mathrm{H}}_1 &: \beta_{1w} + \beta_{1h} > 0 \quad \text{(husband-centered)} \end{aligned}$$

A more flexible specification allowing for different quadratic terms in equation (7) was also estimated and joint F-tests for symmetry of both first and second order terms were carried out. These tests were very sensitive to the thin data on female-headed households and outliers in both tails of s while conclusions based on the reported tests are robust to censoring on s (see Table 6 and 7). Hence, I choose the tests listed above because they are less sensitive to outliers that may very well reflect noise in the measures of earnings potentials.

4.3 Results

Figure 3 shows the partial relationship between the probability of family migration and the quadratic function of husband's share of total income and Table 4 and Table 5 report parameter estimates and tests for symmetry based on equation (6). The columns represent different models with successively larger set of controls. Model 1 is the simplest model with only a quadratic function of husbands contribution to household earnings.

Consistent with the non-paramtric analysis in section 5.2, international migration is significantly biased towards male earnings advantages when family income has not been controled for (see Figure 3 and test statistics in Table 5). The level and trend in family income are added to the vector X in Model 2. The trend is included to account for the possibility that migration reacts to adverse labor market shocks of one or both spouses.[22] The level of family income explains the relative low international migration propensities for families with a female relative earnings advantage and both internal and international migration propensities appear symmetric. Predicted migration propensities and the 95-percent predictive bounds are drawn for Model 2 in Figure A.2 in Appendix A.

Model 3 adds demographic controls. Children may temporarily push the relative earnings within the household towards the husband making migration propensities skewed towards the husband. But

[22] Unemployment reduces the opportunity cost of migrating (Saben, 1964).

the presence of children does not seem to have influenced the results. The demographic controls interfere very little with the household asymmetry and shifts migration propensities in accordance with earlier findings; migration is decreasing with age and the presence of school age children have large negative effect on the mobility of families (e.g. Long, 1974).

The educational attainment of each spouse (vocational, comunity college, university) is controled for in Model 4. Vertical education measures are "bad controls" in the sense that they erode the relationship we are interested in.[23] It is the total earnings similarity within the household that captures the intensity of the colocation problem, no matter whether it is determined by a higher level schooling or not. The male earnings advantages are more often based on the variation in earnings that cannot be explained by education levels, thus the response to husband's earnings advantage is much less affected than the response to wife's earnings advantage by the inclusion of educational variables.

The F-statistic and corresponding p-value for the test of symmetry in equation (6) are reported in the bottom of Table 4 and Table 5. The null hypothesis of symmetry cannot be rejected using a five percent significance level once family income has been controled for, for neither internal nor international migration (using a two sided alternative). The one-sided tests show that the prevalence of migration between regions in Denmark is insignificantly skewed towards female earnings advantage implying strong evidence in favor of gender-neutral family migration if the alternative hypothesis is husband-centered migration. The one-sided tests also confirm that migration is significantly skewed towards husband's advantage when the higher earnings of male-headed households have not been controled for. Demographic controls make the test for symmetry borderline significant for international migration. We should, however, be rather conservative with the signficance level given the large number of observations.

Table 6 and 7 report the coefficients of interest and the tests for symmetry based on equation (7) and the preferred set of controls. The F-test rejects the null hypothesis of symmetry against a two-sided alternative for internal migration, but the null cannot be rejected towards the one-sided alternative of husband-centered migration. Hence, consistent with the results in Table 4 internal migration seem wife-centered if anything. Using the model where the response to male and female comparative advantages in earnings are constrained to be equal (columns to the right), a 10 percentage points increase in either male or female comparative advantage increase the probability of family migration

[23] By vertical I mean the level of education as opposed to field of study. Horizontal specialization measures would be "good controls" to the extent that they capture differences in geographic transferability and not earnings levels.

by 0.15-0.2 percentage points. For international migration we cannot reject the null hypothesis of symmetry irrespective of the alternative being one or two-sided (when we exclude the thin data at the extremes), and the response to increased dispersion of earnings within the household is stronger in percent of the baseline probability for international migration.

The coefficients on educational attainment of husband and wife in Table 4 and Table 5 confirm the robust finding in the literature that mobility of families is more strongly related to husbands' than wives' education. As argued in section 2 this may be due to a more intense colocation problem and lower earnings among families with a female relative earnings advantage. Table 8 illustrates these points. Inclusion of interaction terms between the education level of the husband and the education level of the wife substantially reduces the gender difference in the effect of educational variables to a point where the effect of a university educated wife and a university educated husband is statistically the same for internal migrants. This shows that stronger educational homogamy among the female headed households reduced the estimated impact of female education compared to male education when this more intense collocation problem was not controlled for.

Moreover, female headed households have lower earnings and this could partly be due to differences in specialization. Horizontal education measures and the level of household earnings are therefore included in the third specification. These variables also reduce the differential impact of husbands' and wives' education level. It is, however, not possible to completely eliminate the gendered impact of educational controls. One explanation might be the coarseness of the educational variables as measures of the value of the human capital held by an individual. Reducing the dimensionality of the human capital held by husbands and wives, as done in this paper, to a single measure of earnings potentials therefore seems a more powerful way to go.

5 Conclusion

This paper showed that the colocation problem is non-negligible in the sense that couples with more asymmetric intra-houshold earnings significantly select into migrating and the omission of the intensity of the colocation problem in the existing literature significantly bias conclusions towards husband-centered migration. The hypothesis that family migration is equally responsive to female and male comparative advantages in earnings could not be rejected against the alternative hypothesis that migration is husband-centered once family income has been controlled for. Households where the wife

is the primary earner have lower family income than household with male primary earners, and this explains the lower international mobility of female headed households.

The tests are derived under the assumption that potential gains from geographic mobility are increasing in earnings. Several empirical facts are consistent with this assumption. The higher estimated returns to mobility for men compared to women and the fact that migration rates are increasing in income and education.

The paper argued that the horse race between husbands' and wives' human capital characteristics as determinants of family migration bias conclusions towards husband-centered migration for two reasons: women earn less than men for a given education level partly due to differences in specialization (fields of study) and highly educated women are more often married to highly educated men intensifying the colocation problem for the highly educated women relative to the highly educated men.

The results hold for internal as well as international migration of Danish couples. The selection of couples where income is disproportionately due to one partner is stronger for international migrants, i.e. international migration propensities respond stronger than internal migration popensities to an increase in the intra-household earnings inequality. Results are not sensitive the presence of children in the household.

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Table 1: Migration rates

	Internal	International
Pr(Migration|Single, Man)	3.37	0.64
Pr(Migration|Single, Woman)	3.09	0.61
Pr(Migration|Single)	3.27	0.63
Pr(Family migration|Couple)	0.92	0.19

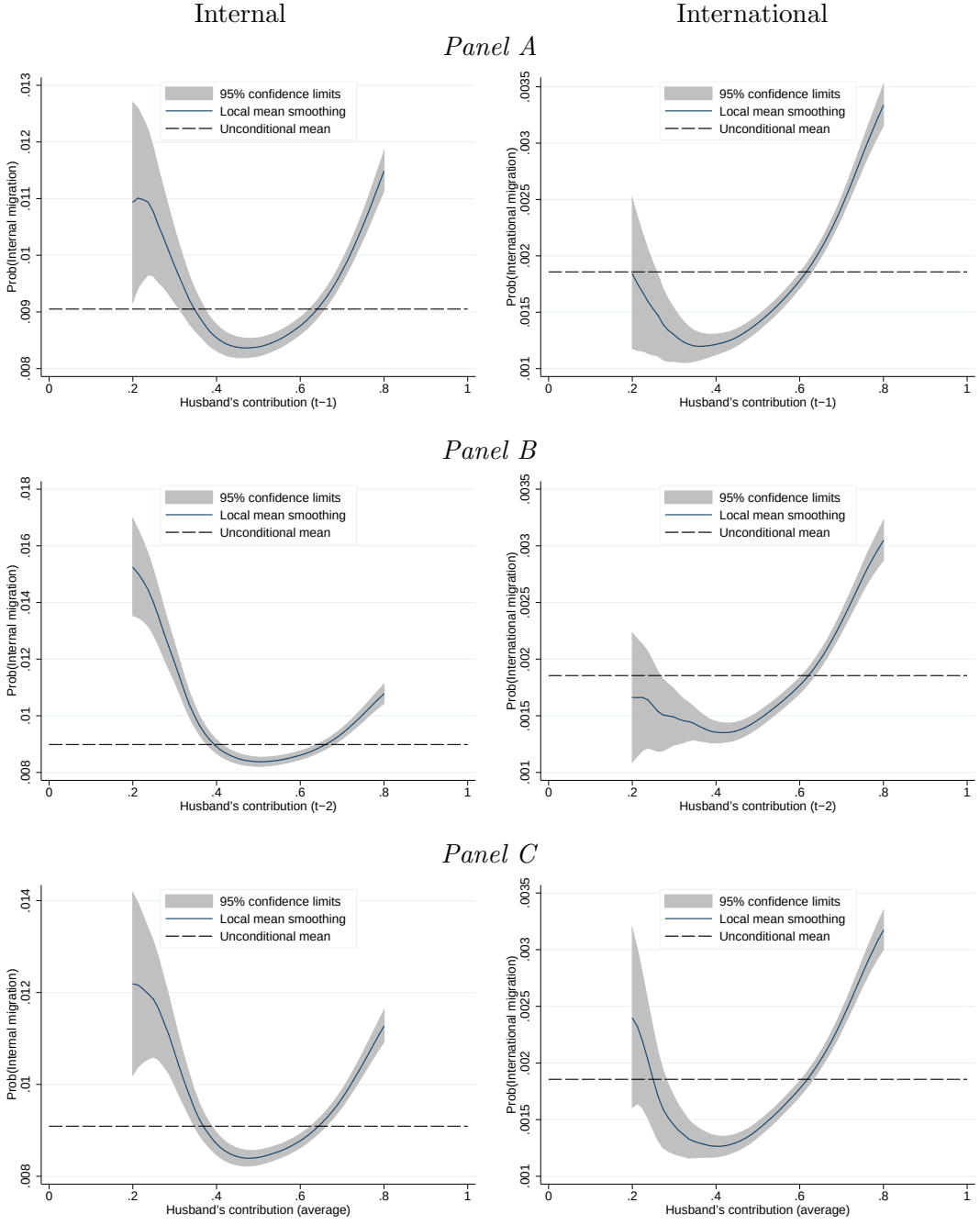
Notes: Migration rates are in percent. Family migration is the joint migration of both partners.

Table 2: Family earnings and migration

	Husband's contribution			Migration	
	0-0.33	0.33-0.66	0.66-1	Internal	International
1st quintile	2.42	65.22	32.37	0.91	0.06
2nd quintile	0.24	85.55	14.21	0.77	0.07
3rd quintile	0.16	88.07	11.78	0.82	0.10
4th quintile	0.15	85.47	14.38	0.96	0.19
5th quintile	0.33	71.05	28.62	1.15	0.53
All	0.66	79.07	20.27	0.92	0.19
Observations	11861	1421391	364392	1797644	1797644

Notes: Each row of the table show distribution according to husbands (average) contribution to household earnings and the family migration rates. The rows are quintiles of (average) family earnings. All table entries are in percent.

Figure 2: Relationship between family migration and relative earnings



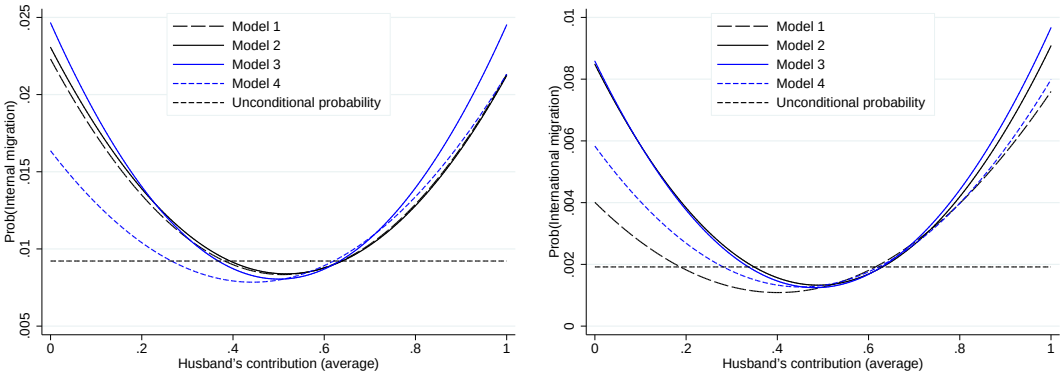
Notes: The local mean. Weighting function: Epanechnikov kernel. Width of smoothing: 0.15. Husband's share has been censored at the 0.5 percentile and at 80 percent of family income. The shares are: Panel A, $s = \frac{Y_{h,t-1}}{Y_{h,t-1}+Y_{w,t-1}}$; Panel B, $s = \frac{Y_{h,t-2}}{Y_{h,t-2}+Y_{w,t-2}}$; and Panel C, $s = \frac{\overline{Y}_h}{\overline{Y}_h+\overline{Y}_w}$.

Table 3: Family migrants' characteristics and relative earnings

	Husband's contribution					
	0-0.33		0.33-0.66	0.66-1		
			Internal migration			
Family earnings	54.57	***	68.84	71.35	***	
Husband/family yrs of education	0.48	***	0.50	0.51	***	
Wife has university degree	0.31	***	0.12	0.06	***	
Husband has university degree	0.18		0.15	0.21	***	
Age of wife	31.47	**	30.52	31.42	***	
Age of husband	32.02		31.96	33.12	***	
Observations	148		12204	4218		
			International migration			
Family earnings	55.05	***	82.88	91.94	***	
Husband/family yrs of education	0.49		0.51	0.52	***	
Wife has university degree	0.24		0.21	0.10	***	
Husband has university degree	0.31		0.34	0.40	***	
Age of wife	31.17		31.27	32.41	***	
Age of husband	31.69		32.37	33.89	***	
Observations	29		2234	1184		

Notes: Each entry of the table is the variable mean by intervals of husband's contribution to family earnings. Significance levels (* p<0.05, ** p<0.01, *** p<0.001) of a t-test of the difference in means (allowing for unequal variances) between "primary-earner" and "dual-earner" families are reported next to the mean for the respective "primary-earner" type. Family earnings are in 1000 USD (2000 prices).

Figure 3: Family migration and relative earnings



Notes: Each curve is the partial relationship from a linear probability model of family migration. Model 1 includes only a quardratic function of husband's contribution and model 2-4 sequentially include additional variables: Model 2 adds family income (level and trend); model 3 adds demographic controls (husband's and wife's age, children-by-age groups); model 4 adds human capital variables (husband's and wife's education level).

Table 4: Internal migration

	Model 1	Model 2	Model 3	Model 4
Husband's contribution	-5.486***	-5.681***	-6.628***	-3.846***
	(0.564)	(0.569)	(0.570)	(0.572)
Husband's contribution (squared)	5.387***	5.498***	6.615***	4.342***
	(0.469)	(0.473)	(0.474)	(0.475)
ln(Family earnings)		0.289***	0.473***	-0.281***
		(0.031)	(0.032)	(0.035)
Dif. ln(Family earnings)		0.823***	0.648***	0.683***
		(0.061)	(0.061)	(0.061)
Age			-0.059***	-0.061***
			(0.003)	(0.003)
Age			-0.010***	-0.031***
			(0.003)	(0.003)
Children aged 0-2			0.065***	-0.056**
			(0.018)	(0.018)
Children aged 3-6			-0.234***	-0.264***
			(0.014)	(0.014)
Children aged 7-17			-0.397***	-0.234***
			(0.017)	(0.017)
Husband, vocational				0.016
				(0.015)
Husband, community college				0.755***
				(0.028)
Husband, university				1.272***
				(0.049)
Wife, vocational				0.064***
				(0.015)
Wife, community college				0.444***
				(0.022)
Wife, university				0.903***
				(0.059)
Constant	Yes	Yes	Yes	Yes
Observations	1797644	1797644	1797644	1797644
R^2	0.000	0.000	0.002	0.005
F-statistic (H_0: symmetry)	0.7	2.3	0.0	16.6
P-value	0.411	0.129	0.914	0.000
t-statistic	-0.822	-1.519	-0.108	4.070
P-value ($\tilde{H}_1$: husband-centered)	0.794	0.936	0.543	0.000

Notes:* p<0.05, ** p<0.01, *** p<0.001. Robust standard errors in parentheses. Coefficients and standard errors scaled by a factor 100.

Table 5: International migration

	Model 1	Model 2	Model 3	Model 4
Husband's contribution	-1.457***	-2.921***	-3.039***	-2.020***
	(0.277)	(0.285)	(0.287)	(0.289)
Husband's contribution (squared)	1.816***	2.980***	3.148***	2.235***
	(0.235)	(0.242)	(0.243)	(0.245)
ln(Family earnings)		0.688***	0.714***	0.461***
		(0.019)	(0.020)	(0.020)
Dif. ln(Family earnings)		-0.070**	-0.098***	-0.084***
		(0.025)	(0.025)	(0.025)
Age			-0.015***	-0.016***
			(0.001)	(0.001)
Age			0.005***	-0.001
			(0.001)	(0.001)
Children aged 0-2			0.024**	-0.008
			(0.008)	(0.008)
Children aged 3-6			-0.035***	-0.042***
			(0.006)	(0.006)
Children aged 7-17			-0.098***	-0.050***
			(0.008)	(0.008)
Husband, vocational				-0.045***
				(0.006)
Husband, community college				0.147***
				(0.013)
Husband, university				0.658***
				(0.031)
Wife, vocational				-0.019**
				(0.006)
Wife, community college				0.042***
				(0.010)
Wife, university				0.103**
				(0.034)
Constant	Yes	Yes	Yes	Yes
Observations	1797644	1797644	1797644	1797644
R^2	0.000	0.002	0.002	0.004
F-statistic (H_0: symmetry)	42.1	1.2	3.8	14.7
P-value	0.000	0.276	0.051	0.000
t-statistic	6.492	1.089	1.948	3.833
P-value ($\tilde{H}_1$: husband-centered)	0.000	0.138	0.026	0.000

Notes: * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors in parentheses. Coefficients and standard errors scaled by a factor 100.

Table 6: The responsiveness of internal migration

	Unconstrained		Constrained	
	Model 2'	Model 3'	Model 2'	Model 3'
$s \times \mathbb{1}(s < .5)$	-2.463***	-2.848***	-1.563***	-2.109***
	(0.293)	(0.293)	(0.095)	(0.096)
$s \times \mathbb{1}(s \geq .5)$	1.554***	2.099***	1.563***	2.109***
	(0.095)	(0.096)	(0.095)	(0.096)
Observations	1797644	1797644	1797644	1797644
F-statistic (H_0: symmetry)	10.6	7.1		
P-value	0.001	0.008		
t-statistic	-3.25	-2.67		
P-value ($\tilde{H}_1$: husband-centered)	0.999	0.996		
	Censor $s < .1$ *and* $s > .9$			
$s \times \mathbb{1}(s < .5)$	-2.563***	-2.931***	-1.468***	-2.046***
	(0.316)	(0.317)	(0.098)	(0.099)
$s \times \mathbb{1}(s \geq .5)$	1.465***	2.040***	1.468***	2.046***
	(0.098)	(0.099)	(0.098)	(0.099)
Observations	1782227	1782227	1782227	1782227
F-statistic (H_0: symmetry)	13.4	8.7		
P-value	0.000	0.003		
t-statistic	-3.65	-2.96		
P-value (H_1: Husband-centered)	1.000	0.998		

Notes: * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors in parentheses. Coefficients and standard errors scaled by a factor 100. C denotes husband's contribution to total earnings. The models are similar to those of Table 4, where the quardratic function of husband's contribution has been substituted with separate slope parameters for female ($\mathbb{1}(s < .5)$) and male ($\mathbb{1}(s \geq .5)$) relative earnings advantage.

Table 7: The responsiveness of international migration

	Unconstrained		Constrained	
	Model 2'	Model 3'	Model 2'	Model 3'
$s \times \mathbb{1}(s < .5)$	-1.269***	-1.311***	-1.021***	-1.129***
	(0.132)	(0.133)	(0.048)	(0.049)
$s \times \mathbb{1}(s \geq .5)$	1.018***	1.126***	1.021***	1.129***
	(0.048)	(0.049)	(0.048)	(0.049)
Observations	1797644	1797644	1797644	1797644
F-statistic (H_0: symmetry)	4.1	2.2		
P-value	0.042	0.137		
t-statistic	-2.03	-1.49		
P-value ($\tilde{H}_1$: husband-centered)	0.979	0.932		
	Censor $s < .1$ *and* $s > .9$			
$s \times \mathbb{1}(s < .5)$	-1.168***	-1.206***	-1.006***	-1.121***
	(0.138)	(0.139)	(0.050)	(0.051)
$s \times \mathbb{1}(s \geq .5)$	1.006***	1.121***	1.006***	1.121***
	(0.050)	(0.051)	(0.050)	(0.051)
Observations	1782227	1782227	1782227	1782227
F-statistic (H_0: symmetry)	1.6	0.4		
P-value	0.203	0.507		
t-statistic	-1.27	-0.66		
P-value (H_1: Husband-centered)	0.898	0.747		

Notes: * p<0.05, ** p<0.01, *** p<0.001. Robust standard errors in parentheses. Coefficients and standard errors scaled by a factor 100. C denotes husband's contribution to total earnings. The models are similar to those of Table 5, where the quardratic function of husband's contribution has been substituted with separate slope parameters for female ($\mathbb{1}(s < .5)$) and male ($\mathbb{1}(s \geq .5)$) relative earnings advantage.

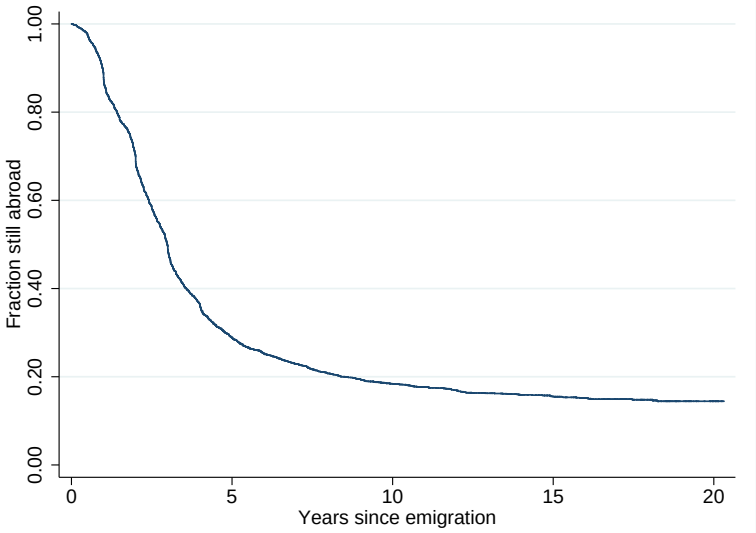
Table 8: The horse race revisited

	Internal			International		
	1	2	3	1	2	3
Husband, vocational	0.012	0.005	0.376***	-0.030***	-0.008	0.093*
	(0.015)	(0.024)	(0.098)	(0.006)	(0.009)	(0.047)
Husband, community college	0.760***	0.686***	1.046***	0.216***	0.174***	0.264***
	(0.027)	(0.061)	(0.121)	(0.013)	(0.028)	(0.060)
Husband, university	1.308***	0.990***	1.402***	0.811***	0.965***	0.956***
	(0.048)	(0.125)	(0.181)	(0.031)	(0.104)	(0.129)
Wife, vocational	0.016	-0.026	0.186*	0.001	0.005	0.008
	(0.015)	(0.026)	(0.090)	(0.006)	(0.010)	(0.044)
Wife, community college	0.374***	0.359***	0.521***	0.054***	0.103***	0.073
	(0.022)	(0.043)	(0.104)	(0.010)	(0.019)	(0.050)
Wife, university	0.761***	1.067***	1.358***	0.161***	0.357***	0.215*
	(0.058)	(0.157)	(0.201)	(0.033)	(0.082)	(0.096)
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Interactions of levels	No	Yes	Yes	No	Yes	Yes
Horizontal specialization	No	No	Yes	No	No	Yes
Family earnings	No	No	Yes	No	No	Yes
Observations	1797644	1797644	1797644	1797644	1797644	1797644
R^2	0.005	0.005	0.005	0.003	0.003	0.004
F-statistic (university)	39.1	0.2	0.0	150.3	21.4	23.5
P-value	0.000	0.696	0.855	0.000	0.000	0.000
F-statistic (joint)	47.8	7.9	7.2	90.2	9.6	9.0
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Notes:* p<0.05, ** p<0.01, *** p<0.001. Robust standard errors in parentheses. Coefficients and standard errors scaled by a factor 100. Demographic controls are age of husband, age of wife and the presence of children by age groups. Interactions of levels are all interactions terms between husband's and wife's education level. Horizontal specialization is either humanities, natural sciences, technical sciences, health or national defense; all main and interaction effects included. Test of equal coefficients on university degree and joint test for pairwise equal effects of all education levels for husband and wife is reported.

Appendix A

Figure A.1: Duration abroad for international family migrants

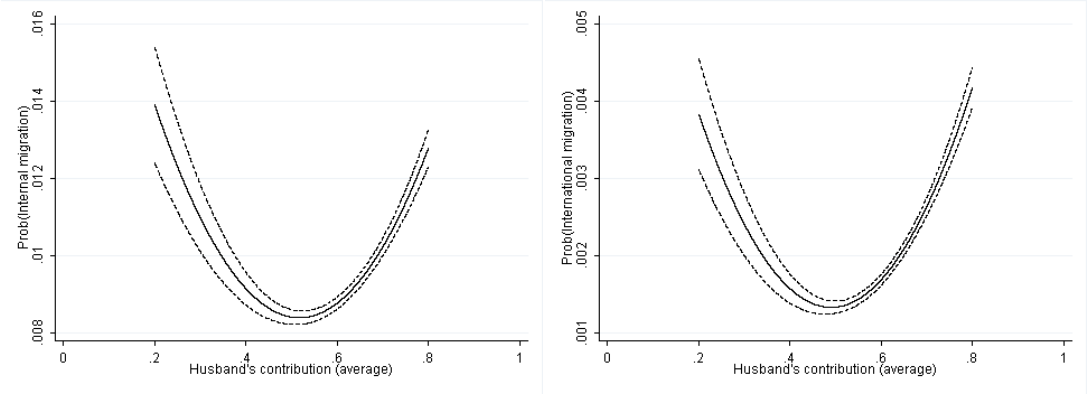


Notes: All couples who emigrate together (leave Denmark within the same calendar year) between 1987-2002 and are non-censored at time t contribute to the estimate of the stay-abroad rate in period t (Kaplan-Meier survival estimate). Duration is measured as the difference between the emigration and return date of the husband.

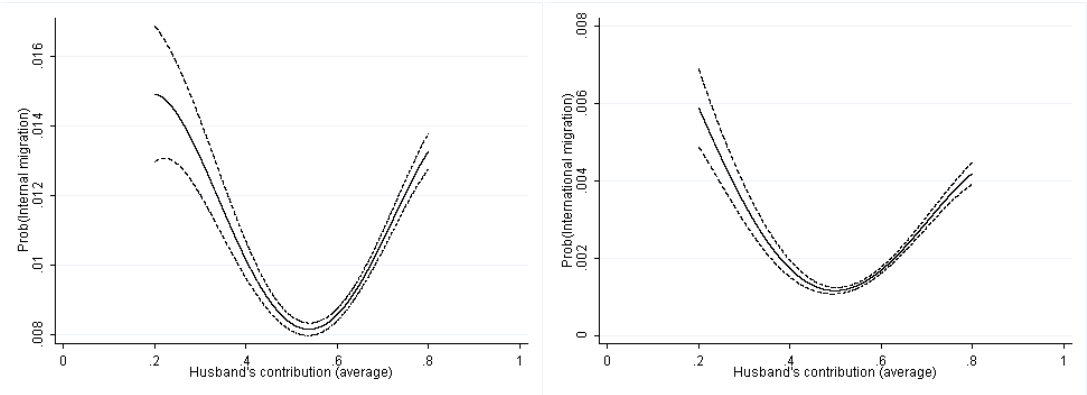
Figure A.2: Predicted family migration rate

Internal International

Panel A



Panel B



Notes: Each graph shows the predicted migration rate and 95-percent confidence bounds fixing the influence of level and trend in family earnings at their means. Graphs in Panel A correspond to Model 2 in Figure 3 and graphs in Panel B include higher order terms of the polynomial.

Appendix B

Table B.1: Family Migration Literature

Author(s)	Type	Method	Finding	Remark
		Internal		
Axelsson and Westerlund (1998)	Sweden (30 km)	Family *income-change equation* with *Heckman correction* for selectivity of migrants	No effect on family disposal income. Usual predictors of migration like education and age are insignificant	No selectivity cannot be rejected. Generally, noisy estimation of migration and family-income growth
Bielby and Bielby (1992)	US (100 miles)	*Probit model* of expressed reluctance to move for a better job due to family considerations	Potential losses for the spouse deter wives from pursuing job opportunities, not husbands	*Gender-role theory*. Use the coefficient on gender as test for symmetry
Cooke (2003)	US (county)	*Lagged-variable model* in husband's, wife's and pooled income (two data waves)	No effect on wife's income, positive effect for high-income husbands	Migration maximizes husband's income, income effects are a function of gender
Costa and Kahn (2000)	US (different sized cities)	*Triple-dif* in location propensities. Defines high (low) power couples as those where both (neither) are college graduates.	Power couples increasingly locate in large cities controling for the growing urbanization of the college educated and trends for low-power couples	Worsening of the colocation problem (increasing female labor force participation) leads to increased location of power couples in large cities
Duncan and Perrucci (1976)	US (state)	*Linear probability model* of migrant status on indices of occupational prestige, migration posibility and compatibility	Migration responds positively to occupational prestige and occupation-specific migration propensities of husbands, not of wives	Focus on occupational determinants of family migration and include also wife's percent of family income (insignificant)
Gemici (2011)	US (census division /grouping of states)	*Structural dynamic model* where partners decide each period whether to relocate and whether to stay together	Family ties deter migration and dampen wage growth of both men and women. Colocation problems increase divorse rates	Decisions are repeated, contrary to the one-time decisions of the classical *human-capital model* (e.g. Mincer, 1978)
Grant and Vanderkamp (1980)	Canada (100 miles)	*Lagged-variable model* in earnings by sex and marital status	Negative earnings effects for married women and positive effects for married men	The estimated earnings effects are too low to rationalize migration for most groups
Lichter (1980)	US (state)	*Contingency tables*	The effect of wife in labor force is negative on average, but wives in professional positions enhance mobility	Lower employment of wives post migration confirms earlier findings (e.g. Mincer, 1978)

Continued on next page

Author(s)	Type	Method	Finding	Remark
Lichter (1982)	US (county or SMSA)	*Logit model* of migrant status on education, labor force attachment and occupational prestige	Employment and job tenure of wives deter migration. Small positive but insignificant effect of wife's education	Effect of wife's education is positive and large when husband's education is left out, author suggest due to assortative mating
Lichter (1983)	US (county or SMSA)	*Lagged-variable model* in wife's earnings	Temporary negative effect, more severe (often not significant) for higher education and occupational prestige	On the duration and the heterogeneity of the effects for wives
Long (1974)	US (county or state)	*Migration probabilities* by age, marital status and employment status of wife before and after a move	Working wives deter long distance moves but increases short distance mobility. Housing considerations account for 2/3 of intra-county family migration	Upgrading of family housing is an important motivation for working for married women. Tied mover status of wives can help explain the gender wage gab
Mincer (1978)	US (county or state)	*Migration probabilities*, repeats Long (1974) and adds probabilities by employment and unemployment rates	Show family migration is associated with increase in wife's unemployment and labor force withdrawal	Defines "*tied movers*" and "*tied stayers*" and shows descriptive evidence consistent with his *human-capital theory*
Nivalainen (2004)	Finland (municipality or province)	*Multinomial logit* comparing staying, short and long distance moves	Wife's education insignificant; working wife deters migration; larger husband/wife income ratio increase migration	Asymmetric; "it continues to be the human capital of the husband that rules"
Rabe (2011)	GB (Local Authority Districts)	*Endogenous swiching model* of wage effects corrected for selection into migration and employment. 2nd stage probit of migration on predicted wage returns	Women suffer a temporary wage penalty, no wage effect for men. The predicted gains of husband and wife positively affect migration	The predicted wage gain is negative for 12 percent of wives and 1 percent of husbands in migrating families
Sandell (1977)	US (county or SMSA)	*Earnings-change equation* for husband's, wife's and family (with lagged earnings)	Positive effect for husbands, negative or insignificant for women and family earnings goes up.	Earnings gains of husbands are large enough to offset their wives' losses
Shauman (2010)	US (county or MSA)	*Logit model* of migrant status on education, labor force attachment, occupation-level variables and measures of the comparative advantage in each variable	Occupational variables do not eliminate the gendered effects of usual controls, effects of occupational variables and educational advantage differ by gender	Adds occupational determinants to usual controls (education, employment and income). Includes also wife's percent of family income (insignificant)
Shihadeh (1991)	Canada (province)	*Logit model* of reason for migrating (in sample of migrants)	Family income and husband reporting job-reasons increase the odds that the wife is accompanying in the migration decision	4% of husbands and 74% of wives state they are accompanying in the migration decisions

Continued on next page

Author(s)	Type	Method	Finding	Remark
Spitze (1984)	US (county or SMSA)	*Lagged-variable model* in wife's employment and earnings	Temporary negative effects on wives' employment and earnings that do not depend on age	On the duration and the age-distribution of the effects for wives
Swain and Garasky (2007)	US (county and SMSA)	*Two-level logit model* of family migration decisions. First individual characteristics, second neighborhood characteristics	Change is husband's earnings has no effect, increase in wife's earnings makes migration less likely. Wife' education insignificant	Mixed evidence on the importance of husband's and wife's characteristics
Tenn (2010)	US (state)	*Probit model* of migrant status and small *structural model*	Wife's education and occupation have lower explanatory power than husband's due to lower weight on wife's private return	Migration follows husband's potential return and this pattern has been stable 1960-2000
Wallston, Foster, and Berger (1978)		Psychological. Interviews dual career couples (both are professionals)	Actual location decisions favor career of male partner. It seems to be a forced choice; it happens when only one job-offer is available	Institutional constraints generate location decisions that favor the husband
		International		
Junge, Munk, and Poutvaara (2013)	Emigration of Danes	*Probit model* of migrant status for all and subgroups defined by children and education of couples	International migration is increasing in husband's earnings but the effect of wife's earnings is zero (small insignificant estimates that bounce around zero)	High power couples (as defined by Costa and Kahn, 2000) are most likely to emigrate, followed by male power couples, then female power couples.

Notes: "Type" refers to type of migration (location) and migration is either defined by distance or by being across geographic borders.
Costa and Kahn (2000) study location choices, while the remaining papers study migration.decisions and/or labor market effects of family migration.
All concidered migration is family migration, i.e. joint migration of husband and wife.

Appendix C

Setup (repeated from main text) $\begin{pmatrix} r_h \\ r_w \end{pmatrix} \sim N_2 \left(\begin{pmatrix} \mu \\ \mu \end{pmatrix}, \begin{pmatrix} \sigma^2 & \rho\sigma^2 \\ \rho\sigma^2 & \sigma^2 \end{pmatrix} \right)$

Define $X \equiv Ysr_h + Y(1-s)\delta r_w - 2C$, thus

$X \sim N\left(\mu Y(s(1-\delta)+\delta) - 2C, \sigma^2 Y^2 \left(\delta^2 - s2(\delta^2 - \delta\rho) + s^2(1+\delta^2-2\delta\rho)\right)\right)$

For ease of notation let $\mu_X = \mu Y(s(1-\delta)+\delta) - 2C$ and $\tilde{z}_s = \sqrt{\delta^2 - s2(\delta^2-\delta\rho) + s^2(1+\delta^2-2\delta\rho)}$

$$\begin{aligned} \text{Corr}(X, r_h) &= \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s} \\ \text{Corr}(X, r_w) &= \frac{s(\rho-\delta)+\delta}{\tilde{z}_s} \end{aligned}$$

ϕ and Φ are the standard normal density and distribution functions, while subscripts r_h, r_w and X on ϕ and Φ indicate their respective density and distribution functions. λ is the inverse Mills ratio.

$$\begin{aligned} \text{E}(r_h|X>0) &= \int_{-\infty}^{\infty} r_h \phi_{r_h}(r_h|X>0)\,\text{d}r_h \\ &= \int_{-\infty}^{\infty} r_h \frac{\int_0^{\infty} \phi_{r_h}(r_h|X=x)\,\phi_X(x)\text{d}x}{\text{P}(X>0)}\text{d}r_h \\ &= \frac{1}{\text{P}(X>0)} \int_0^{\infty} \left(\mu + (x-\mu_X)\frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{\sigma}{\sigma Y \tilde{z}_s}\right)\phi_X(x)\text{d}x \\ &= \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{\sigma}{\text{P}(X>0)} \int_0^{\infty} \left(\frac{\mu\tilde{z}_s}{(s(1-\delta\rho)+\delta\rho)\sigma} + \frac{x-\mu_X}{\sigma Y\tilde{z}_s}\right)\phi_X(x)\text{d}x \\ &= \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{\sigma}{\text{P}(X>0)} \left(\frac{\mu\tilde{z}_s}{(s(1-\delta\rho)+\delta\rho)\sigma} + \int_0^{\infty} \frac{x-\mu_X}{\sigma Y\tilde{z}_s}\phi_X(x)\text{d}x\right) \\ &= \frac{\mu}{\text{P}(X>0)} + \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{\sigma}{\text{P}(X>0)} \int_0^{\infty} \frac{x-\mu_X}{\sigma Y\tilde{z}_s}\phi_X(x)\text{d}x \\ &= \frac{\mu}{\text{P}(X>0)} + \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{\sigma}{\text{P}(X>0)} \int_0^{\infty} \frac{x-\mu_X}{\sigma Y\tilde{z}_s}\frac{1}{\sqrt{2\pi}\sigma Y\tilde{z}_s}\exp\left(-\frac{1}{2}\left(\frac{x-\mu_X}{\sigma Y\tilde{z}_s}\right)^2\right)\text{d}x \\ &= \frac{\mu}{\text{P}(X>0)} + \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{-\frac{1}{\sqrt{2\pi}}\exp\left(-\frac{1}{2}\left(\frac{x-\mu_X}{\sigma Y\tilde{z}_s}\right)^2\right)\Big|_0^{\infty}}{\text{P}\left(\frac{X-\mu_X}{\sigma Y\tilde{z}_s} > \frac{-\mu_X}{\sigma Y\tilde{z}_s}\right)} \\ &= \frac{\mu}{\text{P}(X>0)} + \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\frac{\phi\left(\frac{-\mu_X}{\sigma Y\tilde{z}_s}\right)}{1-\Phi\left(\frac{-\mu_X}{\sigma Y\tilde{z}_s}\right)} \\ &= \frac{\mu}{\text{P}(X>0)} + \frac{s(1-\delta\rho)+\delta\rho}{\tilde{z}_s}\lambda\left(\frac{-\mu_X}{\sigma Y\tilde{z}_s}\right) \end{aligned}$$

Likewise for spouse w

$$\mathrm{E}(r_w|X>0) = \frac{\mu}{\mathrm{P}\left(X>0\right)} + \frac{s(\rho-\delta)+\delta}{\tilde{z}_s}\lambda\left(\frac{-\mu_X}{\sigma_Y \tilde{z}_s}\right)$$

Examine the inequality

$$\begin{aligned}
\mathrm{E}(r_h|X>0) &> \mathrm{E}(r_w|X>0) \\
s(1-\delta\rho)+\delta\rho &> s(\rho-\delta)+\delta \\
s(1-\rho)(1+\delta) &> (1-\rho)\delta \\
s &> \frac{\delta}{1-\delta}
\end{aligned}$$

Chapter 3

Immigration and Native Workers: New Analysis Using Longitudinal Employer-Employee Data

Immigrants and Native Workers:

New Analysis Using Longitudinal Employer-Employee Data

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Abstract

This paper makes progress on a long standing issue: what is the effect of unskilled immigrants on the labor market outcomes of similarly educated natives? Using the universe of individuals and firms in Denmark for the period 1991-2008 we follow natives over time tracking how their wage, employment and occupational choice responded to a large, exogenous inflow of immigrants. We focus on a largely unexplored inflow of non-European immigrants to Denmark, beginning in 1995 and driven by a sequence of international political crises in Bosnia, Somalia, Afghanistan and Iraq, and an economic crisis in Turkey. We find that an increased supply of non-EU immigrants in a Danish municipality pushed less educated native workers to pursue more complex and less manual-intensive occupations. This reallocation took place mainly through the movement of individuals across firms and resulted in higher or unchanged wages. Immigration increased the mobility of natives but did not increase their probability of unemployment.

JEL Codes: F22, J24, J61.

Keywords: Immigration, job transitions, complexity, employment, careers, wages.

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1 Introduction

In this paper we use individual data on the universe of Danish workers matched to data on the establishments where they worked during the years 1991-2008 to quantify the consequences of a supply-driven inflow of less educated immigrants on the occupational choice and working careers of natives. The detail and scope of the data, and the size and nature of the immigration shock allow us to use a credible identification strategy, perform a detailed analysis of outcomes, and explore the mechanisms of adjustment in response to immigration. Do immigrants displace similarly skilled native workers and increase their jobless rates? Or do they complement natives and stimulate natives to specialize in complex tasks? Are effects concentrated within or across firms? Do the combined effects reduce or increase native wages? This paper provides answers to these questions.

The main limitations of existing studies are the ability to identify a genuine supply-shock in the inflow of immigrants and to track the full response of native workers' labor market outcomes. The immigration inflow considered in this paper is that of non-European (non-EU) immigrants, beginning with ex-Yugoslavian immigrants in 1995 following the war and ensuing crisis, and continued due to waves of refugees from Somalia, Afghanistan and Iraq. Turkey, plagued by an economic crisis in 1993-94 was another large supplier of non-EU immigrants. The data shown in Figure 1 point to a discontinuity in the growth rate of the non-EU immigrant population beginning in 1994. In the same period immigrants from the rest of European Union (EU) to Denmark did not increase at all.

For most refugees Denmark applied a Spatial Dispersal Policy across municipalities between 1986 and 1998.[1] This makes their early distribution exogenous to economic conditions as the dispersal policies aimed at spreading refugees across municipality without consideration for their economic performance . Later, when family reunification and working permits were the main causes of entry, immigrants settled, at least for a while, where their family sponsors were located.[2] Hence, the distribution across Danish municipalities of immigrants from refugees' countries as of 1994 was determined by the early dispersal policies. The distribution of Turks (the other group with a large inflow from 1995-2007), instead, was determined mainly by the presence of pre-existing ethnic communities, dating back to the sixties. Both conditions were orthogonal to economic outcomes in those municipalities

[1] The Bosnians were an exception as they were sent disproportionately to rural districts with small existing immigrant communities (Damm, 2009). We therefore exclude them when considering refugees subject to the Dispersal Policy.

[2] By law the sponsor needed "adequately sized accommodation" for the re-unified family. In practice this meant that, at least initially, new family members lived at the same address as their sponsor.

before 1994, as we will show, and this reinforces our trust in their lack of correlation with unobserved determinants of labor market outcomes after 1994.

We exploit the pre-1994 refugee dispersion in our empirical designs, and construct an imputed population of refugee-country immigrants by interacting the post-1994 push-driven flows from crisis-stricken countries with the pre-1994 distribution determined by the early dispersal policy. We also use a similar strategy extended to all non-EU immigrants using the pre-1988 distribution of non-EU communities. This strategy provides variation in refugees (or non-EU immigrants) over time, linked to the timing of crises in sending countries. Their dispersion across municipalities, instead, depends on initial dispersal policy (or to the distribution of pre-existing non-EU communities.

The fact that our data are available beginning in 1991, prior to the surge in non-EU immigration, allows us to identify a "pre-immigration" period (1991-1994) and to test the exogeneity of the instruments to pre-existing economic trends. Our instruments turn out to be relatively strong, they are not correlated with pre-existing trends in economic outcomes of municipalities, and are justified by the credible push-driven episodes in the countries of origin.

The non-EU immigrants considered were significantly less educated than native workers and largely concentrated among non-college educated. They usually spoke the Danish language with low levels of proficiency.[3] These characteristics imply that they were most likely to compete with less educated Danish workers, especially in manual-intensive occupations. The canonical model would imply, therefore, that these immigrants worsened the employment and wage prospects of less educated natives. Non-EU immigrants in other European countries have similar skill composition, thus lending external validity to our study of immigration in Denmark. However, the Danish labor market was and is very flexible relative to many other EU countries. Especially for establishments in the private sector, the hiring and firing/layoff of workers had relatively low costs, the transitions across jobs and occupations were frequent, and wage bargaining was mainly (and increasingly over time) done at the decentralized firm-level (see Dahl, le Maire, and Munch, 2013). This flexibility enhanced the possibility for native workers and firms to make adjustments that responded optimally to immigration.

Our analysis focuses on four main outcomes: the complexity of natives' occupations, their hourly wages, their yearly earnings and the length of their working year. We focus on less educated workers,

[3]Asylum seekers are not in our data and not allowed to work in Denmark. Once (if) their case has been approved they will move into an address in Denmark (assigned to them under the dispersion policy), be allowed to work and appear in the registers. Asylum seekers may attend language causes while their case is being processed.

but we also separately consider more educated natives. First, we analyze what happened to native workers within establishments when exposed to local market inflows of non-EU immigrants. By using a panel regression that includes worker-establishment fixed effects and a host of individual and firm controls, we identify the within-employment-spell variation of outcomes and relate them to non-EU immigrant shares in the local market, instrumented by their imputed values. Second, we use worker-municipality fixed effects in similar panel regressions to identify immigration-induced adjustments within local labor markets. Then we analyze the transition of native outcomes over time following cohorts of native workers during their working careers. This part of the analysis, structured as a difference-in-difference approach, exploits the differential exposure of native incumbent workers to immigrants, based on their 1994 location (before the surge in non-EU immigrants). We follow native individuals over 18 years so as to characterize the short and long-run effects of immigration. Finally, we analyze the impact of non-EU immigrants over the long-run using long-differences in the data to identify the cumulative effects on employment and on inter-establishment and inter-municipality mobility of natives.[4]

Our analysis has three main findings. First, considering native workers within municipalities, larger flows of non-EU immigrants increased their occupational mobility, measured as the probability of changing occupation. This increase was strongly associated with mobility towards complex jobs for workers who changed establishment. This suggests that natives changed their specialization in response to immigrant workers in the local labor market mainly by moving across firms. Second, less educated natives experienced positive or null wage effects. The positive effects were particularly strong for natives initially working in the "advanced service" sector. The only case in which some incumbent native workers had negative effects on their wages was for those in the public sector. Third, the cumulative effect shows that immigration increased the mobility, particularly for highly skilled, across establishments and across municipalities in response to non-EU immigration. However, natives did not experience any effect on cumulative weeks of employment. Therefore immigration increased the cross-establishment and cross-municipality mobility of natives but did not affect the length of their working year.

The rest of the paper is organized as follows. Section 2 frames the present contribution within the existing literature. Section 3 describes the immigration inflow that we consider and the salient

[4]The cumulative regressions are similar to those of Autor et al. (2013) who consider the effect of import competition.

features of the Danish labor market. Section 4 and 5 present the main data, their trends and summary statistics. Section 6 describes a simple decomposition to organize our empirical analysis and discusses the specification and the identification in our regressions. Section 7 shows and discusses the estimation results. Section 8 concludes the paper.

2 Literature Review

The analysis of the labor market effects of immigration has a long history. Considered as a labor supply shock, within the labor demand-labor supply "canonical" framework, a series of studies estimated the impact of immigration on wages and employment of natives in local and national economies.[5] Those studies have generally found small effects of immigration on wages and employment of competing natives.[6] This is at odds with the canonical model's that predicts, other things equal, a negative and significant impact of immigrants on wage and employment of similar native workers. More recently a new generation of studies has focused on new mechanisms and margins of adjustments that depart from the canonical model's predictions. Considering a richer environment one may account for the zero or even positive effects of immigration on native wages. The main departures from the canonical framework considered in recent studies are the following: workers have multiple differentiated skills that differ systematically between immigrants and natives[7]; immigrant labor generates the possibility of specialization and productivity effects within and across firms[8]; and investment and technology are adjusted to absorb immigrant labor in local markets.[9] These new lines of inquiry have produced new hypotheses about the possible impact of immigrants on the economy and on firms, and economists have analyzed a richer set of outcomes to validate them.[10] Our paper follows this line of analysis and presents estimates of a set of native workers' outcomes in response to immigration.

Our analysis also relates to the literature analyzing the effect of aggregate shocks on individual labor market outcomes. The only previous studies using comparable data are **?**, who produces within job-spell estimates of the effect of increased outsourcing on wages in manufacturing firms. The same

[5]Examples are Altonji and Card (1991); Card (2001); Friedberg (2001); Borjas (2003); Ottaviano and Peri (2012).

[6]See for instance the meta-analysis in Longhi, Nijkamp, and Poot (2005), or the review article by Blau and Kahn (2012). Exceptions finding significantly negative or significantly positive effects exist, but overall the estimates are centered around zero.

[7]Manacorda, Manning, and Wadsworth (2012); Ottaviano and Peri (2005, 2012); D'Amuri, Ottaviano, and Peri (2010)

[8]One paper analyzing this channel is Peri and Sparber (2009).

[9]Examples are Lewis (2011, 2013); Ottaviano, Peri, and Wright (2013).

[10]See the recent analysis of immigration and productivity in Peri (2012), Immigration and firm creation in Olney (2013) and immigration and economic growth in Ortega and Peri (2013).

Danish data are used in Malchow-Møller, Munch, and Skaksen (2012) who employ establishment-worker fixed effects to analyze the impact of immigrants on wages of native coworkers.[11] However, the joint analysis of the impact of immigration on wages, occupation and employment of natives within firms, and on inter-firm and inter-municipality mobility is original to our study. Moreover, the analysis over time, following a cohort of workers and using a difference-in-difference approach is new in this literature.[12] The ability of the difference-in-difference method to analyze in the same framework the short- and long-run responses and to test the absence of pre-event trends in outcomes makes it very appealing in this context. We are not aware of other studies of the effects of immigration using such methods.

Very few existing studies analyze the dynamic effects of immigration. Cohen-Goldner and Paserman (2011) allow for labor market effects of immigration on natives to change over time but they assume that this is due to the dynamic adjustment of capital and of immigrants, not to a potentially dynamic response of natives. Notice also that our approach follows workers wherever they move. Hence it makes our analysis, immune from the criticisms of area studies (e.g. Borjas, 2003), which posits that wage effects are not captured when limiting the analysis within a geographic area. By following individuals, our approach captures the effects of immigrants on individuals that may "spill" to other regions through mobility.

Previous studies on the effects of immigration constructed pseudo-panel data sets rather than following a genuine individual panel. By using local or national "cells" of workers they linked over time different groups and looked at their outcomes. Selection/attrition and transition of workers across cells can therefore cloud those results. Hence, we know little about wage, career and occupational effects on individuals from those studies. Similarly, with few very recent exceptions (Cattaneo, Fiorio, and Peri, 2013) career and occupation effects of immigration have only been analyzed in the aggregate by previous studies (e.g. Peri and Sparber, 2009; D'Amuri and Peri, forthcoming). Our study analyzes, for the first time, outcomes for native individuals within and across firms over time. Finally, relative to the

[11] Using similar data Malchow-Møller et al. (2013) analyze the impact of immigrant hirings on firm's job creation in the farm sector; Malchow-Møller, Munch, and Skaksen (2011) look at the Danish preferential tax scheme for foreign professionals and estimate the effect of hiring them on wages and productivity within the firm; and Parrotta, Pozzoli, and Pytlikova (2012) look at the effect of an ethnically diversified workforce on firm productivity. Contrary to these papers we consider the effect of changes in the immigrant share at the municipality - and not the firm - level, and we identify an abrupt change in the share of foreign born driven by refugee-sending countries.

[12] This methodology is somewhat reminiscent of Walker (2013) who uses such a method to analyze the effect of environmental regulation on jobs and wages. Von Wachter, Song, and Manchester (2007) use a similar approach to track the long-run effects of job separations in recession.

previous literature, the availability of the universe of individuals in the data minimizes measurement error and eliminates (or drastically reduces) the concern for attenuation bias expressed in studies such as Aydemir and Borjas (2011).

3 Immigration and Labor Markets in Denmark

Our analysis focuses on Denmark. Three reasons make this case interesting. First, the extraordinary scope and richness of the individual longitudinal data enables us to track several individual outcomes for a longer period than ever done before. Second, non-EU refugees and economic immigrants in Denmark after 1994 represent a little known push-driven episode, ideal to identify the impact of immigration on economic outcomes. Third, Danish labor markets were quite flexible, different from those in many other European countries but more similar to those in the US and UK. They exhibited high turnover rates, low costs of hiring and layoffs and decentralization in wage setting (Dahl, le Maire, and Munch, 2013). This is the frame in which wage and employment should best reflect marginal productivity. Moreover, as occupational and cross-firm mobility turn out to be important margins of adjustment, a flexible labor market such as the Danish one, allows this mechanism to operate most efficiently.

In this section we briefly describe the features of immigration to Denmark during the period 1991-2008 over which we have data. Immigrants were already in the country before 1995. Their presence, however, as share of employment was not large. They represented three percent of total population and were almost equally divided between EU and non-EU, as seen in Figure 1. A generous program to admit refugees and a policy to promote their dispersion across municipalities was set in place since 1986 (see Damm, 2009). This policy dealt only with a limited number of refugees in the first nine years of its existence. This changed in 1995, when a large wave of immigrants from the regions of Former Yugoslavia, and soon afterwards from Somalia, Afghanistan and Iraq entered the country as refugees, because of ruinous wars in their countries of origin. Since then the share of non-EU immigrants grew significantly until year 2007 (Figure 3). The non-EU immigration boom was fueled during the 1995-2003 period by a sequence of refugees waves driven by international crisis, namely by Bosnians and Somalis in the period 1995-2000 and by Afghani and Iraqis in the period around 2000-2003 (Figure 2). The other major non-EU group was represented by Turkish, whose inflow surged following a deep economic crisis in 1993-94. In our analysis we use either immigrants from countries subject to the

Refugee Dispersal Policy or all non-EU immigrants as explanatory variable.

Figure 1 shows EU and non-EU immigrants as a percentage of employment. The figure confirms two features anticipated above. First, we observe the discontinuity in the trend of foreign born (as a percentage of employment) beginning in 1995. Second, the exclusive role of non-EU immigrants in determining this trend is evident. The overall inflow was sizeable, when cumulated over the whole period. From beginning to end the cumulative increase of immigrants was equal to 3.1 percentage points of total employment (from 3.0% to 6.1%). During the same period the growth of foreign born in typical immigration-receiving countries was similar. In Canada it was +3.5%, in the US it was +3.8%, in the UK it was +3.9% (as percentage of the population in working age).[13] All these economies have received much more attention in the analysis of the effects of immigrants. Figure 3 shows, more specifically, that non-EU immigrants were mainly from refugee-countries and from less developed countries outside of Eastern Europe. The inflow from Eastern European Enlargement countries and from developed non-EU economies in fact account for very little of the increased inflow.[14]

Two other features make the 1995-2007 inflow interesting in terms of its potential labor market consequences on natives. First, non-EU immigrants were less educated than natives. 52% of them did not have a post-secondary education versus only 36% among natives. Second most of them did not speak Danish, and as they were coming from non-European countries, they were often culturally and even ethnically different. Hence, they were likely to be employed in low-skilled manual occupations (as we shall see below). A final, but certainly important reason to focus on the impact of non-EU immigrants is that their entry, differently from the entry of EU immigrants was and is regulated by immigration policies. If we are to learn the consequences of immigration to inform immigration policies in developed countries, this is the group of immigrants we should consider.

4 Data and Variables Definition

The data we use are from the Integrated Database for Labor Market Research (IDA). IDA is a collection of registers that link data on individual characteristics of the workers to data on the characteristics of establishments using unique individual and establishment identifiers. The data are recorded annually

[13] During the same period, in Germany the inflow of immigrants implied only a growth by 1.4 percentage points of the labor force and, similarly in France that percentage increase by only 1.1 points.

[14] Eastern European laborers could come to Denmark for work and stay for up to 6 months without registering (like the EU-group) since 2004. Their share of employment is small. Partly because short stays (for temporary work) are under-represented in annual records.

for each individual and establishment in Denmark. Therefore we can observe in what year a match between a worker and an establishment is formed and when it is dissolved. We can also observe detailed occupation and salary for each worker within an establishment.

We select individuals who are between 18 and 65 years old, not attending school (i.e. not eligible for student grants), and not permanently out of the labor force (i.e. not receiving disability pension). This implies that we consider the universe of individuals potentially available to work in the labor market and we refer to them as the "labor force". We eliminate from the sample observations with a missing value in foreign born status or in the municipality of residence (a very small group). We restrict our first empirical analysis (section 6.3.1) to employed individuals in order to analyze hourly wage changes and occupational upgrade within firm and municipality. When turning to the difference-in-difference approach (section 6.3.2) we consider a balanced panel of individuals who were employed in 1994 and we analyze their employment and annual earnings without imposing further restrictions.[15]

We consider three main outcome variables. They are the occupation, the wage and the employment status of Danish native individuals. Specifically, the database contains the annual earnings and employment as the fraction of year worked the labor market status (categorized as self-employed, employed, unemployed, or out of the labor force), the hourly wage rate and the occupation code (according to the ISCO-88 classification) for each individual in each year.

We correct hourly wage and the annual earnings to include mandatory payments to pension schemes. These pension contributions are administered by the employer and reported separately from the income. They are, however, part of the total labor payment and should be accounted for as part of the gross hourly wage and annual labor income[16]. All income variables have been deflated using the Danish consumer price index.

As a measure of the labor supply of an individual we use the fraction of the full-time year worked. The variable takes a value of one if the worker was a full-time employee throughout the year. If either the person was part-time employed and/or if the person was only employed part of the year (and unemployed the rest) the employment variable takes a fractional value equal to a share of the regular

[15]Natives aged 21-51 in 1994 satisfy the age criterion (18-65) throughout the panel and will be included in the panel unless they go back to study, become disabled, leave Denmark or die within the sample.

[16]These mandatory pension contributions vary substantially across industries (between 0 and 17 percent of earnings). As data on the pension payments are available only from 1995 onwards, we only consider wage and income net of pension contributions when we include pre-1995 observations. This might introduce some measurement error in the income variables. The spell analysis however, that can be implemented with net or gross earnings, proved to be robust to the choice of income measures.

working year. The employment of each individual is associated to an occupation according to the internationally standardized ISCO-88 codes.[17] In order to measure the skill content of each occupation we merge the American O*NET database (from the Bureau of Labor Statistics) to the Danish registers using the four-digit ISCO classification of occupations. Thereby, we are able to link most workers to measures of the intensity of use of different abilities on the job. We follow Ottaviano, Peri, and Wright (2013) and aggregate the index of each ability into three categories: communication, analytical and manual skills. We construct an occupational complexity index by combining them. The complexity of an occupation is defined as a composite index increasing in the intensity of communication and analytical skills and decreasing in the intensity of manual skills used.[18]

This method of calculating the skill content of an occupation assumes that such content for a given occupation is similar for Denmark and the US. For instance a "Machine Operator" would use the same intensity of manual, cognitive and communication skills in the US and in Denmark. We also directly observe occupational changes. Hence, we construct a variable that we call "occupational mobility" that equals one whenever an individual changes the (ISCO-88) occupation from period $t-1$ to t. To get a sense of the direction of the mobility, we also combine this variable with the hourly wage measure and define "career upgrade" as a variable that takes the value of one when a worker changes occupation and, at the same time, experiences a wage increase. A "career downgrade", instead, is a change in occupation accompanied by a decrease in wage.

Our individual level controls are age, labor market experience (the cumulative employment in years, since first joining the labor force), job tenure (calculated as the period elapsed between the hiring in the current establishment and the present), education and marital status. In terms of schooling, we define individuals with tertiary education as high skilled, and other workers as low skilled. Using information on the country of origin and a variable that categorizes each individual into native and foreign born, we define as immigrants only those individuals who are born abroad and we use the country of origin to calculate immigrant populations by sending countries.

[17] Occupations are reported to Statistics Denmark by firms and there are no legal consequences of misreporting as opposed to, for example, the income of the worker that is reported for tax-purposes. We constructed an algorithm that replaces a missing or invalid ISCO-88 by the next within the match with the firm if the next is also the most frequent within the worker-firm match. We used next and not previous, since the occupation code is most often missing in the beginning of the worker-firm spell possibly due to lag in registering. This algorithm as well as lack of incentives for firms to change the occupation reported for an employee may lead to under-estimation of the true job mobility within firms.

[18] The index, is calculated as: $\ln\left((\text{Communication} + \text{Analytical})/\text{Manual}\right)$. The underlying skill intensities have been standardized to be between zero and one and each is the average of a series of indicators within the category. Hence the constructed complexity index can take values between $-\infty$ and $+\infty$.

Immigrants are separated in two groups: One consisting of individuals from countries which have had free mobility of labor agreements with Denmark since 1995. These are the EU15 countries plus Norway, Iceland and Liechtenstein (as members of the European Economic Area) and Switzerland (through a bilateral agreement). We define this group (somewhat improperly) as EU. The other group, consisting of immigrants from any other sending country, is defined as non-EU immigrants. They are the source of the variation of immigrants analyzed in this paper. The non-EU group is dominated by Turkey and Former Yugoslavia, but whereas a large number of Turks arrived before our analysis window, refugees from Former Yugoslavia and several other refugee sending countries such as Afghanistan, Iraq, Sri Lanka, Pakistan, Iran and Somalia fueled the immigration we analyze.

The geographic units that we use to approximate local labor markets are 98 municipalities that can be identified consistently in Denmark, over time, beginning in 1988 till 2007. We merge Frederiksberg and Copenhagen since those two municipalities constitute one integrated labor market. This leaves us with 97 areas where Copenhagen, Aarhus and Aalborg are the biggest, most populous ones.[19] Most municipalities are in the mainland part of Denmark. Some municipalities are islands. Bornholm, for instance, is separated by a 5.5 hours boat trip from the nearest municipality in Denmark and is thereby a rather isolated labor market. Municipalities are small geographical units. As we can follow workers across municipalities, we observe that most of the mobility of workers takes place across firms within municipality confirming that municipality are rather self-contained units. Only around 10% of the workers who move across establishments each year change municipality.

5 Descriptive Statistics

The top three receiving municipalities (Ishøj, Arbertslund and Brøndby) experienced an increase of foreign-born larger than 10 percentage points of total employment in the considered period. The bottom three (Læsø, Assens and Lejre) experienced an increase of 1 percentage point or less. Figure 4 provides summary evidence that a remarkable gap between high and low non-EU immigration opened rather abruptly across municipalities beginning in 1995. The figure shows the difference in the non-EU share of employment between highly exposed (above the median) and less exposed (below the median)

[19] Copenhagen (including Frederiksberg) had 603 thousand inhabitants in 2008, and Aarhus and Aalborg had, respectively, 298 and 195 thousand inhabitants. The smallest municipalities are islands with two to seven thousands inhabitants, which will count very little in our estimations. The next smallest municipalities begin at around twelve thousand. In the large cities the employment/population ratio is about 60%, while it is 40% in the more isolated, rural municipalities.

municipalities to non-EU immigrants.[20] It is clear that there is no trend in the pre-1994 difference in share of non-EU immigrants between these two types of municipalities. It is also clear that starting in 1995 a steady and continued inflow of non-EU immigrants increased the gap in the immigrant share across those two types of municipalities. Moreover, Figure 5 shows no break (and essentially no change) in the differential trend for the EU immigrants in the same two groups of municipalities. EU immigrants were free to work in any Danish municipality. Hence if the discontinuity and differential growth shown in Figure 4 was driven by differential demand and labor market conditions it should have manifested itself mainly (or also) with EU immigrants. The presence of no differential trend for EU immigrants does not suggest a local labor demand driven event in the receiving municipalities.

Among the areas with the largest immigrant inflows some are larger cities, such as Copenhagen and Aarhus. The dispersal policy in place between 1986 and 1998, however, spread the non-EU immigrants also to smaller towns. While differences in the initial characteristics of the municipalities will be controlled for, we also run tests in section 6.4 to check that our instruments are uncorrelated with the pre-existing economic trends of a municipality, and in the difference in difference approach we check that a pre-1994 trend is not present in the differences of native outcomes in the municipalities exposed and not exposed to immigration.

In some specifications we distinguish between four broad sectors: manufacturing, complex services, non-complex services and public sector. While the first two sectors tend to produce tradable and differentiated goods and services and are subject to international competition and technological change, the other two tend to produce less differentiated goods and are more protected from competition and international market forces. The largest non-EU immigrant inflow was into manufacturing. The increase in non-EU immigrant workers took place among elementary, manual intensive occupations requiring little education. These were also occupations employing low skilled natives in larger percentages.

Table 1 lists the occupations that experienced the lowest and the highest inflow of non-EU workers, measured as the change in the share of non-EU immigrants employment between 1994 and 2008. For those occupations we also show the index of intensity of use of cognitive, communication and manual tasks and the derived complexity index that combines all of them. Occupations experiencing the largest inflow of non-EU immigrants were significantly more intensive in manual skills and less intensive in

[20]The exact definition of highly and less exposed municipalities is explained in section 6.3.2.

cognitive and communication skills than those attracting a small share of immigrants.[21]

The empirical analysis is based on a 20% random sample of natives.[22] Summary statistics for the controls and for the dependent variables used in the empirical analysis are provided in Table 2. The table is based on the sample used in the spell regressions, which includes only individuals, as long as they are working, over the considered period (1995-2008).[23] We divide the sample between low skilled and high skilled, based on their education (no tertiary or tertiary education) when they first enter the sample. The group of low skilled is younger, has less labor market experience and lower job tenure, and as expected also has, on average, lower hourly wages and lower annual earnings.

6 Framework, Empirical Strategy and Identification

Our identification relies on the variation of non-EU immigrants over time, across Danish municipalities. In this section we first argue that the local labor market, proxied by the municipality, rather than the firm, is the right unit to measure variation in the explanatory variable and to construct a credibly supply-driven change of non-EU immigrants. We then show an easy decomposition of the effects that justifies our two main empirical approaches. Finally, we describe our empirical specifications and discuss identification and instrumental variables.

6.1 Local Supply Shock of Non-EU Immigrants

Previous studies using Danish data such as Malchow-Møller, Munch, and Skaksen (2012) and Parrotta, Pozzoli, and Pytlikova (2012) have considered the increase of immigrants at the *firm level* as explanatory variable. Those studies analyze the correlation between the presence of foreign born and the wages of natives within the firm. They find mainly negative effects. Our strategy, focuses on the variation of immigrants within local labor markets instead. The response of native individuals within and across firms, over time, to changes in the local supply of foreign-born constitutes our outcome of

[21] The low share of immigrants among skilled agricultural workers is somewhat surprising. The share of immigrants in agriculture increased 11 percentage points between 1994 and 2008 (Malchow-Møller et al., 2013). But they do different kinds of unskilled work categorized for instance as "Agricultural, fishery and related labores" (which scores -1.128 in the complexity index) and other elementary occupations.

[22] Immigrant shares (the explanatory variable of interest and instrument) are calculated on the full sample to avoid measurement error.

[23] The difference-in-difference analysis uses all individuals who were working in 1994 and follows them over the period 1991-2008. Their characteristics in terms of age, labor market experience, education and wages are not very different from those of the unbalanced sample of employed reported in Table 2. We define low/high skilled in the cohort sample based on the education in 1994.

interest.

Databases like ours allow the researcher to construct the share of immigrants both at the firm level and at the geographical level (local labor markets). We want to emphasize that it is a much more reasonable strategy to identify a supply-driven shock of immigrants at the geographical level, rather than at the firm level. This is because, the pre-1995 location of refugees and their families, mainly the result of previous enclaves and early dispersal policies, interacted with the post-1995 inflow, driven by international political and economic crises, is likely to be exogenous to economic trends in Danish municipalities since 1995. To the contrary, the pre-1995 hiring of immigrants across firms in a municipality was certainly affected by firm-specific factors. If they are persistent and correlated with its trend in productivity and specialization after 1995 they may be correlated with native outcomes in that period. Moreover, the high mobility of workers within a municipality implies that, even when firms have some market power and ethnic networks make new immigrants more available to some firms than others, wages for a specific occupation are determined at the municipality level. It is more reasonable to think that the supply of a certain type of workers is region-specific rather than firm-specific.

Finally, if we entertain a firm-level supply change of immigrants and construct the instrument based on the initial share of immigrants we can only use the sample of long-lived firms, as they need to exist pre-1995. Those would be very selected firms, that survived for a long time.[24] Hence firm-level data can improve our understanding of the *consequences* of immigration, when analyzing the impact of an exogenous change in immigrant supply on within firm effects and between firm mobility. The units to capture these shocks, however, are local labor markets. Recently, Dustmann and Glitz (2011) also considered immigrants in local labor markets when analyzing the adjustment mechanisms of the local firms. Schmidt and Jensen (2013) use aggregate data on regions in Denmark between 1997 and 2006 and find positive or non-negative effects of immigration on wages and employment of natives.

6.2 A Simple Decomposition

Consider a municipality[25] in which each native worker, that we denote with the index i, works in an establishment (firm) that we denote with the index j. Such initial match, for given initial conditions,

[24] As described in section 6.4 we use 1988-shares to impute our instrument for the total non-EU group, and 1994 for the refugee-sending countries during the Spatial Dispersal Policy.

[25] In this section we omit the municipality index, for brevity. The formulas should be considered as relative to the representative municipality.

maximizes her wage (utility). There is a set of M establishments in the municipality. Each has a specific productivity when matched to worker i. I_{ij} is an indicator that equals 1, when worker i chooses to work in establishment j and it is defined as

$$\begin{aligned} I_{ij} &= 1 \text{ if } w_{ij} = \max\{w_{i1,...}w_{iM}\} \\ I_{ij} &= 0 \text{ for all other values of } j \end{aligned} \tag{1}$$

where M is the number (and the set) of different establishments in the municipality. The wage that each worker receives depends on specific characteristics of the worker, of the firm and on the firm-worker match. The demographic characteristics of the worker X_i, the productivity of the firm A_j, as well as local labor market conditions in the municipality affect the wage that each worker receives from a firm. We focus, in particular, on the effect of the share of foreign born in the municipality, S, on the wages in each establishment. Hence, explicitly capturing this dependence, we can write $w_{ij}(S)$.

There are several channels through which the supply of foreign born can affect native wages in the municipality and in each establishment. First immigrants affect the supply of some skills making the value of complementary skills higher and substitutable skills lower in the municipality e.g. Ottaviano and Peri (2012); Peri and Sparber (2009). Second, immigrants may affect the productivity of the municipality by increasing the variety of skills and intermediate goods produced and used there (Ottaviano and Peri, 2005; Ortega and Peri, 2013). They may also affect the productivity of the establishment (Ottaviano, Peri, and Wright, 2013). Such productivity effects may be stronger in establishments that employ a large share of foreigners. Hence, the share of immigrants affects the relative wages faced by individual i in different establishments and therefore also the optimal matching rule can be written as $I_{ij}(S)$.

We consider the aggregate of native workers initially in a municipality in year t and we denote it with N_t. We indicate the initial share of immigrants with S and we write the aggregate native wage in the municipality as

$$W_t = \sum_{i=1...N_t} \sum_{j \in M} [I_{ij}(S) * w_{ij}(S)] \tag{2}$$

Consider now that between year t and year $t+\Delta t$ the share of immigrants in the municipality increases to $S + \Delta S$. This change has an impact on the wage that each establishment pays to native workers which would equal $w_{ij}(S + \Delta S)$ after the inflow. It will also affect the decision of a worker to stay

in an establishment or to move through crowding-out, productivity or complementarity effects. The optimal decision would be $I_{ij}(S + \Delta S)$ after the inflow. Moreover, as the municipality is an open economy, native workers may also move out of it and find employment in an establishment outside of M. Therefore, we can decompose the effect of an increase in the immigrant share by ΔS, on the average wage of workers who resided in the municipality at time t, into the following three terms

$$\begin{aligned} \Delta W_t \quad = \quad & \sum_{i=1...N_t} \sum_{j \in M} \underbrace{I_{ij}(S)[w_{ij}(S+\Delta S) - w_{ij}(S)]}_{\text{Wage Change Stayers}} + \\ & + \sum_{i=1...N_t} \sum_{j \in M} \underbrace{\left[I_{ij}(S+\Delta S) w'_{ij}(S+\Delta S) - I_{ij}(S) w_{ij}(S)\right]}_{\text{Wage Change for Workers changing Firm}} + \\ & + \sum_{i=1...N_t} \sum_{j \notin M} \underbrace{I_{ij}(S+\Delta S) w'_{ij}(S+\Delta S) - I_{ij}(S) w_{ij}(S)]}_{\text{Wage Change for Workers changing Municipality}} \end{aligned} \tag{3}$$

The first term captures the wage change of people who remained in the same establishment.[26] As immigration affects the productivity of plants and municipalities this term captures simply the changes in the wages of natives who kept their job with the original employer. The second and third term, capture the change in wages of native workers who moved out of the original establishments. The important part of these terms is the fact that immigration affected both the distribution of natives across establishments and the wage of natives in the new establishments. The term $I_{ij}(S+\Delta S)$ captures the new allocation of native workers for those who changed establishment so that $I_{ij}(S+\Delta S) - I_{ij}(S)$ is a measure of the flows to different establishments. By focusing on this term we can analyze how immigration has affected inter-firm movements. The second summation term in expression (3) includes native individuals who changes establishment within the municipality $j \in M$, while the third term includes those who moved to establishments outside of the municipality $j \notin M$. Finally the term $w'_{ij}(S+\Delta S)$ captures the wage for native workers who moved establishment. The notation $w'_{ij}(S+\Delta S)$ implies that the wage for mover i in the new establishment j differ from the previous wage both because the new wages across establishment are affected by immigrants $w_{ij}(S+\Delta S)$ and because moving may have caused a loss of specific capital to the mover. Hence the notation $w'_{ij}(S+\Delta S)$ indicates the individual-specific wage for a mover and can be smaller or higher than $w_{ij}(S+\Delta S)$, the wage for an identical stayer in the same establishment.

Our empirical specifications analyze the effects of non-EU immigrants on native outcomes pro-

[26] The indicator $I_{ij}(S)$ denotes an allocation for these workers as it was before the change in S.

gressively including the different components of expression (3). We also analyze the impact on the inter-establishment flows of native workers $I_{ij}(S + \Delta S) - I_{ij}(S)$. While equation (3) considers wage as native outcomes in our empirical analysis we also look at other outcomes such as specialization in complex tasks, career advancements and labor supply.

The first empirical specification focuses on the effects on individuals within firms. Using a "employment-spell" regression, we will identify changes in outcomes for workers within a worker-establishment match. This correspond to the first term in the right hand side of expression (3). As there is limited literature analyzing the effect of immigration on workers outcomes within a firm, these results will be relatively new.[27] A similar empirical specification, using a different set of fixed effects, allows us to estimate the first two terms of (3) together. In a "municipality-spell" regression we analyze the wage effects (and other outcomes) for native workers who stay within the municipality. Finally the long-run effects on all native workers initially in a municipality, including all three terms in equation (3) are estimated with the difference-in-difference approach. Within this approach we also estimate the effect that immigration has on the flows $I_{ij}(S + \Delta S) - I_{ij}(S)$ across establishments and out of the municipality. We are also able to estimate whether the transition implies that some workers exit employment altogether (adding non-employment as another choice to the set of establishments). The empirical specifications and how we identify the response to immigration is the focus of the remaining of this section.

6.3 Empirical Specifications

In an economy in which workers and firms are heterogeneous and in which mobility is imperfect and costly, analyzing the effects of immigrants on workers within firms, across firms and across municipalities in the short and long run can provide a complete picture of the impact of immigration on natives. Hence, the rich set of outcomes and the variety of empirical specifications help provide a more complete picture of the margins and mechanisms of adjustment.

[27] Malchow-Møller, Munch, and Skaksen (2011, 2012); Malchow-Møller et al. (2013); Parrotta, Pozzoli, and Pytlikova (2012) produce estimates of the effect of hiring immigrant workers on firm outcomes and worker outcomes within the firms. Kerr and Lincoln (2010) exploits the H-1B visa reform to estimate the effect of high skilled immigration on the patenting activity of 77 large firms.

6.3.1 Effects within Establishment or Municipality: The Spell Regressions

The first specification focuses on the effect of immigration on the wages, occupational complexity, career mobility and labor supply of workers within an establishment (the first component of expression (3)) or within a municipality (the sum of the first two terms in expression (3)). It does not consider the potential effect of immigration on workers who move out of the municipality or become non-employed or self-employed. Hence, important displacement effects of immigration will be lost by this approach if immigration, for instance, increases separation rates and workers experience unemployment periods. Moreover, this approach is based on year-to-year within spell-variation and it misses the long-run cumulated effects of immigration. These shortcomings will be addressed in the next section 6.3.2.

The outcomes relative to native (NAT) individual i in establishment j in municipality m at time t will be indicated as the variable y_{ijmt}^{NAT} in regression (4) below. The first outcome analyzed is occupational complexity. We consider three outcomes relative to career mobility: upgrade, downgrade and simply mobility. Then we analyze the logarithm of hourly wages, the logarithm of annual earnings and the log of employment, measured as a fractional value of a complete working year. The main explanatory variable is the non-EU immigrant (or Refugee) share of employment in municipality m and year t, S_{mt}^{nonEU}, calculated as F_{mt}^{nonEU}/P_{mt}, where F_{mt}^{nonEU} is the stock of employed immigrants of non-EU origin and P_{mt} is the total employment in municipality m and year t. In the 2SLS specifications we instrument S_{mt}^{nonEU} with $\widehat{S}_{mt}^{nonEU}$ that we describe and discuss in section 6.4. The regression has the following structure:

$$y_{ijmt}^{NAT} = x_{it}'\alpha + \beta S_{mt}^{nonEU} + \phi_{t,IND} + \phi_{t,REG} + \gamma_{i,u} + \varepsilon_{ijmt} \tag{4}$$

The variable x_{it} is a vector of time-varying individual characteristics including age, labor market experience, experience squared, job tenure, tenure squared, education, and whether the person is married. $\phi_{t,IND}$ and $\phi_{t,REG}$ are industry-by-time and region-by-time effects capturing regional and industry-specific time patterns. Regions are the five administrative regions in Denmark and industries are the eight industries of the 1-digit NACE industrial classification scheme.[28]

The key set of controls in regression (4) is indicated by $\gamma_{i,u}$. It represents fixed effects for each individual (i)-unit (u) pair. Depending on which unit we choose, the inclusion of these effects allow us

[28]The regions and industries are listed in Table 2.

to identify the impact of immigration on outcomes for different groups of native workers. In the first set of regressions we choose the unit u to be an establishment, j. In this case the set of fixed effects $\gamma_{i,j}$ will vary for each different employee-establishment pairing.[29] This is a demanding specification and it implies that our regression controls for any unobserved heterogeneity that is specific to the worker-establishment match (job spell). The regression identifies the impact of an increased supply of non-EU immigrants in the municipal labor market on the outcome of native workers within job-spell.[30] The results of these regressions shed light on the effects for workers within firms (establishment) when an inflow of immigrants increases the availability of non-EU workers in their municipality. This corresponds to the first term of decomposition (3).

In the second set of regressions the unit u is the municipality. Hence, we include a set of individual-municipality fixed effects $\gamma_{i,m}$. These specifications controls for individual-municipality specific productivity, and they estimate the impact of immigrants on the wage, occupation and labor supply of native workers who remain within the same municipality (but may change establishment). Comparing the estimated effects using these two different types of variation allow us to distinguish the effects on workers who do not change establishment and on workers who do. More specifically, we can assess how large and significant occupation, employment, and wage adjustments are for people who do not change establishment in response to immigration, and how these adjustments compare when including all workers in the municipality.

The key explanatory variable, the share of non-EU immigrants, varies at the municipality-year level. This implies that we cannot control for a municipality-year effect, as it would absorb all the identifying variation. To minimize omitted variable bias we use the instruments described below. To account for error correlation within the level of variation of the explanatory variable we cluster standard errors at the municipality level. The estimates cannot be affected by composition effects such as the changing type of firms or of workers over time because only variation within firm-worker match are used.

[29] This is similar to the fixed effects used in Hummels et al. (forthcoming) and Malchow-Møller, Munch, and Skaksen (2011).

[30] 10.7 percent of the observations (individuals × year) are in job spells where the worker changes municipality of residence at some point during the match with the employer. This includes small moves across municipality borders and moves that are due to imperfect timing of job change and change of residence. We exclude these job spells from the within worker-firm match regressions, but results are not sensitive to whether they are excluded or included as two different job spells.

6.3.2 Following Workers: The Difference-in-Difference Approach

To identify the short- and long-run outcomes for all native workers, including those who moved out of the municipality and hence including all terms of expression (3), we use a difference-in-difference empirical approach. The goal is to follow the trajectory of wages, employment and occupation for native workers in response to the supply-driven change in non-EU immigrants described in section 5.

Previously we showed that the immigrant share increased abruptly in some municipalities beginning in 1995, while leaving other municipalities virtually unaffected. As anticipated and as we will discuss in section (6.4) below, a good predictor of the actual non-EU immigration across municipalities is the presence of non-EU communities in 1988 interacted with non-EU aggregate flows post 1995, which we call the *imputed* immigration. Predicted immigrant shares can then be obtained from a first stage regression of the actual immigrant shares on imputed immigrant shares (as well as year and municipality fixed effects). So we define as "exposed to immigration" or the "treated group" those individuals who in year 1994 were living in areas that experienced a subsequent non-EU immigration inflow above the median as measured by the *predicted* exposure. "Non-exposed" or the "control group" are those individuals who lived in areas with less than median inflow of non-EU between 1994 and 2008 as measured by *predicted* exposure.[31] Instead of using the median as a watershed between high and low exposure, we also replicated the analysis comparing the upper and lower quartile of immigration exposure (omitting the intermediate quartiles). This analysis gave larger but less precise estimates. The preferred specification showed here uses the median value as separator.

This difference-in-difference approach has another advantage. It allows us to define a pre-treatment period as the years 1991-1994 and a post-treatment period, 1995-2008. We treat mobility and outcomes after 1995 as endogenous. Hence area, region and industry fixed effects are associated to the worker considering his/her 1994 characteristics and location. We analyze the outcomes of natives in the post-treatment period and test for pre-1995 trends in native outcomes. This will test whether the performance of workers in highly exposed and less exposed municipalities (post 1995) differed already before 1995.

We implement the difference-in-difference estimates within a regression framework, by interacting M_i an indicator for exposure, corresponding to one if individual i was in a treated municipality m as

[31] Specifically, the population weighted distribution of the 1994-2008 difference in the *predicted* non-EU immigrant share is our measure of *predicted* exposure. This strategy, as opposed to using the *imputed* exposure directly, mirrors the 2SLS strategy of the other empirical specifications.

of 1994, with a set of year dummies, $D(year = t)$, that are one in the relevant year and zero otherwise. The coefficients γ_t in equation (5) below capture the difference in outcomes from 1991 (year -3) to 2008 (year 14) between treated and non-treated individuals. Year 1994 is year 0 and the coefficient for that year is standardized to 0.

$$\begin{aligned} y_{imt}^{NAT} &= \tilde{x}_i'\alpha + \sum_{t=-3}^{-1} \gamma_t M_{im} D(year = t) + \sum_{t=1}^{14} \gamma_t M_{im} D(year = t) + \\ &\quad + \tilde{\phi}_{t,IND} + \tilde{\phi}_{t,REG} + \tilde{\phi}_{t,EDUC} + \tilde{\phi}_{t,OCC} + \tilde{\phi}_m + \varepsilon_{it} \end{aligned} \tag{5}$$

A tilde indicates variables that are measured in year 1994; hence, they capture individual characteristics before the non-EU immigration boom. Equation (5) is estimated using a strongly balanced panel to be able to identify the effect on individual workers (unaffected by compositional changes and non-random sorting across industries and areas). We include fixed effects for the 1994-municipality of the worker, $\tilde{\phi}_m$, and industry-by-year, $\tilde{\phi}_{t,IND}$, region-by-year , $\tilde{\phi}_{t,REG}$, education-by-year, $\tilde{\phi}_{t,EDUC}$ and occupation-by-year $\tilde{\phi}_{t,OCC}$[32] fixed effects.[33] The remaining controls $\tilde{x}_i$ are as those defined as in equation (4), but relative to the worker in year 1994.

Consistently with the model of section 6.3.1, we consider as outcome variables, y_{imt}^{NAT}, occupational complexity, hourly wages, annual earnings and employment as fraction of the full-time year worked. The new information in this approach is that we can follow all workers including those that endogenously decided to leave the area or to leave employment, and that this framework allows us to examine the pre-1995 trends of native outcomes.

To capture the effect of immigration on the probability of transition out of the establishment or out of the municipality (i.e. the specific impact on term $I_{ij}(S + \Delta S) - I_{ij}(S)$ in section 6.2) or out-of employment we calculate the cumulative fraction of each year spent in the initial and in new establishments and municipalities as well as in unemployment. We also calculate the cumulative effect on the present discounted value of earnings to summarize the overall impact on the exposed workers

[32]The occupations are: skilled worker, intermediate professional, higher grade professional and managerial position within the firm.

[33]As we include municipality and year effects in the model we omit year 1994 in the interactions with the "treatment" effects. Hence, 1994 is the reference year, namely year 0 in the event. We let NACE 1 in 1991 be reference for the industry-by-year effects, and leave all year effects for one region, education and occupation out. Lastly, since the municipality fixed effects are collinear with region-year fixed effects, one municipality per region is left out.

1995-2008. The regression on these cumulated variables looks as follows:

$$\Delta y^{NAT}_{i,m,1995-2008} = \alpha \tilde{x}'_{i,1994} + \beta \Delta S^{nonEU}_{m,1994-2008} + \tilde{\phi}_{IND} + \tilde{\phi}_{REG} + \tilde{\phi}_{EDUC} + \tilde{\phi}_{OCC} + \varepsilon_i \qquad (6)$$

$\Delta y^{NAT}_{i,m,1995-2008}$ is the cumulated 1995 and 2008 outcomes, and $\Delta S^{nonEU}_{m,1994-2008}$ is the actual change in the immigrant share from the pre-treatment year 1994 to 2008. To avoid correlation between the changes in non-EU immigrants and unobserved municipality-specific shocks we instrument the change with the imputed supply-push variable that we now describe. This regression is simply a cumulated version of equation (5). Standard errors are clustered at the municipality level in both equations since this is the level of variation in our variable of interest.

6.4 Identification and Instrumental Variable

Our explanatory variable of interest measures non-EU migrants as a share of employment in the municipality m at time t (or the change in those shares). We denote this as S^{nonEU}_{mt}. The inflow of non-EU immigrants may be correlated with unobserved demand shocks. In all specifications we control for the time invariant differences between municipalities, and for the industry- and regional-level fluctuations in demand. Nevertheless, we may be left with some municipality-specific unobserved shock affecting both native and immigrant labor demand. Therefore we build an instrument based on the distribution of non-EU population by nationality across municipalities in Denmark as of year 1988, six years before 1994-95 the acceleration in the non-EU immigration. In an alternative instrument, we use the 1994-distribution of refugees. Our hypothesis is that the geographic distribution of early non-EU communities and the distribution of early refugees produced by the Spatial Dispersal Policy (1986-1994) are both uncorrelated with the post-1995 labor demand changes across municipalities.

We then use the national inflow of non-EU immigrants, or refugees only, by nationality, driven mainly by country of origin political and economic crises, and independent of municipality-specific economic shocks. Interacting these aggregate national inflows and the municipality pre-existing shares we obtain the supply-driven increase in non-EU immigrants in each municipality. This method is not new and follows the literature since Altonji and Card (1991).[34] However, the focus on non-EU immigrants and refugees, the post-1994 increase in immigration rates associated with country of origin

[34]Schmidt and Jensen (2012) show for Denmark that initial immigrant shares and subsequent immigrant inflows are positively correlated. (The municipalities they use are before the reform in 2007 where the number of municipalities was three times higher compared to the new, larger municipality definition that we employ.)

crises, the comparison with EU immigrants and the test of orthogonality with the pre-1994 trends (that we will show below) reinforce our confidence in the fact that the instrument variation is supply-driven.

Let F_{ct} denote the total population of immigrants from country c residing in Denmark in year t, and s_{cm1988} the share of that population residing in municipality m as of year 1988.[35] We then construct $\widehat{F}_{cmt}$ the imputed population from country c in municipality m in year t as follows: $\widehat{F}_{cmt} = s_{cm1988} \times F_{ct}$ and the imputed total share of immigrants with non-EU origin as: $\widehat{S}_{mt}^{nonEU} = (\sum_{c \in nonEU} \widehat{F}_{cmt})/P_{m1988}$, where P_{m1988} is the total population in municipality m in year 1988. The variation of $\widehat{S}_{mt}^{nonEU}$ is only driven by the changes in the imputed non-EU population (the denominator is held fixed at is 1988-value) and it is used as instrument for the actual share of non-EU immigrants in municipality m at time t (S_{mt}^{nonEU}).

The exclusion restriction requires that the imputed inflow of non-EU immigrants is uncorrelated with the unobserved determinants of municipal trends in labor demand and labor market conditions once we control for fixed effects and observed variables. Besides the evidence provided above, we perform some important falsification tests. In Table 3 we show whether the 1994-2008 change in the imputed non-EU labor share, our instrument, is correlated with trends in any of the outcome variables (occupational complexity, hourly wages, fraction of year worked and yearly earnings) between 1991 and 1994, the pre-immigration surge period. The unit of observation is the municipality. A significant correlation with trends that pre-date the non-EU immigrant surge would cast doubts on the validity of the instrument.[36]

The regressions of Table 3 include age, labor market experience, job tenure, (and each of them squared) and marital status averaged over the labor force in each municipality in 1994 as controls and weights each municipality by its labor force in 1994. In the upper part of the table we consider imputed immigrants including all non-EU countries. The first rows include estimates using outcomes for low skilled. In the next rows of the table we consider outcomes for high skilled natives, instead. The estimated coefficients on the pre-1994 changes are small and never statistically significant at any standard level. The last column, to the contrary, shows the correlation of the instrument change from 1994-2008 with the explanatory variable (the change in actual labor share of non-EU immigrants). The very significant coefficients and large F-statistics suggest that the instrument is strong.

[35] In the construction of the instrument, as in the analysis of the labor market and as described in section 4, the population that we consider are individuals 16 to 65 years old, not in school and not permanently disabled.

[36] In the analysis of the cohort-based transitions, in section 7.2, we will check whether there is a pre-1994 trend in the differences in outcomes between the high-immigration municipalities and the low immigration municipalities.

The lower part of the table shows the correlation with pre-1994 trends when the instrument is constructed only using countries contributing large numbers of refugees between 1986-1998 and subject to the random Dispersal Policy. Damm and Dustmann (forthcoming) exploit this policy to study the effect on criminal behavior of exposure to crime in the local neighborhood. We follow them and exclude Former Yugoslavia when considering refugees because the unusual large inflow of Bosnians in the early 1990s meant that an exemption had to be made from the random assignment to locations in order to accommodate the large number of refugees who were granted asylum (the so-called Bosnian programme, see Damm, 2009). For remaining refugee-sending, the policy guaranteed that early distributions across municipalities should genuinely be uncorrelated with economic trends. The correlation confirms this assumption, except for a significant (negative) correlation with labor supply of highly educated natives. If anything this would suggest location of refugees in municipalities with bad labor market conditions for highly skilled and would result in a downward biased estimates of the effects on highly skilled natives (which is not the main focus of our analysis).

Overall, these tests are consistent with the identifying assumption that our instrument only affects the outcomes of native workers in the municipality through its effect on the actual share of non-EU workers in the area.[37] We use the imputed non-EU share or refugee share of the labor force as an instrument in the spell regression (equation 4) and the change in the imputed non-EU share as the instrument in the difference-in-difference approach (equation 5 and 6).

Let us also emphasize that Aydemir and Borjas (2011) point out that this instrumental variable approach may not solve attenuation bias due to measurement error in the immigrant share, if a correlated measurement error is also present in the instrument. Aydemir and Borjas (2011) show that when calculations are based on one percent samples of the American census the bias can be large. The presence of fixed effects in the regression may worsen such a bias by identifying the coefficient on time differences only. Our data, however, are not subject to measurement error arising from sampling. In fact they include the *universe* of individuals and firms in Denmark. This allows us to use the full population to calculate the exact immigrant shares of each municipality limiting measurement error bias concerns.

[37] Figure A.1 and A.2 in Appendix shows the partial scatter plots of the 1991-1994 trend in outcomes on the 1994-2008 change in the instrument (thus plots corresponding to the relationships reported in Table 3) for the non-EU immigrants.

7 Results

7.1 Effects within Establishment and Municipality

Tables 4 and 5 show the 2SLS estimates of the effect of immigrants on natives within establishments and within municipalities, respectively. The corresponding OLS estimates are reported in Tables A.1 and A.2 in Appendix. The tables show only the estimates of the coefficient of interest β from specifications (4). Each entry in the tables is an estimate from a different regression using different outcomes (listed as rows), and using the instrument based on all non-EU immigrants (Columns 1 and 3), or on refugees only (Columns 2 and 4).[38]

The first two columns identify the effects for natives without post-secondary education, that we call "low skilled". Columns three and four show the estimated effects for native workers with tertiary education ("high skilled"). We separate the analysis between the two skill groups because, as described in section 3, immigrants from non-EU countries, as a group, were more likely to compete with low-skilled Danish workers and to complement highly skilled Danish workers.

The structure of Tables 4 and 5 (and Tables A.1 and A.2) is the same. The first row shows the effects of an increase in non-EU immigrants by one percentage point of the labor force on the occupational complexity of native workers. The second, third and fourth rows report the estimated effects on the probability of a career upgrade, a career downgrade and a change in occupation. The fifth row reports the effects on the (logarithm of) hourly wages. The sixth row shows the effect on the (logarithm of) annual earning. The seventh row shows the effect on the fraction of the full-time year that the individual worked. The number of observations, the F-statistic, and the coefficient on the excluded instrument in the first stage regression appear in the last rows of the table. In parenthesis under the estimates we report the heteroskedasticity robust standard errors clustered at the municipality level to account for within municipality error correlation.

A tendency of immigrants to settle in areas with fast growing labor demand would generally produce an upward bias in the OLS estimated coefficients. However, as we consider non-EU immigrants doing manual-type of jobs that are potentially attracted by low housing costs, one may think that the correlation between the inflow of these groups and the economic conditions of a municipality can be negative, which would result in downward biased OLS estimates. In the specific case considered here,

[38]The extremely high dimensionality of the fixed effects $\gamma_{i,u}$ implies that the fixed effects estimator has to be implemented by performing a within-transformation. This is inconsequential since we are not interested in the fixed effects per se and hence we do not miss any relevant estimate.

the differences between the OLS estimates and 2SLS estimates show a downward bias of OLS which might suggest a negative correlation between the actual inflow and the contemporaneous labor market conditions.

The instrument is reasonably strong with a F-statistics of the first stage always above 20. Usually researchers consider a value of 10 as threshold below which one could incur in weak instrument problems (Stock and Yogo, 2005). Using non-EU immigrants or refugees to construct the imputed instrumental variable produce qualitatively similar effects. However the point estimates using the refugee instrument are usually larger. This could indicate that the refugees are a more homogenous group of workers focused in manual jobs, and thus more strongly complementary to natives. The more heterogeneous composition of workers in the non-EU group could produce an attenuated effect.

The first interesting result is that on average hourly wages, annual earnings and labor supply increase (not always by a statistically significant amount) in response to immigration for skilled and unskilled native workers, both within establishment and within municipality. Within establishment (Tables 4) both low skilled and high skilled exhibit some evidence of career upgrade, higher hourly wages and larger labor supply, especially in response to refugees. Within municipality (Table 5), including workers who change establishment, low skilled natives exhibit a large and significant shift towards occupational complexity. Among less skilled workers, those remaining within establishments seem to achieve the wage gains without specialization, while those moving between establishment show large occupational changes towards complex jobs. This could happen if natives who do not have to change establishment are those performing less manual intensive jobs that are less substitutable with immigrants. Those who are pushed to change establishments, instead, performed manual intensive jobs and moved towards more complex jobs to protect their wages. The ability to disentangle these responses allows us to identify these important differences between less skilled workers who do and do not change establishments.

High skilled workers increase their specialization towards complex occupations significantly less. Immigrants are likely to be complementary to high skilled natives and increase their wages and earnings even in the absence of occupational specialization of high skilled natives. This is reasonable as high skilled natives already perform production tasks quite different from immigrants. An interesting implication of our results is that, in general, immigration spurs occupational mobility of natives, including more career upgrade as well as more downgrade for those who move out of the establishment.

While on average this mobility rewards natives with higher wages and employment (though not always significant), it is also likely to increase the variance in performance of natives. Immigrants generate an opportunity for natives: those who take advantage of it by upgrading skills gain, while those who do not may lose.

Quantitatively the estimated effects are non trivial, but not unreasonably large. Municipalities exposed to above-average immigration experienced a growth of the non-EU share of employment 2 percentage points larger than the municipalities below-average. This translates, over the 1995-2008 period in 1.0% and 1.8% higher wages for low skilled and high skilled native workers, respectively, within an establishment (almost 4% looking at the refugee immigrants). If we consider the effect on all native workers in the municipality, including those who changed establishment, the average gain for less skilled is an insignificant 0.2% while high skilled gained 2.2% of their hourly wages (2.6% and 4.3% using the refugees). For comparison, the overall increase in average real wages in Denmark during the 1994-2008 period was 18 percentage points for less skilled workers and 19 percentage points for high skilled. One tenth of the wage gain of more educated during this period can be attributed to immigration.

Taken together these results suggest that non-EU immigrants encouraged low-skilled natives to take more complex occupations especially when they changed establishment. On average native wages increased in the local labor market, but the variance of native outcomes increased also and was driven by significant downgrade and upgrade among those who (involuntarily and voluntarily) changed establishment during the surge in the non-EU share in the municipality.

7.1.1 Differences Across Sectors

Pushing the analysis a step further, it is reasonable to think that the degree of complementarity and task specialization/upgrade available to natives in response to immigrants depends on their industry of employment. In industries producing differentiated goods or services and using a larger range of manual and complex abilities, the need for differentiated skills, and the complementarity across workers may be larger. In industries producing more homogenous goods and services, with limited varieties of skills, the opportunities for these gains from complementarity/diversity may be smaller. A second feature that could make workers and firms more responsive to immigration is their exposure to market pressures. Private sector workers should be able to move across occupations more easily

and firms would have stronger incentives to encourage efficient worker allocation and specialization, with stronger potential for the observed specialization/complementarity effects, especially in sectors were wages are bargained at the establishment level. Both mobility and decentralized bargaining were feature of the private sector. In the public sector, instead, workers' wage and firms' specialization may not respond actively to local complementarity as pay is centrally determined and natives simply defend their occupational status as insiders. .

To examine these differences we divide the economy in four broad sectors. The first is manufacturing, the sector producing goods, several of which can be highly differentiated and exposed to international competition. The second is non-complex services (utility, construction, wholesale, retail and hospitality services) producing non-tradable, local and manual-intensive services. The third is complex services (transport, telecommunication, finance, business and real estate) producing differentiated and more sophisticated, skill-intensive services. The last is the public sector (including mainly administration, health care, education and armed forces) whose wages and employment level may be much less responsive to the market and to productivity. Table 6 shows the effects of non-EU immigrants on native workers analyzing each of the four sectors defined above separately and only reporting occupational complexity and hourly wages as outcomes.

Consider first the effects on low skilled workers. The largest positive and significant effects on occupational complexity and hourly wages are experienced by native workers in the complex service sector. The magnitude of the effect is quite large: a one point increase in the non-EU immigrant percentage of the labor force produces an increase in native hourly wages between 1.7% and 2.1%, depending on whether we consider only within establishment or within municipality. Their mobility towards occupational complexity is similarly strong implying a growth by 2.6 to 4.3 percentage points in the complexity index for each increase of non-EU immigrants by one percentage of the labor force. Highly skilled natives in the complex service sector were also positively affected in their wages, without any effect on the complexity of their occupation, as expected.

Low-skilled natives in the non-complex service sector and manufacturing sector were much less affected; experiencing a significant effect only on hourly wages for workers in manufacturing when we considered within-municipality effects. High skilled natives experienced positive effects on wages in non-complex services, indicative of complementarity at work, and positive effects on the complexity of their occupations. Interestingly, low skilled native workers in the public sector were the only group

experiencing negative effects on their hourly wages. Probably because of the lack of mobility and job turnover in that sector. They did not respond to immigrants with any move towards more complex occupations. In the public sector immigration had a negative effect on complexity of tasks performed by skilled natives, the effects on hourly wages, however, was positive.

These results confirm the idea that the gains from complementarity and specialization are larger in complex, diversified sectors that respond to private incentives. In those sectors natives increased the complexity of their occupations in response to immigration, and the high skilled gained directly from complementarity with immigrants. Hence, both low and high skilled natives in complex industries are able to increase their marginal productivity in response to immigration. In sectors with less scope and no private incentives for differentiation (the public sector) natives do not move towards complex jobs and high skilled even decrease their progression towards more complex jobs. High skilled in the public sector still increase their marginal productivity due to their complementarity with immigrants, but the wages of low skilled in the public sector decrease due to competition effects from immigrants without adjustment.

The results of this section add several new findings to the literature. While it was known from Peri and Sparber (2009) that immigration can cause specialization and positive productivity effects for natives, we learn using individual data that occupational mobility of unskilled natives towards more complex jobs in response to immigrants takes place mainly across firms. It also increases wage dispersion such that some workers may experience significant downgrade while other experience upgrade with resulting zero or positive effects on the wage of an average unskilled worker. Specialization is strongest when movers across firms are considered. The gains from specialization offset the loss of firm-specific human capital. We also learn that the positive effects are stronger in sectors producing complex differentiated goods and services and follow market incentives. As in D'Amuri and Peri (forthcoming) and Angrist and Kugler (2003) this seems to support the idea that mobility and flexibility are important characteristics for the firms and workers to earn productivity dividends from immigration.

7.2 Transitions in the Difference-in-Difference Approach

The whole trajectory of the difference in outcomes between three years before and fourteen years after the surge in the immigrant share (1994) based on the specification in equation (5) are shown in Figure

6.[39] As usual we separate the effects on more and less educated natives and show the trajectory of four different outcomes: occupation complexity, hourly wage, annual earning and fraction of year worked. The figure show three important results. First, except for hourly wages of highly educated, which show a slight upward trend before 1994, there is no sign of a pre-event trend in the other differences in outcomes between treated and control municipalities. This is reassuring and it confirms that after controlling for individual characteristics, constant and time-varying fixed effects there was no systematic difference in the trend of wage, employment and occupational complexity of natives before 1994 between high- and low-immigration municipalities.

Second, confirming the within-spell regressions, we find clear evidence that both more and less educated native workers moved, slowly but steadily, towards more complex occupations in response to high non-EU immigration. Fourteen years after 1994 (1994 is denoted as year 0 in the graph) natives in high immigration municipalities had moved to more complex jobs resulting in a significant effect equal to 3 points of the complexity index (see Table A.3 and A.4 in Appendix). This corresponds to a small but significant change of the complexity of an occupation, equal to 4 percent of a standard deviation in the complexity index in the Danish population.

Third, in part as a consequence of this occupational move there is also evidence of a positive effect on hourly wages of less educated in the medium run (3 to 9 years after the beginning of the event), while in the long run the effect is less clear. No significant effect on employment, measured as fraction of year worked, of either group is found in the short and medium run. Towards the end of the response period (after 10 years) a small, barely significant effect on labor supply (positive for high skilled and negative for low skilled) appears to arise. However, as we will see below, these effects are mainly due to older workers who 11 to 14 years after the event might go on early retirement.[40]

These results confirm some findings of the spell regression and at the same time are the first results in this literature, to the best of our knowledge, obtained by following over time (and across municipalities) a cohort of individuals working in municipalities with high or low exposure to immigrants. Hence, this is the first time that we can track the actual workers exposed to an exogenous change in competition from immigrants and measure the impact on their wages, specialization and employment over time. These estimates cannot be driven by changes in composition or selection out of the municipality as the composition of the group is kept constant. They confirm a clear result revealed in

[39] Table A.3 and A.4 in Appendix report the estimates for selected years before and after the surge in immigration.
[40] Effect of immigrants on early retirement can be an additional outcome to analyze. We leave it for future research.

the spell regression, that natives moved to complex occupations in response to immigrants and that wages increased or remained unchanged, and add to this finding that natives were not displaced out of employment.

The magnitudes of the positive effects estimated for the medium to long run in Table A.3 (5 to 9 years) are larger than those estimated in the spell regression for the low skilled but similar for the high skilled. After nine years from 1994 the difference in share of non-EU immigrants between treated and non-treated municipalities was about 1.25% of the labor force. The effect on the wage of less skilled was a positive 1.1 percentage points and for the high skilled was a (non-significant) 0.7 percentage points. This implies and elasticity of 0.9 and 0.6 (respectively for low and high skilled), while the within municipality estimates of those elasticities in Table 5 were 0.1 and 1.1. This suggests that those who changed municipality were differently selected among the low and high skilled, and that the contemporaneous effects estimated in the spell regressions can be different from the long-run effect on all workers. The wage effects for high skilled seem more modest in the long run, when considering also those workers who changed municipality.[41] For the low skilled, instead, their hourly wages slowly increased in response to immigration when considering all workers, revealing positive medium and long run effects.

Analyzing the full transition for less educated workers (Figure 6) we see how the long-run effects accrue over time. In particular we can observe a progressive increase in the occupational complexity, faster in the first five years after the shock. Hourly wages also climb in the first five years and then stabilizes to a permanently higher level. At the same time, we do not observe any significant change in labor supply in the first 9 years after the event. Only towards the very end a slight decline (barely significant) may be due to early retirement behavior (as we will discuss below the effect is driven by older people). Patterns are similar for highly educated, with positive and occasionally significant effects on hourly wages and employment and a progressive and significant increase in the occupational complexity. Towards the end of the period there is an increase in labor supply for highly skilled in treated municipalities, and again it may have to do with their retirement behavior. Overall, there is no evidence of negative effects from displacement, wage competition and loss of specific capital, when we consider all workers exposed to immigrant competition. Low skilled slowly move towards more complex tasks thereby raising their productivity and wage. This margin of response, considering all

[41] We should be cautious, however, as the difference for high skilled is not significant if we consider the standard errors. Moreover we found a pre-1994 trend for high skilled wages which can pollute the estimates.

workers seems to show a more beneficial effect in the long run.

7.2.1 Transitions for Different Groups

To complete the picture of the native labor market transitions following the non-EU immigration surge we consider two further partitions of the native labor force (besides the usual split into more and less educated). First, we consider young and old workers, namely those who were 21 to 36 years old in 1994 and those 37 to 51. All those workers were still below the statutory retirement age (65) as of 2008. The older workers (aged 46-51 in 1994) turn 60 within the last years of the transitions and thereby become eligible for early retirement pension ("efterløn"). The second dimension we consider is the tenure of workers in the establishment as of 1994. We call "low tenure" those workers with less than average tenure (4.35 years) and "high tenure" those with more than 4.35 years of tenure at the establishment, at the time of the beginning of the immigration boom. In both cases we can expect the group of young, low-tenure workers to have lower costs and more opportunities to upgrade and change their occupation. If the opportunity of wage gains from immigration is in part linked to the ability of upgrading and increasing one's occupational complexity, then low tenure, young workers should be better positioned to take advantage of it.[42]

Figures 7 and 8 show the transitions of the usual four outcomes (occupational complexity, hourly wage, annual earnings and fraction of year worked) separately for old and young workers (still separating high and low skilled). Figures 9 and 10 show the split between outcomes of high and low tenure native workers. The results are as expected. For less skilled natives Figures (7 and 9) show that the low-tenure workers are those who respond to immigration with stronger move towards higher occupational complexity in treated municipalities. This implies larger hourly wage gains for them. Young low skilled workers have also larger hourly wage gains, relative to old low skilled workers in treated municipalities. The labor supply of young low skilled workers does not respond significantly in treated municipalities, nor does the labor supply of old low skilled workers, except in the last 3-4 years when a decline in the treated municipalities may be due to early retirement behavior.

The reallocation towards more complex jobs is less noisily estimated for high skilled workers (shown in Figures 8 and 10). Young and low-tenure high skilled workers experience more significant mobility towards occupational complexity in treated versus untreated regions compared to similar low skilled.

[42] We also examined the transitions by sector of employment in 1994 (Figures A.3 and A.4 in Appendix). These results confirmed our findings in the spell regressions.

Whether this translates into higher wages as for the low skilled is harder to establish though, since wages for young and low-tenure high skilled workers exhibit a bit of a pre-trend. Older and high-tenured ones, have a smaller increase in occupational complexity and no significant effect on hourly wages and earnings.[43]

Separating between groups also shows that the decline observed in labor supply after 9 years from the event is mainly due to older worker and hence possibly driven by early retirement behavior. It is possible that the only long-run displacement effect of immigrants on less educated natives is to push some of them into early retirement. Overall, the largest benefit from immigration accrue to young, less experienced workers who can direct their careers towards more complex occupations, complementary to immigrant skills. Their upgrade may imply some further training, but it does not need to come at the expenses of labor supply.[44]

7.3 Cumulated Effects in the Difference-in-Difference Approach

Table 7 (low skilled) and Table 8 (high skilled) report the estimated effects of an increase in non-EU immigrants by one percentage point of the labor force on cumulated variables (over the 14 years). Those estimates are based on equation (6). The first line reports the impact on employment including all sectors (column 1), and then in turn considering natives initially in manufacturing, non-complex services, complex services and the public sector (column 2-5). The following rows produce estimates of the increased (decreased) length of employment in the same (and new) establishment, in the same (and new) sector and in the same (and new) municipality in response to non-EU immigration increases by one percentage point of the labor force. Then we show the effects on the length of cumulated unemployment and self-employment.

The estimated coefficient in the first column and row of Table 7 implies that less educated native workers in municipalities receiving an increase in non-EU immigrants equal to one percentage point of the labor force experienced a non-significant decline in cumulated employment (over fourteen years) by five percent of one work-year, namely two working weeks. A high skilled native also experienced an

[43] In the Figure A.5 and A.6 in Appendix we show the split in transition between men and women. The strongest positive effects on complexity and wages are for men.

[44] In a further analysis (shown in Figure A.7 of the Appendix), we find that the probability of low skilled obtaining a higher degree increases by 2 percentage points given a one percentage point increase in the non-EU immigration share of the municipality, and that the effect accrued mainly in the early years of the immigration boom. The effect was driven by vocational education which is often organized as training programmes that allow workers to obtain formal competencies on the job. No significant effects on educational upgrading are found for high skilled or older workers.

insignificant change to their cumulative employment over the fourteen year period (Table 8).[45] Hence, non-EU immigration did not have any significant effect overall on cumulative employment of native individuals. Similarly, immigration did not affect the cumulative time spent as unemployed either for low or for high skilled natives. In Table 8 we see that immigration actually decreased the probability of high skilled to become self-employed, while it did not have any significant effect on probability of self-employment of less skilled.

Even more interesting is to consider the effect of immigration on cumulative employment in the same establishment, in the same sector and in the same municipality. For highly educated natives immigration increased the time spent in a new establishment and municipality and decreased the time spent in the original one. For low skilled this effect is significant only for the municipality. On average highly educated natives spent six weeks less in the same establishment over the following 14 years, for each increase of non-EU immigrants by one percent point of the workforce. Similarly, they spent 15 working weeks less in the original municipality and 15 weeks more in a new one during the 14 years, if the original municipality experienced an increase in non-EU immigrants by one percentage point of the labor force. The effects were smaller, but very significant in terms of municipality switching, also for less educated natives. Hence cross-municipality mobility of natives was positively affected by non-EU immigration. Cross-sector mobility was not much affected by immigration, except for workers in the manufacturing sector who moved out of municipalities with high immigration earlier, while workers in the complex service sector remained longer in their original sector when experiencing higher immigration rates. Immigration, therefore, was associated with a movement of the native labor force away from manufacturing and into complex services. This is consistent with the findings of section 7.1 and 7.2 that natives move towards more complex tasks in response to immigration. These moves are likely to be associated with wage and earnings gains that may offset and reverse the cost of moving across establishments and sectors due to loss of specific human capital.

Overall immigration seems to increase the churning of jobs and generate a tendency of moving towards more complex jobs, a higher tendency to moving out of the establishment and out of the municipality and out of the manufacturing sector into more complex and differentiated industries.[46] Most of these changes are associated to upgrades and better opportunity, rather than to displacement

[45] We are using 46 weeks as the usual full-time work-year for a Danish worker.

[46] This effect is also consistent with a potential job-creating effect of immigrants that increases the job finding rates for natives, as illustrated by Chassamboulli and Palivos (2014).

and loss of skills, as they may generate increases in wages and yearly income. The probability of being employed or unemployed was not affected.

8 Discussion and Conclusions

In this paper we have used a unique source of individual and firm data during a period that contains a sustained and supply-driven boom of non-EU immigrants to Denmark. We estimate the short- and long-run effects of this boom on native occupations, wages, and employment. The fact that our data allows us to follow every single worker in Denmark and the high quality of the register information imply high reliability. It also implies that we can analyze immigration's effects on workers who remained within the original establishment as well as those who left establishment and municipality. We can also estimate the effects of immigration on mobility of workers across establishments, municipalities, and in and out of employment. Lastly, we exploit a quasi-experiment where we observe a pre-period in which Danish municipalities essentially saw no change in their non-EU immigrant share, followed by a period of large inflows of non-EU refugees to Denmark that were driven by political and economic crises in sending countries. Importantly, the Danish municipalities where such refugees ended up in were exogenously determined by randomized government dispersal policies, and by immigrant preferences to locate in areas with pre-existing immigrant enclaves.

We find robust evidence that native workers, especially less skilled, within and across municipalities responded to immigration increasing significantly their mobility towards more complex occupations. Immigration also increased mobility of natives across firms and out of the municipality. We do not observe an increased probability of unemployment, nor a decrease in employment. Hourly wages of less educated natives were on average positively affected by immigration, the effect increases as the low skilled gradually moved towards more complex occupations.

We think that this analysis is much richer and detailed than ever done before in that it analyzes individual responses of natives to immigrants within and across firm and local labor markets. We produces a much more detailed picture of the impacts of immigration by tracking occupations, careers, wages and employment of natives in response to immigrants. We also show the importance of looking at the dynamic adjustment mechanisms for native workers and looking at individuals in a municipality as well as to include those who (endogenously) may leave over time. We hope that the future analysis of the impact of immigration in several other countries may follow the detail and the approach adopted

in this paper.

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Figure 1: Foreign born share in Denmark, 1991-2008

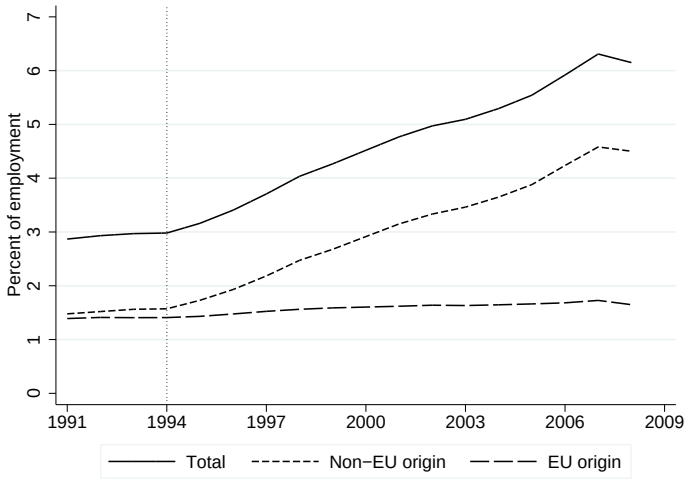
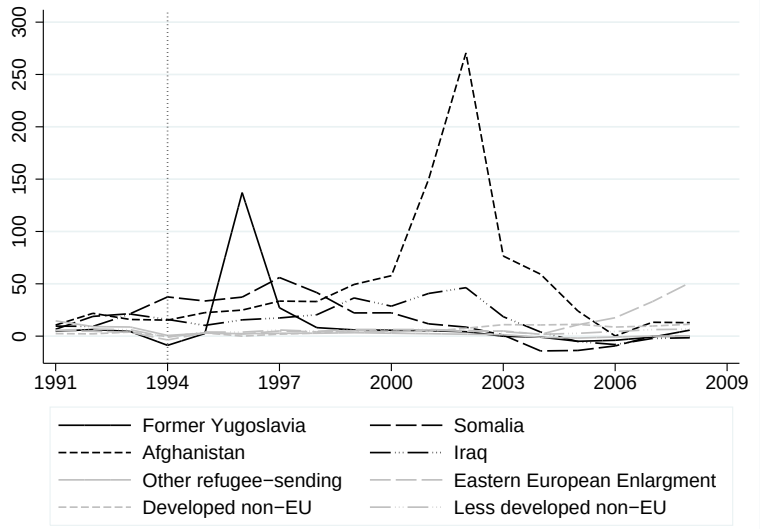


Figure 2: Drivers of non-EU immigration growth, 1991-2008



Notes: Annual inflows in percent of populations in 1994.

Figure 3: Decomposed non-EU share in Denmark, 1991-2008

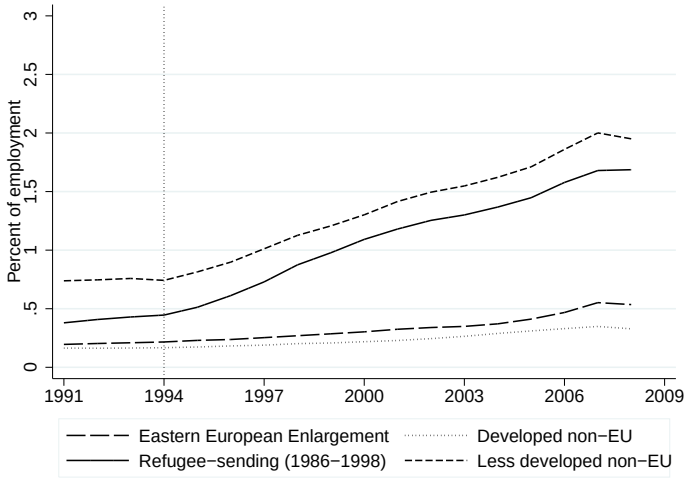
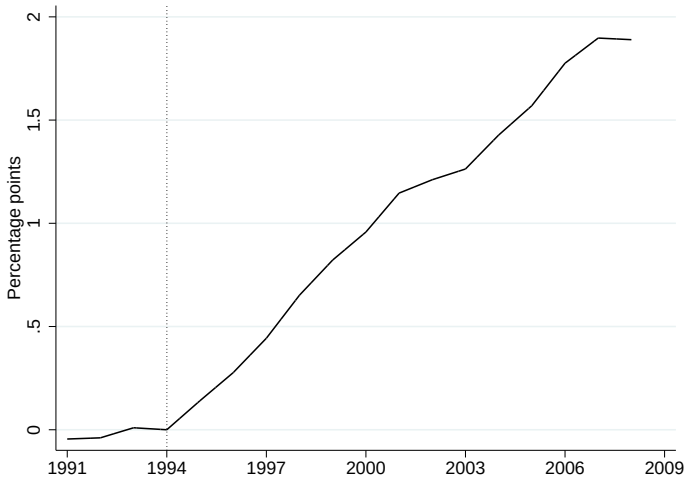
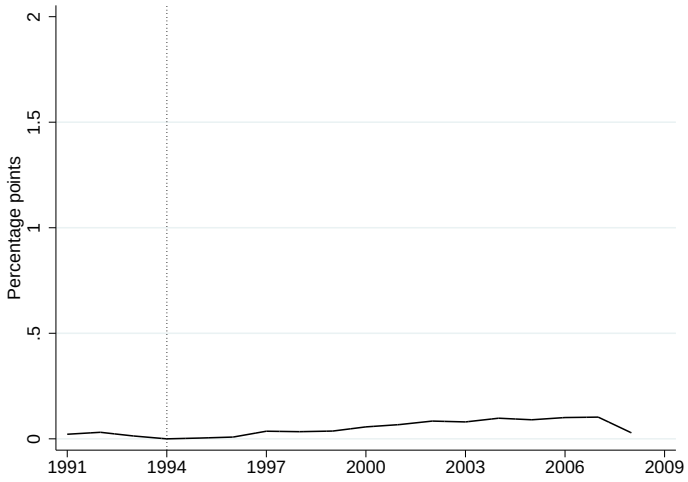


Figure 4: Differential trend in non-EU share of employment



Notes: Difference in actual non-EU share of employment for employed natives above versus below the median of the 1994-2008 difference in predicted non-EU share, normalized to zero in 1994.

Figure 5: Differential trend in EU share of employment



Notes: Difference in actual EU share of employment for employed natives above versus below the median of the 1994-2008 difference in predicted non-EU share, normalized to zero in 1994.

Table 1: Skill content of occupations and their non-EU inflow between 1994-2008

	Non-EU share	Skill content of occupation			
	1994-2008 dif.	Cognitive	Communication	Manual	Complexity
Lowest inflow					
Managers of small enterprises	-0.018	0.666	0.677	0.432	1.136
Legislators and senior officials	0.002	0.897	0.989	0.303	1.828
Corporate managers	0.003	0.796	0.796	0.367	1.488
Armed forces	0.003	0.441	0.390	0.633	0.225
Skilled agricultural and fishery workers	0.007	0.362	0.248	0.736	-0.328
Highest inflow					
Drivers and mobile plant operators	0.039	0.352	0.265	0.810	-0.322
Laborers in mining, construction, mfr. and transport	0.045	0.215	0.156	0.769	-0.783
Machine operators and assemblers	0.057	0.276	0.146	0.790	-0.655
Other elementary occupations	0.087	0.260	0.205	0.742	-0.633
Sales and services elementary occupations	0.148	0.126	0.103	0.695	-1.234

Notes: The skill content of each occupational grouping (2-digit ISCO) is the population weighted average of the underlying occupations (4-digit ISCO).

Table 2: Summary statistics for spell-sample

	Low skilled				High skilled			
	Mean	S.d.	Min	Max	Mean	S.d.	Min	Max
Age	38.17	12.26	18.00	65.00	43.28	9.95	18.00	65.00
Labor market experience	15.03	10.13	0.00	45.00	19.39	9.31	0.00	45.00
Job tenure	4.29	5.52	0.00	28.00	5.63	6.23	0.00	28.00
Married	0.48	0.50	0.00	1.00	0.63	0.48	0.00	1.00
Education, primary	0.64	0.48	0.00	1.00	0.00	0.00	0.00	1.00
secondary	0.15	0.36	0.00	1.00	0.00	0.01	0.00	1.00
vocational	0.16	0.37	0.00	1.00	0.57	0.50	0.00	1.00
higher	0.04	0.21	0.00	1.00	0.43	0.50	0.00	1.00
Region, Northern Jytland	0.11	0.32	0.00	1.00	0.10	0.30	0.00	1.00
Central Jytland	0.23	0.42	0.00	1.00	0.23	0.42	0.00	1.00
Southern Denmark	0.23	0.42	0.00	1.00	0.21	0.41	0.00	1.00
Greater Copenhagen Area	0.27	0.45	0.00	1.00	0.31	0.46	0.00	1.00
Zealand	0.15	0.36	0.00	1.00	0.15	0.36	0.00	1.00
Agriculture, fishing and quarrying	0.03	0.16	0.00	1.00	0.01	0.10	0.00	1.00
Manufacturing	0.23	0.42	0.00	1.00	0.17	0.38	0.00	1.00
Electricity, gas and water supply	0.01	0.07	0.00	1.00	0.01	0.09	0.00	1.00
Construction	0.09	0.28	0.00	1.00	0.06	0.24	0.00	1.00
Wholesale and retail sale, hotels and rest.	0.18	0.38	0.00	1.00	0.14	0.34	0.00	1.00
Transport, post and telecommunications	0.10	0.30	0.00	1.00	0.05	0.23	0.00	1.00
Finance and business activities	0.09	0.29	0.00	1.00	0.14	0.34	0.00	1.00
Public and personal services	0.28	0.45	0.00	1.00	0.42	0.49	0.00	1.00
Occupational complexity	0.13	0.90	-2.69	2.11	0.66	0.81	-2.69	2.11
ln(Hourly wagerate)	5.03	0.38	0.13	9.17	5.24	0.35	-0.17	10.01
ln(Annual earnings)	12.33	0.50	7.05	16.97	12.60	0.44	4.20	17.96
Fraction of year worked	0.92	0.17	0.00	1.00	0.95	0.13	0.00	1.00
Observations	1787910				3154753			

Notes: Employed natives 1995-2008. High/low skilled is defined as the individual enters the panel. Some low skilled upgrade their education level while at the labor market (16% that start out with no post-secondary education obtain a vocational education and 5% obtain a higher education). Native-municipality combinations that are singletons are dropped, since they would not contribute to any of the spell-regressions because all spells are nested within municipalities.

Table 3: Instrument power and correlation with pre-trends in native outcomes

	1991-1994 difference in average				1994-2008 dif.
	Occupational complexity	Hourly wage	Annual earnings	Fraction of year worked	in actual share
			Non-EU		
Low skilled					
1994-2008 dif. in instrument	0.277	-0.091	0.325	0.029	0.519***
	(0.269)	(0.155)	(0.401)	(0.130)	(0.122)
F-statistic instrument	1.06	0.34	0.66	0.05	17.98
Observations	97	97	97	97	97
R-squared	0.37	0.64	0.44	0.81	0.71
High skilled					
1994-2008 dif. in instrument	0.107	0.127	0.074	-0.158	0.574***
	(0.123)	(0.075)	(0.176)	(0.083)	(0.116)
F-statistic instrument	0.76	2.85	0.18	3.67	24.42
Observations	97	97	97	97	97
R-squared	0.69	0.74	0.47	0.81	0.72
	Refugees subject to Dispersion Policy 1986-1998.				
Low skilled					
1994-2008 dif. in imputed share	-0.344	0.273	1.361	0.160	0.409***
	(0.622)	(0.357)	(0.914)	(0.299)	(0.053)
F-statistic instrument	0.31	0.59	2.22	0.29	59.47
Observations	97	97	97	97	97
R-squared	0.37	0.64	0.45	0.81	0.87
High skilled					
1994-2008 dif. in imputed share	0.148	0.157	-0.228	-0.593**	0.483***
	(0.277)	(0.170)	(0.393)	(0.176)	(0.056)
F-statistic instrument	0.29	0.85	0.34	11.31	73.61
Observations	97	97	97	97	97
R-squared	0.69	0.73	0.47	0.83	0.84

Notes: Each regressions is at the municipality level and weighted by the size of the labor force in the municipality. The table shows correlation of instrument with pre-trends in native outcomes and with actual change in foreign born share. Controls not shown are those listed in Table 2 averaged for each municipality in 1994. Refugees from the Former Yugoslavia are excluded from the refugee-group since they constitute an exemption from the random spatial dispersion.

Table 4: Within worker-establishment spell regressions (2SLS)

	(1)	(2)	(3)	(4)
	Low skilled		High skilled	
	Non-EU	Refugee	Non-EU	Refugee
Occupational complexity	0.544	1.039	0.105	0.618
	(0.302)	(0.688)	(0.167)	(0.475)
Career upgrade	0.468**	0.893	0.478**	1.272***
	(0.175)	(0.563)	(0.185)	(0.341)
Career downgrade	0.106	0.245	0.088	0.441*
	(0.091)	(0.396)	(0.065)	(0.198)
Occupational mobility	0.574*	1.138	0.565**	1.712***
	(0.227)	(0.844)	(0.208)	(0.439)
Hourly wage	0.508*	1.816***	0.911**	2.049***
	(0.222)	(0.442)	(0.282)	(0.550)
Annual earnings	0.603*	1.960***	0.964**	1.459*
	(0.271)	(0.512)	(0.318)	(0.587)
Fraction of year worked	0.314***	0.862***	0.126	0.136
	(0.093)	(0.219)	(0.085)	(0.146)
Observations	1,541,654	1,541,654	2,883,266	2,883,266
First stage F-statistic	26.12	55.38	30.96	61.72
First stage coefficient	0.401***	0.362***	0.416***	0.382***
	(0.078)	(0.049)	(0.075)	(0.049)

Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest in equation (4) using a sample of employed natives between 1995 and 2008. The dependent variables (left column) have the same first stage except for occupational complexity that has fewer observations (some missings). Control variables not shown are: age, experience, tenure, (each of those squared), marital status, education, region by year and industry by year dummies (listed in Table 2). Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered by municipality.

Table 5: Within worker-muncipality spell regressions (2SLS)

	(1)	(2)	(3)	(4)
	Low skilled		High skilled	
	Non-EU	Refugee	Non-EU	Refugee
Occupational complexity	2.556**	4.455**	0.448***	1.661***
	(0.873)	(1.623)	(0.133)	(0.413)
Career upgrade	0.520**	1.085*	0.481**	1.091***
	(0.173)	(0.468)	(0.150)	(0.249)
Career downgrade	0.538***	1.139**	0.461***	1.217***
	(0.130)	(0.431)	(0.118)	(0.349)
Occupational mobility	1.058***	2.223**	0.942***	2.308***
	(0.285)	(0.843)	(0.263)	(0.543)
Hourly wage	0.078	1.313*	1.095**	2.173**
	(0.309)	(0.523)	(0.389)	(0.721)
Annual earnings	0.513	1.829***	0.999*	1.430*
	(0.277)	(0.539)	(0.392)	(0.671)
Fraction of year worked	0.479***	1.055***	0.079	0.165
	(0.114)	(0.191)	(0.082)	(0.117)
Observations	1,787,910	1,787,910	3,154,751	3,154,751
First stage F-statistic	24.32	51.05	28.66	56.98
First stage coefficient	0.414***	0.397***	0.429***	0.408***
	(0.084)	(0.056)	(0.080)	(0.054)

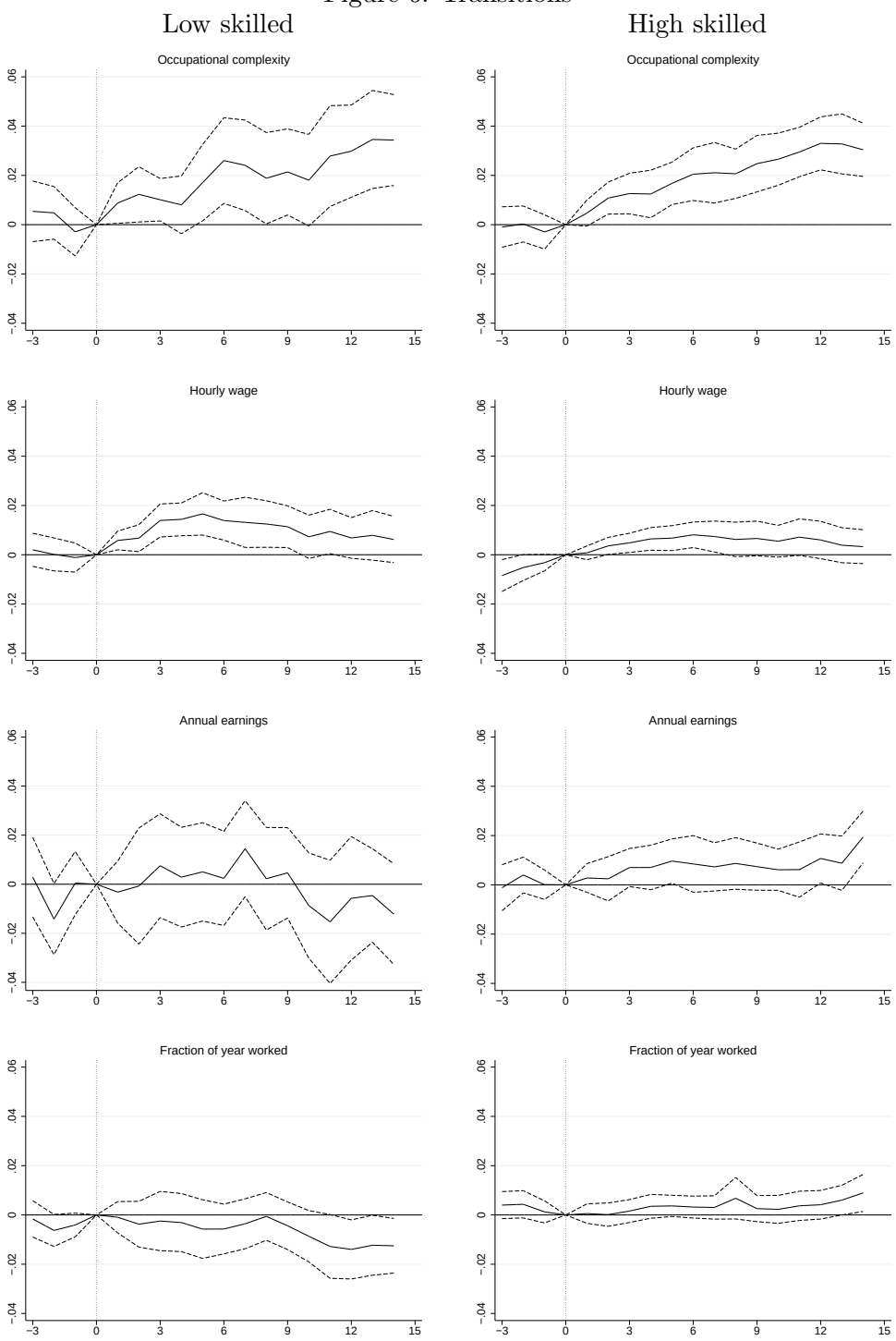
Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest in equation (4) using a sample of employed natives between 1995 and 2008. The dependent variables (left column) have the same first stage except for occupational complexity that has fewer observations (some missings). Control variables not shown are: age, experience, tenure, (each of those squared), marital status, education, region by year and industry by year dummies (listed in Table 2). Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered by municipality.

Table 6: Spell regressions (2SLS) by sector

	(1)	(2)	(3)	(4)
	Within worker-establishment		Within worker-municipality	
	Low	High	Low	High
		Manufacturing		
Occupational complexity	0.489	1.234*	1.194	1.538**
	(0.442)	(0.578)	(0.736)	(0.580)
Hourly wage	0.864	0.771	1.364*	0.528
	(0.579)	(0.395)	(0.608)	(0.360)
Observations	408,153	536,893	443,500	568,319
First stage F-statistic	38.75	37.65	41.93	40.45
		Non-complex services		
Occupational complexity	0.602	0.941	2.096	1.560***
	(0.502)	(0.535)	(1.114)	(0.430)
Hourly wage	0.417	0.958*	-0.561	0.896*
	(0.419)	(0.420)	(0.556)	(0.386)
Observations	399,130	582,887	460,766	636,455
First stage F-statistic	20.89	26.37	20.69	23.60
		Complex services		
Occupational complexity	2.551***	-0.124	4.332***	0.159
	(0.700)	(0.389)	(1.117)	(0.326)
Hourly wage	1.675***	1.960***	2.143***	2.494**
	(0.400)	(0.529)	(0.479)	(0.803)
Observations	295,876	533,656	332,110	578,683
First stage F-statistic	21.21	29.77	18.39	25.60
		Public		
Occupational complexity	-0.478	-0.599**	0.603	-0.467*
	(0.554)	(0.215)	(0.640)	(0.213)
Hourly wage	-0.376	0.482***	-0.714*	0.506***
	(0.266)	(0.141)	(0.352)	(0.130)
Observations	432,847	1,219,449	485,852	1,309,961
First stage F-statistic	23.98	30.99	24.50	29.85

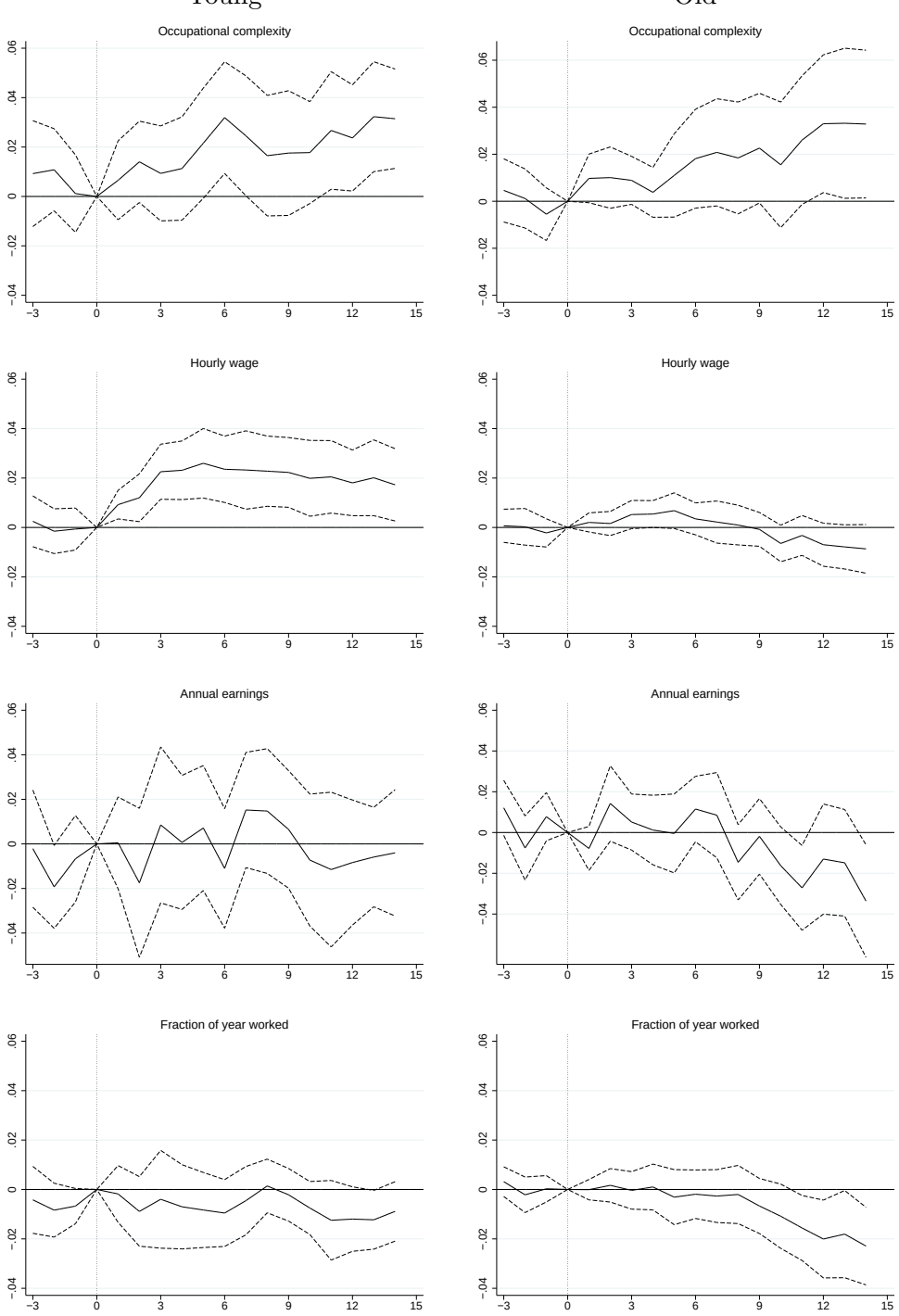
Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest in equation (4) using a sample of employed natives between 1995 and 2008. The dependent variables (left column) have the same first stage except for occupational complexity that has fewer observations (some missings). Control variables not shown are: age, experience, tenure, (each of those squared), marital status, education, region by year and industry by year dummies (listed in Table 2). Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered by municipality.

Figure 6: Transitions



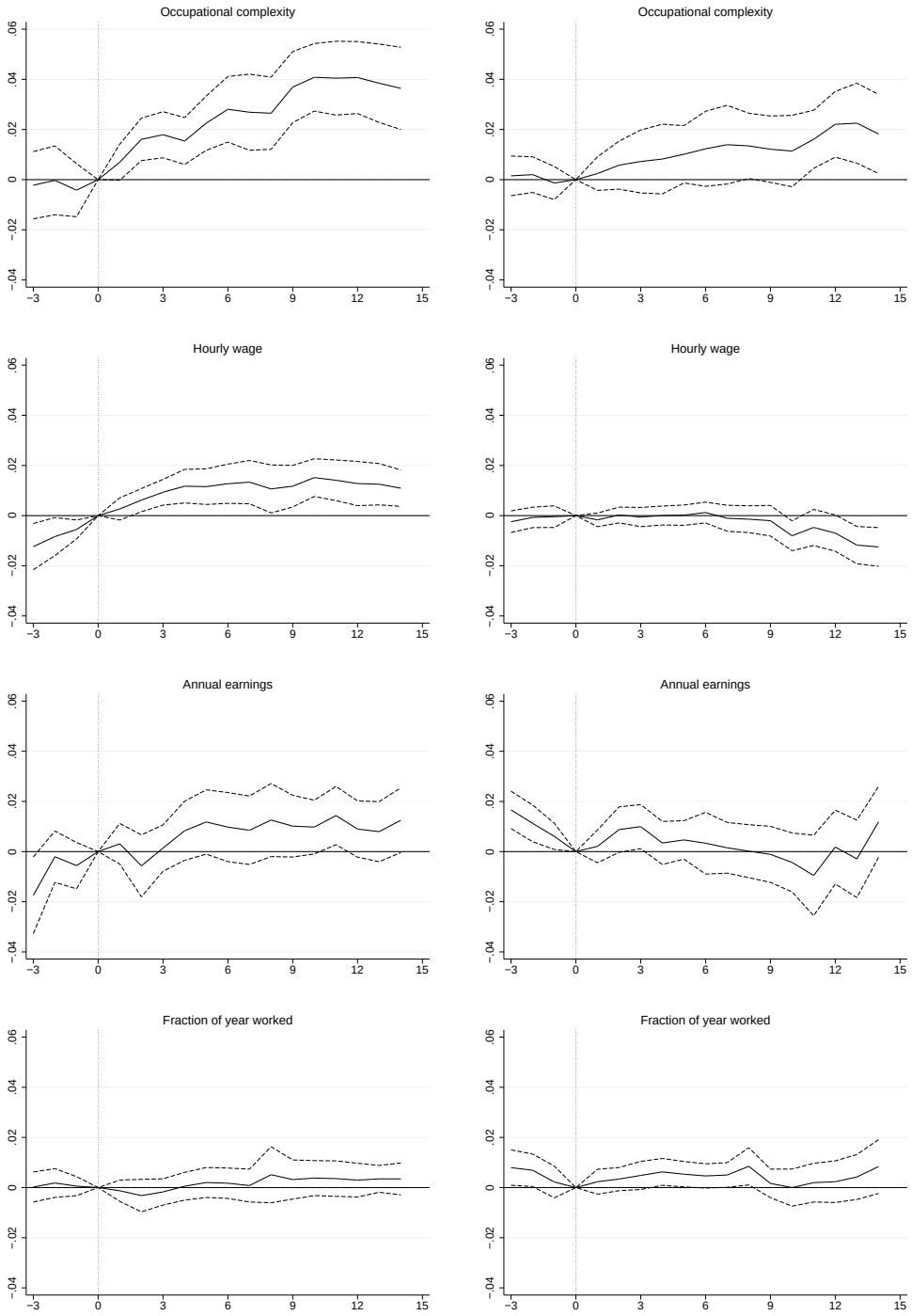
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality.

Figure 7: Transitions by age in 1994 for low skilled



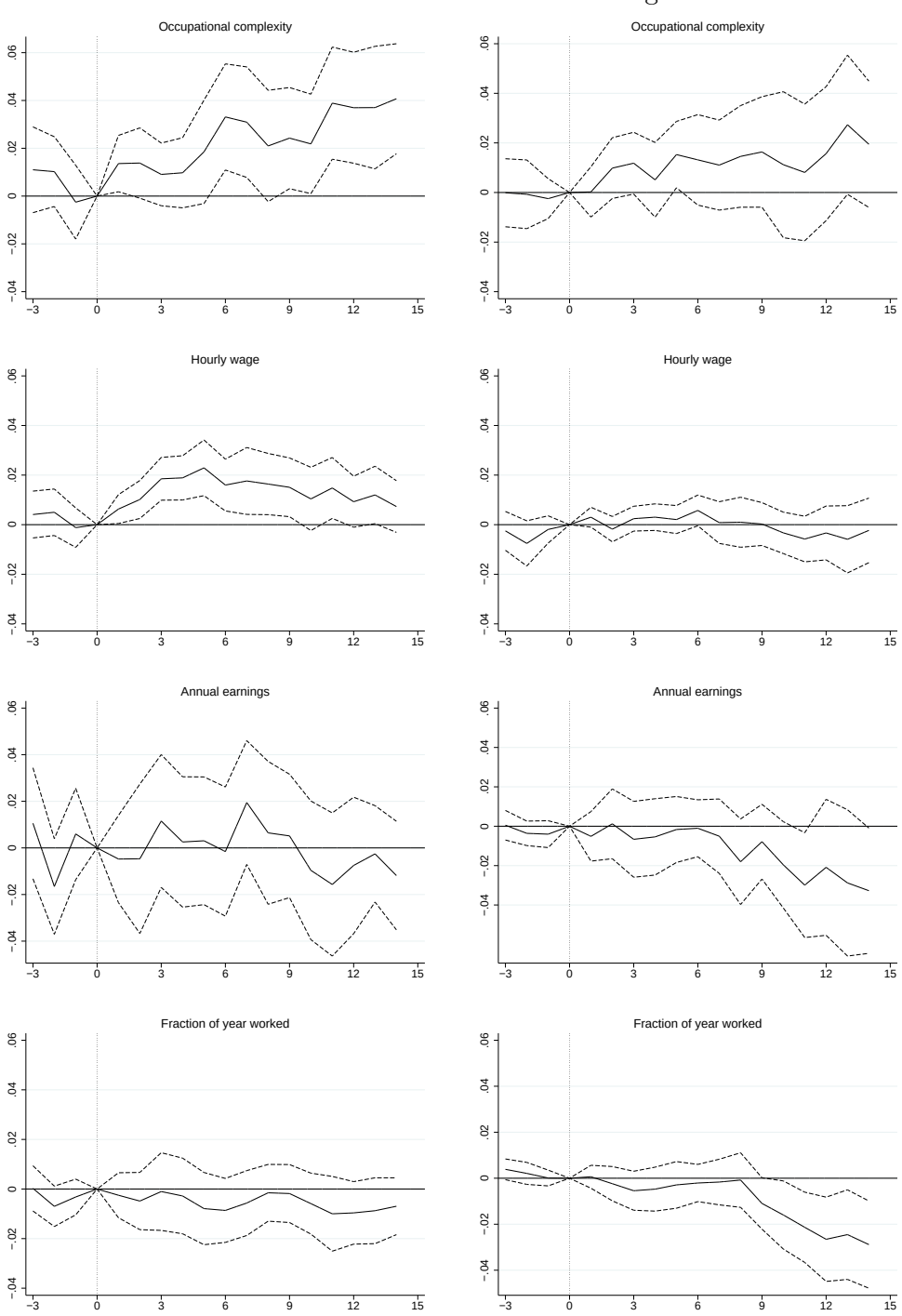
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Young (old) are those aged 21-36 (37-51) in 1994.

Figure 8: Transitions by age in 1994 for high skilled



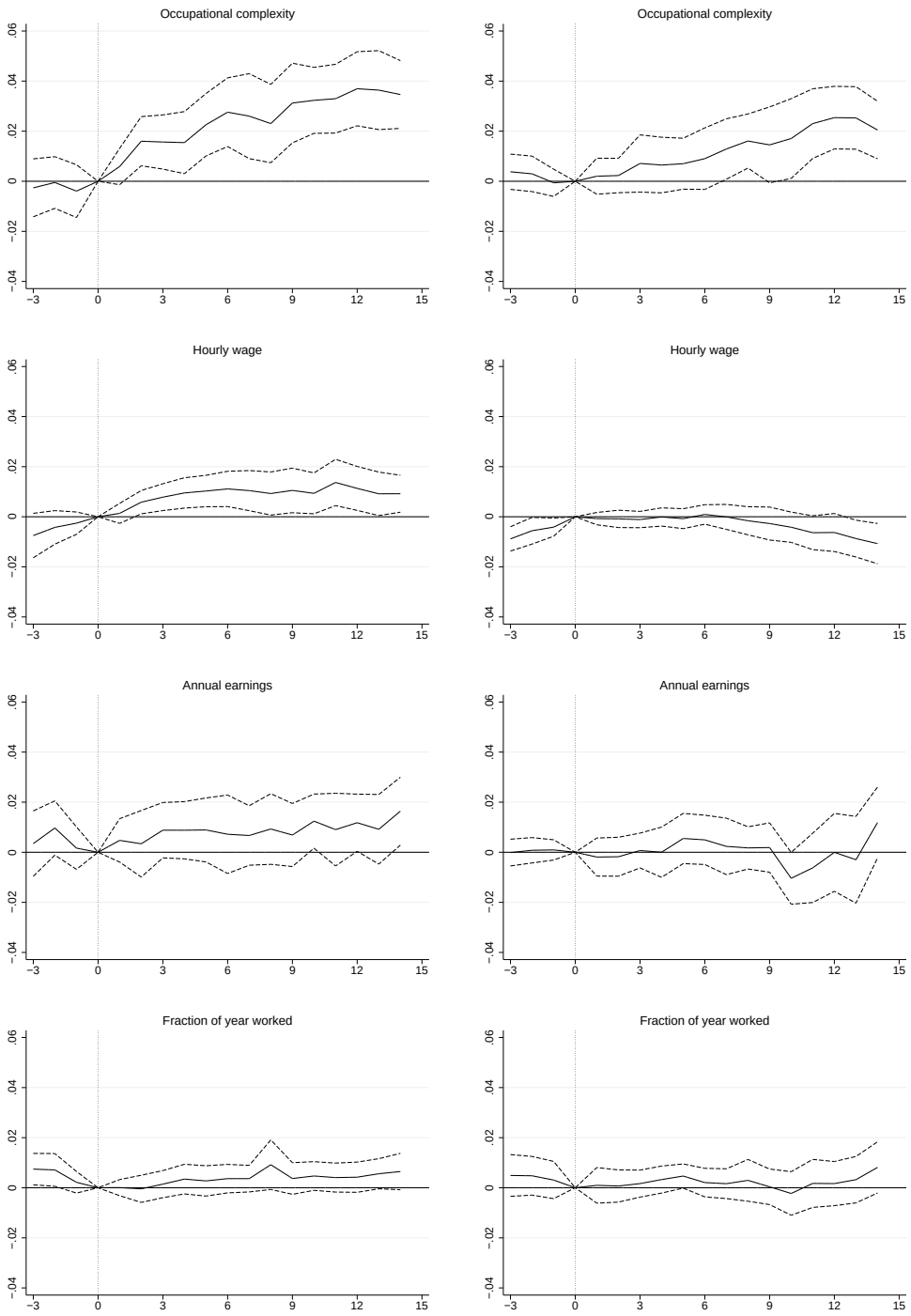
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Young (old) are those aged 21-36 (37-51) in 1994.

Figure 9: Transitions by tenure in 1994 for low skilled



Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Low (high) tenure are those with less than (at least) 4.35 years in the firm in 1994.

Figure 10: Transitions by tenure in 1994 for high skilled



Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Low (high) tenure are those with less than (at least) 4.35 years in the firm in 1994.

Table 7: The cumulative effect on employment and mobility of *low* skilled, 1995-2008

Dependent variable	(1) All	(2) Mfr.	(3) Non-Complex	(4) Complex	(5) Public
Cumulative employment	-4.731	-2.839	-8.303	5.022	-10.263
	(4.868)	(5.697)	(6.023)	(4.562)	(5.410)
- same establishment	-6.137	-8.052	-13.947	2.031	-6.309
	(3.183)	(7.631)	(8.596)	(3.423)	(4.096)
- new establishment	1.406	5.213	5.644	2.991	-3.954
	(3.715)	(8.989)	(5.474)	(5.485)	(3.876)
- same sector	-2.396	-33.182**	-4.605	23.632***	-2.100
	(3.940)	(10.824)	(6.155)	(6.934)	(3.830)
- new sector	-2.335	30.344***	-3.698	-18.610**	-8.163*
	(1.868)	(6.909)	(3.545)	(5.805)	(4.104)
- same municipality	-23.049***	-35.128**	-34.148***	-13.696*	-14.673**
	(6.666)	(12.704)	(9.412)	(5.702)	(5.410)
- new municipality	18.318***	32.289**	25.845***	18.718***	4.410
	(5.210)	(11.634)	(6.441)	(5.111)	(5.574)
Cumulative unemployment	2.211	0.302	3.515	-0.109	3.618*
	(2.397)	(3.697)	(2.469)	(2.440)	(1.790)
Cumulative self-employment	-0.053	0.612	-1.120	-0.368	-0.029
	(1.167)	(1.414)	(1.302)	(2.301)	(1.135)
PDV of annual earnings	0.030	1.343	-0.379	0.621	-0.747
	(0.898)	(1.019)	(1.062)	(1.287)	(0.790)
Observations	71,028	22,274	14,534	14,572	19,648
First stage F-statistic	15.07	21.49	11.47	12.70	16.70

Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest (immigration exposure) in equation (6) using a *strongly balanced* panel of natives employed in 1994. Additional controls not shown in the table are the list of 1994-characteristics in table A.3. Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered at the 1994-municipality. The final row is the discounted sum of the 1995-2008 earnings stream using a four percent annual discount rate.

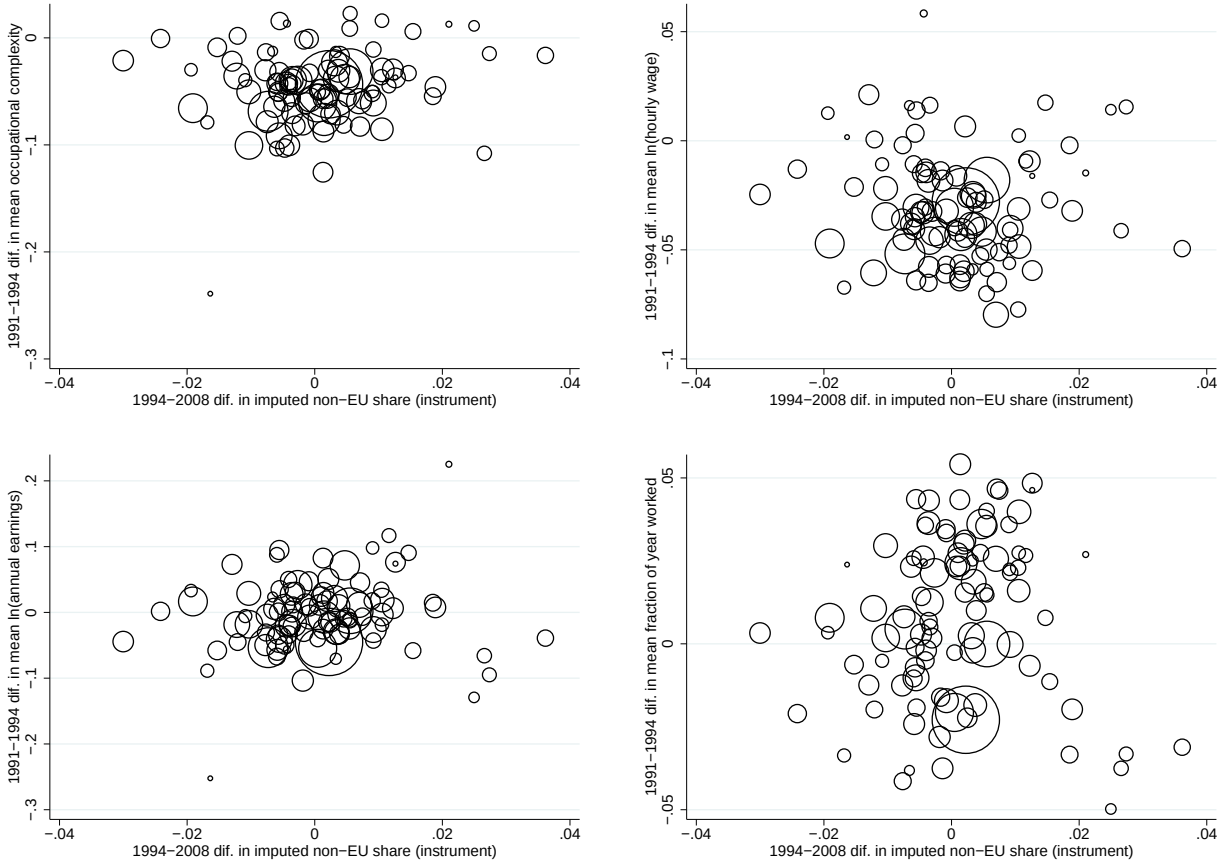
Table 8: The cumulative effect on employment and mobility of *high* skilled, 1995-2008

Dependent variable	(1) All	(2) Mfr.	(3) Non-Complex	(4) Complex	(5) Public
Cumulative employment	-0.114	-2.630	-1.226	-0.748	1.987
	(2.597)	(3.355)	(4.052)	(3.388)	(1.891)
- same establishment	-12.433**	-13.914**	-13.672**	-15.608**	-8.258*
	(3.912)	(5.293)	(5.037)	(5.459)	(4.189)
- new establishment	12.319***	11.285*	12.446**	14.860*	10.245**
	(3.628)	(5.683)	(4.080)	(6.962)	(3.671)
- same sector	-1.055	-26.343***	-2.113	7.247**	4.963**
	(1.767)	(7.139)	(4.111)	(2.266)	(1.665)
- new sector	0.941	23.713***	0.887	-7.995*	-2.976
	(1.631)	(5.055)	(2.717)	(3.260)	(1.752)
- same municipality	-32.268**	-48.351***	-44.684**	-38.251**	-16.312*
	(11.195)	(14.572)	(16.363)	(14.387)	(6.572)
- new municipality	32.154***	45.721***	43.458**	37.502**	18.300**
	(9.486)	(12.583)	(13.221)	(11.727)	(6.164)
Cumulative unemployment	2.198	3.980*	2.649	1.055	1.696*
	(1.168)	(1.643)	(1.899)	(0.978)	(0.822)
Cumulative self-employment	-3.211***	-3.938**	-4.558***	-2.661*	-2.894***
	(0.693)	(1.225)	(1.268)	(1.313)	(0.654)
PDV of annual earnings	1.066	1.691*	1.118	0.279	1.166**
	(0.614)	(0.747)	(1.029)	(0.828)	(0.356)
Observations	164,025	33,833	37,908	29,229	63,055
First stage F-statistic	18.16	21.48	14.67	17.31	19.64

Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest (immigration exposure) in equation (6) using a *strongly balanced* panel of natives employed in 1994. Additional controls not shown in the table are the list of 1994-characteristics in table A.3. Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered at the 1994-municipality. The final row is the discounted sum of the 1995-2008 earnings stream using a four percent annual discount rate.

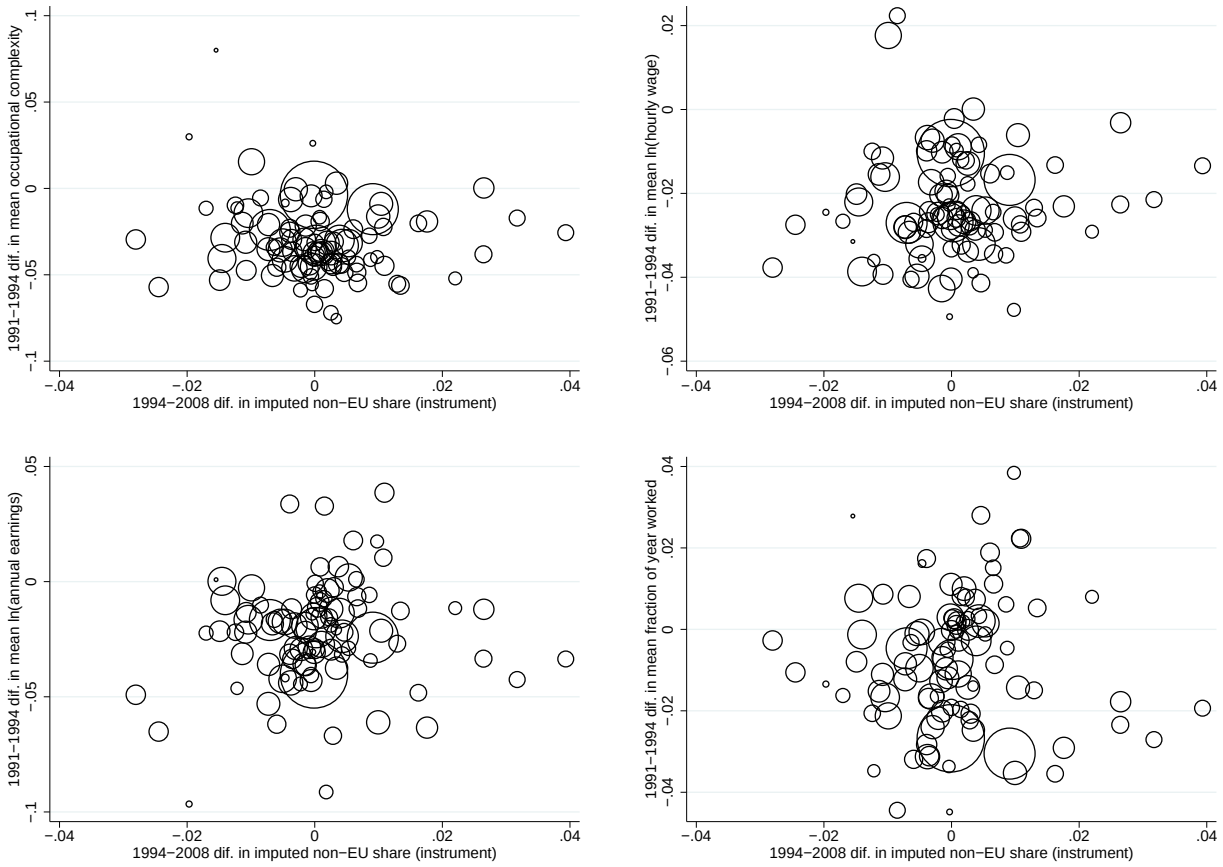
Appendix

Figure A.1: Partial plots of pre-trend in native outcomes and in-sample trend in instrument, *low* skilled



Notes: Each circle represents a municipality, and it's size reflects the average size of the *low* skilled native labor force in the municipality in 1994. The vertical axis shows the pre-event trend in outcome variables averaged for the *low* skilled native labor force in the municipality, and the horizontal axis shows the post-event difference in the instrument (additional controls are those listed in Table 2 averaged for each municipality in 1994).

Figure A.2: Partial plots of pre-trend in native outcomes and in-sample trend in instrument, *high* skilled



Notes: Each circle represents a municipality, and it's size reflects the average size of the *high* skilled native labor force in the municipality in 1994. The vertical axis shows the pre-event trend in outcome variables averaged for the *high* skilled native labor force in the municipality, and the horizontal axis shows the post-event difference in the instrument (additional controls are those listed in Table 2 averaged for each municipality in 1994).

Table A.1: Within worker-establishment spell regressions (OLS)

	(1)	(2)	(3)	(4)
	Low skilled		High skilled	
	Non-EU	Refugee	Non-EU	Refugee
Occupational complexity	0.205	0.845	0.138	0.228
	(0.139)	(0.479)	(0.096)	(0.263)
Career upgrade	0.029	0.574*	0.061	0.385
	(0.120)	(0.292)	(0.064)	(0.200)
Career downgrade	0.030	0.232*	0.075	0.239
	(0.051)	(0.110)	(0.045)	(0.159)
Occupational mobility	0.059	0.806*	0.136	0.625*
	(0.143)	(0.329)	(0.091)	(0.315)
Hourly wage	0.222*	1.070***	0.234	1.053***
	(0.110)	(0.274)	(0.129)	(0.205)
Annual earnings	0.154	0.877*	0.081	0.791**
	(0.122)	(0.410)	(0.144)	(0.249)
Fraction of year worked	0.044	0.085	-0.038	-0.192
	(0.051)	(0.180)	(0.031)	(0.099)
Observations	1,541,654	1,541,654	2,883,266	2,883,266

Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest (non-EU share) in equation (4) using a sample of employed natives between 1995 and 2008. The dependent variables (left column) have the same first stage except for occupational complexity that has fewer observations (some missings). Control variables not shown are: age, experience, tenure, (each of those squared), marital status, education, region by year and industry by year dummies (listed in table 2). Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered by municipality.

Table A.2: Within worker-muncipality spell regressions (OLS)

	(1)	(2)	(3)	(4)
	Low skilled		High skilled	
	Non-EU	Refugee	Non-EU	Refugee
Occupational complexity	0.626*	2.778***	0.357***	0.860***
	(0.285)	(0.837)	(0.098)	(0.250)
Career upgrade	0.173	0.730*	0.105	0.468**
	(0.093)	(0.316)	(0.055)	(0.150)
Career downgrade	0.173*	0.757***	0.175**	0.619***
	(0.084)	(0.167)	(0.064)	(0.157)
Occupational mobility	0.347*	1.487***	0.280**	1.086***
	(0.161)	(0.437)	(0.108)	(0.276)
Hourly wage	0.059	0.695*	0.240	1.268***
	(0.110)	(0.326)	(0.148)	(0.265)
Annual earnings	0.164	0.773*	0.110	0.779**
	(0.120)	(0.379)	(0.146)	(0.286)
Fraction of year worked	0.119*	0.306*	-0.011	-0.219*
	(0.055)	(0.146)	(0.034)	(0.092)
Observations	1,787,910	1,787,910	3,154,751	3,154,751

Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest (non-EU share) in equation (4) using a sample of employed natives between 1995 and 2008. The dependent variables (left column) have the same first stage except for occupational complexity that has fewer observations (some missings). Control variables not shown are: age, experience, tenure, (each of those squared), marital status, education, region by year and industry by year dummies (listed in table 2). Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered by municipality.

Table A.3: The long-run effect on *low* skilled

	(1) Occupational complexity	(2) Hourly wage	(3) Annual earnings	(4) Fraction of year worked
t = -3	0.005	0.002	0.003	-0.002
	(0.006)	(0.003)	(0.008)	(0.004)
t = 0	.	.	.	.
t = 1	0.009*	0.006**	-0.003	-0.001
	(0.004)	(0.002)	(0.006)	(0.003)
t = 5	0.017*	0.017***	0.005	-0.006
	(0.008)	(0.004)	(0.010)	(0.006)
t = 9	0.021*	0.011**	0.005	-0.004
	(0.009)	(0.004)	(0.009)	(0.005)
t = 14	0.034***	0.006	-0.012	-0.013*
	(0.009)	(0.005)	(0.010)	(0.006)
Observations	1,072,035	1,071,244	1,206,145	1,280,376
R-squared	0.44	0.22	0.16	0.13

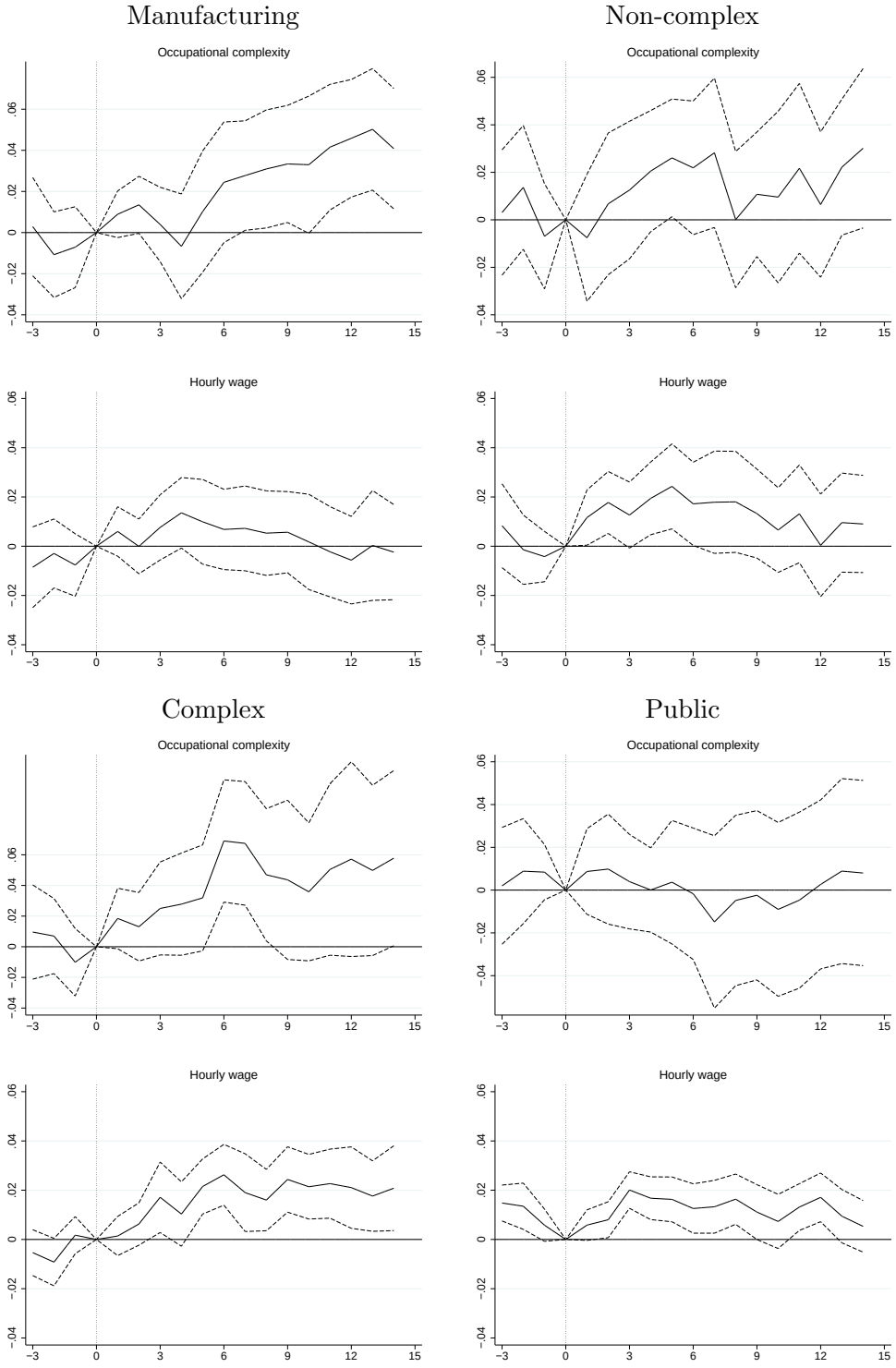
Notes: *** p< 0.01, ** p< 0.05, * p< 0.10. This table reports selected regression coefficients on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors in parentheses are clustered at the 1994-municipality.

Table A.4: The long-run effect on *high* skilled

	(1) Occupational complexity	(2) Hourly wage	(3) Annual earnings	(4) Fraction of year worked
t = -3	-0.001	-0.008*	-0.001	0.004
	(0.004)	(0.003)	(0.005)	(0.003)
t = 0	.	.	.	.
t = 1	0.005	0.001	0.003	0.001
	(0.003)	(0.001)	(0.003)	(0.002)
t = 5	0.017***	0.007**	0.010*	0.004
	(0.004)	(0.003)	(0.005)	(0.002)
t = 9	0.025***	0.007	0.007	0.003
	(0.006)	(0.004)	(0.005)	(0.003)
t = 14	0.030***	0.003	0.019***	0.009*
	(0.005)	(0.003)	(0.005)	(0.004)
Observations	2699752	2617994	2838069	2955330
R-squared	0.47	0.31	0.17	0.08

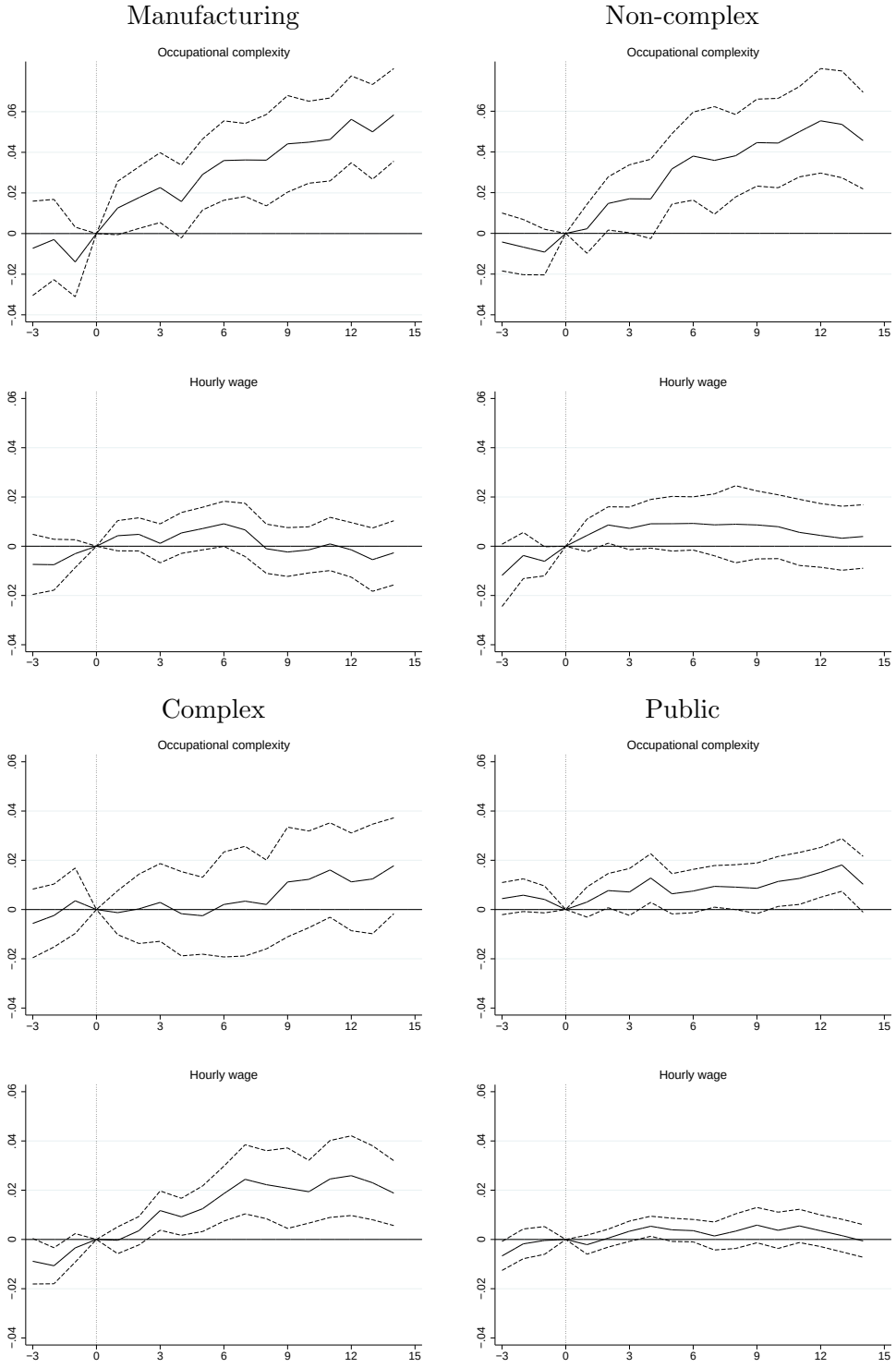
Notes: *** p< 0.01, ** p< 0.05, * p< 0.10. This table reports selected regression coefficients on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors in parentheses are clustered at the 1994-municipality.

Figure A.3: Transitions by sector for low skilled



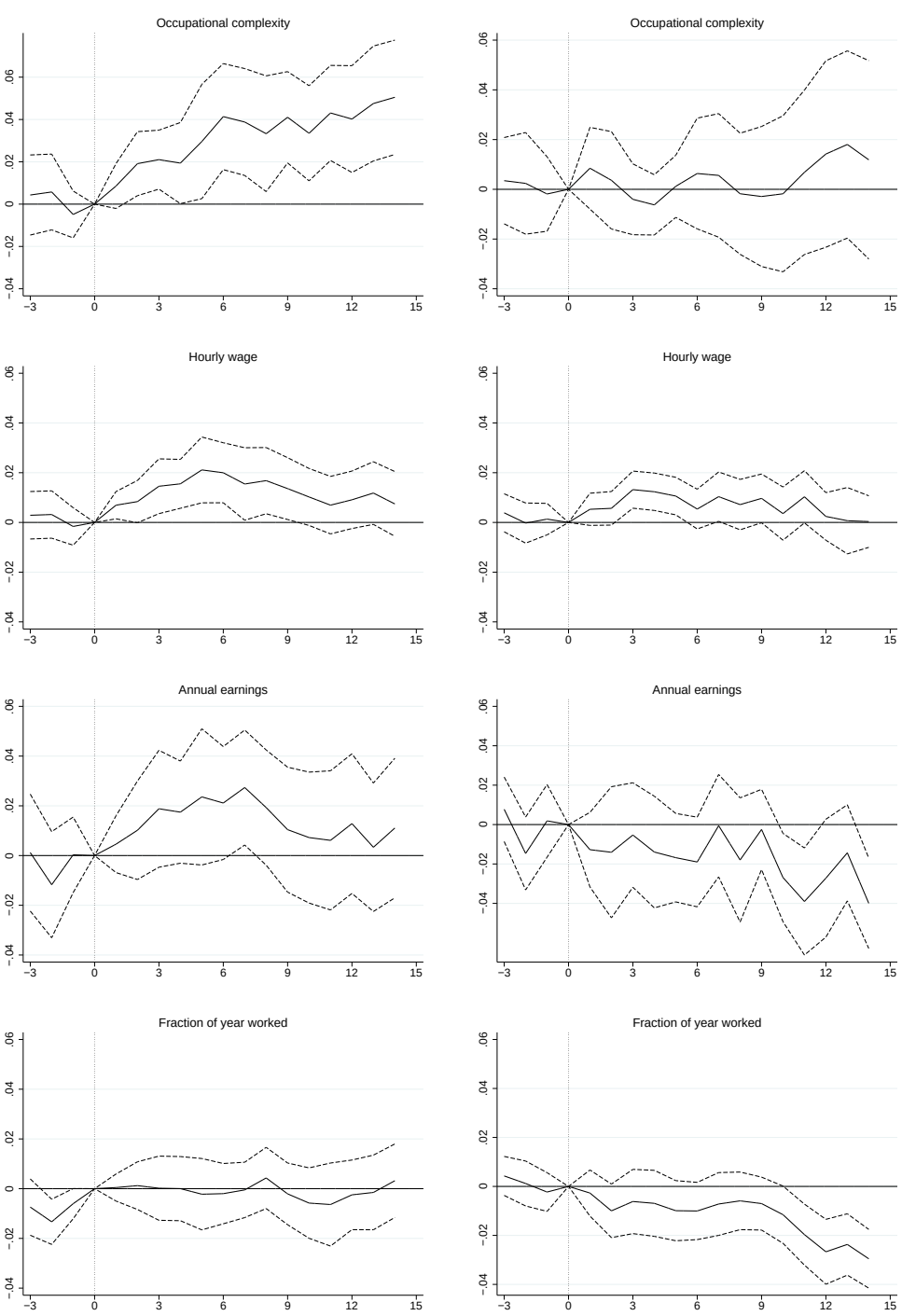
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality.

Figure A.4: Transitions by sector for high skilled



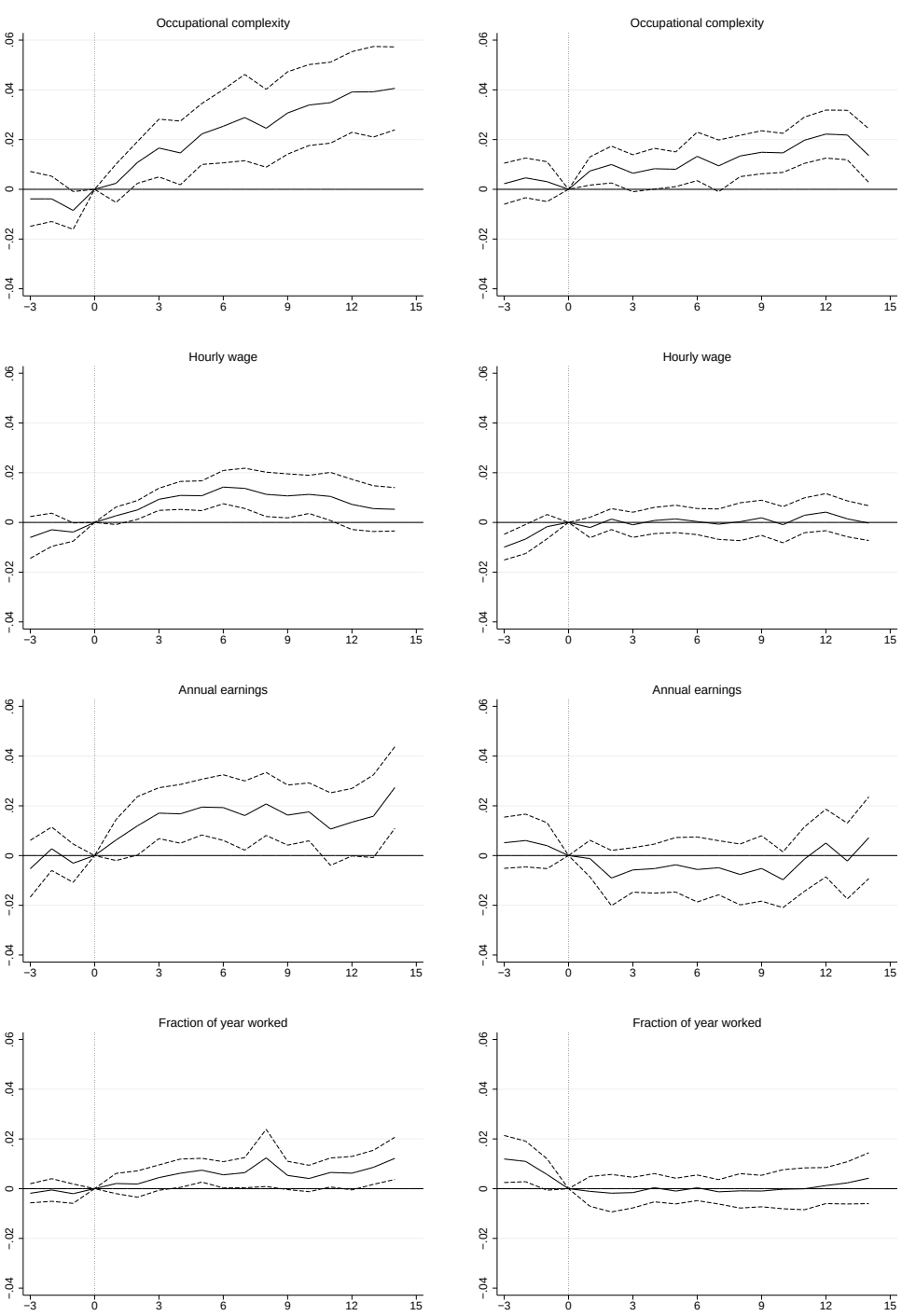
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality.

Figure A.5: Transitions by gender for low skilled



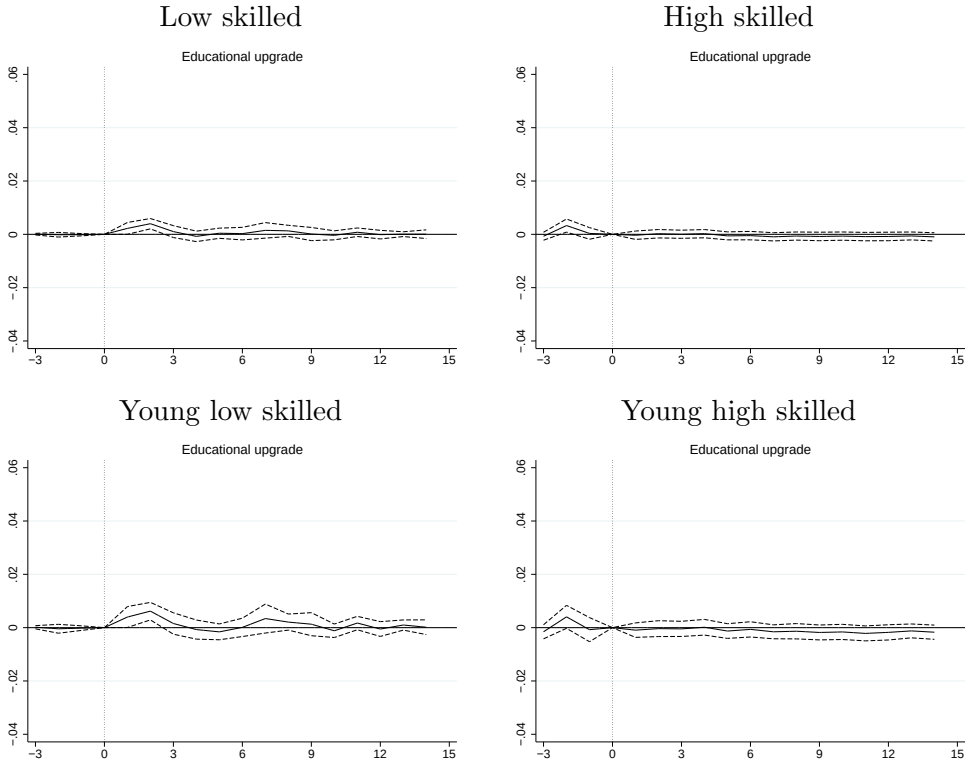
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Low (high) tenure are those with less than (at least) 4.35 years in the firm in 1994.

Figure A.6: Transitions by gender for high skilled



Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Low (high) tenure are those with less than (at least) 4.35 years in the firm in 1994.

Figure A.7: Educational upgrade



Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation 5 using a *strongly balanced* panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality. Educational upgrade is a dummy variable that equals one if the individual upgrades his education between t and $t-1$.