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

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Abstract

Using the universe of workers 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 an 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. We find that an increased supply of non-EU immigrants pushed less educated native workers to pursue more complex occupations. Immigration increased the mobility and wage of less skilled natives and 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? Or do they complement native skills and stimulate natives to specialize in complex tasks? Do these effects reduce or increase native wages? This paper provides answers to these questions.

Many existing studies are limited in their the ability to identify a genuine supply-shock of the inflow of immigrants and in tracking 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 immigrants in the labor market beginning in 1994. In the same period immigrants to Denmark from the rest of European Union (EU) did not increase at all. We use the supply-driven non-EU immigration as key piece of our identification strategy.

The second critical component of our identification is the refugees' distribution across municipalities. 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 that policy aimed at spreading refugees distributing their burden across municipalities, without consideration for their economic preferences. 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 new

[1] The Bosnians were an exception as they were sent disproportionately to rural districts (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.

immigrants from refugees' countries 1986-1998 was determined by the early dispersal policies and affected later inflows. The distribution of Turks (the other non-EU 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 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 construct an imputed population of refugee-country immigrants by interacting the post-1994 push-driven flows from crisis-stricken countries with the distribution determined by the dispersal policy. We also use a similar strategy extended to all non-EU immigrants using the 1988 distribution of non-EU communities.

The non-EU immigrants considered were 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 three main outcomes: the complexity of natives' occupations, their hourly wages and the weeks worked in a year. We consider non-college-educated native workers (less skilled) as the group affacted by non-EU immigrants' competition. 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

[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 courses while their case is being processed.

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 less educated 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 occupations for workers who changed establishment. Second, less educated natives experienced positive or null wage effects. Third, the cumulative effect shows that immigration increased the mobility, particularly across municipalities in response to non-EU immigration. However, natives did not experience any effect on cumulative weeks of employment.

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 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 em-

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

ployment 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] 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. A previous study using comparable data is Hummels et al. (2014), who produces within job-spell estimates of the effect of increased outsourcing on wages in manufacturing firms. The same Danish data are also 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] The joint analysis of the impact of immigration on wages, occupation and

[5]Examples are Card (2001); Friedberg (2001); Borjas (2003); Ottaviano and Peri (2012); Glitz (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]This line of analysis is emphasized in 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).

[11]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 (2014) 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.

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]

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, 2014). Our study analyzes, for the first time, outcomes for native individuals within and across firms over time.

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 push-driven episode, ideal to identify the causal effect of immigration on economic outcomes. Third, Danish labor markets were very flexible similarly 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

[12]This methodology is somewhat reminiscent of Von Wachter, Song, and Manchester (2007) who use a similar approach to track the long-run effects of job separations in recession.

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 allows this mechanism to operate most efficiently.

In this section we briefly describe the features of immigration to Denmark during the period of our analysis: 1991-2008. The presence of immigrants, as share of employment, before 1995 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 (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 1995 the share of non-EU immigrants grew steadily and significantly until year 2007 (Figure 1). The non-EU immigration boom was fueled 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. We use either immigrants from countries subject to the dispersal policy or all non-EU immigrants as explanatory variable.

The overall inflow of immigrants was sizeable. From beginning to end the cumulative increase of immigrants was equal to 3.1 percentage points of total employment (from 3.0 percent to 6.1 percent). During the same period the growth of foreign born in typical immigration-receiving countries was similar. In Canada it was 3.5 percent, in the US it was 3.8 percent, in the UK it was 3.9 percent (of the population in working age).[13] All these economies have received much more attention in the analysis of the effects of immigrants. Non-EU immigrants were mainly from refugee-countries (Figure A.1 in the Appendix). The inflow from Eastern European Enlargement countries and from developed non-EU economies in fact account for very little of the increased inflow.[14]

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

Non-EU immigrants were less educated than natives. 52 percent of them did not have a post-secondary education versus only 36 percent among natives. Moreover most of them did not speak Danish and 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 restrictions.

4 Data and Variables Definition

The data we use are from the Integrated Database for Labor Market Research (IDA), a collection of registers that link data on individual characteristics of the workers to data on the characteristics of establishments. The data are recorded annually for each individual and establishment in Denmark and include detailed information on occupation, salary and other worker characteristics as well as industry and other establishment characteristics.

We select individuals who are between 18 and 65 years old, not attending school and not permanently out of the labor force, i.e. not receiving disability pension,[15] and we refer to them as the "labor force".[16] We restrict our analysis to Danish-born individuals without college education, that we refer to as "low skilled".[17] This is the group most directly in competition with non-EU immigrants. The first empirical analysis (section 6.3.1) selects employed individuals. 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 follow them without imposing further restrictions.[18]

We consider three main outcome variables. They are the occupational complexity, the hourly wage and the labor supply of Danish native individuals. Hourly wages include mandatory payments to pension schemes and have been deflated using the Danish consumer price index.[19] As a measure of the labor supply of an individual

[15] Bratsberg, Raaum, and Røed (2010) show that large fraction of non-EU immigrants in Norway take up disability pension.

[16] We also eliminate a few observations with a missing value in foreign born status or in the municipality of residence.

[17] We will mention the outcomes for individuals with tertiary education in the Appendix.

[18] 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. The spell regression includes each year individual between 18 and 65.

[19] The mandatory pension contributions vary across industries. As data on the pension payments are available only from 1995 onwards, we consider wage net of pension contributions when we

we use the fraction of the year worked. The variable equals 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, the employment variable takes a fractional value equal to a share of the regular working year. Finally, information on the occupation according to the internationally standardized ISCO-88 codes is included.[20] In order to generate a "complexity" index for 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.[21]

This method of calculating the complexity 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 Denmark and the US. We also directly observe occupational changes. Hence, we construct a variable that we call "occupational mobility" that equals one whenever an individual changes the occupation from period $t-1$ to t. To get a sense of the direction of the mobility, we 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 main individual level controls are age, labor market experience (the cumula-

include pre-1995 data. The spell analysis, however, that can be implemented with net or gross earnings, proved to be robust to the choice of income measures.

[20] Occupations are reported to Statistics Denmark by firms. 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. 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.

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

tive 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.

Immigrants (foreign-born) 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. Refugees are people from Former Yugoslavia, Afghanistan, Iraq, Sri Lanka, Vietnam, Lebanon, Iran and Somalia.

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. 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.[22] 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 municipalities are rather self-contained units. Only around 10 percent 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 between 1994 and 2007 larger than 10 percentage points of total employment. The bottom three (Læsø, Assens and Lejre) experienced an increase of 1 percentage point or less. Figure 3 provides summary evidence that a significant gap between high and low non-EU immigration municipalities opened in 1995 and grew up to 2007. The figure shows the difference in the non-EU share of employment between high immigration (above the median) and low immigration

[22]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 percent, while it is 40 percent in the more isolated, rural municipalities.

(below the median) municipalities.[23] There is no trend in the pre-1994 difference in share of non-EU immigrants between these two types of municipalities. Beginning in 1995 a steady and continued inflow of non-EU immigrants opened and increased the gap between those two types of municipalities. Moreover, Figure 4 shows no break (and no pre-post 1995 change) in the difference of the EU immigrants share in the same two groups of municipalities. If the discontinuity and differential growth shown in Figure 3 was driven by differential labor demand, it should have manifested itself mainly (or also) with divergence in EU immigrants, who were free to move to and work in Denmark. The presence of no differential trend for EU immigrants does not support a demand-driven event after 1995, in the receiving municipalities.

The dispersal policy in place between 1986 and 1998 spread the non-EU immigrants to distribute the burden across municipalities. Differences in the initial characteristics of the municipalities will be controlled for and we also run tests in section 6.4 to check that our instruments are uncorrelated with pre-1994 trends in native outcomes in the municipalities.

Table 1 lists the occupations that experienced the lowest and the highest change in the share of non-EU immigrants employment between 1994 and 2008. For those occupations we also show the index of cognitive, communication and manual tasks and the derived complexity index that combines them. Occupations experiencing the largest inflow of non-EU immigrants were usually more intensive in manual skills and less intensive in cognitive and communication skills than those attracting a small share of immigrants.[24]

Summary statistics for the controls and for the dependent variables used in the empirical analysis, as well as dummies indicating workers' region and sector distribution, are provided in Table 2.[25] The table is based on the sample used in the spell regressions, which includes only low-skilled (non college educated) native working individuals (1995-2008).[26]

[23]The exact definition of high and low immigration municipalities is explained in section 6.3.2.

[24]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.

[25]The empirical analysis is based on a 20 percent random sample of natives. Immigrant shares (the explanatory variable of interest and instrument) are calculated on the full sample to avoid measurement error.

[26]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, ed-

6 Framework, Empirical Strategy and Identification

Our identification relies on the variation of non-EU immigrants over time. In this section we first argue that the local labor market, rather than the firm, is the right unit to construct a credibly supply-driven change of non-EU immigrants. We then show an easy decomposition of the effects that justifies our empirical approaches. Finally, we describe our empirical specifications and discuss identification.

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 (2014) have considered the increase of immigrants at the *firm level* as explanatory variable usually finding negative effects on native wages. Our strategy focuses on the variation of immigrants across local labor markets. We believe it is more sensible to identify a supply-driven shock of immigrants at the geographical level. This is because, the pre-1995 location of refugees and their families, resulting from previous enclaves and early dispersal policies, interacted with the post-1995 aggregate inflow, are both 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 those are persistent and correlated with trends in productivity and specialization after 1995 they may be correlated with native outcomes in that period. Moreover, the mobility of workers within a municipality implies that wages for a specific occupation are determined at the municipality level.

Finally, a firm-level supply-driven change of immigrants should be constructed based on the pre-1995 share of immigrants in the firm. This would imply that we can only use a sample of long-lived firms, as firms need to exist pre-1995.[27] This would generate a selected sample. Hence, firm-level data can improve our understanding of the consequences of immigration. 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

ucation and wages are not very different from those of the unbalanced sample of employed reported in Table 2.

[27] 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.

natives' wages and employment.

6.2 A Simple Decomposition

Consider a municipality[28] in which each native worker, i, works in an establishment (firm) that we denote with the index j. Such initial match, for given initial conditions, maximizes her wage (utility). There is a set of M establishments in the municipality. 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. The share of foreign born in the municipality, S, may affact the wages in each establishment. Hence, explicitly capturing this dependence, we write $w_{ij}(S)$.

There are several channels through which the supply of foreign born can affect native wages. First, immigrants affect the supply of some skills making the value of complementary skills higher and substitutable skills lower in the municipality (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 establishments (Ottaviano, Peri, and Wright, 2013) and such productivity effects may be stronger in establishments that employ a large share of foreigners. Hence, the share of immigrants may affect also the optimal matching rule can be written as $I_{ij}(S)$.

We consider the aggregate of native low-skilled workers initially in a municipality in year t and we denote it with N_t. We indicate the initial share of non-EU immigrants with S and we write the aggregate native wage W in the municipality

[28] In this section we omit the municipality index. The formulas should be considered as relative to the representative 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. $I_{ij}(S + \Delta S)$ represents the optimal matching 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 of (3) captures the wage change of less skilled native workers who remained in the same establishment.[29] The second term captures the change in wages of workers who changes establishment within the municipality $j \in M$. The third term captures changes for those who moved to establishments outside of the municipality $j \notin M$. Immigration affected both the distribution of natives across establishments and the wage of natives in the new establishments. The notation $w'_{ij}(S + \Delta S)$ in the second and third term of (3) emphasizes that the wage for mover i in the new establishment j may differ from the previous wage both because the new wages across establishment are affected by immigrants ($S+\Delta S$) and because moving may have caused a loss of specific capital to the mover (earning the wage $w'_{ij}(S + \Delta S)$ rather than $w_{ij}(S + \Delta S)$, that she would have earned as an incumbent in that establishment).

Our empirical specifications analyze the effects of non-EU immigrants on native outcomes progressively including the different components of expression (3). While

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

equation (3) considers wage as outcome in our empirical analysis we also look at other outcomes such as occupation complexity and labor supply. Let us notice, finally, that in (3) the term $I_{ij}(S+\Delta S)$ captures the new allocation of native workers so that $\sum [I_{ij}(S+\Delta S) - I_{ij}(S)]$ is a measure of the workers' flow to different establishments. Within this approach we also estimate the effect that immigration has on the flows of workers across establishments and out of the municipality. The empirical specifications and how we identify the response to immigration is the focus of the remaining of this section.

6.3 Empirical Specifications

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. These shortcomings will be addressed in the next section 6.3.2.

The outcomes relative to low skilled 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 and the 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.[30] The regression has the following structure:

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

[30] In the 2SLS specifications we instrument S_{mt}^{nonEU} with $\widehat{S}_{mt}^{nonEU}$ that we describe in section 6.4.

The variable x_{it} is a vector of time-varying individual characteristics including age, age squared, 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.[31]

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 to identify the impact of immigration on outcomes for native workers within that unit. 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 employee-establishment pair.[32] The regression identifies the impact of an increased supply of non-EU immigrants on the outcome of native workers within a job-spell.[33] 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 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 but stay within the municipality.

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 establishment-worker or municipality-worker match is used.

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

[32] This is similar to the fixed effects used in Hummels et al. (2014) and Malchow-Møller, Munch, and Skaksen (2011).

[33] 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

We use a 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). Previously, we showed that the non-EU immigrant share increased abruptly in some municipalities beginning in 1995, while leaving other municipalities virtually unaffected. 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 municipalities 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 in 1994 lived in other municipalities.[34]

This difference-in-difference approach 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 the 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 an indicator for exposure, M_i, corresponding to one if individual i was in a treated municipality m as of 1994, with a set of year dummies, $D(year = t)$, that are one in year t 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

[34]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.

coefficient for that year is standardized to 0.

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

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 balanced panel to be able to identify the effect on individual workers unaffected by compositional changes and non-random sorting after 1994. 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 $\tilde{\phi}_{t,OCC}$ fixed effects.[35] The occupations are skilled worker, intermediate professional, higher grade professional and managerial position within the firm. The remaining controls $\tilde{x}_i$ are as those defined in equation (4). All controls are relative to the worker in year 1994.

As in the model of section 6.3.1, we select only less skilled natives and we consider as outcome variables, y_{imt}^{NAT}, occupational complexity, hourly wages and employment as fraction of year worked.

To capture the cumulated effect of immigration on the probability of transition out of the establishment or out of the municipality or out-of employment for the whole post-1995 period 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 1995-2008. The regression on these cumulated variables looks as follows:

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

$\Delta y_{i,m,1995-2008}^{NAT}$ is the cumulated 1995 and 2008 outcomes, and $\Delta S_{m,1994-2008}^{nonEU}$ 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

[35] 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.

municipality-specific shocks we instrument the change with the imputed supply-push variable that we now describe. This last specification 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 or refugees as a share of employment in the municipality m at time t (or the change in those shares). The inflow and employment may be correlated with unobserved demand shocks. Therefore, we build an instrument based on the refugees assigned to locations during the spatial dispersal policy (1986-1998), and an alternative instrument using the early settlements of the entire non-EU group (in 1988). Our hypothesis is that the geographic distribution of refugees produced by the dispersal policy and the distribution of early non-EU communities are both uncorrelated with the post-1995 labor demand changes across municipalities. The population that we use in the construction of the instrument are those potentially available for work; individuals 16 to 65 years old, not in school and not permanently disabled.[36]

We interact the national inflow by nationality, driven by country of origin political and economic crises, with the pre-determined shares to obtain the supply-driven increase in immigrants in each municipality. This method is not new and follows the literature since Altonji and Card (1991). However, the focus on refugees whose initial distribution was determined by the policy, the sudden post-1995 acceleration, 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.

The location of refugees was random during the years 1986-1998 conditional on a few personal characteristics like birth date, marital status, number of children and nationality that were available to the placement officers through a questionnaire (Damm, 2009; Damm and Dustmann, 2014). The policy aimed at distributing refugees proportional to municipal inhabitants in Denmark while maintaining ethnic clusters to facilitate the reception of refugees. The geographic dispersion was successful. Immigrant shares continued to growth, however, and the growth rate

[36]The fraction of working age non-EU immigrants receiving disability pension increased from 4.3 to 11.9 during the period we consider. Thus a significant share are not available for work due to servere health problems but we account for this by excluding them from sample we use.

differed across municipalities due to the ethnic clusters and different durations of the country of origin crises. This continued to create differential time-variation in the immigrant share across municipalities in the period we analyze.

Refugee status is not directly observed from the registers. Instead we use the fact that it is possible to identify refugee-sending countries from aggregate statistics on type of permit by country and year. We focus on immigrants from Iraq, Iran, Vietnam, Sri Lanka, Lebanon, Ethiopia, Afghanistan and Somalia and refer to this group as refugee. Former Yugoslavia is excluded, although it is another large supplier of refugees in during the dispersal policy, 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 many refugees who were granted asylum (the "Bosnian programme", see Damm, 2009). For remaining refugee-countries, the policy guaranteed that early distributions across municipalities should genuinely be uncorrelated with economic trends.

Let F_{ct} denote the total population of immigrants from country c residing in Denmark in year t, and s_{cm} the share of that population assigned to municipality m during the quasi-random assignment of refugees to municipalities in Denmark. We then construct $\widehat{F}_{cmt}$ the imputed population from country c in municipality m in year t as follows: $\widehat{F}_{cmt} = s_{cm} \times F_{ct}$ and the imputed total share of immigrants with origin in countries that were refugee sending 1986-1988: $\widehat{S}_{mt}^{nonEU} = (\sum_{c \in Refugee} \widehat{F}_{cmt})/P_{m1988}$, where P_{m1988} is the total population in municipality m in year 1988. (In the alternative instrument using the early settlements of all non-EU immigrants s_{cm} is simply the share from country c resident in municipality m in 1988, and we sum over all non-EU to obtain the total imputed share.) 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 immigrants is uncorrelated with the unobserved determinants of municipal trends in labor demand once we control for fixed effects and observed variables. Besides the evidence provided above, we perform some important tests. Table 3 shows whether the 1994-2008 change in the imputed non-EU labor share, our instrument, is correlated with trends in the outcome variables (occupational complexity, hourly wages and fraction of year worked) for low skilled natives between 1991 and 1994, the pre-immigration surge

period. The unit of observation is the municipality.[37] A significant correlation with trends that pre-date the non-EU immigrant surge would cast doubts on the validity of the instrument.

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 non-EU immigrants. The lower part of the table shows the correlations when the instrument is constructed only using the refugee-sending countries. The first row shows the correlation of the non-EU instrument with outcomes for low skilled. The estimated coefficients on the pre-1994 changes are small and never statistically significant at any standard level. The last column shows the correlation of the instrument change from 1994-2008 with the explanatory variable, the change in the immigrant group's actual share of employment. The very significant coefficient and large F-statistics suggest that the instrument is strong.

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. Our data, however, are not subject to measurement error arising from sampling. We calculate the exact immigrant shares of each municipality based on full population registers thereby limiting concerns for measurement error.

7 Results

7.1 Effects within Establishment and Municipality

Table 4 shows the 2SLS estimates of the effect of immigrants on low skilled natives within establishments and within municipalities. The corresponding OLS estimates are reported in Tables A.1 in the Appendix. The tables show only the estimates of the coefficient of interest, β in equation (4). Each entry in the tables is an estimate from a different regression using different outcomes listed as rows. The first two columns show the results for the individual-establishment spell and columns 3 and 4 show the results for the individual-municipality spell regression. The instrument

[37] In section 7.2, we check whether there is a pre-1994 trend in the differences in outcomes between the high immigration municipalities and the low immigration municipalities using individual level data.

and explanatory variable are based on all non-EU immigrants in columns 1 and 3 and on refugees subject to dispersal in columns 2 and 4.

The first row of Table 4 shows the effects of an increase in non-EU immigrants by one percentage point of the labor force on the occupational complexity of low skilled 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 fraction of the 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 OLS estimates. 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. The differences between the OLS and 2SLS show a downward bias of OLS which suggest a negative correlation between the actual inflow and the contemporaneous labor market conditions in our case.

The instrument is 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 of the wage effect are larger and specialization is less significant using the refugee instrument. This could indicate that the refugees are a group of workers especially focussed in manual jobs, different from natives and thus more strongly complementary to them. The more heterogeneous composition of workers in the non-EU group with some groups more similar to natives could produce an attenuated effect.

The first interesting result is that on average, hourly wages and labor supply increase (not always by a statistically significant amount) in response to immigration for low-skilled native workers, both within establishment and within municipality. Within establishment (columns 1 and 2) low skilled exhibit some evidence of career upgrade, higher hourly wages and larger labor supply, especially in response

to refugees. Within municipality (columns 3 and 4), including workers who change establishment, low skilled natives exhibit a large and significant shift towards occupational complexity. Those remaining within establishments seem to achieve the wage gains without increased specialization, while those moving between establishment show large occupational changes towards complex jobs. This could happen if natives who do not 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 in other firms 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.[38] An interesting implication of our results is that 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.

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 two percentage points larger than the municipalities below average. This translates over the 1995-2008 period into 1.0 percent higher wages for low skilled native workers within an establishment (3.6 percent looking at the refugee immigrants). The impact is more modest if we consider the effect on all native workers in the municipality, including those who changed establishment. Here the average gain is an insignificant 0.2 percent (2.6 percent 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. Taken together these results suggest that non-EU immigrants encouraged low-skilled natives to take more complex occupations especially when they changed establishment.

[38]Table A.3 in the Appendix shows the same results as Table 4 relative to high skilled native workers. The main finding is that their wage and employment increase. They also moved, but less, towards more complex occupations. This is reasonable as high skilled natives already performed production tasks quite different from non-EU immigrants.

7.2 The Medium and Long Run Transitions

The trajectories of the difference in treated-control outcomes between three years before and fourteen years after the surge in the immigrant share are shown in Figure 5.[39] We show three different outcomes: occupation complexity, hourly wage and fraction of year worked. The figure shows three important results. First, there is no sign of a pre-event trend in any difference in outcomes between treated and control municipalities. This is reassuring and it confirms that after controlling for individual characteristics 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 less educated native workers moved steadily towards more complex occupations in response to high non-EU immigration. Fourteen years after the divergence in immigrant shares (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.4 in the Appendix). This corresponds to a 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). In the long run the effect is positive but less significant. No significant effect on employment, measured as fraction of year worked is found in the short and medium run. After 10 years a small, barely significant effect on labor supply appears to arise. As we will see below, this effect is mainly due to older workers who 11 to 14 years after the event could go on early retirement.

The results confirm some findings of the spell analysis and at the same time are the first results in this literature, to the best of our knowledge, obtained by following a cohort of native 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

[39]The coefficients represented are estimated in the context of specification 5. Table A.4 in Appendix reports the estimates for selected years before and after the surge in immigration.

in 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.4 are larger than those estimated in the spell regression. After nine years from 1994 the difference in share of non-EU immigrants between treated and non-treated municipalities was about 1.25 percent of the labor force. The effect on the wage of less skilled natives was a positive 1.1 percentage points. This implies an elasticity of 0.9, while the within establishment estimates of those elasticities was 0.6 and within municipality only 0.1 (Table 4). This suggests that those who changed municipality were differently selected among natives, and that the contemporaneous effects estimated in the spell regressions can be different from the long-run effect on all workers.

Summarizing the full transition for less educated workers in Figure 5, 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. 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). This effect is driven by older people as discussed below.

7.2.1 Treatment Effects for Different Groups

To complete the picture of the native labor market transitions following the non-EU immigration surge we consider two partitions of the native low skilled labor force. First, we consider young and old workers, namely those who were 21 to 36 years old in 1994 and those 37 to 51. 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.

Figures 6 shows the transitions of the usual three outcomes (occupational complexity, hourly wage and fraction of year worked) separately for old and young low-skilled native workers. Figures 7 shows the split between outcomes of high and low tenure. The results are as expected. 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 workers have also larger hourly wage gains, relative to old workers in treated municipalities. The labor supply of young workers does not respond significantly in treated municipalities, nor does the labor supply of old workers, except in the last 3-4 years when a decline in the treated municipalities may be due to early retirement behavior.[40]

Hence, the decline observed in labor supply after 9 years from the event is due to older workers, and it is possible that a 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.

7.3 Cumulated Effects

Table 5 reports the estimated effects of an increase in non-EU immigrants by one percentage point of the labor force on cumulated native outcomes over 14 years (1994-2008). Those estimates are based on equation (6). The first line reports the impact on employment. The seond and third lines report the effect on the length of employment in the same and new establishment. The fourth and fifth show the length of employment in the same and new municipality. All those are in response to non-EU immigration increases by one percentage point of the labor force. The last three rows show the effects on the length of cumulated unemployment, self-employment and on the present discounted value of annual earnings.

Column 1 of Table 5 shows the estimated coefficient on the whole low-skilled native labor force. The first row implies that less educated native workers in municipalities receiving an increase in non-EU immigrants equal to one percentage point

[40]Figure A.2 in the Appendix shows the split in transition between men and women. The strongest positive effects on complexity and wages are for men.

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.[41] 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 (sixth row) or the probability of self-employment (seventh row).

However, on average, less educated natives spent three weeks less in the same establishment over the following 14 years (not significant), for each increase of non-EU immigrants by one percent point of the workforce. They also spent 12 working weeks less in the original municipality and 9 weeks more in a new one during the following 14 years. Thus, cross-municipality mobility of natives was positively affected by non-EU immigration. Columns 2 and 3 of Table 5 show the cumulated effects when we separate the sample between young and old workers as of 1994. The young workers exhibit stronger inter-municipality mobility response relative to older ones, as expected. We do not find any effect on employment for either group on the aggregate over 14 years. 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 municipality and an insignificant increase in the mobility across firms for low skilled.[42] Most of these changes are associated to upgrades and better opportunity, and not to displacement and loss of skills, as they may generate increases in wages and yearly income.

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

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

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

on mobility of workers across establishments, municipalities, and in and out of employment. We exploit a quasi-experiment where we observe a pre-event 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 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. It 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

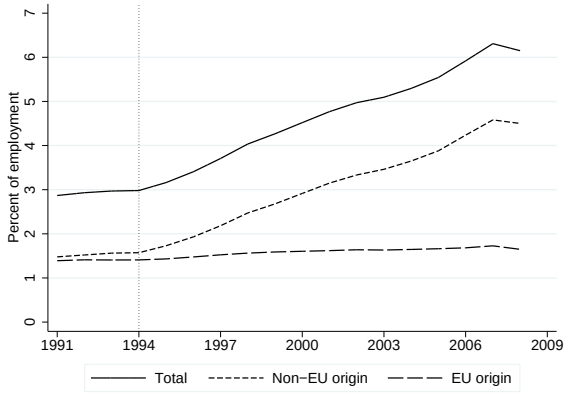
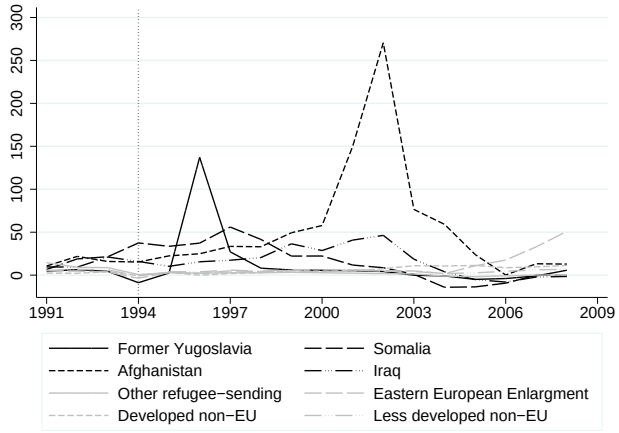
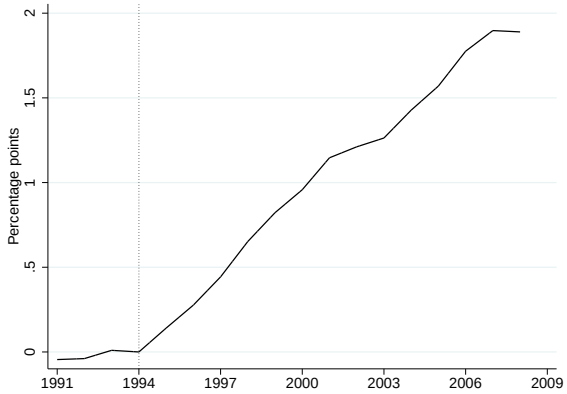


Figure 2: Drivers of non-EU immigration growth, 1991-2008



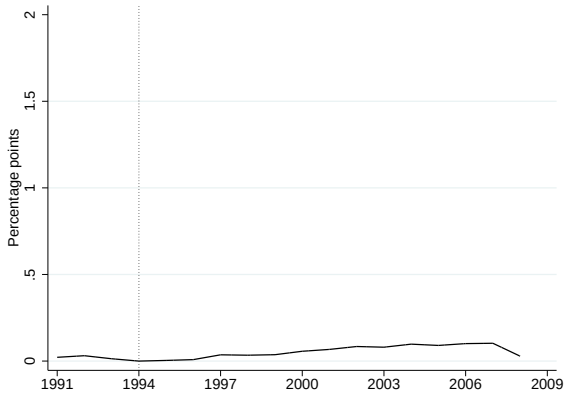
Notes: Annual inflows in percent of populations in 1994.

Figure 3: Difference in non-EU immigrants' 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 4: Difference in EU immigrants' 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 change in non-EU immigrants share 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 native workers			
	Mean	S.d.	Min	Max
Age	38.17	12.26	18.00	65.00
Labor market experience	15.03	10.13	0.00	45.00
Job tenure	4.29	5.52	0.00	28.00
Married	0.48	0.50	0.00	1.00
Education, primary	0.64	0.48	0.00	1.00
secondary	0.15	0.36	0.00	1.00
vocational	0.16	0.37	0.00	1.00
higher	0.04	0.21	0.00	1.00
Region, Northern Jytland	0.11	0.32	0.00	1.00
Central Jytland	0.23	0.42	0.00	1.00
Southern Denmark	0.23	0.42	0.00	1.00
Greater Copenhagen Area	0.27	0.45	0.00	1.00
Zealand	0.15	0.36	0.00	1.00
Agriculture, fishing and quarrying	0.03	0.16	0.00	1.00
Manufacturing	0.23	0.42	0.00	1.00
Electricity, gas and water supply	0.01	0.07	0.00	1.00
Construction	0.09	0.28	0.00	1.00
Wholesale and retail sale, hotels and rest.	0.18	0.38	0.00	1.00
Transport, post and telecommunications	0.10	0.30	0.00	1.00
Finance and business activities	0.09	0.29	0.00	1.00
Public and personal services	0.28	0.45	0.00	1.00
Occupational complexity	0.13	0.90	-2.69	2.11
ln(Hourly wagerate)	5.03	0.38	0.13	9.17
ln(Annual earnings)	12.33	0.50	7.05	16.97
Fraction of year worked	0.92	0.17	0.00	1.00
Observations	1,787,910			

Notes: Employed natives 1995-2008. 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 outcomes for low skilled natives

	1991-1994 difference in average			1994-2008 dif.
	Occupational complexity	Hourly wage	Fraction of year worked	in actual share
			Non-EU	
1994-2008 dif. in imputed share	0.277	-0.091	0.029	0.519***
	(0.269)	(0.155)	(0.130)	(0.122)
F-statistic instrument	1.06	0.34	0.05	17.98
Observations	97	97	97	97
R-squared	0.37	0.64	0.81	0.71
			Refugee	
1994-2008 dif. in imputed share	-0.590	0.527	-0.005	0.559***
	(0.832)	(0.477)	(0.402)	(0.070)
F-statistic instrument	0.50	1.22	0.00	64.00
Observations	97	97	97	97
R-squared	0.37	0.64	0.81	0.87

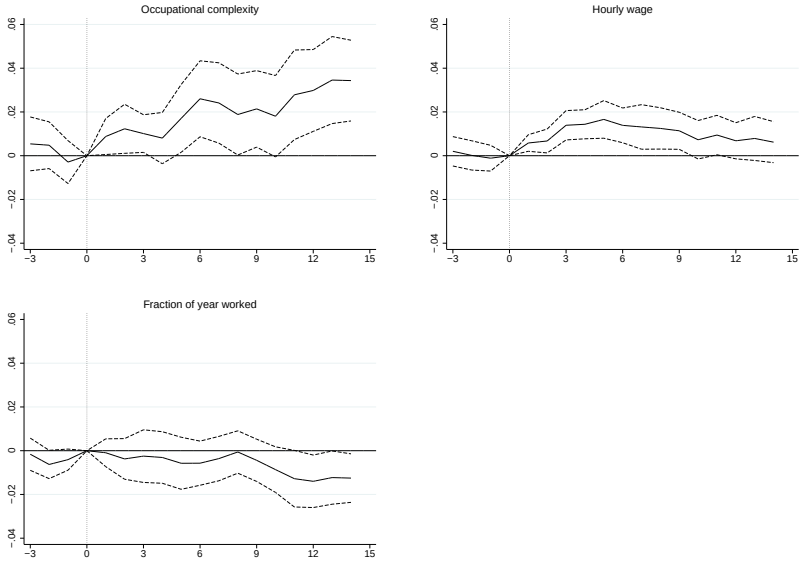
Notes: Each regressions is at the municipality level and weighted by the size of the labor force in the municipality. The table shows correlation of instrument with pre-trends in native outcomes and with actual change in foreign born share. Controls are those listed in Table 2 averaged for each municipality in 1994. Refugees from the Former Yugoslavia are excluded from the refugee-group since they constitute an exemption from the random dispersion policy.

Table 4: Worker-establishment and worker-municipality spell regressions (2SLS), low skilled

	(1)	(2)	(3)	(4)
	Worker-establishment		Worker-municipality	
	Non-EU	Refugee	Non-EU	Refugee
Occupational complexity	0.544	0.294	2.556**	3.635*
	(0.302)	(0.754)	(0.873)	(1.822)
Career upgrade	0.468**	0.927	0.520**	0.966*
	(0.175)	(0.528)	(0.173)	(0.465)
Career downgrade	0.106	0.219	0.538***	1.241***
	(0.091)	(0.357)	(0.130)	(0.363)
Occupational mobility	0.574*	1.145	1.058***	2.206**
	(0.227)	(0.714)	(0.285)	(0.755)
Hourly wage	0.508*	1.856***	0.078	1.102
	(0.222)	(0.475)	(0.309)	(0.581)
Fraction of year worked	0.314***	0.669**	0.479***	0.943***
	(0.093)	(0.246)	(0.114)	(0.199)
Observations	1,541,654	1,541,654	1,787,910	1,787,910
First stage F-statistic	26.12	55.23	24.32	52.77
First stage coefficient	0.401***	0.467***	0.414***	0.516***
	(0.078)	(0.063)	(0.084)	(0.071)

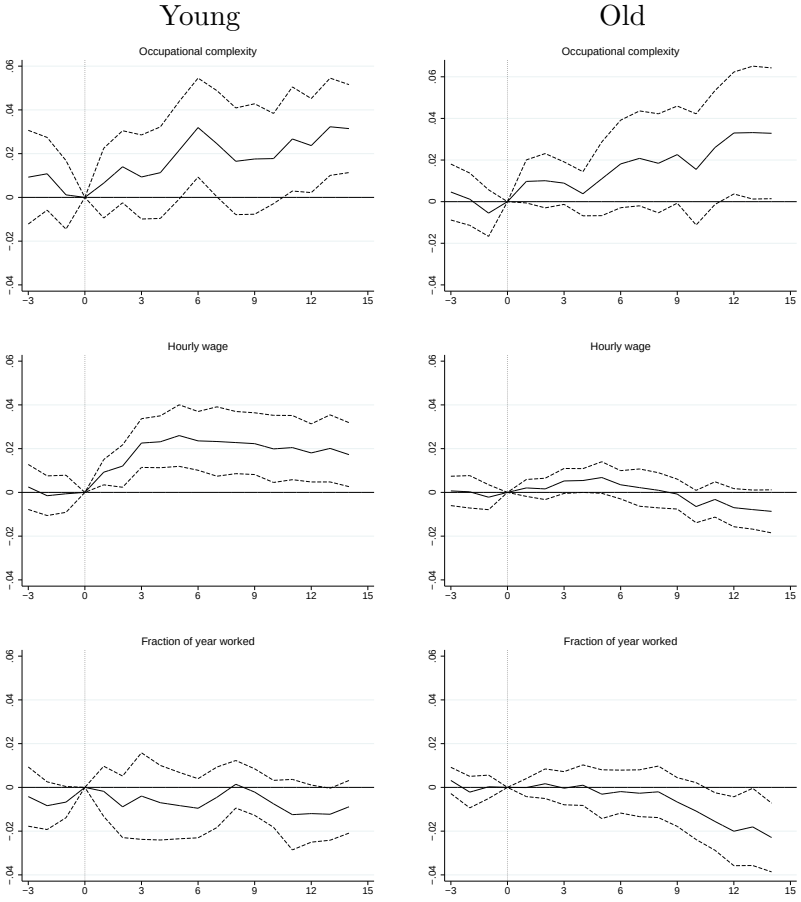
Notes: *** p< 0.001, ** p< 0.01, * p< 0.05. Each entry of the table is the coefficient on the explanatory variable of interest in equation (4) using a sample of employed low-skilled natives between 1995 and 2008. The dependent variables (left column) have the same first stage except for occupational complexity that has fewer observations (some missings). Standard errors in parentheses and F-statistic for significance of excluded instrument are clustered by municipality.

Figure 5: Treatment-control estimated differences in outcomes, low skilled



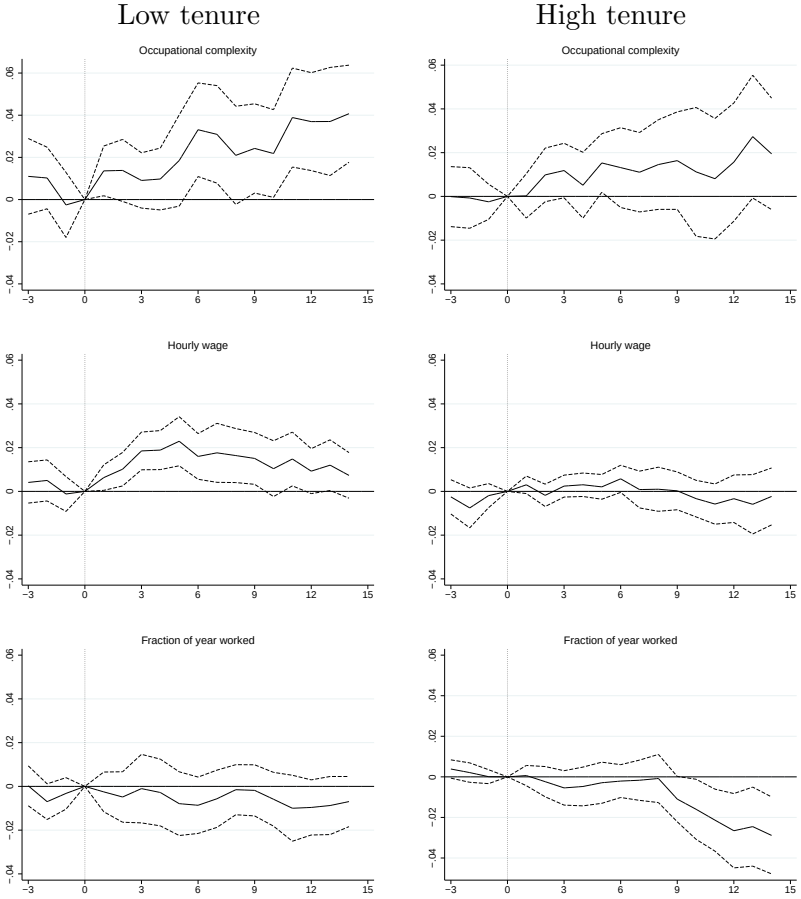
Notes: Parameter estimates (——) and 95% confidence limits (- - -) on the interaction terms of immigration exposure and year dummies in equation (5) using a strongly balanced panel of natives employed in 1994. Standard errors are clustered at the 1994-municipality.

Figure 6: Treatment-control estimated differences in outcomes by age group, 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 7: Treatment-control estimated differences in outcomes by tenure group, 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.

Table 5: The cumulative effect on employment and mobility for low skilled, 1995-2008

	All	Young	Old
Cumulative employment	-4.731	-5.259	-0.982
	(4.868)	(4.574)	(4.603)
- same establishment	-6.137	-5.685	-4.426
	(3.183)	(3.453)	(3.716)
- new establishment	1.406	0.426	3.444
	(3.715)	(4.745)	(3.597)
- same municipality	-23.049***	-36.016***	-3.429
	(6.666)	(9.254)	(3.009)
- new municipality	18.318***	30.757***	2.447
	(5.210)	(7.499)	(4.434)
Cumulative unemployment	2.211	1.411	1.581
	(2.397)	(2.396)	(2.275)
Cumulative self-employment	-0.053	-1.127	0.264
	(1.167)	(0.848)	(1.542)
PDV of annual earnings	0.030	0.777	-0.230
	(0.898)	(0.805)	(1.018)
Observations	71,028	35,573	35,455
First stage F-statistic	15.07	14.66	15.45

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. 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.