Study No. 17

What Happens to the Employment of Native Co-Workers when Immigrants are Hired?

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The Rockwool Foundation Research Unit

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Foreword

In 2005, the Rockwool Foundation decided to initiate, through its Research Unit, a project that would investigate the significance for the Danish labour market of the immigration of foreign labour. Such a project became especially relevant in light of the enlargement of the EU in 2004 to include a number of Eastern European countries. Moreover, the immigration of labour and integration into the labour market have always constituted one of the most highly prioritised areas of research for the Foundation.

The Research Unit then entered into a collaboration agreement with the Centre for Economic and Business Research (CEBR) at the Copenhagen Business School. Nikolaj Malchow-Møller (Director of Research), Jakob Roland Munch (Associate Professor) and Jan Rose Skaksen (Professor), all of CEBR, then carried out the major task of collecting and analysing the available data.

This publication at a midway stage of the project presents some of the main results concerning the consequences of immigration for the employment of Danish workers. We focus in particular on some of the potential consequences of immigration that are often overlooked in the literature. These concern the short-term costs of immigration to Danish workers currently in employment. Are there indeed such costs associated with the adaptation to new situation? And if there are, then who gains and who loses in the short term with respect to employment? Later, the study of these issues will be supplemented by analyses at the macro level.

Since the immigration of labour in connection with the enlargement of the EU has only been going on for a short while, it has only been possible to trace the consequences of immigration until the end of 2004 in the present working paper, and, of course, the EU enlargement only accounts for a small part of the effects of immigration up to that point.

In addition to the researchers mentioned above, I would like to thank Vibeke Borchsenius, Jonas Helth Lønborg and David Tønners for their extremely competent research assistance. My thanks also go to Assistant Professor Anna Piil Damm (University of Aarhus), Professor Christian Dustmann (University College London), Professor Peder J. Pedersen (University of Aarhus) and Associate Professor Michael Svarer (University of Aarhus) for their expert commentary on the researchers' analyses.

I would also like to mention the contribution of Mai-britt Sejberg of the Research Unit, who has been responsible for proof-reading the text.

As always with the Research Unit's projects, this research has been carried out in complete academic independence and free from the influence of any party, including the Rockwool Foundation itself. The Foundation has, however, with its usual dependability, provided the project with the necessary resources, and the

research group and I are indebted to the staff of the Foundation, including the Director, Elin Schmidt, and the Board and their chair Tom Kähler. Our warmest thanks go to them for their support and cooperation.

Copenhagen, October 2007 *Torben Tranæs*

Contents

Abstract: While immigration is unlikely to affect the employment of native workers in the long run, employment of immigrants may be associated with significant short-run adjustment costs for native workers as they have to find alternative employment or are temporarily pushed into unemployment. In this paper, we therefore study the impact of immigrants at the workplace on the employment of native co-workers using a rich matched worker-firm data set for Denmark. Estimation of a single risk duration model for job spells of native workers shows that job separation rates increase if more immigrants are hired, especially when it comes to immigrants from Eastern Europe and less developed countries (LDCs). Furthermore, in a competing risks duration model, we find that while immigrants from LDCs increase the unemployment risk for native workers, immigrants from Eastern Europe instead increase the job change probability of native workers. Thus, adjustment costs for native workers are more likely in the case where LDC immigrants are hired. Finally, we find that the results only apply for low-skilled native workers.

1. Introduction

The recent enlargements of the European Union with a number of Central and Eastern European countries have sparked concerns among workers in the old and relatively rich EU-countries that workers from the new and poorer EU-countries will move to the richer EU-countries and undermine their labour markets. But what do in fact happen to native workers? There have been several attempts to answer this question, and it can be approached in a number of different ways. In this paper, we analyse the short-run employment consequences for native workers when firms hire immigrants. While the employment of native workers is likely to be supply driven in the long run – and hence unaffected by immigration – there may be significant short-run adjustment costs for individual native workers.

There are numerous studies in the literature on how immigrants affect wages of native workers; see, *e.g.*, Card (1990), Borjas (2003), Ottaviano and Peri (2005), and the meta study by Longhi, Nijkamp and Poot (2005), who find that, in general, the wage effects are very small. A smaller number of studies have focused on the employment consequenses. Most of these studies adapt an "area approach" where they exploit that immigrants are distributed differently across regions compared to the native population to estimate the impact of immigrants on the employment of native workers. Examples of such analyses are Borjas, Freeman and Katz (1997) and Card (2001), both using U.S. data, Dustmann, Fabbri and Preston (2005), using U.K. data, Pischke and Velling (1997), using German data, and Angrist and Kugler (2003), using EU data. There is substantial variation in the results from this type of analysis, but the general conclusion seems to be that immigration has (very) small negative net employment implications for native workers; see Longhi, Nijkamp and Poot (2006).

In this paper, we take a different approach. We argue that much can be learned by analysing the relationship between immigration and the employment of native workers at the most disaggregate level: the workplace. For example, focussing on the net employment implications of immigration into local areas may understate the costs of immigration for the native workers, because even reallocations that do not lead to a net decline in employment may be associated with adjustment costs for individual native workers as they have to find alternative employment or are temporarily pushed into unemployment; see, *e.g.*, Klein et al. (2003). Therefore, in this paper we focus on the adjustments taking place at the firm level when firms hire immigrants. More specifically, we estimate the impact of immigrants at the workplace on the individual job separation probability of native workers. To the best of our knowledge, this is a novel approach in the analysis of employment effects of immigration.

We use a very detailed linked employer-employee data set for the Danish labour market for the period 1993-2004. This is a period with a large inflow of immigrants into the Danish Economy. In our data, the employment share for immigrants increased from 3.0 percent in 1993 to 5.2 percent in 2004, which consti-

tutes one of the most pronounced relative increases in immigration among developed countries in recent years.

We estimate both a single-risk duration model for job spells of native workers as well as a competing risks duration model that distinguishes between job-to-job transitions and job-to unemployment transitions, as the latter transitions are more likely to be associated with adjustment costs for the individual worker. Furthermore, we estimate separate effects for different educational groups of native workers.

The literature on job turnover at the individual level suggests that it is important to control for socio-economic characteristics such as gender and education; see, *e.g.*, Royalty (1998). Also, it is well known that job separation rates decline with time on the job due to, *e.g.*, the accumulation of firm specific human capital; see Farber (1999) for an overview. We use a duration model that controls for unobserved heterogeneity. Of particular importance is the fact that the workplace immigrant share may be endogenous if, for example, workers with less stable employment patterns tend to self-select into workplaces with many immigrants. We attempt to account for this potential endogeneity bias by simultaneously estimating a selection equation for the workplace immigrant shares.

We find that immigrants at the workplace have important effects on native employment. Immigrants and native workers are substitutes in the sense that job separation rates of native workers increase after more immigrants are hired. These effects are particularly pronounced for immigrants from Eastern Europe and less developed countries. Furthermore, in a competing risks duration model, we find that while immigrants from LDCs increase the unemployment risk for native workers, immigrants from Eastern Europe instead increase the job change probability of native workers. Thus, adjustment costs for native workers are more likely in the case where LDC immigrants are hired. Distinguishing between different types of native workers, we also find that the results only apply for low-skilled workers, whereas workers with further (tertiary) education are unaffected by immigrants at the workplace.

The rest of the paper is organized as follows: In section 2, we present the empirical hypotheses considered in the paper. Section 3 presents our data, and in Section 4 we present the econometric model. Section 5 contains the results of the paper. Finally, Section 6 concludes.

2. Empirical Hypotheses

As argued in the introduction, existing studies of the employment effects of immigration tend to focus on the net implications, *i.e.* the effects on average employment or unemployment rates of native workers. As argued by Longhi, Nijkamp and Poot (2006), the fact that they only find very limited effects on the employment of native workers "reinforces the broad consensus among economists that, in practice, when the labour market has adjusted in a number of ways, the impact of immigration is rather small" (p. 14). In other words, with a reasonably flexible labour market, we should not expect employment rates to be affected.

However, while this is likely to be true "after the labour market has adjusted", there may be significant adjustment costs for individual workers in the short run. If the employment of immigrant workers is associated with native workers being crowded out – perhaps experiencing a period of unemployment before finding a new occupation, the short run costs can be considerable. Focussing on the (long-run) effects on net employment ignores these adjustment costs for individual workers.

That short run adjustment costs should be taken seriously is for example suggested by Davidson and Matusz (2004) who show – by calibrating a general equilibrium model of international trade with unemployment and training – that adjustment costs make up a significant fraction of the gross benefits of a reform that removes trade barriers. Furthermore, it is clear that from the individual perspective, costs related to displacement may be substantial; see, *e.g.*, Farber (2005), Bender et al. (2002) and Borland et al. (2002). Job loss is associated with lower re-employment earnings, long spells of unemployment for some workers, and a higher probability of being part-time employed when re-employed (Farber, 2005).

In this paper, we try to assess the quantitative importance of the effects of immigration on the individual job separation rates of native workers and hence the adjustment costs associated with increased employment of immigrants. Specifically, we consider three questions: First, does the employment of immigrants substitute or complement employment of native workers? Second, are there signs of active substitution by firms and thus particularly high adjustment costs for native workers? Third, are certain groups of native workers affected more than other groups?

To answer the first question, we assess whether the hiring of immigrants increase or decrease the probability that native co-workers stay in a firm. Native workers and immigrants are substitutes if the separation probability rises, and *vice versa* if the probability falls.

There may, of course, be several explanations behind any observed complementarity or substitutability. One possible explanation is the technology in the firms. Another is the goods markets conditions of the firms. If immigrants are mainly

employed in expanding firms, this tends to create an observed complementarity between the employment of native workers and immigrants. A third possible source is the labour market conditions of firms. If immigrants are mainly employed in firms where native workers no longer "want" to work, we will tend to find that native workers and immigrants are substitutes. In the first part of our analysis, we attempt to determine whether the two types of labour are substitutes or complements, but we will not be able to distinguish directly between the different reasons for an observed substitutability or complementarity.

Second, to throw some more light on whether active substitution takes place and thus whether adjustment costs for native workers are likely to be important, we estimate a competing risks model in the second part of our analysis.

The idea is that if native workers are laid off when immigrants are hired, this is more likely to be associated with adjustment costs than if the native workers voluntarily quit the jobs, *cf.* the empirical evidence cited above. In our data, we can observe if native workers leave a firm when the firm hires immigrants. However, we cannot directly observe whether the native worker quits the job or she is fired. Instead, we can observe the destination state for workers ending their job spells, *i.e.*, the data allows us to distinguish between job-to-job and job-to-unemployment transitions. This information is used to estimate a competing risks model. A particularly strong indication of active substitution and adjustment costs is thus if native workers have a higher risk of becoming unemployed when firms hire immigrants.

Third, are native workers with different educational backgrounds affected differently by immigrants at the workplace? If immigrants predominantly are of a certain skill type, then native workers in that skill group are more likely to be substitutes to immigrants, while other native workers perhaps are more likely to be complements. To study this question, we assess the differential impact on three different groups of native workers in the third part of our analysis: Workers with basic education, workers with vocational education, and workers with further education. In doing this, we also distinguish between different types of immigrants as discussed below.

As adjustments need not occur instantly, following the employment of immigrants, we use two measures for the hiring of immigrants at the workplace level. First, we use the change in the immigrant share in the previous period and, second, we use the share of immigrants at the beginning of a job spell as a measure of the cumulated hiring of immigrants at the workplace.[1]

1. As an alternative measure of the cumulated hiring of immigrants at the workplace, we tried to use the share of immigrants in the previous period. This did not affect the results.

3. Data and the Danish Labour Market

An important characteristic of the Danish labour market is that it is heavily unionised and although a process of decentralisation of wage formation has been ongoing since the late 1980's, the wage structure is still relatively compressed even for European standards. Compared to other continental European labour markets, the Danish labour market is often described as being very flexible as employment protection is relatively weak, while at the same time replacement rates of UI benefits are high (especially for unskilled workers). A third distinguishing characteristic of the Danish labour market is that large sums are spent on active labour market policies (ALMP) – see Nickell et al. (2005) for a recent cross-country comparison of labour market measures on, *e.g.*, union density and coverage, employment protection, UI benefit replacement ratios and ALMP expenditures.

Together these ingredients form what by some has been dubbed the "flexicurity" model. The idea behind this model is that Danish firms relatively easily may adjust employment according to demand. As compensation for high job turnover, workers receive relatively generous UI benefits when unemployed, but incentives to search for jobs during unemployment are reinforced by a strict "activation" regulation. This labour market model has led to turnover rates and an average tenure which are in line with those of the Anglo-Saxon countries. In 1995, the average tenure in the Danish labour market was the lowest in continental Europe with 7.9 years – just exceeding the number for UK (7.8 years), *cf.* OECD (1997).[2]

To investigate the importance of immigrants for job separations of employed native workers in Denmark, a very rich data set, which is drawn from administrative registers, is used. The data set covers the full Danish population for the years 1993-2004, but to save on estimation time, only a five percent random sample is used in the analysis. In each year, detailed information about the labour market states of all individuals along with information on socioeconomic characteristics is available. These socioeconomic variables are extracted from the integrated database for labour market research (IDA) and the income registers in Statistics Denmark. Of particular importance is the fact that a workplace identity is associated with each worker at the end of each year. Job spells with annual observations are then straightforwardly constructed from successive years at the same workplace. Note that a firm can have more than one workplace, so if a worker changes between two workplaces within the same firm, this is counted as a job change in the present analysis.

Here we are interested in the duration of job spells and transitions into new jobs and unemployment, and for the present purposes, job spells are flow sampled

2. Another reason for the relatively low average tenure in Denmark may have to do with the fact that firms are relatively small in Denmark compared to other countries.

such that only spells starting in 1994 and later are included in the analysis.[3] The destination state for all spells that end before 2004 is known, and if job spells end with transitions into other states than a new job or unemployment (*e.g.* out of the labour force), or if spells are not completed by the end of 2004, they are treated as independently right-censored observations.

In the following, we restrict attention to job spells of native workers between 18 and 65 years with fulltime employment in private sector workplaces with at least 10 employees. Some descriptive statistics for the job spells in the sample are given in Table 1. It is seen that more than 60 percent of the spells end in a job-to-job change while 5 percent end in unemployment.

Table 1: Job Spell Statistics

Number of persons	51,960
Number of spells	89,492
Persons with more than one spell (share)	0.1803
Mean duration of spells (years)	3.0815
Proportion of spells:	
right-censored spells	0.2934
end with job change	0.6051
end with unemployment	0.0539
end in other destinations	0.0475

The importance of immigrants at the workplace is measured in two different ways. First, as the share of immigrants among workers in the first year of the job spell. Second, as last periods change in the number of immigrants relative to the number of workers at the beginning of last period. Since we have access to data on the full population, we can construct exact measures for these variables. Note that immigrants are defined as individuals born outside Denmark with non-Danish parents. If there is no information about the parents and the individual is born outside Denmark, he/she is also classified as an immigrant.

It may be important to distinguish between different types of immigrants as they have come to Denmark for different reasons. Employment related immigration may in particular be the case for immigrants from the old EU-countries and the Nordic countries, whereas most of the immigrants from less developed countries are refugees or family reunified persons. For this reason, it seems fair to assume that immigrants from different regions of the world have different qualifications and may therefore have different consequences for native workers. Hence, we operate with the following four different types of immigrants: 1) Immigrants from EU-15 countries, Norway and Iceland; 2) Immigrants from the 10 new EU countries as of May 1, 2004; 3) Immigrants from all remaining

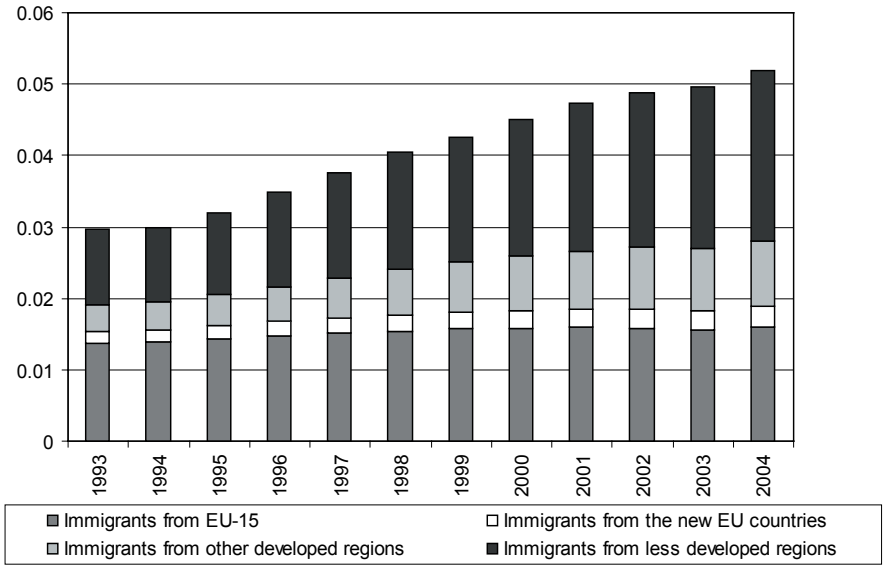
3. We also use covariates measuring changes between two years, so spells starting in 1993 are not included in the analysis.

developed countries according to the UN definition; and 4) Immigrants from all remaining countries, *i.e.*, countries from less developed regions according to the UN definition.[4]

Figure 1 shows that since 1994 – the beginning of our sample window – the share of immigrants in the population of employed workers in Denmark has increased markedly. The increase corresponds to a relative increase of almost 75 percent over the period 1994-2004. It is also evident that the immigrant type with the steepest increase is type 4, *i.e.*, immigrants from less developed countries. This substantial increase in the stock of immigrants is, of course, very useful in identifying effects from immigration.

It should be mentioned that we also tried to measure immigration at the local labour market level, but these variables never had any significant effects on job separations in the analysis below so they are omitted.[5] This finding is consistent with the numerous studies cited in the introduction which find limited or no local labour market impact of immigration.

Figure 1: Share of Immigrants Among Employed Workers



Finally, Table 2 displays summary statistics for all individual and workplace control variables included in the analysis. Self-explanatory dummies for age, gender, the presence of children, marriage, and education are included. Also three geo-

4. See http://esa.un.org/unpp/definition.html.

5. The local labour markets are so-called commuting areas, which are defined such that the internal migration rate is 50 percent higher than the external migration rate. This definition results in 51 commuting areas in Denmark.

graphic dummies are included to distinguish between the capital Copenhagen, 5 large cities, and all other localities (small cities). Information on years of labour market experience is also included. Roughly one third of the observations (one observation is a person-year) are from workplaces without immigrants, while two thirds have immigrant co-workers. It is seen that native workers in workplaces with immigrants are more likely to be older, live in Copenhagen and have further education, whereas workers without immigrant co-workers are more likely to have vocational education.

Table 2: Summary Statistics

	All observations		Workplaces without immigrants		Workplaces with immigrants	
	Mean	Stdv.	Mean	Stdv.	Mean	Stdv.
Individual characteristics:						
Age 18-24	0.1195	0.3243	0.1600	0.3666	0.0983	0.2977
Age 25-29	0.1633	0.3696	0.1718	0.3772	0.1588	0.3655
Age 30-39	0.3469	0.4760	0.3179	0.4656	0.3621	0.4806
Age 40-49	0.2192	0.4137	0.2078	0.4057	0.2252	0.4177
Age 50+	0.1464	0.3535	0.1383	0.3452	0.1506	0.3577
Female	0.3288	0.4698	0.3102	0.4626	0.3384	0.4732
Children 0-17 years	0.2550	0.4358	0.2499	0.4329	0.2576	0.4373
Married	0.4911	0.4999	0.4807	0.4996	0.4965	0.5000
Copenhagen	0.2283	0.4197	0.1443	0.3514	0.2721	0.4450
Large city	0.1318	0.3383	0.1405	0.3475	0.1273	0.3333
Small city	0.6399	0.4800	0.7151	0.4514	0.6006	0.4898
Experience (years)	0.1476	0.0923	0.1446	0.0920	0.1492	0.0924
Basic education	0.3448	0.4753	0.3395	0.4736	0.3475	0.4762
Vocational education	0.4758	0.4994	0.5372	0.4986	0.4437	0.4968
Further education	0.1795	0.3838	0.1233	0.3288	0.2088	0.4064
Workplace characteristics:						
10-50 employees	0.4024	0.4904	0.7967	0.4025	0.1967	0.3975
51-200 employees	0.3044	0.4601	0.1941	0.3955	0.3619	0.4806
> 200 employees	0.2932	0.4552	0.0092	0.0956	0.4414	0.4966
Share with basic education	0.3520	0.1780	0.3367	0.1953	0.3600	0.1677
Share with further education	0.1765	0.1996	0.1212	0.1807	0.2054	0.2029
Share female	0.3280	0.2342	0.3150	0.2683	0.3348	0.2139
Share age above 40	0.4180	0.1762	0.3999	0.2061	0.4274	0.1575
Imm. share type 1	0.0138	0.0251			0.0210	0.0284
Imm. share type 2	0.0021	0.0083			0.0032	0.0100
Imm. share type 3	0.0078	0.0245			0.0119	0.0294
Imm. share type 4	0.0163	0.0443			0.0248	0.0527
Person-years	234,150		80,296		153,854	

4. Econometric Model

To investigate the impact of the employment of immigrants at the workplace on job separations of native workers, this section sets up an empirical model for job duration and selection into workplaces with different immigrant variables.

In studies of individual job separations, it is important to control for duration dependence since the job separation rate typically declines with time on the job due to the accumulation of match specific human capital; see Farber (1999) for an overview. Therefore, we use a duration model which allows for right-censored job spells as well as duration dependence in the transition process out of the current job. Furthermore, to distinguish between job-to-job transitions and job-to-unemployment transitions, a competing risks duration model is specified (Sueyoshi, 1992) in the second part of the analysis. In the following, we outline only the latter model, as it generalises the single-risk model used in the first part of the analysis.

Even when there is access to a comprehensive data set, there might still be some unobserved heterogeneity left, as no measures for, *e.g.*, ability or motivation are available. We capture unobserved worker characteristics by specifying a mixed proportional hazard model for the labour market transitions:

$$\theta_i\left(t\middle|x_t, z_t, v_i\right) = \lambda_i\left(t\right)\cdot \exp\left(\beta_i x_t + \gamma_i z_t + v_i\right) \qquad (1)$$

where $i = e,u$ indicates the different destination states (*i.e.*, employment and unemployment) for the transition, $\lambda_i(t)$ is the baseline hazard capturing the time dependence for transitions into destination i, and $\exp\left(\beta_i x_t + \gamma_i z_t + v_i\right)$ is the systematic part giving the proportional effects of workplace immigrant variables, z_t, other observed and time-varying characteristics, x_t, and unobserved characteristics, v_i. The vector of workplace immigrant variables may both include the workplace shares of different types of immigrants as well as changes in these variables over time. All job spells that end with a transition to another state than one of the two described above (*e.g.*, out of the labour force) are treated as independent right-censored observations.

The annual nature of the data imply that the duration variable, T, is grouped into $K + 1$ intervals $\{[0,t_1),[t_1,t_2),..,[t_k,\infty)\}$, which must be accounted for in the econometric specification. Thus, following Kiefer (1990), the interval specific survival rate is defined as

$$\begin{aligned}\alpha &= P\left(T \geq t_k \middle| T \geq t_{k-1}, x_k, z_k, v\right) \\ &= \exp\left[-\sum_{i=e,u} \int_{t_{k-1}}^{t_k} \theta_i\left(t \middle| x_k, z_k, v_i\right) dt \right] \\ &= \exp\left[-\sum_{i=e,u} \exp\left(\beta_i x_k + \gamma_i z_k + v_i\right) \Lambda_{i,k} \right] \\ &= \prod_{i=e,u} \alpha_{i,k}\end{aligned} \tag{2}$$

where $\Lambda_{i,k} = \int_{t_{k-1}}^{t_k} \lambda_i(t)dt$ and $\alpha_{i,k} = \exp[-\exp(\beta_i x_k + \gamma_i z_k + v_i)\Lambda_{i,k}]$.

To find the contribution to the likelihood function from a job spell, it is noted that the probability that a spell ends in interval k is given by the conditional probability of failure in that interval times the probability that the spell survives until interval k, or $(1-\alpha)\prod_{j=1}^{k-1}\alpha_j$. Right-censored spells contribute to the likelihood with the survivor function, $\prod_{j=1}^{k}\alpha_j$, and so the contribution to the likelihood function from a job spell ending in interval k can be written as:

$$L_e\left(t \middle| x_1,...,x_k, z_1,...,z_k, v_e, v_u\right) = (1-\alpha_{e,k})^{d_e}(1-\alpha_{u,k})^{d_u}\alpha_k^{\,1-d_e-d_u}\prod_{j=1}^{k-1}\alpha_j \tag{3}$$

where d_e and d_u are destination state indicators. If the job spell is right censored then $d_e = d_u = 0$. Instead of imposing a functional form on the baseline hazard, we allow for a flexible specification by simply estimating the interval specific baseline parameters, $\Lambda_{i,k}$.

To account for potential endogeneity of the workplace immigrant variables, z_t, we simultaneously model these and the transition rate out of the job spell. For example, the workplace share of immigrants in year t, m_t, depends on explanatory variables, x_t and y_t, and an unobserved component, ε_t, and since m_t takes the value zero in many workplaces, the equation for m_t must be specified as a Tobit model:[6]

$$\begin{aligned} m_t^* &= \beta_m x_t + \gamma_m y_t + \varepsilon_t, \\ m_t &= 0 \quad if \quad m_t^* \leq 0, \\ m_t &= m_t^* \quad if \quad m_t^* > 0, \end{aligned} \tag{4}$$

where x_t are the same explanatory variables that are included in the duration model, and y_t are variables that are included in the Tobit model, but not in the duration model. Note that the subscript "m" on the parameters indicates that these

6. When the immigration variable is measured as a change between two years, it takes values between -1 and 1, and here the selection equations is estimated by OLS with an individual random effect.

belong to the selection model, whereas subscripts "*e*" and "*u*" are used in the duration model. For a given individual, the error term is composed of two components, an independently normally distributed idiosyncratic component, u_t, and a random individual-specific effect, v_m, which does not vary over time:

$$\varepsilon_t = u_t + v_m \tag{5}$$

The likelihood contribution from a sequence of immigrant shares over a job spell is thus

$$L_m\left(m_1,...,m_k \middle| x_1,...,x_k, y_1,...,y_k, v_m\right) = \prod_{j=1}^{k} \frac{1}{\sigma_u}\varphi\left(\frac{m_j - \beta_m x_j - \gamma_m y_j - v_m}{\sigma_u}\right)^{d_m} \times\left(1-\Phi\left(\frac{\beta_m x_j + \gamma_m y_j + v_m}{\sigma_u}\right)\right)^{1-d_m} \tag{6}$$

where σ_u is the standard deviation of the idiosyncratic component, $\varphi(.)$ is the standard normal probability density function, $\Phi(.)$ is the standard normal cumulative distribution function, and d_m is an indicator variable taking the value 1 if $m_t > 0$ and zero otherwise.

We assume that all sources of correlation between the two processes can be represented by the individual-specific heterogeneity terms. These terms are assumed to be time-invariant and hence constant across repeated spells for the same individual.

The unobserved heterogeneity is specified by the stochastic variables, v_e, v_u, v_m, so the complete contribution to the likelihood function for from a job spell is:

$$L = \iiint\limits_{v_e,v_u,v_m} L_e\left(t \middle| x_1,...,x_k, z_1,...,z_k, v_e, v_u\right) \cdot L_m\left(m_1,...,m_k \middle| x_1,...,x_k, y_1,...,y_k, v_m\right) dF\left(v_e, v_u, v_m\right) \tag{7}$$

where F is the joint CDF for the unobserved heterogeneity. We use a flexible and widely applied specification of the distribution for the unobservables: It is assumed that v_e, v_u, and v_m each can take two values, where one of the support points in each destination specific hazard is normalized to zero (*i.e.*, $v_e = 0$, and $v_u = 0$), because the baseline hazard acts as a constant term in the hazard rates. Thus, there are 8 possible combinations of this unobserved heterogeneity distribution, each with an associated probability. For more details on this class of mixture distributions in duration models, see, *e.g.*, van den Berg (2001).

4.1 Identification

To identify the causal relation between the workplace immigrant variables and the outcomes of interest, two identification strategies may be pursued. The first identification strategy relies on the occurrence of multiple job spells for individuals. This implies that we observe some individuals in several job spells with different values of the immigrant variables. Moreover, during a given job spell, some persons work in workplaces with changing immigrant shares which further adds to the identification of the model parameters. This identification approach has recently been used in applied duration models by, *e.g.*, Munch et al. (2006, 2007).

The identification strategy requires that we – for at least a subset of the individuals – observe job spells with different values of the workplace immigrant variable. The intuition behind the identification strategy is provided by the following simple example (building on Panis (2004)): Suppose we only observe one worker in two job spells where the workplace immigration variable changes value. In this sample, there is no heterogeneity and no correlation across equations and so the equations are independent. The effect of the workplace immigrant variable on exit rates from employment is identified because of repeated observations on job spells and variation in the immigrant variable. More generally, conditional on heterogeneity, the equations are independent, and identification rests on repeated outcomes with variation in the workplace immigrant variable. In our sample, almost 18 percent of the workers are observed with multiple job spells (see Table 1), which is comparable to other studies using the same identification strategy (Munch et al. 2006, 2007).

The second identification strategy uses exclusion restrictions. That is, the existence of a set of variables that affect the workplace immigrant share but have no direct impact on job separations is postulated. In the literature on immigration and local labour markets, this strategy has been employed by, *e.g.*, Card (2001) and Cortes (2006). While we use the first identification strategy as our baseline scenario, we check robustness of the results by estimating the model using both identification strategies.

5. Results

This section presents results of estimating different versions of the duration model outlined above. We start out with a simplified model where we do not distinguish between different causes behind job separations, *i.e.*, a single risk model. Next, we distinguish between job-to-job and job-to-unemployment transitions in a competing risks model. This is followed by a model which allows for differential impacts on native workers with different educational attainments. Finally, we consider robustness of our results by studying the importance of controlling for possible endogeneity of the immigrant variables.

As mentioned above, we use two measures of immigrants at the workplace. First, we use the *change* in the number of immigrants at the workplace relative to the initial number of workers at the workplace. That is, as we study native job separations between year t and year $t+1$, this change variable is defined for the change in immigrants between year $t-1$ and t such that it is exogenous with respect to the interval specific survival rate. Second, we include the share of immigrants in the first year of the job spell as a measure of the cumulated change in immigrants at the workplace. We use the immigrant share in the first year of the job spell, instead of the immigrant share at the beginning of the period, so as to better distinguish it from any change in the number of immigrants during the job spell (our first variable). However, using the immigrant share at the beginning of the period instead of the immigrant share at the beginning of the job spell does not affect the results qualitatively. Finally, it should be recalled that we operate with four different types of immigrants, so this leaves us with eight different immigrant variables.

Table 3 presents estimation results from different specifications of the single risk duration model. Before we proceed to the impacts of immigrant variables, we note that all model specifications include as controls the variables listed in Table 2. The effects of these variables are not shown in the table, but there are no surprising results. For example, young workers, male workers and workers at relatively large workplaces are least likely to separate from their jobs.

In the first column, only the four immigrant variables for the relative changes in immigrants at the workplace are included. There is a relatively strong positive and significant impact on the job separation hazard rate from hiring type 2 immigrants (*i.e.*, workers from the Eastern European EU countries). Thus, there is evidence that immigrants from Eastern Europe substitute the employment of native workers. The quantitative importance of the estimated coefficient of 1.0831 for type 2 immigrants can be assessed by calculating the relative (percentage) change in the separation rate in response to a 1 percentage point increase in the immigration measure as $\exp(1.0831*0.01) - 1 = 0.0109$. That is, the separation rate rises 1.09 percent if the immigration variable rises one percentage point.

The second model uses only the four share variables, and here the coefficients to all four variables are positive, again with the impact of type 2 immigrants

Table 3: Estimation Results: Single Risk Model

	(1)		(2)		(3)	
	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std.err.
Δ imm. share type 1	0.0376	0.0263			0.0294	0.0271
Δ imm. share type 2	**1.0831**	0.1718			**1.2540**	0.1660
Δ imm. share type 3	-0.0069	0.0659			-0.0127	0.0694
Δ imm. share type 4	0.0580	0.0357			0.0358	0.0371
Initial imm. share type 1			0.2419	0.1377	0.1870	0.1382
Initial imm. share type 2			**1.0158**	0.4199	-0.0128	0.4491
Initial imm. share type 3			**0.4300**	0.1401	0.0864	0.1539
Initial imm. share type 4			**0.5303**	0.0791	**0.5640**	0.0803

Notes: Bold numbers indicate a significant parameter estimate (5% level). All models have been estimated with the control variables listed in Table 2. Unobserved heterogeneity is controlled for using a two-point discrete distribution. Parameter estimates of covariates, the distribution for unobservables and duration dependence are available from the authors upon request.

being the strongest. These results are consistent with the view that previous period hiring of immigrants (column 1) and the share variables (column 2) tend to capture the same aspect of immigration, namely the extent to which immigrants are substitutes or complements to native labour. The results are unequivocal in suggesting that immigrants are substitutes to native workers although to a varying extent across the four types of immigrants.

In the final column, we enter all eight immigrant variables, and it is seen that it is now only type 2 immigrants that displace native workers in the short run, while it is only type 4 immigrants (immigrants from less developed countries) that have longer lasting positive impacts on native job separation rates as reflected in the positive coefficient to the type 4 share variable.

We then turn to the next question that we set out to answer in Section 2: Does the hiring of immigrants lead to adjustment costs for native workers? We analyse this question by distinguishing between transitions into new jobs and into unemployment. Clearly, if the employment of immigrants leads to unemployment for native workers, it may be associated with significant adjustment costs. Job-to-job changes, on the other hand, are more likely to reflect voluntary quits, although it should be noted that many job-to-job changes are observed following layoffs. According to Browning et al. (2006), more than half of the displaced workers in the Danish labour market have no unemployment at all in the displacement year. This is possible in flexible labour markets as the Danish, and it is therefore also likely that immigration affects the job change probability. Such transitions may, however, also involve adjustment costs. In particular, if the worker takes a wage cut after a job change. But this issue will not be explored further in this paper.

Table 4 displays results of estimating the competing risks model. It is seen that the positive impact of a change in type 2 immigrants in the previous period found in the single risk model may entirely be ascribed to a higher job-to-job transition rate, while there is no impact on the unemployment hazard. Thus, im-

migrating workers from Eastern Europe are substitutes for native workers but these immigrants tend to be hired when native workers voluntarily leave their jobs or involuntarily are pushed into new jobs. On the other hand, the positive impact of the type 4 immigrant share variable is seen to primarily lead to transitions into unemployment although there is also a positive effect on the job-to-job hazard rate.

Table 4: Estimation Results: Competing Risks Model

	Job change hazard		Unemployment hazard	
	Coeff.	Std. err.	Coeff.	Std. err.
Δ imm. share type 1	0.0274	0.0275	-0.2766	0.1842
Δ imm. share type 2	**1.0770**	0.2020	0.0376	0.8501
Δ imm. share type 3	**0.1113**	0.0565	-0.1326	0.2896
Δ imm. share type 4	0.0424	0.0384	0.0243	0.1357
Initial imm. share type 1	0.0549	0.1592	0.3357	0.3725
Initial imm. share type 2	-0.0213	0.5020	0.1580	1.2342
Initial imm. share type 3	**-0.6038**	0.1923	0.3148	0.4003
Initial imm. share type 4	**0.2762**	0.0957	**1.4282**	0.1868

Notes: Bold numbers indicate a significant parameter estimate (5% level). All models have been estimated with the control variables listed in Table 2. Unobserved heterogeneity is controlled for using a two-point discrete distribution. Parameter estimates of covariates, the distribution for unobservables and duration dependence are available from the authors upon request.

To sum up, immigrants from Eastern Europe have a positive impact on job separation rates, but it is not clear that it is associated with significant adjustment costs for native workers, while immigrants from least developed countries tend to increase the unemployment risk of native workers.

The third question we look at is whether different groups of native workers are affected differently by immigrants at the workplace. To study this issue, we interact the immigration variables with three education indicators for the native workers: Workers with basic education, workers with vocational education and workers with further education. Several interesting results are found. First, it is seen from Table 5 that type 1 immigrants (immigrants from EU-15 countries) have a positive effect on the job change hazard, but only for workers with vocational or further education. This probably reflects the fact that type 1 immigrants are relatively well educated and therefore are more likely to act as substitutes for high-skilled native workers. Second, the variable measuring changes in type 2 immigrants in the previous period does not affect workers with further education, while less educated workers see their job-to-job change hazard increase. This suggests that Eastern Europeans are only substitutes for native workers with basic or vocational education. Third, much the same picture emerges with respect to the share of type 4 immigrants; further educated workers are not affected while especially workers with just basic schooling have higher job-to-job and job-to-unemployment transition rates if they have co-workers from less developed countries.

Table 5: Estimation Results: Interaction Effects

	Job change hazard		Unemployment hazard	
	Coeff.	Std. err.	Coeff.	Std. err.
Δ imm. share type 1 × basic edu.	-0.0589	0.0758	-0.0969	0.2368
Δ imm. share type 1 × vocational edu.	**0.1850**	0.0691	0.0533	0.4103
Δ imm. share type 1 × further edu.	**0.1474**	0.0586	0.0393	0.5357
Δ imm. share type 2 × basic edu.	**0.9154**	0.3934	0.9132	1.3365
Δ imm. share type 2 × vocational edu.	**1.1001**	0.3200	1.0015	1.3062
Δ imm. share type 2 × further edu.	0.1073	0.3907	0.0422	4.2912
Δ imm. share type 3 × basic edu.	0.0219	0.1087	-0.0699	0.4216
Δ imm. share type 3 × vocational edu.	0.0385	0.1313	0.0345	0.6339
Δ imm. share type 3 × further edu.	-0.0645	0.2757	-0.0558	1.0524
Δ imm. share type 4 × basic edu.	0.0886	0.0588	0.0668	0.1634
Δ imm. share type 4 × vocational edu.	-0.0326	0.0805	-0.0945	0.2993
Δ imm. share type 4 × further edu.	-0.0263	0.1385	-0.0736	0.9379
Initial imm. share type 1 × basic edu.	0.2626	0.2522	0.2845	0.5189
Initial imm. share type 1 × vocational edu.	0.1469	0.2351	0.3118	0.6068
Initial imm. share type 1 × further edu.	-0.1756	0.3639	-0.1187	1.0685
Initial imm. share type 2 × basic edu.	0.6527	0.7801	0.6776	1.7741
Initial imm. share type 2 × vocational edu.	-0.0640	0.6640	-0.0251	1.9616
Initial imm. share type 2 × further edu.	0.0893	1.4329	0.0961	3.6348
Initial imm. share type 3 × basic edu.	0.1257	0.2640	0.3004	0.5144
Initial imm. share type 3 × vocational edu.	-0.1386	0.2794	0.0183	0.7173
Initial imm. share type 3 × further edu.	-0.2130	0.4826	-0.1222	1.5599
Initial imm. share type 4 × basic edu.	**0.4056**	0.1201	**0.8753**	0.2328
Initial imm. share type 4 × vocational edu.	**0.3145**	0.1594	0.4459	0.3372
Initial imm. share type 4 × further edu.	0.0806	0.2849	0.1852	0.7390

Notes: Bold numbers indicate a significant parameter estimate (5% level). All models have been estimated with the control variables listed in Table 2. Unobserved heterogeneity is controlled for using a four-point discrete distribution. Parameter estimates of covariates, the distribution for unobservables and duration dependence are available from the authors upon request.

5.1 Robustness

An important question related to the results presented above is whether the estimated coefficients are plagued by endogeneity bias. The workplace immigration variables may be endogenous if, for example, workers with unobserved characteristics that give them higher job separation rates tend to self-select into workplaces with many immigrants. In this case the coefficients to the immigrant share variable would be upward biased. Therefore, as outlined above, we attempt to account for potential endogeneity bias by simultaneously estimating a selection equation for workplace immigrant shares.

Table 6 shows the results of estimating the single risk model corresponding to model 3 in Table 3 extended with a Tobit selection equation for the type 4 immigrant share variable.[7] Here, we only use the first identification strategy exploiting the multiple spell feature of our data. With respect to the selection equation, it is seen that the type 4 immigrant share – not surprisingly – is positively correlated

with the share of immigrants of the other three types. Among other important explanatory variables in the selection equation, workplace size should be mentioned (not displayed in the table). Thus, bigger workplaces are more likely to have a higher share of type 4 immigrants. Turning to the job separation hazard, the most important result is that the coefficient to type 4 immigrant share almost doubles compared to the coefficient in Table 3. Thus, there appears to be a negative correlation between the unobservables in the two equations, such that unobserved characteristics that make the worker more likely to work at workplaces with many type 4 immigrants also make the worker less likely to separate from her job.[8]

Table 6: Estimation Results: Selection Model

	Job separation hazard		Selection equation	
	Coeff.	Std. err.	Coeff.	Std. err.
Δ imm. share type 1	0.0289	0.0268	**-0.3231**	0.0072
Δ imm. share type 2	**1.1983**	0.1662	**-1.3066**	0.0950
Δ imm. share type 3	0.0124	0.0728	**-0.9967**	0.0076
Δ imm. share type 4	0.0290	0.0385	**1.2186**	0.0049
Initial imm. share type 1	**0.4663**	0.1348	**2.9406**	0.0482
Initial imm. share type 2	0.4121	0.4522	**10.4683**	0.1063
Initial imm. share type 3	0.1718	0.1517	**9.4274**	0.0262
Initial imm. share type 4	**0.9378**	0.0966		

Notes: Bold numbers indicate a significant parameter estimate (5% level). All models have been estimated with the control variables listed in Table 2. Unobserved heterogeneity is controlled for using a four-point discrete distribution. Parameter estimates of covariates, the distribution for unobservables and duration dependence are available from the authors upon request.

7. In principle all eight immigration variables could be treated as potentially endogenous, but that would yield eight selection equations which would be almost impossible to estimate. Instead we focus on possible endogeneity of the variables with the most interesting effects.

8. It should be noted that the four support points in the unobservables distribution have estimated probabilities of 0.30, 0.64, 0.01 and 0.05 respectively, where the two first points of support represent the ‚high' job separation hazard case. This indicates that there is not a strong correlation between the unobservables in the two processes.

6. Conclusion

This paper has analysed the impact of immigration on native worker employment. As a novel feature, our data allows us to look at this relationship at a very detailed level – immigrants at the workplace and employment outcomes for the individual native worker. In contrast to much of the existing literature that typically studies the issue at the local labour market level, we find clear evidence of employment effects on native workers.

Our data set is linked employer-employee data set for the Danish labour market for the period 1993-2004. This is a period with a very large inflow of immigrants into Denmark as the immigrant share among employed workers increased from 3.0 percent in 1993 to 5.2 percent in 2004.

Estimation of a duration model for native worker job spells shows that native workers and immigrants tend to be substitutes in the sense that native job separation rates increase if more immigrants are hired. These effects are particularly pronounced for immigrants from Eastern Europe and less developed countries. Adjustment costs for native workers are likely if immigrants lead to unemployment, and in a competing risks duration model, we find that immigrants from less developed countries increase the unemployment risk for native workers while immigrants from Eastern Europe increase the native job change probability. Distinguishing between different types of native workers, we also find that the results only apply for low-skilled workers, whereas workers with further education are unaffected by immigrants at the workplace.

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