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Foreign workers and the wage distribution: Where do they fit in?*

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Abstract

The presence of foreign workers is commonly deemed as driving wage inequality upwards. By 2006, seven in ten private sector workers in Luxembourg were foreign. This note builds on recentered influence function regression methods to identify where these foreign workers stand in the distribution of private sector wages, and assess whether and how much their wages contribute to overall wage inequality. Our analysis of the 2006 Structure of Earnings Survey reveals that foreign workers have generally lower wages than natives and therefore tend to haul the overall wage distribution downwards. Yet, surprizingly, their influence on wage inequality reveals small and negative. All impacts are further muted when accounting for human capital and, especially, job characteristics. Not observing any large positive inequality contribution on the Luxembourg labour market is a striking result given the sheer size of the foreign workforce and its polarization at both ends of the skill distribution.

Keywords: immigrant wages; wage inequality; cross-border workers; influence function; RIF regression; Luxembourg

JEL Classification: J15 ; J31 ; J61

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1 Introduction

The presence of foreign workers is commonly deemed as (and sometimes blamed for) driving wage inequality upwards if only because immigrants are typically concentrated in the tails of the occupation and skill distributions (Card, 2009). Yet, while abundant empirical research has documented the 'nativity wage gap'—the wage difference between foreign and native workers; see, among many others, Chiswick (1978), Borjas (1985, 1995), Adsera and Chiswick (2007)—much less evidence is available on how foreign workers actually fit in and shape the wage distributions in host countries. The objective of this short paper is to illustrate descriptive methods to examine carefully the matter in question and describe how much foreign workers' wages contribute to private sector wage inequality in Luxembourg.

With a share of foreign workers in total employment above 70 percent, Luxembourg is the European Union country relying most on foreign labour to fuel its domestic economic activity. These foreign workers are composed of both immigrants (that is, foreign residents) and cross-border workers (that is, foreign workers residing in neighbouring countries—Belgium, France or Germany—but who are employed and work in Luxembourg). As per official statistics from Statec, in the first quarter of 2013, Luxembourg natives represented just 29.2 percent of total employment, immigrants represented 26.8 percent and cross-border workers represented 43.9 percent of total employment.[1] In the fourth quarter of 2006—the period covered by our analysis, see *supra*—the respective proportions were at 31.2 percent, 26.4 percent and 42.3 percent. This atypical situation arises from the small size of the domestic population, the supply of labour readily available from neighbouring regions abroad, and sustained economic growth (most notably driven by a specialization in banking and finance since the 1990s after the gradual decline of a large steel industry) (see, e.g., Annaert, 2004, OECD, 2012).

Foreign labour in Luxembourg is largely European but is nonetheless heterogeneous in skill and human capital and polarized on both low-skill and high-skill (e.g., management) positions (Amétépé and Hartmann-Hirsch, 2011, Fusco et al., 2014).[2] Because of this concentration in both ends of the occupation ladder and their sheer number, foreign workers are typically perceived as pushing earnings dispersion upwards. This paper confronts such a claim to data derived from a large matched employer-employee dataset, the 2006 Luxembourg Structure of Earnings survey. We separate out the potential contributions of immigrants and cross-border workers as they tend to differ in their characteristics, the latter being generally younger, better educated and with more recent and weaker attachment to the Lux-

[1] See `http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=7252` (accessed 2013-09-17).

[2] Such polarization is perhaps uncommon but not exceptional: similar concentration on both tails has been documented for example in Switzerland (Müller and Ramirez, 2009) or the United Kingdom (Dustmann et al., 2013).

embourg labour market. Cross-border workers are also less strongly polarized in skills and occupations than immigrants, exhibit lower within-group wage inequality and may therefore be expected to have smaller influence on overall wage dispersion.

To be clear, our approach is descriptive or 'static': we are not attempting here to identify causal or general equilibrium impacts of immigrants on the total wage distribution (or on native workers wages); see Card (2009), Blau and Kahn (2012) for recent reviews of this contentious literature.[3] Rather we carefully document where foreign workers' earnings stand in the earnings distribution and quantify their contribution to wage inequality. As we explain shortly, we do so by calculating the immediate, short-term effect that a notional uniform marginal substitution of native workers for foreign workers would have on the shape of the earnings distribution—on wage inequality indicators in particular. Checking if marginally substituting native workers for (observationally equivalent) foreign workers has any impact on distributional statistics turns out to be an indirect but informative way to apprehend how foreign workers' wages fit in and influence the overall wage distribution.

Our analysis builds upon recently developed recentered influence function (RIF) regression methods (Firpo et al., 2009). RIF regression is well-suited for our purpose as it is designed to capture how a marginal change in the prevalence of a covariate impacts on some distributive statistic of interest. Such a statistic has typically been a quantile in recent applications, but the methods can be applied to any statistic summarizing particular features of a distribution function. We consider both a series of quantiles (to analyse the overall shape of the distribution) and the variance and the Gini coefficient (to examine wage inequality). Crucially, a key advantage of such an approach over, say, conventional inequality decomposition methods (Shorrocks, 1984) is that RIF regressions allow us to assess the distributive impact of a notional marginal increase in the proportion of foreign workers both unconditionally and conditionally on other relevant covariates (such as human capital and job characteristics) that may account for wage differentials between native and foreign workers, as we describe in more details in Section 2.

Our baseline finding is that, with only few exceptions, foreign workers tend to drive the wage distribution down. Most quantiles of the wage distribution would be reduced by an increase in the share of foreign workers. This is a direct implication of the lower wages generally paid to foreign workers

[3]The equilibrium impacts of immigration on the distribution of native workers wages remains a debated topic in migration research. They crucially depend on the degree of complementarity or substitutability between foreign and native labour—and this may vary by occupation and skill groups—so net impacts are not unambiguous. In the United States for instance, while Grossman (1982), Card (1990) or, more recently, Card (2009) and Ottaviano and Peri (2012) show that the impact of immigration on native wages is small or negligible, Borjas (1999, 2003) find that immigration lowers the wage of competing native workers. Manacorda et al. (2012) and Dustmann et al. (2013) show that the impact of immigration on wages in the UK is heterogeneous across the distribution: the overall effect on native wages is positive as a combination of a negative effect at lower percentiles of the distribution but a positive effect at higher percentiles. No or small positive impacts have been identified in Spain and Israel (Friedberg, 2001, Carrasco et al., 2008).

compared to natives (Van Kerm et al., 2014). However, and this is the main contribution of this paper, we also find that their impact on wage inequality is most often insignificant or even negative. All effects are further muted when human capital and job characteristics are taken into account (that is, when one considers substitutions of native workers for foreign workers with similar characteristics).

Section 2 formally defines 'policy effects' of interest and details the RIF regression methodology. Section 3 describes the data used in the analysis. Section 4 presents our results and Section 5 concludes.

2 Methods

As explained above, we assess the leverage of foreign workers on inequality and the overall distribution of wages indirectly. We do so by calculating the impact on a number of distributional statistics of notional marginal substitutions of native workers by foreign workers holding within-group wage distributions constant. Estimated impacts are a function of the location of the foreign and native subgroup wage distributions relative to each other and quantify how much these configurations impact on particular distributional statistics of interest.

Definition of counterfactual 'policy effects' of interest

Let F be the distribution function of wages and $\upsilon(F)$ denote some generic distributive statistic such as the mean, a quantile, a measure of inequality. F can be expressed as the mixture of subgroup wage distributions for different workers types (which we define according to nationality and country of residence):

$$F(y) = \sum_{x \in \Omega_X} s_x \, F_x(y) \tag{1}$$

where F_x is the wage distribution among workers of type x, s_x the proportion of workers of type x in the population, and Ω_X the set of K workers types.

We seek to calculate the effect of a marginal substitution of native workers by foreign workers on $\upsilon(F)$. Such a measure—labelled an 'unconditional partial effect' in Firpo et al. (2009), a 'policy effect' in Rothe (2010) or a 'counterfactual effect' in Chernozhukov et al. (2013)—is formally defined here as

$$\text{UPE}(\upsilon(F), k) = \lim_{t \downarrow 0} \frac{\upsilon(G_r^{F,t,k}) - \upsilon(F)}{t} \tag{2}$$

where $G_r^{F,t,k}$ is the wage distribution after exchanging a proportion t of reference workers type r (the 'natives') for foreign workers of type k, that is

$$G_r^{F,t,k}(y) = (s_k + t) \, F_k(y) \; + \; (s_r - t) \, F_r(y) \; + \sum_{x \in \Omega_X \setminus \{k,r\}} s_x \, F_x(y). \tag{3}$$

(Note that we stick to the label 'policy effect' to position the methods in the literature although the substitution of native for foreign workers is not a 'policy' *per se* in this context.)

Firpo et al. (2009, Theorem 1) demonstrate that $\mathrm{UPE}(\upsilon(F),k)$ can be expressed as

$$\mathrm{UPE}(\upsilon(F),k)=\int \mathrm{RIF}(y;\upsilon,F)\,d(G_r^{F,t,k}-F)(y) \tag{4}$$

where $\mathrm{RIF}(y;\upsilon,F)=\upsilon(F)+\mathrm{IF}(y;\upsilon,F)$ is the *recentered influence function* of υ in distribution F and

$$\mathrm{IF}(y;\upsilon,F)=\lim_{\epsilon\downarrow 0}\frac{\upsilon((1-\epsilon)F+\epsilon\Delta_y)-\upsilon(F)}{\epsilon}$$

is the influence function as defined in Hampel (1974). The influence function captures the effect on the statistic υ of an infinitesimal increase in the density of the data at y. The shape of the influence function depends on the statistic of interest υ and on F itself. Influence functions are easily derived using simple differentiation rules for most functionals (see, e.g. Essama-Nssah and Lambert, 2012).

It follows from a straightforward extension of results from Firpo et al. (2007, Corollary 3) to multinomial variables that our $\mathrm{UPE}(\upsilon(F),k)$ of interest can be expressed as

$$\mathrm{UPE}(\upsilon(F),k)=\mathrm{E}[\mathrm{RIF}(y;\upsilon,F)|X=k]-\mathrm{E}[\mathrm{RIF}(y;\upsilon,F)|X=r] \tag{5}$$

where $\mathrm{E}[\mathrm{RIF}(y;\upsilon,F)|X=x]$ is the expected value of $\mathrm{RIF}(y;\upsilon,F)$ among workers of type x. Expressed in this form, $\mathrm{UPE}(\upsilon(F),k)$ is easily estimated from sample data on wages; see below.

The marginal substitution of workers just described does not account for workers characteristics (beyond their nationality group). Imagine foreign workers are low-skilled and primarily work in low-paid occupations. The UPE on, say, mean wages of a marginal increase in the proportion of foreign workers is then likely negative, since it increases disproportionately low-paid workers overall. To address this concern, we also consider a marginal substitution between native and immigrant workers done conditionally on a set of human capital and/or job characteristics Z. A proportion t of workers are assumed substituted within all configurations of Z so as to marginally change the proportion of foreign workers but preserve the overall distribution of workers' characteristics Z in the population. We refer to the impact on $\upsilon(F)$ of such a modified marginal substitution which preserves the overall distribution of the covariates Z as an 'conditional unconditional policy effect' (CUPE) since we are assessing the impact on the *unconditional* wage distribution of a counterfactual substitution done *conditionally* on additional covariates. $\mathrm{CUPE}(\upsilon(F),k)$ is defined as

$$\mathrm{CUPE}(\upsilon(F),k)=\lim_{t\downarrow 0}\frac{\upsilon(H_r^{F,t,k})-\upsilon(F)}{t} \tag{6}$$

where

$$H_r^{F,t,k}(y) = \int_{\Omega_Z} \left((s_{k|z} + t)\, F_{k,z}(y) \;+\; (s_{r|z} - t)\, F_{r,z}(y) \;+ \sum_{x \in \Omega_X \setminus \{k,r\}} s_{x|z}\, F_{x,z}(y) \right) f_Z(z) dz \quad (7)$$

and $F_{x,z}$ and $s_{x|z}$ now denote respectively the conditional distribution of wage given worker type $X = x$ and characteristics $Z = z$ and the share of workers of type x among workers with characteristics $Z = z$. This marginal substitution leaves the distribution of covariates f_Z unchanged in the population.

As above, $\mathrm{CUPE}(\upsilon(F), k)$ can be re-expressed as a function of expected recentered influence functions

$$\begin{aligned} \mathrm{CUPE}(\upsilon(F), k) &= \int \mathrm{RIF}(y; \upsilon, F) d(H_r^{F,t,k} - F)(y) \quad (8) \\ &= \int_{\Omega_Z} \mathrm{E}[\mathrm{RIF}(y; \upsilon, F) | X = k, Z = z] - \\ &\quad \mathrm{E}[\mathrm{RIF}(y; \upsilon, F) | X = r, Z = z]\; f_Z(z) dz \quad (9) \end{aligned}$$

Estimation by RIF regression

$\mathrm{UPE}(\upsilon(F), k)$ and $\mathrm{CUPE}(\upsilon(F), k)$ as expressed in (5) and (9) are simple functions of conditional expectations of RIFs. Specifying a linear relationship between x, z and $\mathrm{RIF}(y; \upsilon, F)$ leads to an estimator for UPE or CUPE referred to as a RIF-OLS estimator by Firpo et al. (2009). Two-step estimation of the RIF-OLS is straightforward. First, the value of $\mathrm{RIF}(y_i; \upsilon, F)$ is computed for all sample observations i for the statistic of interest υ. Second, $\mathrm{RIF}(y_i; \upsilon, F)$ is regressed by OLS on x_i and z_i to obtain estimates of α, β and γ in

$$\mathrm{E}[\mathrm{RIF}(y; \upsilon, F) | X = x, Z = z] = \alpha + x\beta + z\gamma$$

where x is a vector of $K-1$ dummy variables identifying worker types and z is a vector of potential additional covariates. UPE and CUPE are then directly obtained from the regression coefficients provided natives are taken as omitted category in the vector of workers type x. The UPE for immigrants and cross-border workers are given by the relevant coefficients in the vector β when no other covariates are included in the regression. The CUPE are given by the same coefficients in the vector β in a regression where the covariates z are included as additional regressors.

Note that the dependent variable in the RIF-OLS regressions ($\mathrm{RIF}(y_i; \upsilon, F)$) is a function of F which is typically unknown but itself derived from one's sample. This two-stage procedure therefore results in complex sample dependence between observations which can be taken into account easily by resorting to bootstrap resampling for inference.

The distributive statistics $\upsilon(F)$ that we focus on in our analysis are (i) a set of selected quantiles in order to show the general contribution of foreign workers to the overall wage distribution and then (ii)

the variance and the Gini coefficient to capture their resultant influence on wage inequality. The RIF for quantile τ is

$$\mathrm{RIF}(y; q_\tau, F) = q_\tau + \frac{\tau - \mathbf{I}[y \leq q_\tau]}{f(q_\tau)}$$

where $f(q_\tau)$ is the density function at the quantile τ and $\mathbf{I}[\cdot]$ is equal to 1 if the expression in bracket is true and 0 otherwise (Firpo et al., 2009). The RIF for the variance and the Gini coefficient are respectively

$$\mathrm{RIF}(y; \mathrm{Var}, F) = (y - \mu(F))^2$$

and

$$\mathrm{RIF}(y; \mathrm{GINI}, F) = -\frac{y}{\mu(F)}\mathrm{GINI}(F) + 1 - \frac{y}{\mu(F)} + \frac{2}{\mu(F)}\int_0^y F(x)dx$$

(see, e.g. Essama-Nssah and Lambert, 2012).

3 Data

Our empirical analysis exploits data from the 2006 Luxembourg Structure of Earnings Survey. The survey is collected in all European Union countries on the basis of common variable definitions and sampling design defined in European Community regulations. It aims to provide detailed information on earnings in the European Union. The Luxembourg SES is collected by STATEC—Institut national de la statistique et des études économiques, the national statistical institute.

The SES is a nationally representative matched employer-employee survey covering, in 2006, non-profit and private sector firms (NACE C–K and M–O) employing at least 10 workers. This sampling frame covers 79 percent of salaried workers in Luxembourg at the time of the survey (STATEC, 2009).[4] The distinctive feature of the SES in the context of Luxembourg is that—since it is based on a sampling frame of firms—it collects information on both resident and cross-border workers.

The survey has a two-stage design. A sample of firms (stratified by firm size) was drawn in a first stage. A sample of workers from the selected firms was drawn in a second stage. In total, the 2006 Luxembourg SES dataset covers 1,856 firms and 31,329 workers (STATEC, 2009). Information is available on both employers (sector of activity, size, collective agreement coverage) and employees (earnings plus basic demographic information (including educational achievements) and occupation and job characteristics).

We focus on the distribution of gross hourly wage of workers aged 18 to 65. Hourly wage is calculated as the earnings received in the month of reference of the survey (October 2006) divided by the

[4]Most noticeably, civil servants and agricultural sector workers are excluded from the sampling frame. These sectors employ only few foreign workers (in particular cross-border workers) however.

number of paid hours worked in the month. Table 1 reports sample means for hourly wage for the three main categories of workers we focus on (Luxembourg nationals, immigrants and cross-border workers), and for nationality and a series of human capital and job characteristics. Mean wage of Luxembourg workers is 29% higher than mean wage of immigrant workers (€23.23 versus €18.02) and 30% higher than mean wage for cross-border workers (€23.23 versus €17.83). Of course, between-group differences in job and productivity-related characteristics can explain (part of) the wage differences between natives and foreigners. For instance, native workers are more likely to work in large firms, have much longer job tenure or more likely to have supervisory positions. Immigrants are more likely to work in the construction sector while cross-border workers are more likely to work in the real estate sector. Noteworthy is also the polarized distribution of educational achievements of immigrants—with a higher fraction of both primary and tertiary education workers. Cross-border workers generally have higher educational achievements, but are also younger and have the lowest job tenure.

Table 1: Sample means of hourly wage, nationality and human capital and job characteristics by worker types (Luxembourg nationals, immigrants and cross-border workers)

	Luxembourg nationals	**Immigrant workers**	**Cross-border workers**
Hourly wage	23.23	18.02	17.83
Luxembourg	1.00	0.00	0.00
Belgian	0.00	0.08	0.22
French	0.00	0.13	0.50
German	0.00	0.05	0.22
Portuguese	0.00	0.47	0.01
Other EU	0.00	0.18	0.04
Non-EU	0.00	0.10	0.01
Female	0.39	0.38	0.32
Age	39.90	37.63	37.20
Primary educ. or less (ref)	0.11	0.24	0.08
Secondary education	0.80	0.62	0.80
Tertiary education	0.08	0.14	0.12
Years at current employer	11.82	6.32	5.59
Manager	0.17	0.14	0.14
10-49 employees in firm	0.24	0.32	0.27
50-249 employees in firm	0.24	0.30	0.35
250-499 employees in firm (ref.)	0.11	0.13	0.14
500-999 employees in firm	0.08	0.11	0.11
1000 or more employees in firm	0.33	0.14	0.13
Part time contract	0.18	0.15	0.13
Industry/Manufacture	0.17	0.10	0.18
Construction	0.05	0.21	0.14
Wholesale	0.12	0.10	0.13
Hotel/Restaurant	0.01	0.06	0.03
Trans/Comm	0.16	0.07	0.09
Finance	0.17	0.16	0.17
Real estate	0.08	0.18	0.19
Education, Health & Other not-for-profit (ref)	0.24	0.11	0.08
Managerial	0.07	0.06	0.04
Professional	0.10	0.09	0.12
Associate professional	0.23	0.13	0.18
Clerk	0.23	0.11	0.15
Service worker	0.09	0.10	0.11
Craft and trade worker	0.13	0.21	0.20
Manufacturers	0.08	0.09	0.13
Low skilled and laborer (ref)	0.08	0.20	0.07
Number of observations	7537	8367	15105

Notes: Based on the 2006 Luxembourg Structure of Earnings Survey. Sample weights applied.

4 Results

Unconditional impacts: UPE estimates

Figure 1 shows our first baseline results: the UPEs on a set of 19 quantiles from the 5th percentile to the 95th percentile for both immigrants and cross-border workers.[5] The UPEs on all quantiles are unambiguously negative for both groups of workers: with the current configuration of each group's wage distribution relative to each other, a marginal increase in the share of foreign workers would haul the overall wage distribution downwards. The UPEs for immigrants are more negative than for cross-border workers until the 70th percentile. This is a reflection of immigrants' comparatively lower wages and their relatively larger concentration in the bottom part of the wage distribution. Beyond the 70th percentile, the UPEs for cross-border workers continues to decline while the UPEs for immigrants starts increasing. This finding brings empirical support to claims that immigrants in Luxembourg include both top earners that contribute to high wages as much as natives do (yet not *more*) and low skill migrants that drive bottom quantiles down (Amétépé and Hartmann-Hirsch, 2011). This pattern does not hold true however for cross-border workers.

What these patterns imply for wage dispersion and inequality can be read from the RIF regression coefficients reported in the top panel of Table 2 (under Model 1). All estimates are negative: overall, wages of foreign workers tend to *reduce* inequality. The coefficients are not significantly different from zero for immigrants, while they are larger (in absolute value) and significantly negative for cross-border workers. This is particularly noteworthy since this finding is in sharp contrast with what could be conjectured from the polarization of foreign workers in both tails of the skill and pay distributions and the evidence on the quantile UPEs from Figure 1. It turns out that the wage distribution of foreign workers does not appear so polarized (compared to the distribution of native workers) as to drive inequality upwards.

[5] All RIF regression calculations in our application were done with the user-written package for Stata `rifreg` available from Nicole Fortin at `http://faculty.arts.ubc.ca/nfortin/datahead.html`. Bootstrap confidence intervals for the UPE and CUPE estimates were constructed on the basis of 1,000 replications from a repeated half-sample bootstrap resampling scheme (Saigo et al., 2001) and account for the two-stage design of the survey (see Section 3). We use the *rhsbsample* Stata user-written package for generating the replication weights (Van Kerm, 2013). Pointwise confidence intervals are based on the bias-corrected percentile method (Efron, 1981).

Figure 1: Unconditional 'policy effects' (UPE) on quantiles of the wage distribution of a marginal increase in immigrant and cross-border workers

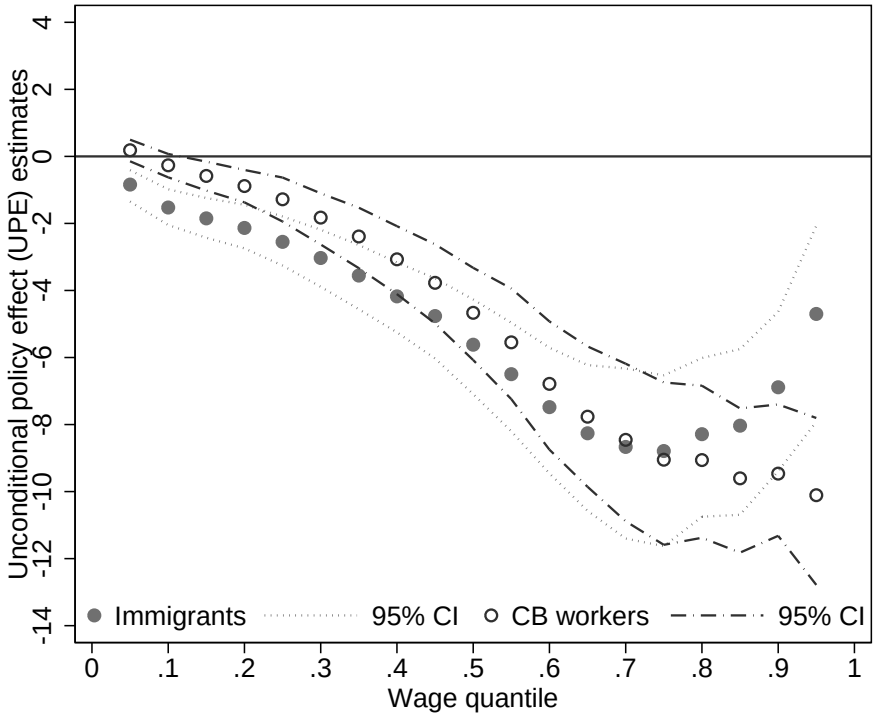


Table 2: UPEs and CUPEs on the variance of hourly wages and the Gini coefficient

	Variance			Gini		
	UPE	**CUPE**		**UPE**	**CUPE**	
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
By aggregate nationality groups						
Immigrant	-75.8	-67.0	-17.7	-0.003	-0.004	0.002
Cross-border worker	-141.7∗	-133.8∗	-66.8†	-0.054∗	-0.052∗	-0.030∗
By disaggregate nationality groups						
Be-Fr-Ge resident	39.1	-67.8	-63.6	0.029‡	-0.019	-0.026‡
Portuguese resident	-194.2∗	-100.1∗	-11.0	-0.046∗	-0.011	0.007
Other EU resident	-3.2	-49.1	-26.4	0.027‡	0.006	0.007
Non-EU resident	54.2	60.3	116.1†	0.060∗	0.058∗	0.057∗
German CB	-107.2∗	-104.5†	-37.1	-0.044∗	-0.043∗	-0.013
French CB	-176.6∗	-153.9∗	-71.5∗	-0.066∗	-0.059∗	-0.034∗
Belgian CB	-102.0∗	-116.0∗	-80.6∗	-0.040∗	-0.046∗	-0.036∗

Notes: Based on the 2006 Luxembourg Structure of Earnings Survey data. ∗, † and ‡ indicate significance at 1, 5 and 10 percent levels respectively. Model 1 does not include covariates, Model 2 includes human capital covariates, Model 3 includes both human capital and job characteristics. See Appendix for full regression coefficient estimates.

Accounting for human capital and job characteristics: CUPE estimates

Of course, cross-border workers and immigrants have markedly different characteristics than native workers. It is therefore useful to consider CUPEs, that is, the impacts of a marginal substitution of native workers by foreign workers that preserves the overall distribution of human capital and job characteristics in total employment. In other words, it is now the locations of each subgroup's wage distributions relative to each other conditionally on covariates that is captured.

CUPEs on 19 quantiles are shown in Figure 2: the top panel accounts for individual characteristics only (age, gender and level of education), the bottom panel accounts for both individual and job characteristics. (Full RIF regression coefficient estimates for three selected quantiles are reported in the Appendix.)

Adjusting for individual characteristics reduces only moderately the absolute impact of foreign workers. However, further adjusting for job characteristics markedly reduces this impact. CUPEs remain generally negative (except at the very bottom for cross-border workers and at the very top for immigrants), but they are much smaller in absolute value and globally significantly below zero only between the 35th and 80th percentiles. After controlling for individual and job characteristics CUPEs are, overall, very small throughout the bottom half of the distribution. CUPEs for cross-border workers become more markedly negative for quantiles above the median and CUPEs for immigrants display again a U-shape with declining values until the 65th percentile and an increase up to about zero for the highest quantile.

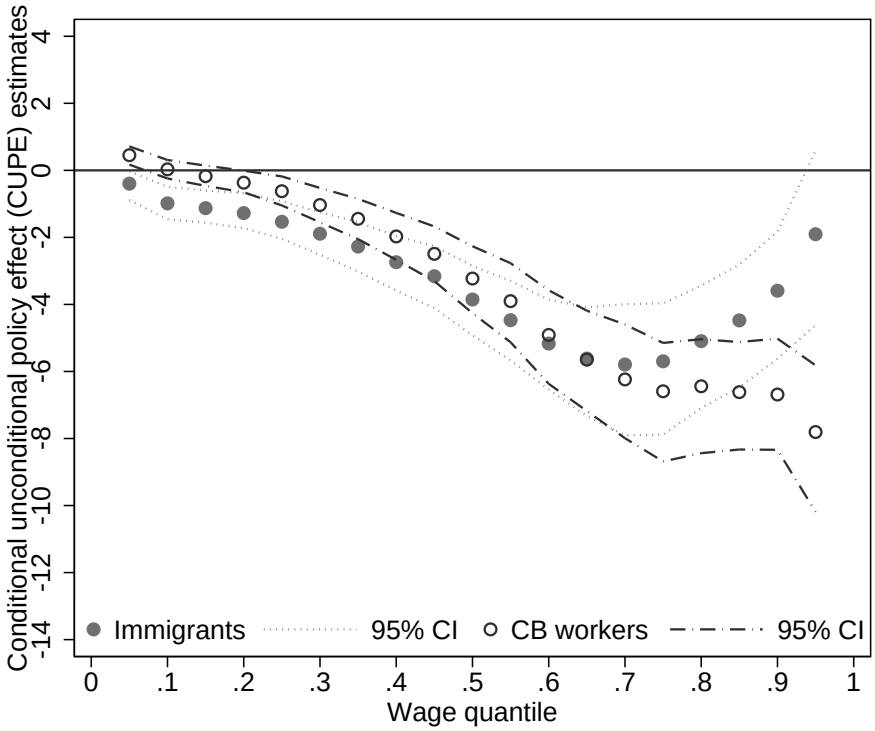
Holding characteristics constant, the impacts of foreign workers on the variance and the Gini coefficient are further muted; see top panel of Table 2 under Model 2 and Model 3. (Full RIF regression coefficient estimates for the Gini and the variance are reported in the Appendix.) They remain negative for cross-border workers, while immigrant workers' impacts on wage dispersion and inequality remain negative, small and not significantly different from zero.

Impacts by disaggregate nationality groups

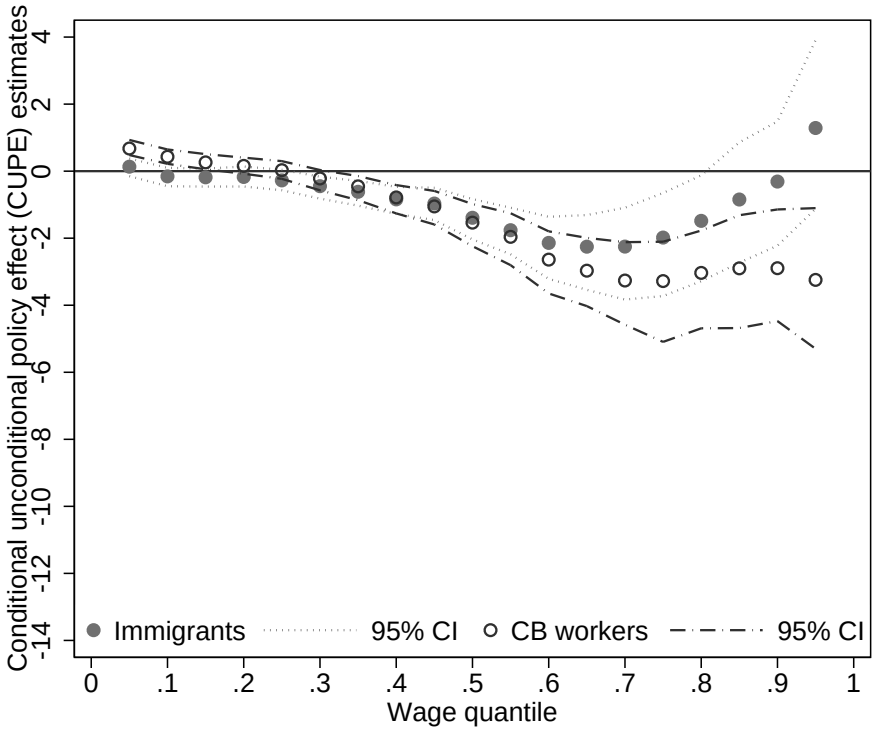
Disaggregation of foreign workers types by less coarsely defined nationality groups leads to more homogeneous subgroups and sheds some light on the patterns just observed. Cross-border workers from France, Belgium and Germany form a relatively homogeneous labour force in terms of skill composition. There is much more heterogeneity across immigrant groups. Portuguese immigrants with generally low educational achievements form the largest share of immigrants (47 percent in our sample). Belgian, French and German immigrants taken together represent 26 percent of our sample, other EU

Figure 2: Conditional unconditional 'policy effects' (CUPE) on quantiles of the wage distribution of a marginal increase in immigrant and cross-border (CB) workers

(a) Conditional on age, education level and gender



(b) Conditional on age, education level, gender and job characteristics



immigrants, 18 percent and non-EU immigrants, 10 percent.

Figures 3 and 4 show disaggregated UPEs and CUPEs on quantiles by country of residence (for cross-border workers) and by broad nationality groups (for immigrants). The coefficients are for marginal impacts of substituting workers from one of these groups against native residents. Unsurprizingly, the shape of impacts of the three cross-border groups are similar, with the largest negative impact attributed to Belgian residents. There is much more heterogeneity across immigrant groups. Portuguese immigrants are consistently found to depress all quantiles: they are paid relatively low wages. However the impact largely disappears (even at high quantiles) after controlling for individual and job characteristics. At the other end of the spectrum, Belgian, German and French residents appear to have positive UPEs, especially at top quantiles: they are paid higher wages than natives and drive up the top quantiles.[6] Non-EU and other EU immigrants have parallel profiles although at different levels. UPEs and CUPEs for both groups exhibit a markedly U-shape; this suggests that a fraction of the population in these groups tend to receive low pay (and therefore quickly reduce quantiles in the bottom of the distribution) while a fraction of the groups is highly paid and increases top quantiles. This pattern is particularly strong for non-EU immigrants that—after accounting for human capital and job characteristics—is the group that depresses most bottom quantiles and increases most top quantiles.

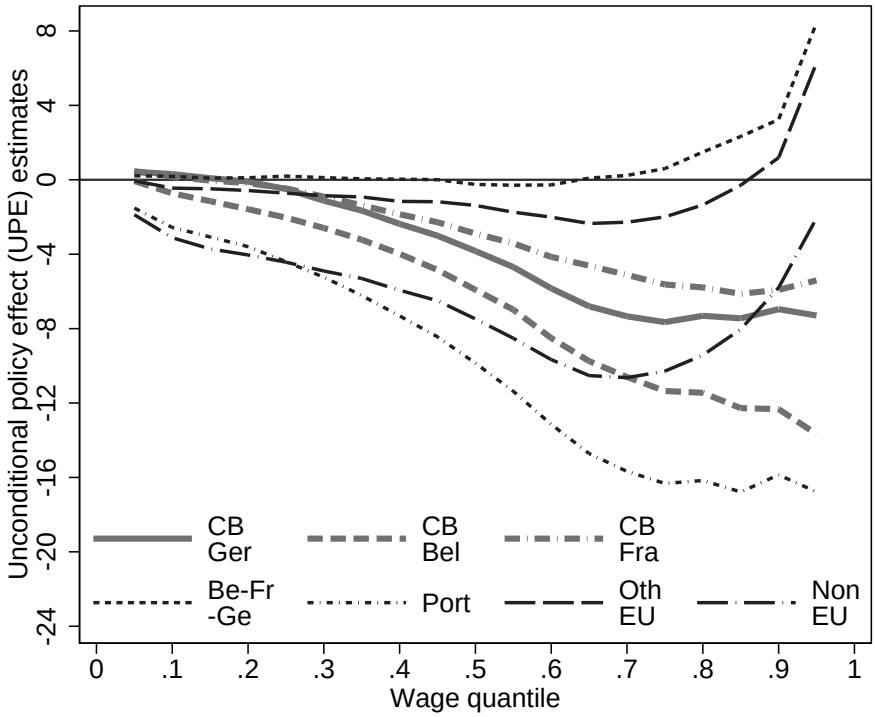
As a consequence, wages of non-EU immigrants are found to significantly increase wage inequality (and form the only group found to do so); see the bottom panel of Table 2. By contrast, wages of French and Belgian cross-border workers are consistently found to reduce inequality (with similar orders of magnitude). All other groups have no significant impacts after controlling for human capital and job characteristics.

5 Summary and conclusion

This note exploits recentered influence function regression to assess how foreign workers fit in and shape the wage distribution in Luxembourg. In particular we empirically confront claims that foreign workers wages inflate overall wage inequality. We do this indirectly. Following Firpo et al. (2009) and Rothe (2010), we carefully define a distributional 'policy effect' that quantifies the potential effect of a notional marginal substitution of native workers for foreign workers on various distributional statistics. This is estimated both unconditionally and conditionally on workers' human capital and job characteristics.

[6]Endogenous selection is likely at play here with high wage workers from Belgium, France or Germany affording the potential costs of migrating into Luxembourg.

Figure 3: Unconditional 'policy effects' (UPE) on quantiles of the wage distribution of a marginal increase in immigrant and cross-border workers disaggregated by nationality groups

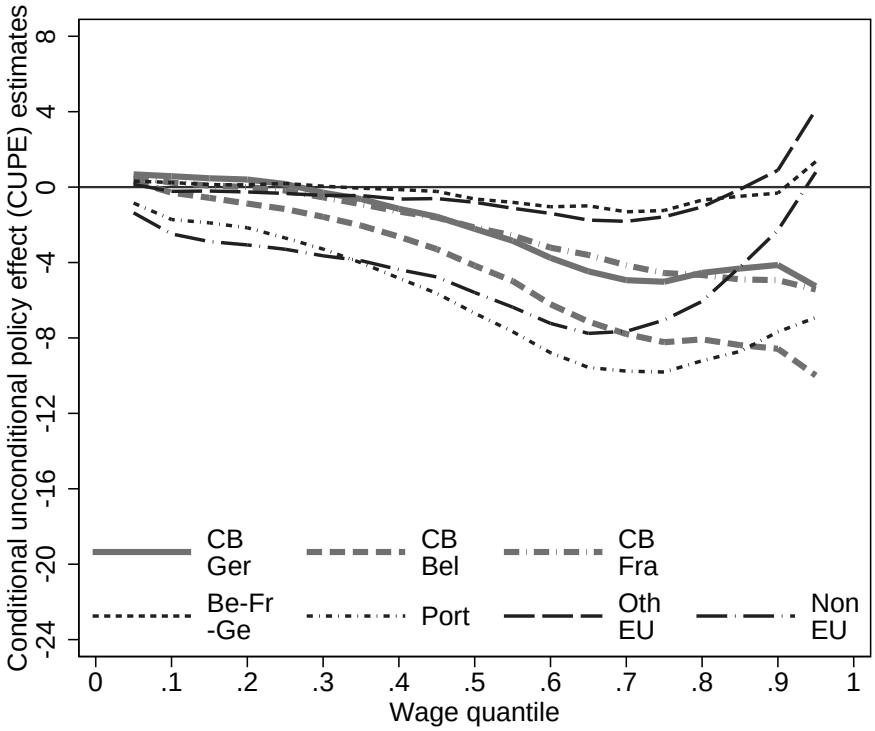


We observe first that quantiles of the wage distribution are generally driven *down* by foreign workers. Exceptions are only found for top quantiles which are driven up by immigrants from neighbouring countries and other EU countries (Portugal excluded) if we do *not* condition on covariates, and by non-EU immigrants and EU immigrants (Portugal and neighbouring countries excluded) if we condition on human capital and job characteristics. This is consistent with the fact that foreign workers are strongly polarized and 'sandwich' the distribution at both high skill and low skill positions. Note however that, altogether, neither cross-border workers nor immigrants are observed to *increase* any percentile of the wage distribution. Furthermore, the implication of these patterns for wage inequality are very limited. There is hardly any indication that immigrants wages inflate the variance or the Gini coefficient. The only significant exception is for non-EU immigrants—not more than 10 percent of immigrants—that appear to contribute to wage dispersion. All other immigrants affect inequality downwards if at all, while cross-border workers significantly drive inequality down.

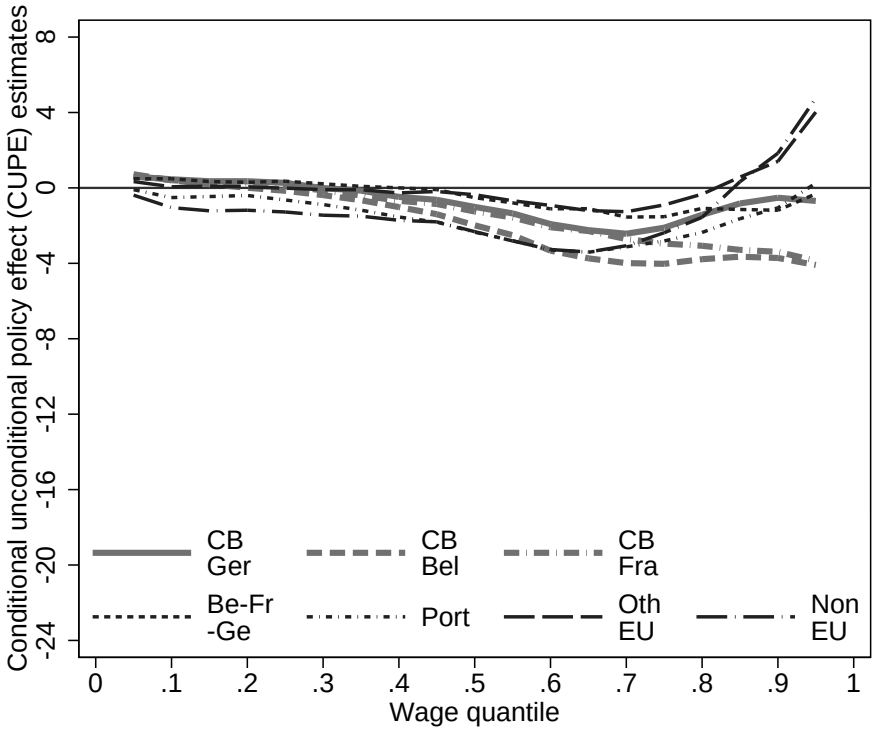
Influence function regression reveals well-suited to the analysis conducted in this paper, and it could easily be expanded to additional distributional statistics, such as measures of earnings polarization or low pay. Of course, resulting estimates of immediate marginal impacts must not be mis-interpreted as long-term general equilibrium effects of migration. We do not estimate longer-term equilibrium effects

Figure 4: Conditional unconditional 'policy effects' (CUPE) on quantiles of the wage distribution of a marginal increase in immigrant and cross-border workers disaggregated by nationality groups

(a) Conditional on age, education level and gender



(b) Conditional on age, education level, gender and job characteristics



of such a change in employment composition or, to put it differently, we assume wages of employed workers to be unaffected by a marginal increase in foreign workers in total employment.[7] Our results instead provide informative descriptive evidence on how the structure of wages of foreign workers contribute to the overall wage distribution and in particular to wage inequality.

Despite the size, heterogeneity and relatively peculiar composition of the foreign labour force in Luxembourg, foreign workers remain paid less than natives and therefore tend to drive wages downwards, but their (marginal) impact on inequality is small. These results should remind us that aggregate inequality indicators are potentially complex combinations of subgroup wage distributions and their dependence on human capital and job characteristics. Merely observing that foreign workers have polarized skill distributions and/or are lower paid than natives (on average or even at different quantiles) does not appear to inform much about the magnitude of their impact on overall wage inequality.

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[7] Note that estimates of general equilibrium effects of immigration available for other countries are in fact generally small (Card, 2009, Blau and Kahn, 2012), although of course these findings may not necessarily apply to the Luxembourg case.

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Appendix Detailed RIF regression results

Table A.1: Coefficient estimates of RIF regressions - Variance

	Aggregate nationality groups			Disaggregate nationality groups		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Immigrant	-75.8	-67.0	-17.7			
Non-resident	-141.7∗	-133.8∗	-66.8†			
Be-Fr-Ge resident				39.1	-67.8	-63.6
Portuguese resident				-194.2∗	-100.1∗	-11.0
Other EU resident				-3.2	-49.1	-26.4
Non-EU resident				54.2	60.3	116.1†
German CB				-107.2∗	-104.5†	-37.1
French CB				-176.6∗	-153.9∗	-71.5∗
Belgian CB				-102.0∗	-116.0∗	-80.6∗
Female		-48.3∗	-101.7‡		-47.7∗	-102.2‡
Age		-27.9∗	-37.4∗		-28.4∗	-37.8∗
Age squared/100		48.6∗	54.6∗		48.9∗	55.0∗
Secondary education		110.0∗	28.1†		102.3∗	29.6†
Tertiary education		636.2∗	313.1∗		621.9∗	316.5∗
Years at current employer		-0.6	0.8		-0.4	0.9
Manager			26.6			29.1
10-49 employees in firm			-1.1			-3.0
50-249 employees in firm			119.7†			120.4†
500-999 employees in firm			13.3			15.1
1000+ employees in firm			-23.8			-22.3
Part time contract			203.6∗			203.1∗
Industry/Manufacture			-228.9†			-227.2†
Construction			-234.9∗			-236.7∗
Wholesale			-144.4			-142.0
Hotel/Restaurant			-168.9†			-169.7†
Trans/Comm			-160.8			-164.2
Finance			-214.9			-212.7
Real estate			-262.3†			-259.2†
Managerial			1033.3∗			1043.1∗
Professional			188.8‡			199.4†
Associate professional			70.5			79.1
Clerk			13.5			22.0
Service worker			-3.7			1.7
Craft and trade worker			26.6			31.2
Manufacturers			7.2			13.2
Constant	250.7∗	424.9∗	777.4∗	250.7∗	442.3∗	773.3∗

Notes: Based on 2006 Luxembourg Structure of Earnings Survey data. ∗, † and ‡ indicate significance at 1, 5 and 10 percent levels respectively. Model 1 does not include covariates, Model 2 includes human capital covariates, Model 3 includes both human capital and job characteristics.

Table A.2: Coefficient estimates of RIF regressions - Gini

	Aggregate nationality groups			Disaggregate nationality groups		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Immigrant	-0.003	-0.004	0.002			
Non-resident	-0.054∗	-0.052∗	-0.030∗			
Be-Fr-Ge resident				0.029‡	-0.019	-0.026‡
Portuguese resident				-0.046∗	-0.011	0.007
Other EU resident				0.027‡	0.006	0.007
Non-EU resident				0.060∗	0.058∗	0.057∗
German CB				-0.044∗	-0.043∗	-0.013
French CB				-0.066∗	-0.059∗	-0.034∗
Belgian CB				-0.040∗	-0.046∗	-0.036∗
Female		-0.005	-0.023†		-0.005	-0.023†
Age		-0.018∗	-0.021∗		-0.018∗	-0.022∗
Age squared/100		0.028∗	0.030∗		0.028∗	0.030∗
Secondary education		0.033∗	0.012‡		0.033∗	0.013‡
Tertiary education		0.255∗	0.126∗		0.254∗	0.129∗
Years at current employer		-0.001	-0.000		-0.001	-0.000
Manager			0.028∗			0.029∗
10-49 employees in firm			-0.003			-0.004
50-249 employees in firm			0.022			0.022
500-999 employees in firm			0.017			0.018
1000+ employees in firm			-0.009			-0.008
Part time contract			0.067∗			0.067∗
Industry/Manufacture			-0.060†			-0.060†
Construction			-0.056†			-0.058†
Wholesale			-0.003			-0.002
Hotel/Restaurant			-0.007			-0.007
Trans/Comm			-0.028			-0.029
Finance			-0.043			-0.042
Real estate			-0.073∗			-0.071∗
Managerial			0.398∗			0.403∗
Professional			0.018			0.023
Associate professional			-0.051†			-0.047†
Clerk			-0.085∗			-0.081∗
Service worker			-0.034∗			-0.031∗
Craft and trade worker			-0.054∗			-0.052∗
Manufacturers			-0.072∗			-0.069∗
Constant	0.311∗	0.510∗	0.680∗	0.311∗	0.513∗	0.678∗

Notes: Based on 2006 Luxembourg Structure of Earnings Survey data. ∗, † and ‡ indicate significance at 1, 5 and 10 percent levels respectively. Model 1 does not include covariates, Model 2 includes human capital covariates, Model 3 includes both human capital and job characteristics.

Table A.3: Coefficient estimates of RIF regressions - P20

	Aggregate nationality groups			Disaggregate nationality groups		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Immigrant	-2.13∗	-1.27∗	-0.17			
Non-resident	-0.88∗	-0.37†	0.16‡			
Be-Fr-Ge resident				0.11	0.12	0.30†
Portuguese resident				-3.59∗	-2.16∗	-0.40‡
Other EU resident				-0.58†	-0.26‡	0.05
Non-EU resident				-4.04∗	-3.07∗	-1.18∗
German CB				-0.10	0.40†	0.35†
French CB				-1.58∗	-0.87∗	0.01
Belgian CB				-0.18	0.00	0.24†
Female		-1.95∗	-1.38∗		-1.92∗	-1.37∗
Age		0.68∗	0.57∗		0.67∗	0.58∗
Age squared/100		-0.80∗	-0.65∗		-0.80∗	-0.66∗
Secondary education		2.26∗	0.50‡		1.91∗	0.45
Tertiary education		5.14∗	1.21∗		4.44∗	1.13∗
Years at current employer		0.13∗	0.08∗		0.13∗	0.08∗
Manager			0.50∗			0.48∗
10-49 employees in firm			-0.09			-0.08
50-249 employees in firm			0.00			0.01
500-999 employees in firm			-0.45			-0.44
1000+ employees in firm			0.07			0.09
Part time contract			-0.42†			-0.42†
Industry/Manufacture			-1.25∗			-1.26∗
Construction			-1.51∗			-1.47∗
Wholesale			-3.69∗			-3.68∗
Hotel/Restaurant			-4.51∗			-4.45∗
Trans/Comm			-0.38			-0.39
Finance			-0.38‡			-0.40‡
Real estate			-1.39∗			-1.35∗
Managerial			5.80∗			5.65∗
Professional			6.42∗			6.26∗
Associate professional			6.59∗			6.44∗
Clerk			5.88∗			5.74∗
Service worker			3.13∗			3.05∗
Craft and trade worker			4.74∗			4.66∗
Manufacturers			4.86∗			4.76∗
Constant	12.26∗	-4.22∗	-4.56∗	12.26∗	-3.64∗	-4.42∗

Notes: Based on 2006 Luxembourg Structure of Earnings Survey data. ∗, † and ‡ indicate significance at 1, 5 and 10 percent levels respectively. Model 1 does not include covariates, Model 2 includes human capital covariates, Model 3 includes both human capital and job characteristics.

Table A.4: Coefficient estimates of RIF regressions - P50 (median)

	Aggregate nationality groups			Disaggregate nationality groups		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Immigrant	-5.62∗	-3.85∗	-1.39∗			
Non-resident	-4.67∗	-3.23∗	-1.54∗			
Be-Fr-Ge resident				-0.25	-0.63†	-0.52†
Portuguese resident				-9.86∗	-6.69∗	-2.35∗
Other EU resident				-1.38∗	-0.81†	-0.36
Non-EU resident				-7.48∗	-5.59∗	-2.32∗
German CB				-3.83∗	-2.21∗	-1.01∗
French CB				-5.91∗	-4.16∗	-1.98∗
Belgian CB				-2.89∗	-2.14∗	-1.25∗
Female		-0.16	-1.30∗		-0.13	-1.25∗
Age		0.94∗	0.64∗		0.92∗	0.64∗
Age squared/100		-1.11∗	-0.71∗		-1.10∗	-0.72∗
Secondary education		4.33∗	0.37		3.37∗	0.21
Tertiary education		12.83∗	1.94∗		10.93∗	1.66∗
Years at current employer		0.30∗	0.18∗		0.29∗	0.18∗
Manager			2.19∗			2.15∗
10-49 employees in firm			-0.60			-0.61‡
50-249 employees in firm			-0.31			-0.31
500-999 employees in firm			-0.00			0.03
1000+ employees in firm			1.50‡			1.54‡
Part time contract			0.72∗			0.71∗
Industry/Manufacture			-2.28∗			-2.27∗
Construction			-5.17∗			-4.98∗
Wholesale			-5.25∗			-5.18∗
Hotel/Restaurant			-5.24∗			-5.15∗
Trans/Comm			-1.39‡			-1.43‡
Finance			0.28			0.21
Real estate			-3.31∗			-3.19∗
Managerial			10.17∗			9.74∗
Professional			11.51∗			11.10∗
Associate professional			10.28∗			9.88∗
Clerk			6.43∗			6.06∗
Service worker			2.58∗			2.33∗
Craft and trade worker			3.24∗			3.05∗
Manufacturers			2.66∗			2.41∗
Constant	19.38∗	-7.24∗	-1.76	19.38∗	-5.71∗	-1.27

Notes: Based on 2006 Luxembourg Structure of Earnings Survey data. ∗, † and ‡ indicate significance at 1, 5 and 10 percent levels respectively. Model 1 does not include covariates, Model 2 includes human capital covariates, Model 3 includes both human capital and job characteristics.

Table A.5: Coefficient estimates of RIF regressions - P80

	Aggregate nationality groups			Disaggregate nationality groups		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Immigrant	-8.29∗	-5.10∗	-1.48†			
Non-resident	-9.06∗	-6.44∗	-3.03∗			
Be-Fr-Ge resident				1.49	-0.69	-1.09‡
Portuguese resident				-16.16∗	-9.21∗	-2.36∗
Other EU resident				-1.35	-1.05	-0.33
Non-EU resident				-9.43∗	-6.06∗	-1.56†
German CB				-7.31∗	-4.55∗	-1.43†
French CB				-11.45∗	-8.08∗	-3.78∗
Belgian CB				-5.79∗	-4.66∗	-3.07∗
Female		-0.95‡	-3.05∗		-0.90‡	-3.00∗
Age		1.36∗	0.69∗		1.33∗	0.68∗
Age squared/100		-1.33∗	-0.56∗		-1.30∗	-0.56∗
Secondary education		8.99∗	1.86∗		7.61∗	1.70†
Tertiary education		30.71∗	7.03∗		27.99∗	6.76∗
Years at current employer		0.48∗	0.35∗		0.48∗	0.35∗
Manager			5.89∗			5.89∗
10-49 employees in firm			-0.87			-0.90
50-249 employees in firm			0.02			0.04
500-999 employees in firm			2.29†			2.38†
1000+ employees in firm			2.13			2.25‡
Part time contract			3.78∗			3.76∗
Industry/Manufacture			-7.25∗			-7.21∗
Construction			-7.95∗			-7.79∗
Wholesale			-7.16∗			-7.03∗
Hotel/Restaurant			-7.34∗			-7.17∗
Trans/Comm			-2.07			-2.20
Finance			-1.86			-1.91
Real estate			-7.75∗			-7.50∗
Managerial			30.86∗			30.48∗
Professional			22.12∗			21.78∗
Associate professional			14.40∗			14.01∗
Clerk			3.81∗			3.47∗
Service worker			3.04∗			2.85∗
Craft and trade worker			2.29†			2.10†
Manufacturers			-0.09			-0.33
Constant	31.64∗	-15.23∗	1.14	31.64∗	-12.98∗	1.64

Notes: Based on 2006 Luxembourg Structure of Earnings Survey data. ∗, † and ‡ indicate significance at 1, 5 and 10 percent levels respectively. Model 1 does not include covariates, Model 2 includes human capital covariates, Model 3 includes both human capital and job characteristics.

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