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ABSTRACT

Migration, the Quality of the Labour Force and Economic Inequality*

Mobility of workers involves flows of labour, human capital and other production factors and thus contributes to a more efficient allocation of resources. Besides these effects on allocative efficiency, migrant flows affect relative wages and also change the international and national distribution of skills and thereby equality in the receiving society. This paper suggests that skilled immigration promotes economic equality in advanced economies under standard conditions. The context is theoretically explained in a core model and empirically documented using unique data from the WIID database and OECD.

JEL Classification: D33, E25, F22, J15, J61 and O15
Keywords: ethnicity, Gini-coefficient, human capital, income distribution, inequality, migration, minority and skill allocation

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1. Introduction

International flows of people are an integral part of the globalized world economy.[1] Economic migration involves flows of labour, human capital and other production factors and thus, at least in theory, contributes to a more efficient allocation of resources and welfare of nations. Yet, the distributional effects of migration may be considerable, as one of the main repercussions of migration is that it changes the composition of the labour force in the receiving and sending countries. These effects are especially far-reaching if migrant flows change the distribution of skills in the labour force. This is the case if, for example, a country experiences a steady inflow of workers whose skill level is on average higher (or lower) than the skill level of the typical native worker. The induced changes in the composition of the labour force have the direct effects on inequality through changing the shares of "poor" and "rich" people in the economy. Furthermore, they affect the wages of high and low skilled labour in the economy. Finally, individuals may react to such changes in labour force quality[2] by changing their investment decisions, including those regarding their investment into human capital acquisition.[3]

The economic consequences of migration have been one of the central topics of labour economics since the early works of Chiswick (1978, 1980) and Borjas (1983, 1985). While various distributional effects have been considered in the ensuing literature that we summarize below, there is little evidence on the relationship between migration and inequality. Yet, it is mainly the distributional effects of migration that drive public attitudes towards immigration and the related policy discourse (see Zimmermann, 2005).

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[1] United Nations (UN) estimates that the share of international migrants in the total world population was 2.4% in 1965, 2.3% in 1985 and reached 3.0% in 2005. In the developed world, including Europe, Northern America, Australia, New Zealand and Japan, the corresponding share reached 9.5% in 2005. See United Nations, Department of Economic and Social Affairs, World Migrant Stock: The 2005 Revision Population Database.

[2] We measure the quality of the labour force by the incidence of skilled workers in it. We define skilled and unskilled workers by their highest attained levels of education, albeit we understand that skill is a broader category than education.

[3] As another example, low skill immigration may increase the overall quality of the labour force, if it brings about a larger increase in the quality of the native labour force.

In this paper we theoretically and empirically study the relationships between economic inequality, the quality of the labour force and international migration. We consider these relationships from the perspective of developed countries that receive inflows of migrants that vary across countries and over time in terms of their skill composition (Zimmermann, 2005).

We proceed as follows. The next section maps the relevant literature. We then develop a simple model that links inequality as measured by the Gini coefficient and the share of skilled workers in the labour force. In this model we illustrate the effects of skilled and unskilled immigration. Section 4 provides empirical evidence on the link between inequality, labour force quality, and migration and establishes some stylised facts about these relationships. Next, we empirically investigate the relationship between inequality and labour force quality using country statistics from the 2007 OECD Statistical Compendium and a unique compilation of inequality data provided by the WIDER institute at the United Nations University in 2007. As a third step, we study the overall relationship between the share of immigrants in the labour force and its quality. We then discuss the policy relevance of our findings and conclude.

2. Theories of Economic Impact of Migration

The impact of immigration on the destination labour market has been modelled by a number of studies, including Chiswick, Chiswick and Karras (1992) and Chiswick (1980, 1998). The key factor driving the effects of migration on income inequality in receiving countries in these models is the substitutability or complementarity of immigrant and native labour. While the early empirical studies (Grossman, 1982; Borjas, 1983; Borjas, 1987) report labour market effects of immigration of small magnitudes, more recent studies provide evidence of diverse and non-negligible effects. Using data from the 1990 US census, Card (2001) distinguishes the effects of immigration for various occupational groups and finds significant negative employment effects in most cases. In a similar study, Orrenius and Zavodny (2007) find negative wage effects of immigration on unskilled natives but do not find significant effects in skilled occupations. Borjas, Freeman and Katz (1997) report that immigration explains a significant proportion of the increase in the wage gap between high and low skill labour in the US in the 1980s and early 1990s. Negative wage effects of immigrants on their co-ethnics in the same linguistic group are reported by Chiswick and Miller (2002). In a natural experiment setting of the Mariel boatlift, which brought an influx 45,000 Cubans into Miami in 1980, Card (1990) finds that any effects of unexpected immigration were cancelled out by mobility response of natives and former immigrants.[4]

The international evidence is mixed, ranging from weak negative effects on employment or wages found by Winkelmann and Zimmermann (1993), Hunt (1992, Carrington and de Lima (1996), Angrist and Kugler (2003) and Roy (1987), through non-significant effects reported by Pischke and Velling (1997), Akbari and DeVoretz (1992), Dustmann, Fabbai, and Preston (2005), Addison and Worwick (2002), Roy (1997), Friedberg (2001) and Zorlu and Hartog (2005), to positive effects found by Chapman and Cobb-Clark (1999) and Parasnis, Fausten and Smyth (2006). De New and Zimmermann (1994) support the complementarity hypothesis by finding negative effects of (largely unskilled) immigration on the wages of the German unskilled but positive wage effects on the wages of native high-skilled. The book edited by Zimmermann (2005) summarizes migration experiences since the Second World War for European countries and the US, Canada and New Zealand. The conclusion obtained is that immigration is largely beneficial for the receiving countries, since, besides phases of adjustment, there is no overall evidence that natives' wages are strongly depressed or that unemployment is substantially increasing as a consequence of immigration.

[4] Borjas (1999, 2003, 2006) and Filler (1992) provide further evidence on the negative effects of immigration in the US.

Immigrant adjustment is another important determinant of immigrant-native labour market disparities. The works of Chiswick (1978) and Borjas (1985) initiated a large body of literature depicting immigrant adjustment and the roles of the immigrant's lack of skills specific to and experience in the host country, migrant (self-)selection and cohort effects. Constant and Zimmermann (2008) discuss the role of ethnicity and its dynamics on immigrants' labour market outcomes and Kahanec (2007) develops a model of persevering skill and occupational specialization of ethnic minorities. Dustmann, Frattini and Preston (2007) provide evidence that immigrants temporarily downgrade to less skilled occupations than they are qualified for due to incomplete transferability of their skills upon arrival.

These interactions between immigrants and natives determine how immigrants fare across the earnings distribution in host societies. This issue has been addressed by a significant body of literature, including Borjas (1990, 1995) that focus on mean immigrant-native earnings gaps and Butcher and DiNardo (2002) and Chiswick, Le and Miller (2008) who investigate this gap at different deciles of earnings distribution. This literature generally reports significant earnings gaps whose magnitudes and determinants vary by gender, year and immigrant cohort as well as across the deciles of the earnings distribution. Employment gaps between immigrants and natives in the US labour market are documented by Chiswick, Cohen and Zach (1997), among others. Borjas (1986) reports higher self-employment rates among immigrants than natives. Gaps in various measures of labour market outcomes of immigrants and natives in other developed countries are reported by a number of studies, including Amuedo-Dorantes and de la Rica (2007) for Spain, Constant and Massey (2003) for Germany and Wheatly Price (1999) and Dustmann, Fabbri, Preston and Wadsworth (2003) for the UK.

3. The Theoretical Model

In this section we develop an analytical labour market model that relates inequality to skill composition of the labour force and then explicate its predictions for the inequality effects of migration. Following Kahanec and Zimmermann (2008), we consider an economy of size one with L low-skilled and $S = 1 - L$ high-skilled workers earning wages w_l and w_h, respectively, where we let $\theta = w_l / w_h$.[5] Consider a specific case with the Constant Elasticity of Substitution (CES) production function $C = \left(L^{1-\rho} + (\alpha S)^{1-\rho}\right)^{\frac{1}{1-\rho}}$, where $\rho = 1/\varepsilon$ and $\varepsilon > 0$ is the (finite) elasticity of substitution of high- and low-skilled labour in a competitive industry and $\alpha > 1$ is the efficiency shift factor of skilled relative to unskilled labour. Under these assumptions $\theta = \left(L/\left(\alpha(1-L)\right)\right)^{-\rho}$ and the earnings of an unskilled relative to a skilled worker are θ/α. We first consider the natural case where the earnings of high-skilled workers are higher than those of low-skilled ones, $\theta/\alpha < 1$. In the Appendix we show that the Gini coefficient[6] is

$$G(L) = \frac{L(1-L)\left(\alpha - \left(\alpha(1-L)\right)^{\rho} / L^{\rho}\right)}{\alpha - \alpha L + \left(\alpha(1-L)\right)^{\rho} / L^{\rho-1}}$$

and that there is a nondegenerate range L^1L^2 within the interval [0,1] where $G(L)$ is increasing in *L*. In fact, whenever $\varepsilon \in (0,1]$, $dG(L)/dL > 0$ for any $L \in (0,1)$. For $\varepsilon > 1$, $G(L)$ is increasing within and decreasing outside of L^1L^2, that is, for very low and very high

[5] That is, we normalize the size of the labour force to unity and *L* denotes also the share of lows-skilled workers.

[6] The Gini coefficient is the area between the line of perfect equality, the 45 degree line, and the Lorenz curve $z(\lambda)$, depicting the share of economy's income accruing to the λ poorest individuals, divided by the area between the line of perfect equality and the line of perfect inequality. The line of perfect inequality attains zero for any $\lambda \in [0,1)$ and $z(1) = 1$.

values of *L*. It turns out that the range L^1L^2 tends to be quite large.[7] Parametric values determine which $L \in (0,1)$ are admissible with respect to the condition $\theta/\alpha < 1$ and which are not. We denote L^* the value of L at which $\theta/\alpha = 1$. In the Appendix we show that $L^* = \alpha^{1-1/\rho}/(1+\alpha^{1-1/\rho})$, $L^1 < L^* < L^2$, and $\theta/\alpha < 1$ for any $L \in (L^*,1)$ and $\theta/\alpha > 1$ for any $L \in (0, L^*)$.[8] It turns out that for the values of $L \in (0, L^*)$ the Gini coefficient equals $-G(L)$. Note that these results imply that for OECD economies with a large share of skilled labour the relevant segment of $G(L)$ is decreasing in the share of skilled labour, 1-*L*, for the most part and may pick up for $L \in (0, L^*)$, where, counterfactually, the low-skilled earn more than the high-skilled.

This result enables us to consider the effects of changes in L that occur when immigrants of different skill composition (vis-à-vis the natives) enter (leave) the economy under the conditions of flexible wages. For example, for $L \in (L^*, L^2)$ an inflow of immigrants who are on average more skilled than the natives decreases inequality in the economy.[9]

To summarize, theory predicts that inequality is decreasing with skilled immigration for moderate to high values and may be increasing for very high values of the share of skilled labour, 1-*L*. In advanced economies such as the OECD countries where skilled labour is abundant and under the natural case where skilled workers earns more than unskilled ones this prediction implies that skilled immigration decreases inequality.

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[7] For example, if the substitutability of skilled and unskilled labour is about 2.5, as estimated by Chiswick (1978C), and high skilled labour is twice as productive as its low skilled counterpart, the corresponding values are $L^1 = 0.07$ and $L^2 = 0.83$.

[8] Note, that if $\varepsilon > 1$ ($\varepsilon \in (0,1)$), it must be that $L < 0.5$ ($L > 0.5$) for $\theta/\alpha < 1$ to hold. $L^* = 0.26$ under the assumptions of the previous footnote.

[9] Note that we consider the case $\varepsilon > 1$.

4. Inequality and the Quality of the Labour Force

What is the empirical relationship between inequality and educational attainment levels in the labour force?[10] To address this question, we combine data on education, labour force characteristics and other national indicators from the OECD Statistical Compendium 2007 with the Gini measures reported in the World Income Inequality Database (WIID 2007) version 2.0b compiled by the WIDER institute at the United Nations University and published in May 2007. The OECD Statistical Compendium provides historical statistics on a wide range of economic variables, such as labour force characteristics, national accounts, and education, mainly for developed countries that are members of OECD.

The WIID 2007 dataset reports Gini coefficients for a large number of countries covering many years of collection and estimation of this inequality indicator. In those cases where WIID 2007 reports multiple Gini coefficients per year and country, we prefer those of the highest quality if based on gross rather than net takings and earnings rather than broader measures of income to quantify those components of economic inequality that stem from the labour market as precisely as possible.[11] The combined dataset covers 29 OECD member states and provides 109 observations with non-missing information on the Gini coefficient the shares of the labour force with at least upper secondary or post-secondary education.

[10] As mentioned earlier, education measures a certain type of skills.

[11] It needs to be acknowledged that whether earnings inequality is measured at the individual or household level is a non-trivial issue in the context of measuring the relationship between inequality and immigration. In particular, immigrants often have larger households and different family structures than natives. As a result, measures of inequality based on individual and household earnings may give different pictures of inequality. The analysis of this complex relationship is beyond the scope of this chapter, however. Nevertheless, we control for the level (individual vs. household) at which the Gini coefficient was measured in our empirical analysis.

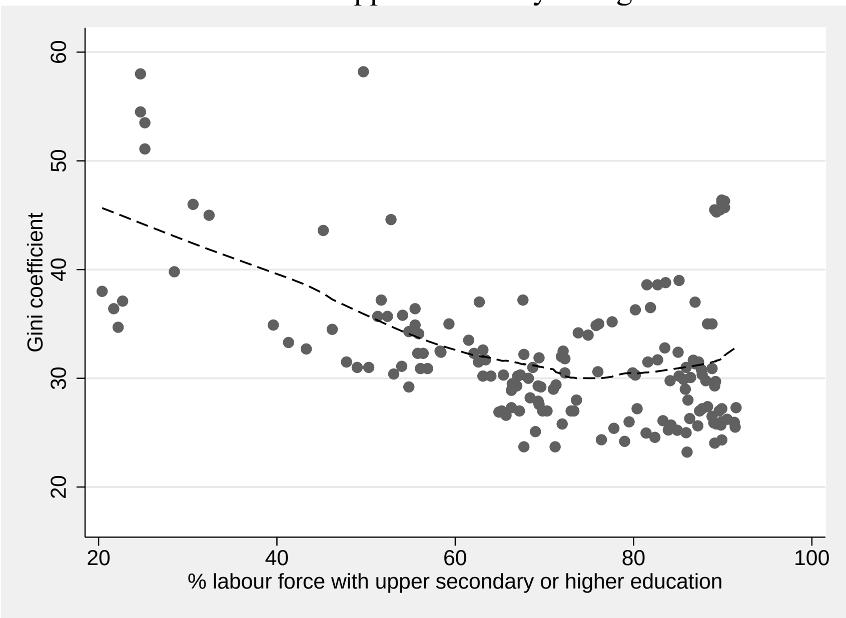
Table 1: Descriptive statistics

	Mean	Standard deviation	Number of observations
Gini coefficient	31.95	6.14	109
Share of upper secondary or higher education	72.84	17.17	109
Share of post-secondary or higher education	50.64	20.26	109
Share of foreign labour force	5.11	3.85	110
Inflation rate	2.63	2.50	109
Share of population 15-64 years of age	66.86	1.56	109
Unemployment rate	7.49	3.53	109
Female unemployment rate	8.37	4.61	109
Participation rate	73.01	6.24	109
Female participation rate	65.00	8.44	109
Share of labour force in agriculture	5.68	4.00	109
Government size	20.25	3.38	109
GDP per capita, 1000s USD	19.95	12.15	109

Note: Share of foreign labour force computed for the sample including observation for which information on the Gini coefficient was missing but excluding Luxembourg with unusually high share of foreigners.

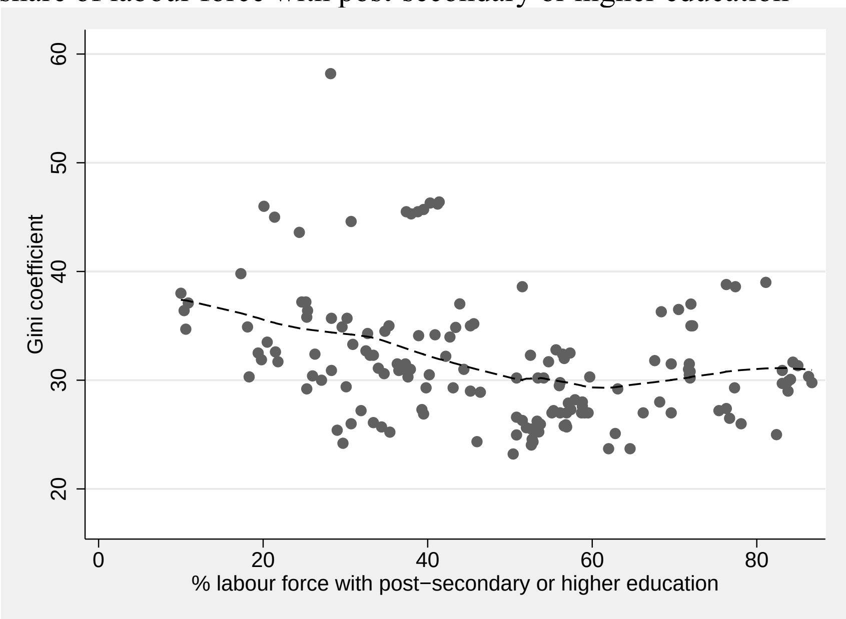
Table 1 reports basic descriptive statistics of the main variables used in the analysis. We observe that the mean Gini coefficient is about 32%, the mean share of workers with upper secondary or higher education is about 73%, the corresponding figure for post-secondary or higher education is 51%, and the mean share of foreigners in the labour force is about 7%. To illustrate some basic characteristics of the relationship between inequality and labour force quality, we plot these two variables and compute the predicted values of a locally smoothed regression of the Gini coefficient on the measures of educational attainment in the labour force. Figures 1 and 2 confirm that for the most part inequality is a negative function of labour force quality for both measures of labour force quality that we apply. Indeed, this relationship is negative for about 80% of the observations in case of post secondary or higher education. The corresponding percentage for upper secondary or higher education is about 60%. In fact, the observed relationships are not too different from simple quadratic fits.

Figure 1: Scatter plot of the Gini coefficient as a function of the share of labour force with upper secondary or higher education



Notes: OECD members except for Iceland. Data on Gini coefficients are from the WIID 2007 database. Data on the shares of labour force with given education are from the OECD Compendium. 1992-2003. Line plot of the nonparametric locally weighted regression of the Gini coefficient as a function of the share of labour force with upper secondary or higher education

Figure 2: Scatter plot of the Gini coefficient as a function of the share of labour force with post-secondary or higher education



Notes: OECD members except for Iceland and Mexico. Data sources see Figure 1. 1992-2003. Line plot of the nonparametric locally weighted regression of the Gini coefficient as a function of the share of labour force with post-secondary or higher education.

Besides the distribution of educational levels in the labour force, there are other factors that may influence the relationship between inequality and labour force quality. Katz and Murphy (1992) report that increased demand for skilled workers and females as well as changes in the allocation of labour between industries contributed to increasing inequality in the US in recent years. Gustafsson and Johansson (1999) provide evidence that the share of industry in employment, per capita gross domestic product, international trade, the relative size of the public expenditures, as well as the demographic structure of the population affect inequality measured by the Gini coefficient across countries and years. Topel (1994) finds that technological and economic development determines economic inequality.

We examine the robustness of the observed decreasing and convex relationship with respect to the possible covariates mentioned in the literature by testing its stability in a formal regression analysis. In particular, we consider the effects of the aggregate and female labour force participation rates, aggregate and female unemployment rates, share of the population between 15 and 64 years of age, labour force in the agricultural sector, share of the government in the economy,[12] gross domestic product and inflation rate. We further control for the year, country and the method of computing the Gini coefficient, distinguishing various income measures, net and gross figures and the unit of analysis used to calculate any particular Gini coefficient.

Our regression analysis reported in Table 2 confirms that the observed decreasing and convex relationship is robust for both considered measures of education and across a number of model specifications, including the standard OLS model, the weighted least squares model with quality weights for the Gini coefficient from the WIID database, and the model with random country effects.[13] In particular, at high significance levels, the share of educated labour force is negatively and its square positively associated with inequality in all

[12] Defined as the expenditures of the central government divided by the aggregate GDP.

specifications. The estimated coefficients predict the minimum of the U-shaped relationship between the share of skilled labour and the Gini coefficient to lie at about 80% of the labour force with upper secondary or higher education and 66% of the labour force with post secondary or higher education. In our sample these numbers imply a downward sloping relationship between the share of skilled labour and inequality for about 67% and 84% of the observations for the two applied measures of skilled labour, respectively.

Table 2: Gini coefficient as a function of labour force quality

	(1)	(2)	(3)	(4)	(5)	(6)
	Upper secondary and higher			Post-secondary and higher		
	OLS	Quality weighted	Random effects	OLS	Quality weighted	Random effects
Share of highly educated in the labour force	-0.834***	-0.747***	-0.814***	-0.305**	-0.315**	-0.287**
	(0.162)	(0.167)	(0.171)	(0.133)	(0.122)	(0.130)
Share of highly educated in the labour force, sq/100	0.558***	0.493***	0.543***	0.235**	0.237**	0.221*
	(0.147)	(0.136)	(0.139)	(0.114)	(0.114)	(0.122)
Inflation rate	0.211	0.175	0.184	0.114	0.086	0.079
	(0.258)	(0.242)	(0.252)	(0.237)	(0.262)	(0.282)
Share of population 15-64 years of age	-0.523	-0.435	-0.599	-0.677	-0.442	-0.782
	(0.482)	(0.481)	(0.490)	(0.565)	(0.507)	(0.529)
Unemployment rate	2.948***	2.915***	2.952***	2.092***	2.193***	2.107***
	(0.828)	(0.522)	(0.537)	(0.705)	(0.558)	(0.590)
Female unemployment rate	-1.867***	-1.857***	-1.882***	-1.336**	-1.418***	-1.362***
	(0.590)	(0.388)	(0.396)	(0.530)	(0.419)	(0.441)
Participation rate	0.113	0.315	0.157	0.471	0.670*	0.537
	(0.404)	(0.385)	(0.392)	(0.341)	(0.379)	(0.405)
Female participation rate	-0.312	-0.435	-0.348	-0.466*	-0.593**	-0.524*
	(0.319)	(0.297)	(0.307)	(0.237)	(0.281)	(0.303)
Share of labour force in agriculture	-0.338	-0.287	-0.317*	-0.195	-0.181	-0.160
	(0.261)	(0.177)	(0.183)	(0.211)	(0.181)	(0.194)
Government size	-0.411	-0.358*	-0.404**	-0.425*	-0.364*	-0.407**
	(0.248)	(0.187)	(0.193)	(0.234)	(0.191)	(0.204)
GDP per capita, 1000s USD	0.062	0.045	0.050	-0.081	-0.079	-0.095
	(0.063)	(0.074)	(0.077)	(0.071)	(0.073)	(0.077)
Gini definition controls	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	115.401***	99.307***	118.887***	93.424**	68.776*	95.976***
	(34.235)	(34.195)	(34.021)	(40.970)	(35.815)	(37.063)
Observations	109	109	108	109	109	108
R-squared	0.70	0.71	0.70	0.62	0.66	0.62

Notes: Robust standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

[13] This result remains robust in alternative models with weighting by country size, clustering, and fixed effects. The coefficients on post-secondary or higher education measure of labour force quality retain the correct signs but become insignificant in the fixed effect model. Results available upon request.

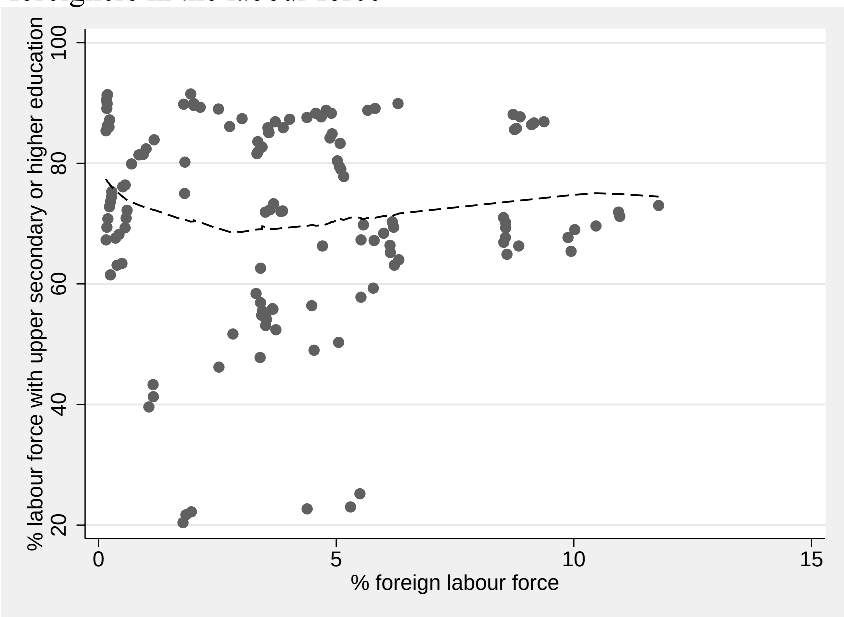
As concerns the other regressors, the results are as expected. The general unemployment rate is positively associated with inequality. However, female unemployment rate negatively affects inequality. There is also some indication that the same holds for general and female participation rates. These results are probably picking up the effect of female selection into labour force, whereby high female unemployment and participation rates indicate that women with less favourable earnings opportunities are joining the labour force and thus increasing earnings dispersion. The size of the government is negatively associated with inequality, which is consistent with the hypothesis that redistribution decreases inequality.

5. Labour Force Quality and Migration

The composition of the labour force is a function of a number of socio-economic variables, among which international migration stands as one that is momentous both in terms of its effects and its sensitivity among the policy makers. Figures 3 and 4 indeed show that across OECD countries the share of labour force with upper secondary or higher educational attainment is a predominantly positive function of the share of foreign labour force in the economy, while the same relationship is monotonously increasing in case of post-secondary or higher education.

To evaluate this relationship as a causal phenomenon requires, inter alia, accounting for the endogeneity of the migration decision, the effects of migration on the educational attainment of the native labour force, and the skill level of the immigrant relative to native workers. While such causal evaluation would require a much more detailed dataset than we have, we do go beyond the raw relationships presented in Figures 3 and 4. Namely, we evaluate the association between the share of foreign labour force and its quality controlling for a number of potential covariates such as the size of the government and age composition of the labour force. Table 3 reports evidence that the quality of the labour force increases with the share of foreigners in the labour force.[14] This finding arises in all econometric models and for any measure of education (post-secondary or higher and upper-secondary or higher) that we consider.[15] As for the control variables, government size as well as GDP per capita have positive effects on the quality of labour force in the OLS models in columns 2 and 5, but the sign of these effects reverses in the random effects models. This reversal is consistent with the hypothesis that the association of these variables is positive between but negative within countries.

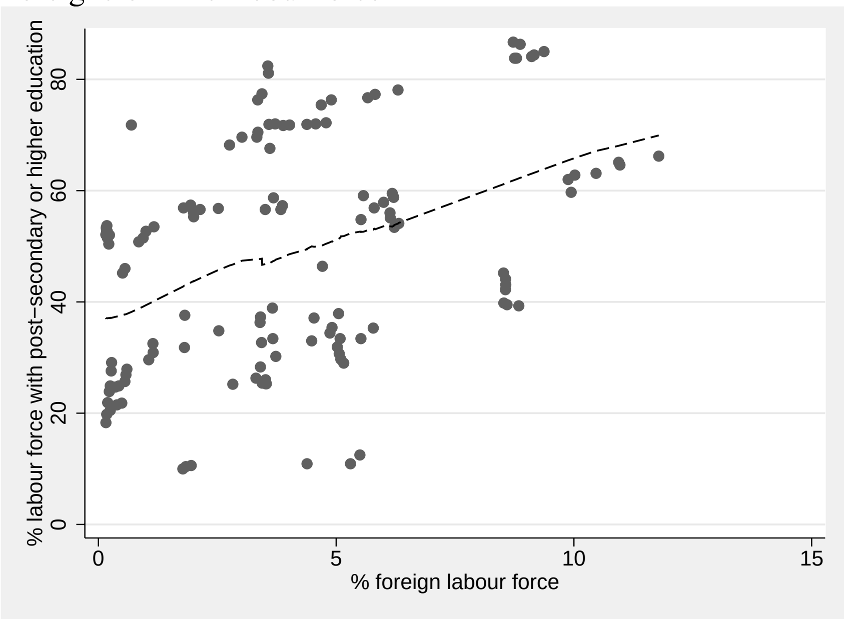
Figure 3: Scatter plot of the share of labour force with upper secondary or higher education as a function of the share of foreigners in the labour force



Notes: OECD members. Data on the shares of labour force with given education and foreigners are from the OECD Compendium. 1992-2003. Line plot of the nonparametric locally weighted regression of the Gini coefficient on the share of labour force with upper secondary or higher education

[14] The sample included observation for which the information on the Gini coefficient was missing. Luxembourg was dropped from the analysis due to its unusually high share of foreigners. The results are fairly robust with respect to inclusion of Luxembourg, though.
[15] It is also robust with respect to the fixed effects model specification as well as for the restricted sample of observations for which Gini coefficient is available.

Figure 4: Scatter plot of the share of labour force with post-secondary or higher education as a function of the share of foreigners in the labour force



Notes: OECD members. Data sources see Figure 3, 1992-2003. Line plot of the nonparametric locally weighted regression of the Gini coefficient on the share of labour force with post-secondary or higher education.

Table 3: Share higher education as a function of share foreign labour force

	(1)	(2)	(3)	(4)	(5)	(6)
	Upper secondary and higher			Post-secondary and higher		
	OLS	OLS	Random effects	OLS	OLS	Random effects
Share of foreign labour force	0.906***	1.140***	0.650***	2.621***	2.882***	1.427***
	(0.287)	(0.295)	(0.229)	(0.334)	(0.426)	(0.415)
Share of population 15-64 years of age		1.991	-0.159		1.847	-0.160
		(1.568)	(0.460)		(1.767)	(0.860)
Government size		1.793***	-0.569**		1.377*	-1.579***
		(0.557)	(0.270)		(0.764)	(0.497)
GDP per capita, 1000s USD		0.684***	-0.002		0.470***	-0.132**
		(0.141)	(0.032)		(0.179)	(0.060)
Year dummies		Yes	Yes		Yes	Yes
Constant	66.283***	-112.345	85.596**	37.508***	-110.036	87.214
	(2.750)	(115.003)	(34.390)	(2.709)	(128.109)	(63.902)
Observations	110	110	109	110	110	109
R-squared	0.04	0.27	0.73[a]	0.22	0.30	0.52[a]

Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%
[a] Within R-squared.

5. Discussion and Conclusions

The relationships between inequality, the quality of the labour force and migration is important from both a scientific and a public policy perspective. This paper provides a number of notable theoretical and empirical findings about these relationships.

First, theory predicts that inequality is decreasing in labour force quality for advanced economies under standard conditions. This effect arises mainly as a consequence of the standard economic law of diminishing marginal product of production factors: as the share of skilled workers in the economy increases, its price decreases and thus the wage differential between high and low skilled labour decreases as well. In our theoretical model migration affects inequality in the economy inasmuch as it changes the quality of the labour force. In particular, inflows of workers with average skill level above that of the receiving country depress inequality, and the opposite holds for low-skilled immigration.

Second, we confirm empirically that the relationship between inequality and the quality of the labour force is predominantly a negative one. This finding is evident from the raw data and confirmed by a more elaborate econometric analysis that accounted for a number of possible covariates and considered several alternative model specifications. Our results show that in the sample of OECD countries inequality decreases in labour force quality for most observations; a positive relationship shows up for observations with the quality of the labour above certain high threshold level.

How migration affects the distribution of wealth and income is one of the focal points of public policy debate. We evaluated the overall relationship between migration and labour force quality as observed across OECD countries. We find that the share of foreigners in the labour force and its quality as measured by educational attainment are positively associated. Given our finding that labour force quality and inequality are negatively associated, this result implies that immigration is negatively associated with inequality. Further research is necessary to evaluate the causal links through which migration affects inequality.

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Appendix: Gini coefficient and immigration

Consider an economy of size 1 with L low-skilled and $S=1-L$ high-skilled workers earning wages w_l and w_h, respectively, as in the main text. We denote $\theta = w_l/w_h$ and normalize the total income to unity, $w_l L + w_h(1-L)=1$. Consider the case with endogenous wages such that $\theta = \left(L/\left(\alpha(1-L)\right)\right)^{-\rho}$ where $\rho>0$.

Proposition

For $L\in\left[\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right),1\right)$ the Gini coefficient equals

$$G(L)=\frac{L(1-L)\left(\alpha-\left(\alpha(1-L)\right)^{\rho}/L^{\rho}\right)}{\alpha-\alpha L+\left(\alpha(1-L)\right)^{\rho}/L^{\rho-1}}.$$

For $L\in\left(0,\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)\right]$ the Gini coefficient equals $-G(L)$.

If $\rho\ge 1$, $dG(L)/dL>0$ for any $L\in(0,1)$.

For $0<\rho<1$ and $L\in(0,1)$, there exist $L^1\in\left(0,\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)\right)$ and $L^2\in\left(\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right),1\right)$, such that $dG(L)/dL>0$ for $L\in\left(L^1,L^2\right)$, $dG(L)/dL<0$ for $L\in(0,1)-\left[L^1,L^2\right]$ and $dG(L)/dL=0$ for $L\in\left\{L^1,L^2\right\}$. Also, $L^1<L^*<L^2$, where $L^*=\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)$

Proof:

Given $\theta = \left(L/\left(\alpha(1-L)\right)\right)^{-\rho}$, $L\in\left(\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right),1\right)$ implies $\theta/\alpha = w_l/\alpha w_h<1$, that is, high-skilled workers earn more than low-skilled ones. Then the Lorenz curve is then defined by

$z(\lambda)=\dfrac{\theta\lambda}{\theta L+\alpha(1-L)}$ for $\lambda\in[0,L]$ and

$z(\lambda)=\dfrac{\theta L+\alpha(\lambda-L)}{\theta L+\alpha(1-L)}$ for $\lambda\in[L,1]$.

Similarly as above we integrate the Lorenz curve over $\lambda\in[0,1]$ and substitute for θ to obtain

$G(L)=\dfrac{L(1-L)\left(\alpha-(\alpha(1-L))^{\rho}\big/L^{\rho}\right)}{\alpha-\alpha L+(\alpha(1-L))^{\rho}\big/L^{\rho-1}}$ to depict the Gini coefficient in this case and

$$\frac{dG(L)}{dL}=\frac{\alpha^{2}(1-L)^{2}L^{2\rho}+L^{2}\alpha^{2\rho}(1-L)^{2\rho}-\alpha^{\rho+1}L^{\rho}(1-L)^{\rho}(1-\rho-2L(1-L))}{\left(\alpha^{\rho}(1-L)^{\rho}L+\alpha(1-L)L^{\rho}\right)^{2}}.$$

If $L\in\left(0,\alpha^{1-1/\rho}\big/\left(1+\alpha^{1-1/\rho}\right)\right)$, $\theta/\alpha=w_l/\alpha w_h>1$ and high-skilled workers earn less than low-skilled ones. The Lorenz curve becomes

$z(\lambda)=\dfrac{\alpha(1-L)}{\theta L+\alpha(1-L)}$ for $\lambda\in[0,L]$ and

$z(\lambda)=\dfrac{\alpha(1-L)+\theta(L-\lambda)}{\theta L+\alpha(1-L)}$ for $\lambda\in[L,1]$.

Integrating the Lorenz curve over $\lambda\in[0,1]$ we obtain that the Gini coefficient in this case is $-G(L)$. $L=\alpha^{1-1/\rho}\big/\left(1+\alpha^{1-1/\rho}\right)$ is the case of perfect equality.

For $\rho\geq 1$ obviously from the expression for $dG(L)/dL$ it is positive for any $L\in(0,1)$.

For $0<\rho<1$, first note that $G(L)$ and $dG(L)/dL$ are continuous functions for $L\in(0,1)$. Observe as well that $G(L)\to 0$ for $L\to 1$ or $L\to 0$ and substituting $L=\alpha^{1-1/\rho}\big/\left(1+\alpha^{1-1/\rho}\right)$ into $G(L)$ above yields $G\left(\alpha^{1-1/\rho}\big/\left(1+\alpha^{1-1/\rho}\right)\right)=0$. To see the former, note that $\lim\limits_{L\to 0^{+}}G(L)=\lim\limits_{L\to 0^{+}}\dfrac{L^{1-\rho}(1-L)\left(\alpha L^{\rho}-(\alpha(1-L))^{\rho}\right)}{\alpha-\alpha L+(\alpha(1-L))^{\rho}\big/L^{\rho-1}}=0$ and

$$\lim_{L\to 1^-} G(L) = \lim_{L\to 1^-} \frac{L(1-L)^{1-\rho}\left(\alpha - \left(\alpha(1-L)\right)^{\rho} / L^{\rho}\right)}{\alpha(1-L)^{1-\rho} + \alpha^{\rho} L^{1-\rho}} = 0$$, where we made use of $0 < \rho < 1$.

Furthermore, $dG(L)/dL \to -\infty$ whenever $L \to 1$ or $L \to 0$ and substitution yields $dG(L)/dL > 0$ at $L = \alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)$. In fact, $dG(L)/dL = \rho$.[16] These properties imply that there exists at least one minimum of $G(L)$ on the interval $L \in \left(0, \alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)\right)$ and at least one maximum on the interval $L \in \left(\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right), 1\right)$, where $dG(L)/dL = 0$.

To show the uniqueness of each and the maxima of $dG(L)/dL$, consider the second derivative of $G(L)$. Assume for the moment that $\alpha = 1$; we extend the argument to the case where $\alpha > 1$ below. First note that

$$\frac{d^2G(L)}{dL^2} = -\frac{(\rho-1)\left(L(1-L)\right)^{\rho-1}}{\left(-L(1-L)^{\rho} + L^{\rho}(L-1)\right)^3}\left(L^{\rho}(1-L)(2L-\rho) + L(1-L)^{\rho}(2L+\rho-2)\right).$$

Since the sign of the ratio $\frac{(\rho-1)\left(L(1-L)\right)^{\rho-1}}{\left(-L(1-L)^{\rho} + L^{\rho}(L-1)\right)^3}$ is unambiguously positive for $0 < \rho < 1$ and $L \in (0,1)$, the sign of the second derivative is the same as the sign of

$$-\left(L^{\rho}(1-L)(2L-\rho) + L(1-L)^{\rho}(2L+\rho-2)\right). \tag{A1}$$

[16] This result involves tedious algebra. One can show this by evaluating $dG(L)/dL$ at L^*, simplifying it, and realizing that $dG(L)/dL = 1 + f(\alpha,\rho)(\rho-1)$ where the term $f(\alpha,\rho) = 1$.

For $0<\rho<1$ and $L\in(0,0.5)$ we can rewrite A1 into the following form $-L^{\rho}(1-L)\left((2L-\rho)+\left(\frac{L}{1-L}\right)^{1-\rho}(2L+\rho-2)\right)$. Also, since $2L+\rho-2<0$ and $L/(1-L)<1$ we can write

$(2L-\rho)+\left(\frac{L}{1-L}\right)^{1-\rho}(2L+\rho-2)\le(2L-\rho)+\frac{L}{1-L}(2L+\rho-2)=\rho\frac{2L-1}{1-L}\le 0$. This result and that $-L^{\rho}(1-L)<0$ imply $-\left(L^{\rho}(1-L)(2L-\rho)+L(1-L)^{\rho}(2L+\rho-2)\right)>0$ for $0<\rho<1$ and $L\in(0,0.5)$. Similarly, rewriting A1 as $-L(1-L)^{\rho}\left(\left(\frac{1-L}{L}\right)^{1-\rho}(2L-\rho)+(2L+\rho-2)\right)$ one can show that $-\left(L^{\rho}(1-L)(2L-\rho)+L(1-L)^{\rho}(2L+\rho-2)\right)<0$ for $0<\rho<1$ and $L\in(0.5,1)$.

That $d^2G(L)/dL^2>0$ (and thus $G(L)$ is strictly convex) for any $L\in(0,0.5)$ and $d^2G(L)/dL^2<0$ (and thus $G(L)$ is strictly concave) for any $L\in(0.5,1)$, $dG(L)/dL<0$ for $L\to 1$ or $L\to 0$ and $dG(L)/dL>0$ for $L=\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)=0.5$, and the continuity of $dG(L)/dL$ for $L\in(0,1)$ imply the desired uniqueness of the extrema and the properties of $dG(L)/dL$ for $\alpha=1$.

To extend the argument to the case where $\alpha>1$, note that for $dG(L)/dL=0$ to have at most two solutions within $L\in(0,1)$, it suffices to show that $d^2G(L)/dL^2=0$ has at most one solution. Note as well that

$$\frac{d^2G}{dL^2}=\frac{L^{\rho-1}(1-L)^{\rho}\alpha^{\rho+1}(\rho-1)}{(L-1)\left((L-1)L^{\rho}\alpha-L(1-L)^{\rho}\alpha^{\rho}\right)^3}\left((L-1)L^{\rho}\alpha(-2L+\rho)+L(1-L)^{\rho}\alpha^{\rho}(-2+2L+\rho)\right)$$

and

$$(L-1)L^{\rho}\alpha(-2L+\rho)+L(1-L)^{\rho}\alpha^{\rho}(-2+2L+\rho)=\alpha L^{\rho}(1-L)\left(2L-\rho+\left(\frac{L}{(1-L)\alpha}\right)^{1-\rho}(2L+\rho-2)\right)$$

.

Thus, we need to show that

$$H(L)=2L-\rho+\left(\frac{L}{(1-L)\alpha}\right)^{1-\rho}(2L+\rho-2)=0$$

has at most one solution within $L\in(0,1)$ for $\alpha>1$ and $0<\rho<1$. For this to be true it suffices that $H(L)$ is monotonous for $L\in(0,1)$, that is, for $L'>L$ it must be that $H(L')>H(L)$. Consider $L'>L$. Then

$2L'-\rho+\left(\frac{L'}{(1-L')\alpha}\right)^{1-\rho}(2L'+\rho-2)>2L-\rho+\left(\frac{L}{(1-L)\alpha}\right)^{1-\rho}(2L+\rho-2)$, which one can rewrite as

$$2(L'-L)+\alpha^{\rho-1}\left(\left(\frac{L'}{(1-L')}\right)^{1-\rho}(2L'+\rho-2)-\left(\frac{L}{(1-L)}\right)^{1-\rho}(2L+\rho-2)\right)>0. \tag{A2}$$

A2 trivially holds whenever

$$\left(\left(\frac{L_1}{(1-L_1)}\right)^{1-\rho}(2L_1+\rho-2)-\left(\frac{L_2}{(1-L_2)}\right)^{1-\rho}(2L_2+\rho-2)\right) \tag{A3}$$

is positive. If A3 is negative, we already know that A2 holds for $\alpha=1$. Since $\alpha^{\rho-1}$ is decreasing for $\alpha\in(1,\infty)$ a negative A3 and the fact that A2 holds for $\alpha=1$ imply that A2 holds for a negative A3 as well.

Therefore, given their continuity, $d^2G(L)/dL^2=0$ has at most one and $dG(L)/dL=0$ at most two solutions and thus $G(L)$ has at most two interior extrema within $L\in(0,1)$. We already know that there exists at least one minimum of $G(L)$ on $L\in\left(0,\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)\right)$ and at least one maximum on $L\in\left(\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right),1\right)$. Therefore, these extrema are unique and we can denote $L^1\in\left(0,\alpha^{1-1/\rho}/\left(1+\alpha^{1-1/\rho}\right)\right)$ the minimum and

$L^2 \in \left(\alpha^{1-1/\rho} \big/ \left(1+\alpha^{1-1/\rho}\right), 1\right)$ the maximum. Clearly, it also follows that $L^1 < L^* < L^2$, where $L^* = \alpha^{1-1/\rho} \big/ \left(1+\alpha^{1-1/\rho}\right)$. ■