The effect of immigration on native earnings

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Abstract. This study investigates the extent of labour market competition among native Dutch workers and ethnic minorities. *Firstly*, the direct effect of immigrants on local labour markets is considered. It is shown that ethnic minorities from non-EU countries have a positive effect on the earnings of high skilled natives and an adverse effect on the earning of low skilled native workers. Ethnic minorities from EU-countries may have a negative effect on the earnings of high skilled natives and a positive effect on the earnings of low skilled natives. *Secondly*, the effect of an immigration flow by 5% of the total labour force on native earnings is examined along three scenarios using a general equilibrium model. Immigration has a large negative effect on the wages of less skilled natives and a small positive effect on the wages of high skilled workers as new immigrants are less skilled than natives. If the immigration flow is mainly composed of high skilled workers, immigration has a relative large adverse effect on high skilled natives and a small negative effect on low skilled natives. In all cases, medium skilled natives are a little adversely affected by immigrants.

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1 Introduction

Most research on ethnic minorities in the Netherlands has concentrated on documenting their disadvantaged position. Economic research is limited to analysis of the impact of 'guest workers' (Heijke 1979, Hartog and Vriend 1989) and documentation of their labour market position. Kee (1993) and van Beek (1993) provide strong evidence that ethnic minorities face resistance in the Dutch society, which results in unproportionally high unemployment and disadvantaged earning profiles. .

There is a popular belief that immigrants induce a large burden on the national economy and during the 1990's immigration policy is increasingly becoming more restrictive. High structural unemployment in the lower segment of the Dutch labour market where immigrants are concentrated is the basis for this argument. However, evidence is lacking. We do not know how the Dutch labour market reacts to immigration. Do immigrants compete with the native Dutch workers, displace them in production or push down their wages? This study is a contribution to answering these questions.

In the United States, a number of empirical studies have sought to identify the effect of immigration on labour market outcomes distinguishing between effects on substitutes and complements in production while this literature indeed finds loosing substitutes and winning complements (Grant and Hamermesh 1981,Chiswick 1982, Grossman 1982, Borjas 1983, 1987, Borjas et al. 1997, Abowd and Freeman 1991). But Friedberg and Hunt (1995) conclude in their survey that no substantial evidence is found for a large adverse impact of immigration on the wages and employment of the native-born population. Similar studies for Europe reach the same conclusion (De New and Zimmerman 1994, Gang and Rivera-Batiz 1994, Venturini 1999, Zorlu 2000). As in the United States, immigrants have been found to have a little or no effect on wages and employment of natives in EU countries.

This paper investigates the effect of the presence of immigrants on wages for Dutch workers distinguished by level of education. First, the direct effect of immigration on wages of natives is examined by estimating earnings functions in which the proportion of immigrants in cities are included. Then, the wages of Dutch workers are predicted from the estimated earnings functions. We prefer the predicted wages instead of observed wages because in this way, a possible non-random distribution of workers with certain observable characteristics across geographical areas is taken into account. After that, employment and mean wages over 46 areas are constructed from which production functions are estimated. On the basis of technology coefficients, the elasticities of complementarity and price elasticities between different types of labour are calculated. These price elasticities allow us to identify the possible effect of an immigration flow along three scenarios. Section 2 gives theory, section 3 documents the presence of ethnic minorities, section 4 presents estimation earning functions, section 5 calculates the implied elasticities and presents some alternative scenarios of the effects of immigration. Section 6 concludes.

2 Theory

Altonji and Card (1991) develop a theoretical framework to study the effect of immigration on the wages of unskilled and skilled labour. We extend their model by adding medium skilled labour. Suppose that a single competitive industry produces Y units of goods by a linear production function with constant returns to scale employing low skilled, medium skilled and high skilled labour and other inputs. The total labour force, L, consists of low skilled L_u , medium skilled, L_m and high skilled, L_s; $L = L_u + L_m + L_h$ and proportions of low, medium and high skilled labour are respectively $u = L_u/L, m = L_m/L$ and $h = L_h/L$; $u + m + h = 1$. Total cost in industry is given as

$$C(w_u, w_m, w_h) = Y c\left(w_u, w_m, w_h\right) \tag{1}$$

where w_u, w_m and w_h are wages of low , medium and high skilled labour respectively and $c(w_u, w_m, w_h)$ is unit labour cost. Perfect competition implies that unit labour cost, in the absence of capital, is equal to the price of output, $p = c(w_u, w_m, w_h)$.

Goods produced are consumed by low , medium and high skilled workers and some part of goods are exported. Product market equilibrium is given

$$Y = L_u D_u\left(p, w_u\right) + L_m D_m(p, w_m) + L_h D_h\left(p, w_h\right) + D_x(p) \tag{2}$$

Where Y is units of goods produced, D_j, $j = u, m, h$, is demand by skill types and D_x is export demand. Labour supply functions of low skilled, medium skilled and high skilled workers are given by $S_u(w_u, p), S_m(w_m, p)$ and $S_h(w_h, p)$. Labour market equilibrium occurs when

$$L_i S_i\left(w_i, p\right) = Y c_i\left(w_u, w_m, w_h\right), i = u, m, h \tag{3}$$

where $c_i = \frac{\partial c}{\partial w_i}$ are marginal labour costs of low, medium and high skilled labour.

Suppose that an immigrant flow of size ΔI occurs: a fraction of immigrants, α_u, is low skilled workers, α_m , is medium skilled and the rest is high skilled, α_h. The effects of the immigration flow on the wages of native workers can be obtained by differentiating equations (2) and (3), and assuming that the cross-elasticities of the output demand and labour supply are zero $\frac{\partial D_i}{\partial w_i} = 0$ and that the cross-elasticities of factor demand are zero. $\frac{\partial S_i}{\partial p} = 0$. The proportional changes in wage rates of each type labour are defined as

$$\lambda_u \left(\frac{\alpha_u}{u}\right) \frac{\Delta I}{L} = \left(\eta_{\mathrm{u}\, u} - \varepsilon_u\right) \Delta \log w_u + \eta_{um} \Delta \log w_m + \eta_{uh} \Delta \log w_h \tag{4}$$

$$\lambda_m \left(\frac{\alpha_m}{m}\right) \frac{\Delta I}{L} = \eta_{mu} \Delta \log w_u + \left(\eta_{mm} - \varepsilon_m\right) \Delta \log w_m + \eta_{mh} \Delta \log w_h \tag{5}$$

$$\lambda_h \left(\frac{1-\alpha_u-\alpha_m}{1-u-m} \right) \frac{\Delta I}{L} = \eta_{hu} \Delta \log w_u + \eta_{hm} \Delta \log w_m + (\eta_{hh} - \varepsilon_h) \Delta \log w_h \tag{6}$$

where η_{ij} is the elasticity of labour demand for skill group i with respect to the wage of group j, ε_i indicates the elasticity of labour supply of skill group i and λ_i is a number between zero and one. It is the fraction of output demanded by skill group i, i.e. ($\lambda_i = \frac{L_i D_i(w_i,p)}{Y}$), and it adjusts gross changes in labour supply for net increases in demand for goods produced in local labour markets (Altonji and Card 1991). Suppose that some part of output is consumed locally and another part is exported, and the skill composition of the immigration flow is the same as the skill composition of the existing population, then $\lambda_u = \lambda_m = \lambda_h = \frac{Y_x}{Y}$. If the immigration flow is less skilled, i.e. $\alpha_u > u, \alpha_m < m$ and $\alpha_h < h$, then $\lambda_u > \frac{Y_x}{Y} > \lambda_m > \lambda_h$. If the immigration flow is higher skilled than the existing population, i.e. $\alpha_u < u, \alpha_m > m$ and $\alpha_h > h$, then $\lambda_u < \lambda_m < \frac{Y_x}{Y} < \lambda_h$. The left-hand sides of the equations (4)-(6) indicate the effective proportional increase in the supply of labour for the skill groups as a result of immigration flow.

If the demand for a certain skill group of labour is independent of the wage rate of another skill group, i.e. cross-demand elasticities are zero ($\eta_{ij} = 0, i = u, m, h$ and $i \neq j$), we can rewrite equations (4), (5) and (6) in terms of changes in log wages of each skill group as

$$\Delta \log w_u = \frac{-\lambda_u}{(\varepsilon_u - \eta_{\mathrm{u}\,u})} \left(\frac{\alpha_u}{u} \right) \left(\frac{\Delta I}{L} \right) \tag{7}$$

$$\Delta \log w_m = \frac{-\lambda_m}{(\varepsilon_m - \eta_{mm})} \left(\frac{\alpha_m}{m} \right) \left(\frac{\Delta I}{L} \right) \tag{8}$$

$$\Delta \log w_h = \frac{-\lambda_m}{(\varepsilon_h - \eta_{hh})} \left(\frac{1-\alpha_u-\alpha_m}{1-u-m} \right) \left(\frac{\Delta I}{L} \right) \tag{9}$$

If the skill composition of workers in the immigration flow is equal to the skill composition of workers in the native population, linear homogeneity of the production function implies that relative wages of skill groups will not change as a result of immigration flow. In an alternative case, if workers in the immigration flow are less skilled than the skill composition of the existing population, $\alpha_u > u$, immigration increases the skilled wage and decreases the unskilled wage.

If demand for a certain skill group is related to wages of other skill groups, in addition to its own wage rate, i.e. the cross-elasticities of factor demand differ from zero ($\eta_{ij} = 0$), the reduced-form impact of immigration on the wages follows from solving the equation system (4)-(6) for $logw_u, logw_m$ and $logw_h$.

$$\Delta \log w_u = B - \frac{1}{\eta_{mu}} \left(A \left(\frac{\left(\frac{(K \alpha_m \eta_{hu} \lambda_m)}{m} - \frac{(K(-\alpha_u - \alpha_m + 1)\eta_{mu}\lambda_h)}{(-u-m+1)} \right)}{(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm}))} \right) - \frac{C}{D} \right) \tag{10}$$

where
$A = (\epsilon_m - \eta_{mm})$
$B = \frac{(K\alpha_m\lambda_m)/(m\eta_{mu}) + (\eta_{mh}(b - (\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{uu})(\epsilon_m - \eta_{mm})))b_1)}{(\eta_{mu}(((\epsilon_u - \eta_{uu})\eta_{mh} + \eta_{uh}\eta_{mu})(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_u - \eta_{uu})(\epsilon_m - \eta_{mm}))))}$
where

$$b = (\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm})) \begin{pmatrix} -(K\alpha_u\eta_{mu}\lambda_u)/u \\ -(K\alpha_m(\epsilon_u - \eta_{uu})\lambda_m)/m \end{pmatrix}$$

$$b_1 = \left(\frac{(K\alpha_m\eta_{hu}\lambda_m)}{m} - \frac{(K(-\alpha_u - \alpha_m + 1)\eta_{mu}\lambda_h)}{(-u - m + 1)}\right)$$

$$C = \left(c \begin{pmatrix} c_1(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm}))c_2 \\ -(\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{uu})(\epsilon_m - \eta_{mm}))c_3 \end{pmatrix}\right)$$

where

$$c = (-\eta_{hu}\eta_{mh} - (\epsilon_h - \eta_{hh})\eta_{mu})$$
$$c_1 = (-\eta_{hu}\eta_{mh} - (\epsilon_h - \eta_{hh})\eta_{mu})$$
$$c_2 = (-(K\alpha_u\eta_{mu}\lambda_u)/u - (K\alpha_m(\epsilon_u - \eta_{uu})\lambda_m)/m)$$
$$c_3 = \left(\frac{(K\alpha_m\eta_{hu}\lambda_m)}{m} - \frac{(K(-\alpha_u - \alpha_m + 1)\eta_{mu}\lambda_h)}{(-u - m + 1)}\right)$$

$$D = \begin{pmatrix} (d(\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{\mathrm{u}\,u})(\epsilon_m - \eta_{mm}))) \\ (\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm})) \end{pmatrix}$$

where

$$d = ((\epsilon_u - \eta_{uu})\eta_{mh} + \eta_{uh}\eta_{mu})(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm})) - (-\eta_{hu}\eta_{mh} - (\epsilon_h - \eta_{hh})\eta_{mu})$$

$$\Delta \log w_m = \frac{(E((\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm}))F - MG))}{(H(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm})))} - N \tag{11}$$

where
$E = (-\eta_{hu}\eta_{mh} - (\epsilon_h - \eta_{hh})\eta_{mu})$
$F = \left(-\frac{(K\alpha_u\eta_{mu}\lambda_u)}{u} - \frac{(K\alpha_m(\epsilon_u - \eta_{uu})\lambda_m)}{m}\right)$
$M = (\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{\mathrm{u}\,u})(\epsilon_m - \eta_{mm}))$
$G = \left(\frac{(K\alpha_m\eta_{hu}\lambda_m)}{m} - \frac{(K(-\alpha_u - \alpha_m + 1)\eta_{mu}\lambda_h)}{(-u - m + 1)}\right)$
$H = ((\epsilon_u - \eta_{uu})\eta_{mh} + \eta_{uh}\eta_{mu})(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_u - \eta_{uu})(\epsilon_m - \eta_{mm})) - (-\eta_{hu}\eta_{mh} - (\epsilon_h - \eta_{hh})\eta_{mu})(\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{\mathrm{u}\,u})(\epsilon_m - \eta_{mm}))$
$N = \frac{((K\alpha_m\eta_{hu}\lambda_m)/m - (K(-\alpha_u - \alpha_m + 1)\eta_{mu}\lambda_h)/(-u - m + 1))}{(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm}))}$

$$\Delta \log w_h = \left(J - \frac{Y\left(\frac{(K\alpha_m\eta_{hu}\lambda_m)}{m} - \frac{(K(-\alpha_u - \alpha_m + 1)\eta_{mu}\lambda_h)}{(-u - m + 1)}\right)}{(Z - (-\eta_{hu}\eta_{mh} - (\epsilon_h - \eta_{hh})\eta_{mu})X)}\right) \tag{12}$$

where
$J = (\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm}))\left(-\frac{(K\alpha_u\eta_{mu}\lambda_u)}{u} - \frac{(K\alpha_m(\epsilon_u - \eta_{uu})\lambda_m)}{m}\right)$
$Y = (\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{uu})(\epsilon_m - \eta_{mm}))$
$X = (\eta_{um}\eta_{mu} - (\epsilon_u - \eta_{\mathrm{u}\,u})(\epsilon_m - \eta_{mm}))$
$Z = ((\epsilon_u - \eta_{uu})\eta_{mh} + \eta_{uh}\eta_{mu})(\eta_{hm}\eta_{mu} + \eta_{hu}(\epsilon_m - \eta_{mm}))$

3 Ethnic minorities

On the basis of their social- economic position, we deal with ethnic minority groups as two major categories: people from EU-countries are defined as one category, '*EU*' and people from other countries are defined as another category, '*non-EU*'.

Immigration from current EU countries started with the recruitment of guest workers from Italy, Greece, Spain and Portugal in the earlier 1960's when these countries, except Italy, were not yet a member of the (then) European Economic Community. After the seventies, immigration from these recruitment countries has continuously decreased and a large share of guest workers has returned with advancing integration of EU countries. Immigration from other EU countries has gradually increased after the 1960s (Penninx et al. 1994) and has taken up the largest share in immigration flows in the 1990s. Immigrants from EU countries are more likely to be white-collar and highly qualified than blue-collar and poorly qualified (Ode 1996). Main groups are Germans, Belgians and British. The composition of labour force and labour market position of these groups show similar patterns as the native Dutch. In fact, they may even have a better labour market position than the native Dutch.

On the other hand, people in the second category, are from

1. former Dutch colonies such as Surinam, Indonesia and from Dutch Antilles
2. Mediterranean countries that provided guest workers in the sixties such as Turkey, Morocco
3. Eastern European countries and other developing countries that have become more important as a source of especially political refugees in the nineties.
4. the rest of the world

This category has generally a disadvantaged position in the Dutch labour market that is correlated with their immigration history. Most of the people from former colonies immigrated after the colonies became independent. People from Mediterranean countries were recruited as guest workers for unskilled jobs. Indonesian people immigrated right after WW II and have somehow a better labour market position. Therefore, they are not reported in statistics. The share of working permits issued to people from industrialised countries in the total permits increased from 16,2 percent to 39.8 percent between 1979-1992 while the share of working permits issued to the immigrants from ex-colonies, Turkey, Morocco, Algeria and Tunisia decreased from 62 percent to 8.1 percent in the same period[1].

Table 1 indicates relevant characteristics of ethnic minorities from the second category. One can easily observe that the ethnic minorities strongly differ from the native Dutch people. They are younger, less educated, more frequently unemployed, more concentrated in large cities and their participation rate is considerably lower, compared to the native Dutch population. In the rest of this paper, we assume that labour supply from category '*non-EU*' is low skilled while labour supply from '*EU countries*' category is higher skilled.

[1]Penninx et al. (1994) give a comprehensive description of post-war immigration to the Netherlands.

Table 1. Population and labour force by nationality, age and education level in the Netherlands 1995/1997

	native Dutch	non-native dutch							total
		Total	Target groups						
			total	Turks	Moro	Suri	An/A	others	
Total Population x1000									
Populat. 15-64	9410	1120	573	143	110	182	45	94	10530
Labour force	6080	626	307	63	47	116	26	54	6705
employed	5703	514	241	47	34	97	21	43	6217
unemployed	377	112	66	17	13	19	5	11	488
Non-lab. force	3330	495	267	79	63	65	18	40	3825
Participation rate	%								
gross	65	56	53	44	42	64	59	57	64
net	61	46	42	33	30	53	47	46	59
Age									
15-24	13	12	15	19	23	12	12	11	13
25-44	59	63	67	70	62	69	65	67	59
45-64	28	25	18	11	15	19	23	22	28
Education level	%								
bao	7	19	29	46	49	18	12	22	8
ibo/mavo	22	23	27	25	23	29	31	26	22
mbo/havo/vwo	46	35	31	23	22	37	34	35	45
hbo/wo	25	23	13	6	6	16	23	17	25
Registered unemployment	%								
4 large cities	8	23	25	46	27	17	42	20	12
$\geqq$100000 inhabs	6	19	23	31	30	14	23	20	8
$<$100000 inhabs	5	14	20	31	22	10	17	20	6
Total	5	18	23	36	25	15	27	20	6

Bao: primary education. ibo/mavo: extended primary education. Mbo/havo/vwo: secondary education. hbo/wo: higher education. Bao/ibo/mavo is described as low skilled. Mbo/havo/vwo is described as medium skilled. Hbo/wo is described as high skilled. Gross participation rate indicates the proportion of labour force, which is employed or seek a job for minimal 12 hours per week and Net participation represents the percentage of labour force which is employed.

Source: CBS

Table 2 shows that ethnic minorities are concentrated in certain regions/cities. The standard deviations indicate that the concentration of ethnic minorities from non-EU countries is higher compared to immigrants from EU-countries. They are especially concentrated in large cities. Immigrants from non-EU countries compose an average of 13,5 percent of population in large cities. This percentage is 6 in semi-large cities and 2.6 in small cities. On the other hand, ethnic minorities from industrialised countries are more spread over the Netherlands. Surinamese and Moroccan people are more concentrated while the concentrations of Indonesian and Turkish people are relatively small.

Since ethnic minorities are concentrated in certain areas, the potential effect of immigration may be correspondingly concentrated in these local labour markets. In that sense, geographical distribution of skills gains more importance in explaining the effect of immigrants on the local labour market.

Table 2 Means of population in 548 Dutch municipalities by country of origin (of parents), 1998.

Absolute	N	Mean	Std. D.	Min.	Max.
EU countries	548	556.4	1676.32	0	28105
Belgian	548	71.0	198.73	0	2045
German[1]	548	239.5	652.98	0	8230
English	548	78.13	306.16	0	5725
Non-EU countries	548	2362	13022.4	0	215020
Turkish	548	509.7	2480.00	0	36770
Moroccan[2]	548	425.6	2688.49	0	49445
Surinamese	548	468.5	3807.75	0	64855
Antillian	548	129.3	704.33	0	11460
Others	548	828.9	3660.41	0	60950
Indonesian[3]	548	392.1	1046.83	0	14780
Total non-native pop.	548	3313.9	15516.2	0	257905
TOTAL POPULATION	548	28537	51034	1000	717304
Fractions					
EU countries	548	.01650	.02294	0	.36487
in large cities[4]	25	1.31e-7	6.00e-8	4.37e-8	3.05e-7
in semi-large cities[5]	195	4.96e-7	4.72e-7	0	3.24e-6
in small cities[6]	328	1.84e-6	3.45e-6	6.54e-8	.000034
Non-EU countries	548	.044232	.039750	0	.320366
% in large cities	25	.135745	.071842	.038056	.320366
% in semi-large cities	195	.061556	.036668	0	.195356
% in small cities	328	.026958	.018657	0	.144840

1) Germany including Germany before 1949; German Democratic Republic and Saarland.

2) Morocco including French Morocco, Ifni, Spanish Morocco, Spanish Shara, and Western Shara.

3) Indonesia including former Dutch East-Indies, former Dutch New-Guinea and Portuguese Timor.

4) Large cities: city population >100 000

5) Semi-large cities: 100 000 <city population >10 000

6) Small cities: city population < 10 000

Source: calculated on basis of CBS population statistics, 1998

4 Data and Estimation

The data is taken from a questionnaire included in 20 local newspapers on Saturday, January 17, 1998 and hypothetically came in the hands of 1.7 million households in the whole country[2]. Unfortunately, Amsterdam is excluded. Very few responses are obtained from ethnic minority groups. From population statistics gathered by the Dutch Central Bureau for Statistics (CBS) for 1998. we used the number of residents in 548 municipalities by ethnicity. For ethnic minorities, a narrow definition is used: first and second generation (anyone belongs to an ethnic group if s/he is born in the country of origin mentioned, and if s/he has a mother who was born abroad.).

We extend the standard Mincer earnings equation by adding the fraction of ethnic minorities in the respondent's residential area.

$$\ln w_i = \alpha_0 + \alpha_1 EXP_i + \alpha_2 EXP^2 + \beta \mathbf{X}_i + \gamma_1 NONEU_i + \gamma_2 EU + \varepsilon_i \quad (13)$$

Where w is logarithm of weekly earnings, EXP is experience and, X covers a vector of individual characteristics (like age, tenure, working hours) and control variables (like function, form of employment), and other relevant socio-economic characteristics. The percentages of ethnic minorities from EU and from non-EU are separately included.

Experience is calculated based on the year that an individual really started to work. We estimated the model separately for three skill levels: low, medium and high using the Stata package.

Low skill involves primary and extended primary education (in Dutch; BO, ULO, UBO, ITS and huishoudschool). *Medium skill* level covers secondary (vocational) education (in Dutch; HVO, MMS, HBS, gymnasium, MBO and VWO). *High skill level* is defined as higher vocational and university education.

The results of estimations are presented in Table 3. We apply a heteroskedasticity-consistent estimation technique, Newey and West's method. Estimations of the earnings function provide expected results for tenure, working hours, experience, experience squared and gender dummy. Those are all significant at the 5 percent level for the three skill levels. The coefficient of Age is significant at the 10 percent level for the low skilled and is not significant for the medium skilled labour. Presence of immigrants from EU countries has a positive effect on low skilled natives and a negative effect on medium and high skilled natives. However, none of the coefficients is significant. The estimated coefficients clearly show that the concentration of people from non-EU countries has a significant negative effect on the wages of low skilled workers and a significant positive effect on the wages of high skilled native workers. The coefficient for medium skilled workers is not significant. These outcomes can be expressed in terms of the figures in Table 3 as follows: a 1 percent increase in the percentage of ethnic minorities from non-EU countries decreases the earnings of low skilled workers

[2]We are grateful to Professor Bernard van Praag and SEO-Amsterdam for allowing us to use these data

by 37.23% and increases the earnings of high skilled workers by 23.14%. These results imply that immigrants from non-EU countries are substitutes for the low skilled and complements with the high skilled native Dutch workers while people from EU-countries are close to complementary to low skilled and close to substitutes for high skilled native Dutch workers. Medium skilled natives are weak complements for all non-natives. The signs of these effects are quite plausible, but the magnitude of true effect of low-skilled non-EU immigrants is very large and needs further research. Given all the controls in the earnings equations, we have no obvious candidate to explain this very large sensitivities.

Table 3. Estimates of logarithmic weekly wages for low, medium and high skilled labour, Netherlands, 1998.

	low skilled		medium skilled		high skilled	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Constant	5.244	37.00	5.396	48.36	5.305	56.671
Age	.0083	1.88	.0036	1.66	.0124	4.83
Tenure	.0073	5.66	.0074	6.80	.0045	4.32
Working hours	.0137	7.78	.0159	11.36	.0121	10.04
Experience	.0223	4.36	.0155	3.98	.0224	6.61
Experience^2	-.0005	6.39	-.003	-3.69	-.0006	-7.41
D-single	.0153	0.50	-.0421	-2.28	-.0360	-1.86
D-female	-.2384	-7.01	-.1662	-7.88	-.1705	-9.74
D-full-time	.1514	2.80	.2298	4.60	.3440	5.92
D-irregular	-.3266	-4.25	-.0342	-0.66	-.1128	-1.97
D-part-time	-.1223	-1.89	-.0536	-1.04	.0855	1.49
D-in education	-.0103	-0.11	-.0386	-0.52	-.0727	-1.69
D-unskilled worker	-.0561	-0.72	-.1257	-0.80	-.2803	-1.87
D-skilled worker	.0431	0.69	-.0269	-0.44	.0363	0.42
D-low employee	.0063	0.09	-.1244	-1.63	-.3744	-3.52
D-medium employee	.1431	2.34	.6467	1.09	.0379	0.89
D-high employee	.3152	4.21	.2374	3.86	.1857	4.42
D-low official	.0208	0.30	.0799	1.02	-.1301	-1.55
D-medium official	.1636	2.55	.1088	1.73	.0886	2.12
D-high official	.2168	1.73	.3512	4.53	.2088	4.74
D-starting entrepreneur	.4430	1.55	-.1215	-0.87	-.1011	-0.60
D-retail trade	.0377	0.34	.0966	1.14	.0692	0.32
D-manager/owner company	.3080	2.41	.3198	3.88	.2328	2.85
D-manager employee	.6655	5.84	.4274	3.39	.3423	6.42
D-student	.0102	0.09	-.3380	-1.99	-.5790	-4.37
D-private sector	-.0105	-0.35	.0236	1.18	.0568	2.73
D-large city (>100 000)	.0324	1.19	.0079	0.42	.0038	0.22
D-small city (<20 000)	-.0018	-0.06	-.0079	-0.40	.0086	0.44
% EU	.6995	0.65	-.0063	-0.02	-.8743	-1.37
% non-EU	-.3723	-2.26	-.0584	-0.50	.2314	2.010
R^2	0.45		0.51		0.47	
N	1682		2809		3424	

Variables beginning with initial D are all dummy variables. For instance, D-single =1 if single and dummy =0 if otherwise.

D-gender=1 if female and D-gender =0 if otherwise.

5 Estimation of elasticities of complementarity

In order to understand how the three-types of labour interact with each other, we estimate the degree of substitutability or complementarity among low, medium and high skilled labour. Grant and Hamermesh (1981) argue that a production function approximation rather than the cost function provides better results because factor quantities are more likely viewed as exogenous than factor prices. Therefore, we prefer the production function approach.

Suppose that an economy produces Y units of goods using as before three-types labour:

$$Y = F\left(L_u, L_m, L_h\right) \tag{14}$$

We assume that production function satisfies standard neo-classical assumptions so that firms in the factor markets are price takers and production factors are awarded equally their marginal productivity.

$$\frac{\partial Y}{\partial L_i} = w_i \ , \quad i = u, m.h \tag{15}$$

Goods are produced by a transcendental logarithmic (translog) production technology (see Christensen et al. (1973), Grant and Hamermesh (1981), Grossman (1982), and Gang and Rivera-Batiz (1994).

$$\ln Y = \ln \alpha_0 + \sum_i \alpha_i \ln L_i + \frac{1}{2} \sum_i \sum_j \beta_{ij} \ln L_i L_j \ , \qquad i = u, m, h \tag{16}$$

The production function is characterised by constant returns to scale which implies that the production function is linearly homogeneous in L, imposing a constraint on the technology parameters $\sum_i \alpha_i = 1$ and $\sum_i \beta_{ij} = 0$

The three factor share equations are derived from the three output elasticity equations, using equation (14).

$$\frac{\partial \ln Y}{\partial \ln L_i} = \frac{\partial Y}{\partial L_i} \frac{L_i}{Y} = \frac{w_i L_i}{Y} = S_i \quad \text{for all } j \tag{17}$$

where w_i is the wage rate and S_i is now the share of input i in the value of output, with $S_u + S_m + S_h = 1$. The factor share equations can be derived from equation (16), imposing linear homogeneity.

$$S_i = \frac{\partial \ln Y}{\partial \ln L_i} = \alpha_i + \sum \beta_{ij} \ln L_j + + u_u \tag{18}$$

where u is the error term. Demand theory requires symmetry which implies cross-equation restrictions $\beta_{ij} = \beta_{ji}$. Since homogeneity is assumed, one of the factor share equations becomes redundant. Because wages of the three skill groups, w_u, w_m and w_h, are estimated by the earning functions, we can estimate the factor share equations, (18). Since perfect competition is assumed,

output may be equal to the sum of income generated by the production factors employed, in this case $Y = \sum_i w_i L_i$. Then we may construct the factor share equations as follows:

$$S_i = \frac{w_i L_i}{\sum_i w_i L_i} \tag{19}$$

By choice of production function instead of the cost function, we assumed that factor quantities are exogenous, rather than factor prices. Therefore, the Hicks partial elasticities of complimentarity are appropriate measures of factor substitutability. The Hicks partial elasticity of complementarity between factors L_i and L_j, η_{ij}, is defined as the proportional change in factor price i as a result of exogenous changes in factor j's supply, holding the output price and other input quantities constant.

$$\eta_{ij} = \frac{FF_{ij}}{F_i F_j} \tag{20}$$

where F_i is the first derivative of the production function F with respect to factor i, i.e. $F_i = \frac{\partial F}{\partial L_i}$. and F_{ij} is the second derivative of the production function F, i.e. $F_{ij} = \frac{\partial^2 F}{\partial L_i \partial L_j}$

In terms of the translog share equations, the Hicks partial elasticity of complementarity is given by (Hamermesh 1986)[3] :

$$\eta_{ij} = \frac{d\left(\ln w_i\right)}{d\left(\ln L_j\right)} = \frac{\left(\beta_{ij} + S_i S_j\right)}{S_i} \tag{21}$$

$$\eta_{ii} = \frac{d\left(\ln w_i\right)}{d\left(\ln L_i\right)} = \frac{\left(\beta_{ij} + S_i^2 - S_i\right)}{S_i} \tag{22}$$

If an increase in input j raises the price of i, i.e. $\eta_{ij} > 0$, factors i and j are complements. If an increase in input j decreases price of i, i.e. $\eta_{ij} < 0$, factors i and j are substitutes.

Estimation procedure of elasticities of complementarity is as follows. Firstly, mean wages and factor shares are calculated for 46 municipalities per skill category. This is done on the basis of wages predicted from the results in Table 3 and aggregating to 46 geographical areas to get a sufficient minimum number of observations per region. Then, a new sample is created including mean wages and employment level for each of these 46 municipalities. Finally, the system of the factor share equations (18) is estimated. We apply Zellner's seemingly unrelated regression technique to take into account possible correlation among the error terms, u_u, u_m and u_h. Because cross-section restrictions are imposed on the model, the factor share equations of low and high skilled labour are estimated. The medium skilled share equation is deleted for estimation. The estimated technology coefficients of factor share equations are presented in table

[3]The relationship between the complementary and substitution elasticities is demonstrated by Sato and Koizumi (1973)

4. Almost all coefficients are highly significant, except the coefficient indicating technology between low and medium skilled labour, β_{um}.

Table 4. Translog coefficients for the production function

	Coefficient	Std. Error	t-statistic
α_u	0.1822	0.019	9.53
α_m	0.3449	0.016	21.21
α_h	0.4729	0.020	23.46
$\beta_{\mathrm{u}\,u}$	0.1083	0.013	8.04
β_{um}	-0.0024	0.018	-0.13
β_{uh}	-0.0892	0.015	-6.07
β_{mm}	-0.2052	0.015	13.43
β_{hm}	-0.2028	0.019	-10.71
β_{hh}	0.2543	0.015	16.40
	equation 19	equation 21	
R^2	0.68	0.86	
N	46	46	

On the basis of the technology coefficients and mean values of each factor in production, partial elasticities of complementarity are calculated using equations (21) and (22), and reported in Table 5. As expected, the own-price elasticities for low and medium skilled labour are negative but the own-price elasticity of high skilled labour is surprisingly positive although very low. This implies that a possible increase in high skilled labour supply has no negative effect on high skilled wages. The cross-elasticities among the three-type labour show both substitution and complementarity relationships. Low skilled labour seems to be substitute for high skilled labour and complementary to medium skilled labour. Medium and high skilled labour are substitutes.

Table 5. Partial elasticities of factor complementarity

	With respect to quantity of		
wage of	L_u	L_m	L_h
w_u	-0.2184	0.3167	-0.0053
w_m		-0.0482	-0.0838
w_h			0.0090
Average factor shares			
	0.18	0.33	0.49

These results are generally in line with economic theory except the positive own elasticity for high skilled labour. They confirm in some degree the earlier empirical work on the Dutch labour market conducted in the last decade. Broer and Jansen (1989) estimate small substitution elasticity between high skilled labour and other production factors using time series data. They also find strong substitution elasticity between low skilled labour and capital, but low substitution elasticity between low skilled labour and high skilled labour. Hebbink (1991) uses cross-section data covering two years and finds that high skilled labour and capital are complementary, just as low and medium skilled

labour. The recent study of Draper and Manders (1997) reports a strong substitutability between low and high skilled labour in the sheltered sector and low substitution elasticity in the market sector with modest substitution elasticity between low skilled labour and capital. Our estimates are quite low compared to these studies. One possible reason may be the lack of production factor capital in our the production function. We implicitly assume that capital and other production factors are strongly separable. We ignore thus a possible shift of demand towards capital as a result of an increase in the price of one of the production factors.

Table 6 presents the price elasticities among the three types of labour. In terms of figures, one percent increase in the supply of low educated labour may reduce the wages of this category of labour by roughly 0.04 percent. Straightforwardly, a one percent increase in medium skilled labour supply leads to a circa 0,02 percent decrease in the wages of medium skilled while the same increase in the supply of high skilled labour increases high skilled wages by about 0.04 percent. Concerning cross-elasticities, one percent increase in the supply of low skilled labour increases medium skilled wages by 0.05 percent and decreases high skilled wages by 0,01 percent (first column). One percent increase in the supply of medium skilled labour increases the wages of low skilled labour by 10 percent and decreases the wages of high skilled workers by 0,02 percent (second column). The last column shows that one percent increase in the supply of high skilled labour decreases the wages of low skilled labour by roughly 0.03 percent and also decreases the wages of medium skilled workers by 0,04 percent.

Table 6. Own- and cross wage elasticities*

	With respect to quantity of		
change in the wage of	L_u	L_m	L_h
w_u	-0.039	0.1045	-0.0026
w_m	0.057	-0.0159	-0.0411
w_h	-0.001	-0.0277	0.0044

* The elasticities are calculated on basis of Table 6 using the formula for the price elasticity $\frac{d(\log w_i)}{d(\log L_i)} = S_i \eta_{ij}$

5.1 Three scenarios

In the previous part of this paper, we have created enough instruments to identify the effect of immigration on the Dutch labour market using equations (10), (11) and (12) provided we assume some arbitrary values to develop three scenarios for the Netherlands. We calculate changes in wages of the skill groups as a result of increasing immigration. In addition to the own- and cross-elasticities from Table 7, we assume supply elasticities of labour, ε_i, be 0.70, 0.75 and 0.80 for low, medium and high skilled labour respectively. The composition of immigrant labour, α_i, and the fraction of output demanded by the three skill groups, λ_i, are assumed to be different for the scenarios. The percentage of production demanded by the low skilled labour is assumed to be lower than the share of

this skill group in the immigration flow, i.e. $\lambda_u < \alpha_u$ while that is accounted for $\lambda_h > \alpha_h$, because high skilled workers earn relatively high. They may consume relatively more while the other way around may be true for low skilled workers.

Suppose that immigration flow occurs in the magnitude of 5% of the total Dutch population. Additionally we assume that the labour supply behavior of newly entering immigrants is identical to that of natives. Discrimination on any basis does not exist. Then we imagine three scenarios. In the first scenario, 75 percent of immigrant flow is low skilled, 20 percent is medium skilled and only 5% is high skilled. We assume also that the new immigrant population may not generate an enough proportional demand for goods produced but 25% of output is exported, so that $\lambda_u > (Y_x/Y) > \lambda_m > \lambda_h$. This scenario is called *recruitment policy*.

In scenario II, skill composition of immigrants is exactly the same as the skill composition of the Dutch labour force and 25 percent of output is exported, $\lambda_u = (Y_x/Y) = \lambda_m = \lambda_h$. This scenario is called *balanced immigration* policy, which may be associated with an increasing labour mobility within the European Union, since skill composition of labour force may be similar among the EU-countries.

In scenario III, we assume that government policy is designed to allow only high skilled immigrants, so that only a small portion of immigrants is low skilled, 10%. Further, immigrants generate demand for goods or export increases so that product markets may not form a constraint for employment, i.e. $\lambda_u < \lambda_m < (Y_x/Y) < \lambda_h$. This scenario is called *selective immigration policy*.

Table 7 shows the effect of the 5 percent increase of labour supply by immigration on the logarithmic wages of the skill groups. Notice that the effect of immigration on the wages of the natives from the skill groups is determined by the skill distribution of the immigration flow. If immigrants are less skilled than the natives as suggested by the first scenario, immigration has a large negative effect on the wages of less skilled workers and a small positive effect on the wages of high skilled workers (first column). If the skill composition of immigrants is the same as the natives, immigration still has a small negative effect on all skill groups, but this effect is relatively small and is distributed equally over the skill groups (second column). As entering immigrants are higher skilled than the natives, immigration hurts especially high skilled workers (the last column).

From our predictions, it is clear that immigration has the largest negative effect on the wages of the skill group which is a close substitute for new immigrants but this effect is small. This result is in line with the predictions of Kuhn and Wooten (1991) who estimate the impact of immigration on the US labour market by a general equilibrium model . In the literature, strong evidence is found that new immigrants are more likely a closer substitute for old immigrants and female workers (Grant and Hamermesh 1981, Grossman 1982, Borjas 1983, 1987). Therefore, the negative effect of immigration flows is captured mainly by immigrants arrived earlier. The effect on natives is negligible. Moreover, immigrants assimilate rapidly in the labour market so that the shock effect of immigration flow is smoothed over years and likely disappears after some time. Altonji and Card (1991) find even a small positive effect of immigration on the

US economy. Unfortunately, the data used does not allow us to estimate substitution elasticities of separate groups of ethnic minorities. We aggregate the labour force on three skill levels and implicitly assume that labour is a homogenous production factor in all skill categories and the labour market behavior of immigrants is similar to natives. A desegregation of each skill category can give more insight to understand the effect of immigration flows.

Table 7. Predicted effect of 5% increase in immigration, $\Delta I/L = 0.05$, on wages of the skill groups.

	Recruitment policy	Balanced imm. policy	Selective imm. policy
	$\alpha_u = .75; \alpha_m = .2;$ $\alpha_h = .05$ $\varepsilon_u = .7; \varepsilon_m = .75;$ $\varepsilon_h = .8$ $\lambda_u = .45; \lambda_m = .2;$	$\alpha_u = .18; \alpha_m = .33;$ $\alpha_h = .49$ $\varepsilon_u = .7; \varepsilon_m = .75;$ $\varepsilon_h = .8$ $\lambda_u = .25; \lambda_m = .25;$	$\alpha_u = .1; \alpha_m = .25;$ $\alpha_h = .65$ $\varepsilon_u = .7; \varepsilon_m = .75;$ $\varepsilon_h = .8$ $\lambda_u = .05; \lambda_m = .2;$
	$\lambda_h = .1$	$\lambda_h = .25$	$\lambda_h = .4$
Log w_u	-0.1293	-0.0193	-0.0048
Log w_m	-0.0175	-0.0170	-0.0083
Log w_h	0.0001	-0.0151	-0.0331

The negative effect on wages predicted refers to a short run outcome of the labour market. In the long run, these effects may even be smaller by two mechanisms. First, the model assumes that the local labour market is perfectly competitive. This means that wages are completely elastic. In the Dutch labour market, this assumption may be violated. Wages in the Netherlands are downwardly inelastic because of the existence of a binding minimum wage level, unemployment benefit and other social security arrangements. In the Dutch context, one might expect that the effect of immigration flows will be mainly on (un-)employment of the existing labour force. The effect on wages might be expected to be smaller than predicted by equations (10)-(12) that

Second, we have implicitly assumed that the existing labour force is immobile between geographical areas. However, the existing labour force in local labour markets may adjust to conditions, which arise after the immigration flow. For instance, if the immigration flow to a certain region is dominated by low skilled workers, one may expect that some of the existing low skilled labour will move to other regions. This internal migration may reduce the effect of immigration flow on wages and employment. Borjas et al. (1997) shows that the native flow to California has been drastically limited by the increasing immigration to this state since 1970.

In the highly regulated Dutch labour market, the effect of immigration flows may be mainly concentrated on employment outcome. Unemployment rate among those who are a close substitute for new immigrants may increase in the formal labour market. Additionally, a growth of informal employment in labour intensive sectors where immigrants are involved may be a reaction. Catering,

cleaning and horticulture are examples for such a phenomenon. Moreover, immigrants act not only as employees, but also as employers in the labour market. They preserve or even re-create some labour intensive sector by their small firms such as grocers and clothing industry which were disappearing in the 1980s (Hartog and Zorlu 1999).

6 Conclusions

This study provides some empirical evidence for the effect of immigrants on the earning of natives, and for the impact of a possible immigration flow. It is shown that the proportion of people from non-EU countries in cities has a positive effect on the earning of the high skilled native workers and a negative effect on wages of the low skilled native workers. The proportion of people from EU countries has a negative effect on the earnings of the high and medium skilled native Dutch labour force and a positive effect on the earnings of the low skilled natives.

Then, elasticities of complementarity are estimated for the three skill categories. Low skilled is a substitute for medium and high skilled workers; medium skilled labour is a substitute for low skilled labour and a compliment of high skilled labour while high skilled seems to be complementary with medium and low skilled labour in production.

It is predicted, assuming the three scenarios, that a possible immigration flow of 5 percent of the existing labour force may cause a small decline in wages of all skill categories. However, this inverse effect is, in general, small and it differs per skill categories in connection with the skill distribution of new immigrants.

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