

The Annals of Regional Science  
<https://doi.org/10.1007/s00168-019-00953-8>

ORIGINAL PAPER



# The incompatibility of local economic prosperity and migrants' social integration: evidence from the Netherlands

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Received: 24 February 2018 / Accepted: 30 October 2019  
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## Abstract

This paper investigates the effects of the conditions of local labour markets on the social networks of immigrants, with an emphasis on co-ethnic contact and contact with people native to the locality. This study focuses on the case of immigrants in the Netherlands. For this case, I derived and empirically tested a job and residential search model. I found that a high job arrival rate and large wage differences between the ethnic labour market and the host labour market both correlate with immigrants developing stronger co-ethnic networks and weaker native networks as well as with immigrants choosing to live in more ethnically concentrated areas. These findings suggest that local economic prosperity does not necessarily beget social integration: in this case study, immigrants spontaneously assimilated less into the host society during a good economic period.

**JEL Classification** R23 · J15 · Z13

## 1 Introduction

Migrants' network composition substantially affects their economic performances (Battisti et al. 2016; Chiswick and Wang 2016; Kanas et al. 2012; Lancee 2010). The first type of social network is developed among the co-ethnic group. Ethnic communities often help new immigrants to settle and find work (Chiswick and Miller 2004; Patacchini and Zenou 2012). However, the immigrant's success in the local labour market is equally dependent on their ability to network with the community native to the area. Native populations often provide immigrants with job information of

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higher quality, as this population is typically very informed and familiar with the local labour market (Iosifides et al. 2007; Kazemipur 2006; Lancee 2012).<sup>1</sup>

In the Netherlands, the discourse on the integration of ethnic minorities has undergone profound changes over the past few decades (Scholten and Holzhacker 2009). The first phase of this discourse emerged in the 1960s when Turks and Moroccans migrated to the Netherlands in large numbers as ‘guest workers’. At this time, Dutch political discourse stressed that it was important for ethnic minorities to build strong social networks among themselves. This discourse discouraged migrants from networking with natives; the administration ultimately hoped that these temporary workers would return to their home countries when their work was complete. The second phase occurred in the 1980s, when Dutch immigration policy allowed for the permanent settlement of ethnic minorities; in this period, local political discourse began to encourage the development of networks between immigrants and natives. After 2000, a third phase emerged. This phase is defined by a discourse that suggested that co-ethnic networks were eroding Dutch national identity. In response to this fear, political discourse became assimilationist (Bruquetas-Callejo et al. 2006; Joppke 2007).

Today, almost all countries with high immigration rates encourage immigrants to integrate into the native population. However, immigrants can sometimes struggle to integrate. As such, scholars are becoming increasingly interested in the underlying mechanisms of social networking in the very early phase of immigration. Individual socio-demographic characteristics such as age (Glaeser et al. 2002), education (Huang et al. 2009; Martinovic et al. 2009), family composition (Roskrugue et al. 2013b), and home ownership (DiPasquale and Glaeser 1999; Roskrugue et al. 2013a) are frequently presented as the determinants of individual social capital accumulation. However, this view overlooks very important meso-level determinants, i.e. the conditions of the local labour market, with only a few exceptions (Roskrugue et al. 2012; Sato and Zenou 2015; Zenou 2015). Moreover, little work has been done on how local labour market conditions determine migrants’ time allocation between co-ethnic networks and native networks. And yet, the growing rate of international migration demands studies that give us deeper knowledge about the nuances of migrant networks.<sup>2</sup> This paper aims to fill this gap in the scholarly archive by responding to the following research questions: how do local labour market conditions impact an immigrant’s social networking? Do immigrants invest more in native networks during good economic conditions?

To answer these questions, I employ a standard job search model with an endogenous network intensity (see e.g. Goel and Lang 2019; Montgomery 1992; Mortensen 1986; Van Den Berg and Van Der Klaauw 2006). To maximise her utility, an immigrant searches for a job and chooses a location of residence at the same time while

<sup>1</sup> There are various terms expressing similar meanings. Take, for example, ‘homophily’ and ‘heterophily’ (Lazarsfeld and Merton 1954), ‘strong ties’ and ‘weak ties’ (Granovetter 1973), ‘bonding’ and ‘bridging’ (Putnam 2000; Woolcock and Narayan 2000), and ‘intragroup interaction’ and ‘intergroup interaction’ (Martí and Zenou 2009).

<sup>2</sup> According to UN statistics, the total number of international migrants in the world has increased by about 100 million over the past 20 years, and the total number is expected to reach 405 million by 2050.

also choosing the optimal allocation of her time between co-ethnic networks and native networks. The comparative statics from the model yield some implications on the relationship between an immigrant's network composition and the conditions of the local labour market. I test these implications using a micro dataset of immigrants in the Netherlands with the aid of regional information from Statistics Netherlands. The first dataset is the Dutch survey 'Sociale Positie en Voorzieningsgebruik Allochtonen' (SPVA), which is a large-scale, cross-sectional survey of the four largest non-Western immigrant groups in the Netherlands: Turks, Moroccans, Surinamese, and Antilleans. It contains rich information on the socio-economic characteristics and social contact frequencies of immigrants. The second dataset is the Centraal Bureau voor de Statistiek (CBS), which provides information about the provincial levels of ethnic concentration and yearly local labour market conditions. I merge these datasets to identify the local labour market conditions in the year of an immigrant's first job search.

I find that local labour market conditions are associated with the degree of migrants' social integration. First, a more buoyant labour market leads to more co-ethnic networking and little native networking as well as the residential choice of more ethnically concentrated areas. It appears that an incompatibility exists between local economic prosperity and migrants' social integration in the sense that immigrants spontaneously assimilate less into host society when the host economy is good. This result implies that when the economy is booming, migrants are more concerned with building an ethnic community and participating in cultural activities than with optimising their job search. However, in economic recessions, the opportunity cost of developing networks is low enough that migrants have an incentive to bridge. Second, a larger wage difference between the ethnic labour market and the host labour market leads to a more co-ethnic networking, less native networking, and the residential choice of more ethnically concentrated areas. At first sight, this conclusion is surprising: shouldn't economic incentive drive immigrants to develop more native networks? I argue that changes in the demands of the labour market may account for these findings. Because the relatively lower wage in the ethnic labour market increases labour demand, co-ethnic networking may offer immigrants a faster and easier return than native networking.

The remainder of the paper is organised as follows: Section 2 presents a theoretical model where comparative statics are derived for labour market conditions and individual characteristics. Section 3 empirically tests the model's implications. The final section provides concluding remarks and discusses avenues for future research.

## 2 A theoretical model

The theoretical framework is based on a standard job search model with an endogenous network intensity. I present a simplistic setting in which immigrants are unemployed at the time of entering the destination country.<sup>3</sup> Upon arrival, immigrants

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<sup>3</sup> It was reported that 58% of immigrants arrive in the Netherlands without having a definite job (Source: SPVA).

make decisions about how much time to spend with co-ethnic people and native people and about where to reside. In considering the conditions of the local labour market, immigrants choose the optimal ethnic concentration level and social interaction level to maximise their utility.

I divide the labour markets for immigrants into an ethnic labour market and a host labour market. This division is analogous to, but not entirely the same as, Reich et al. (1973) and Bulow and Summers (1986)'s dual market segmentation. The ethnic labour market is primarily constituted by elementary jobs. The wages in this market are low, and the positions do not require much effort. In the early years of immigration, many migrant workers specialise in manual labour. Meanwhile, the host labour market is primarily constituted by high-wage jobs and job ladders, and positions that are more intensely predicated on communication-language tasks relative to the ethnic market. Access to the two markets depends on the migrant's social network: the co-ethnic network facilitates the spread of job information in the ethnic labour market, while the native network provides the migrant with information about better job opportunities in the host labour market. The ethnic labour market and the host labour market give different economic incentives for immigrants to develop social networks, and immigrants must allocate time between co-ethnic networks and native networks to maximise their utility. It is important to note that just because a worker accepts a job does not mean that they will hold that position for the long-term. A job may end for some exogenous reason, and the worker may need to search for a job once again.

## 2.1 A job search model

Consider an unemployed immigrant searching for a job. The unemployment benefit is  $b$ . The individual can conduct her employment search by using either her co-ethnic contacts (for the ethnic labour market) or her native contacts (for the host labour market). Every individual allocates her social time between the co-ethnic group and the native group, where the time constraint is normalised to 1. An amount of time  $s$  is devoted to the co-ethnic network, and  $1 - s$  is devoted to the native network. For simplicity, I situate the co-ethnic network as incurring no cost, and the native network as incurring the cost of  $\beta$ . Jobs are offered to the immigrant according to a Poisson process, with rate  $s\alpha_1$  for the ethnic labour market and  $(1 - s)\alpha_2$  for the host labour market. A job offer is characterised by a random draw from contact-specific wage offer distributions,  $F_1$  for the ethnic labour market and  $F_2$  for the host labour market.  $\underline{w}_1$  and  $\bar{w}_1$ , and  $\underline{w}_2$  and  $\bar{w}_2$  are, respectively, the lower bound and upper bound for the two wage distributions. The exogenous layoff rate is  $\delta$  and is the same for both markets.

$e$  refers to the level of ethnic concentration in a residential area. On the one hand, ethnic concentration  $e$  generates a significant psychic benefit for immigrants, and it compensates for the potential wage gap between the ethnic labour market and the host labour market. It yields a psychic benefit  $R(s, e)$ , with  $R_e > 0$ ,  $R_s > 0$ , and  $R_{es} > 0$ . On the other hand, living in an ethnic enclave weakens the efficiency with which an individual can search for higher-paid jobs in the host labour market

because it limits the exposure the migrant has to the natives. Therefore, an efficiency function  $G(e) \in [0, 1]$  is introduced.  $G(0) = 1$  and  $G' < 0$  hold.

An unemployed immigrant who has newly arrived derives utility as follows:

$$\begin{aligned}
 rU = & b + R(s, e) + s\alpha_1 \int_{\underline{w}_1}^{\bar{w}_1} \max[W(w) - U, 0]f_1(w)dw \\
 & + (1 - s)\alpha_2 G(e) \int_{\underline{w}_2}^{\bar{w}_2} \max[W(w) - U, 0]f_2(w)dw - C(s),
 \end{aligned}
 \tag{1}$$

where  $rU$  is the flow value of being unemployed with  $r$  being the interest rate. This equals the instantaneous net pay-off  $b + R(s, e) - C(s)$ , plus the probability  $s\alpha_1$  of accepting a job offer from wage distribution  $F_1(w)$ , and the probability  $(1 - s)\alpha_2 G(e)$  of accepting a job offer from wage distribution  $F_2(w)$ .

Once a job offer is accepted, the worker keeps it until an exogenous separation occurs. The inflow value of being employed at the wage rate  $w$  is:

$$rW(w) = w + R(s, e) - \delta(W(w) - U),
 \tag{2}$$

which equals the sum of the instantaneous net pay-off  $w + R(s, e)$ , minus the expected loss of being laid off. The psychic benefit function  $R(s, e)$  remains. Once the network is developed, it lasts even if the immigrant becomes unemployed, enabling the worker to continue to reap psychic benefits from their network during periods of unemployment.

Equation (1) is simplified to the following maximisation problem with respect to  $s$  and  $e$ :<sup>4</sup>

$$\max_{s,e} rU = b + R(s, e) + \frac{s\alpha_1}{r + \delta} Q_1 + \frac{(1 - s)\alpha_2 \cdot G(e)}{r + \delta} Q_2 - C(s),
 \tag{3}$$

with  $Q_i$  being the surplus function of  $F_i(w)$ :

$$Q_i = \int_{w_r}^{\bar{w}_i} (1 - F_i(w))dw,
 \tag{4}$$

$w_r$  is the reservation wage rate. Note that job offers from the host labour market have a higher surplus than those from the ethnic labour market, i.e.  $Q_2 - Q_1 > 0$ . The reservation wage  $w_r$  should be the same for both markets, as the probability of being laid off ( $\delta$ ) is the same.

The heterogeneity of job arrival rates emerges with the difference in labour demand. If there is a high wage gap between the host labour market and the ethnic labour market, then the ethnic labour market has a relatively higher demand for workers, making jobs in this market more accessible. It is written that

<sup>4</sup> See "Appendix 2" for the derivation.

$\alpha_1 = \alpha \cdot \frac{E(w_2) - E(w_1)}{E(w_1)}$  and  $\alpha_2 = \alpha$ .<sup>5</sup> The term  $\frac{E(w_2) - E(w_1)}{E(w_1)}$  captures the average wage difference between two labour markets.

## 2.2 Solutions and comparative statics

The model has three arguments:  $w_r$ ,  $s$ , and  $e$ . To solve the model, I shall derive the two first-order conditions for  $s$  and  $e$  from Eq. (3), respectively, and use the reservation wage identity (i.e. the immigrant is indifferent about accepting a job offer at a wage rate of  $w_r$  and remaining unemployed).

$$w_r + C(s) - b - \frac{s\alpha_1}{r + \delta} Q_1 - \frac{(1-s)\alpha_2 \cdot G(e)}{r + \delta} Q_2 = 0; \quad (5)$$

$$R_s + \frac{\alpha_1 \cdot Q_1 - \alpha_2 \cdot G(e) \cdot Q_2}{r + \delta} - C' = 0; \quad (6)$$

$$R_e + \frac{(1-s) \cdot G' \cdot \alpha_2 \cdot Q_2}{r + \delta} = 0. \quad (7)$$

I implement a numerical simulation to analyse the comparative statics from the interior solution of the model.<sup>6</sup> Given feasible ranges for all parameters, the comparative statics show that the optimal solutions  $w_r^*$ ,  $s^*$ , and  $e^*$  vary with other parameters, especially those describing the labour market conditions. To achieve this, I assign specific functional forms and calibrate all parameters with appropriate values.

First, I choose specific forms for the various functions in the model. An unemployed individual samples one independently and identically distributed (i.i.d.) offer each period from a known distribution  $F_i$ . The wage offer density function is chosen as the following functional form (Van Den Berg 1990):  $f_i(w) = \frac{1}{w} \cdot \frac{1}{\log(\bar{w}_i/w_i)}$  for  $w$  in  $[w_i, \bar{w}_i]$ , with  $\bar{w}_i$  being the upper bound, and  $w_i$  being the lower bound of its corresponding wage offer distribution. The psychic benefit function is written as  $R(s, e) = b \cdot s \cdot e^{(1+\sigma)}$ .  $\sigma \in [0, 1]$  proxies individual preference for residing in ethnically concentrated areas.<sup>7</sup> The higher  $\sigma$  is, the more compensated she is by ethnic concentration. The unemployment benefit  $b$  is used as an adjustment term to

<sup>5</sup> In mathematical terms,  $E(w_i) = \int_{w_i}^{\bar{w}_i} w dF_i(w)$ .

<sup>6</sup> There are also two corner solutions to the model: (1)  $s^* = 0$ ,  $e^* = 0$ , and (2)  $s^* = 1$ ,  $e^* = 1$ . The first equilibrium is stable only if  $\beta < \frac{\alpha_2 Q_2 - \alpha_1 Q_1}{2b(r+\delta)}$ . This implies that when the cost of developing native networks is small, the immigrant no longer requires co-ethnic contact. The economic benefit from job offers in the host labour market is much higher than the psychic benefit from living in an ethnic enclave. The second equilibrium is always stable. This scenario situates the immigrant as communicating only with her co-ethnic group, i.e. as not communicating with natives at all. The marginal benefit of  $s$  and  $e$  is always higher than the marginal cost.

<sup>7</sup> In the highly influential works of Schelling (1969, 1971), the residential composition preference is singled out as a critical factor in explaining persistent segregation. I incorporated the Schelling-type residential preference in the search model for individual sorting.

monetise the psychic benefit. The higher  $b$  is, the more satisfaction she gets from an ethnically concentrated area. The efficiency function is written as  $G(e) = (1 - e)^2$ , which satisfies  $G' < 0$ . Lastly, the cost function is written as  $C(s) = b \cdot \beta(1 - s)^2$ . Like the psychic benefit function, the unemployment benefit  $b$  is also used as an adjustment term to monetise the cost of developing native networks.

Second, I calibrate all labour market parameters using Dutch labour market facts from the year 1994 (as reported by CBS). A quarter is used as the time unit. The CPI adjusted unemployment benefit per quarter is 2234 euros, and this is set to be the value for  $b$ .<sup>8</sup> By assumption, the exogenous job separation is the only reason for unemployment. The inflow rate of the unemployed per quarter is 7%, and this is set to be the value for  $\delta$ . Wage distribution in the ethnic labour market was determined by those sectors most likely to hire foreign-born workers, namely: (1) industry and energy and (2) trade, transport, hotels, and restaurants. The lower bound of the wage is 2973 euros per quarter, and the higher bound of the wage is 4200 euros per quarter. Wage distribution in the host labour market was determined by those sectors most likely to hire native workers, namely: (1) information and communication; (2) financial services; (3) rental and commercial property; (4) business services; (5) government and care; and (6) culture, recreation, and other services. The lower bound of the wage is 3699 euros per quarter, and the highest bound of the wage is 5148 euros per quarter. Therefore  $\underline{w}_1 = 2973$ ,  $\bar{w}_1 = 4200$ ,  $\underline{w}_2 = 3699$ , and  $\bar{w}_2 = 5148$ . The yearly long-term interest rate is 7.2%, and the corresponding quarterly rate is calculated as 1.8%<sup>9</sup> (Van Der Bie and Smits 2001). Therefore  $r$  is set to be 0.018. The value for  $\alpha$  is calculated from the hazard rate  $\alpha[1 - F(w_r)]$ . The average period of a job search is 2.97 quarters, making the hazard rate of  $1/2.97 = 0.337$ . Solving the hazard rate function, Eqs. (5), (6), and (7) together yield the solution 0.5 for  $\alpha$ . The calibration of all parameters is shown in Table 1.

Each time, one parameter varies within the range of simulation in Table 1, with all other parameters fixed at their initial values. The comparative statics of social integration indicators  $s^*$  and  $e^*$ , with respect to all the labour market parameters, are summarised in Table 2.

This table implies that co-ethnic networking unambiguously: (1) rises with the job arrival rate,  $\alpha$ ; (2) declines with the layoff rate,  $\delta$ ; (3) declines with wage offered in the ethnic labour market,  $\underline{w}_1$  and  $\bar{w}_1$ ; and (4) rises with wage offered in the host labour market,  $\underline{w}_2$  and  $\bar{w}_2$ . It also implies that the probability a migrant will choose to live in an ethnically concentrated area unambiguously: (1) rises with the job arrival rate,  $\alpha$ ; (2) declines with the layoff rate,  $\delta$ ; and (3) rises with wage offered in the host labour market,  $\underline{w}_2$  and  $\bar{w}_2$ .

<sup>8</sup> Although an immigrant who has just arrived at the destination country may not be eligible for unemployment benefits, it is likely that she does have some monetary sources such as family remittances or savings. The value of this parameter here is simply a proxy for this amount of money during unemployment.

<sup>9</sup> The compound interest formula  $(1 + r)^4 = 0.072$  is used here.

**Table 1** Calibration of parameters

Parameters	Definitions	Calibration from CBS	Values
$b$	Unemployment benefit	CPI adjusted unemployment benefit per quarter	2234
$\alpha$	Baseline job arrival rate	Calculated from hazard rate function	0.5
$\delta$	Layoff rate	Inflow rate of the unemployed per quarter	0.07
$r$	Interest rate	Quarterly interest rate	0.018
$\underline{w}_1, \bar{w}_1$	Lower and upper bounds of wage offer distribution in the ethnic labour market	Wage distribution from the following sectors: (1) industry and energy; and (2) trade, transport, hotels, and restaurants.	(2973, 4200)
$\underline{w}_2, \bar{w}_2$	Lower and upper bounds of wage offer distribution in the host labour market	Wage distribution from the following sectors: (1) information and communication; (2) financial services; (3) rental and commercial property; (4) business services; (5) government and care; and (6) culture, recreation, and other services.	(3699, 5148)
$\beta$	Cost of developing native networks	NA	(0, 1)
$\sigma$	Residential preference parameter for ethnic concentration	NA	(0, 1)



**Table 2** The comparative statics of  $s^*$  and  $e^*$

Parameters	$\alpha$	$\delta$	$\underline{w}_1$	$\bar{w}_1$	$\underline{w}_2$	$\bar{w}_2$
$s^*$	+	-	-	-	+	+
$e^*$	+	-	-	+	+	+

### 2.3 Hypotheses derived from the model

I derive some testable hypotheses with regard to local labour market conditions. Here I stick to the assumption that the labour market conditions are exogenous factors to migrants, in particular at the moment upon arrival. Migrants accept the labour market conditions as given and decide how they build up their social networks and choose where to live.<sup>10</sup>

When the overall labour market is strong and promising due to an exogenous positive demand shock (high  $\alpha$  and low  $\delta$ ), immigrants are able to get a job from their friends or acquaintances from the same country of origin relatively easily compared with networking with the native population. This suggests that *a higher job arrival rate or a lower job destruction rate leads to more co-ethnic networking and less native networking* ( $H_1$ ); and *a higher job arrival rate or a lower job destruction rate correlates with the immigrant choosing to reside in more ethnically concentrated areas* ( $H_2$ ).

The average wage difference between the ethnic labour market and the host labour market (embodied, respectively, in  $\underline{w}_1$  and  $\bar{w}_1$ , and  $\underline{w}_2$  and  $\bar{w}_2$ ) also impacts the migrant's choice of social network and residence. A large difference in wages leads to differences in labour demand in the ethnic market and the host market and ultimately makes jobs in the ethnic labour market more accessible. As such, an incentive emerges for immigrants to focus their search more in the ethnic labour market. In addition, because a large difference in wage is usually accompanied by wage discrimination, such a difference further drives immigrants to cluster together. From these findings, the following hypotheses are derived: *A higher average wage difference between the ethnic labour market and the host labour market leads to more co-ethnic networking and less native networking* ( $H_3$ ); and *a higher average wage difference between the ethnic labour market and the host labour market encourages migrants to reside in more ethnically concentrated areas* ( $H_4$ ).

### 3 An empirical analysis

In order to test these hypotheses, I make use of two datasets from the Netherlands to study the determinants of its immigrants' social networks and ethnic concentrations. Turks, Moroccans, Surinamese, and Antilleans are the four largest

<sup>10</sup> A possible concern is that migrants comprise a self-selected sample. For example, a good economy at the destination country only attracts migrants in favour of co-ethnic networks, while a bad economy only attracts migrants in favour of local networks. I check this self-selection issue in Fig. 1 in the later section. In brief, I compared different cohorts of migrants by year of entry. Their degrees of co-ethnic contact and levels of ethnic concentration are not directly correlated with the labour market conditions.

immigrant ethnic minority groups in the Netherlands. Turks and Moroccans were responsive to the ‘guest workers’ programme by the Dutch government, and migrated to the Netherlands in large numbers in the 1960s. Family reunification in the 1980s and second-generation children born in the Netherlands then substantially increased the proportion of Turks and Moroccans in the country. A mass inflow of Surinamese took place after the decolonisation of Surinam in 1975. Meanwhile, large groups of people from the Netherlands Antilles (an autonomous area within the Kingdom of the Netherlands) have been migrating to the Netherlands since the 1990s. These massive inflows of immigrants to the Netherlands have made the sociocultural adaptation of these four ethnic minority groups a central political topic.

### 3.1 Data and variables

The first dataset is the Dutch survey ‘Sociale Positie en Voorzieningsgebruik Allochtonen’ (SPVA), which is a large-scale, cross-sectional survey of the four largest non-Western immigrant groups in the Netherlands, which are, as stated above: Turks, Moroccans, Surinamese, and Antilleans. The survey reports information about the socio-economic and sociocultural position of the four largest ethnic minorities in the Netherlands. The sample frame consists of 10–13 cities (depending on the survey year) in which immigrants are relatively overrepresented. The survey was conducted in the years of 1991, 1994, 1998, and 2002, with, respectively, 2581, 2572, 5231, and 3614 households. My analysis uses the data about the head of the household. The second dataset is the Centraal Bureau voor de Statistiek (CBS), which provides ethnic concentrations and annual local labour market conditions at the provincial level.

The two dependent variables in which we are most interested are the social network variable  $s^*$  and the ethnic concentration variable  $e^*$ . The social network variable is a measure of the relative time the migrant spends with co-ethnic contacts relative to native Dutch people. *Contact composition*: the respondent was asked about frequency of her co-ethnic and Dutch contact during her free time. The three categories are: (1) more contact with the Dutch; (2) equal contact with Dutch and co-ethnics; (3) more contact with co-ethnics. The variable is recoded as a numerical value between 1 and 3. The higher the value, the greater the time the migrant allocated to developing co-ethnic networks. *Ethnic concentration*: this is measured by the percentage of the respondent’s ethnic group in the resident population of the province, for, respectively, Turks, Moroccans, Surinamese, and Antilleans.<sup>11</sup>

Table 3 presents descriptive statistics for the social network variable and the ethnic concentration variable. It shows that the ethnic composition varies significantly across four ethnic groups. In general, Surinamese people and Antilleans networks more with Dutch people relative to Turks and the Moroccans. Turks demonstrate the highest level of co-ethnic networks. 64% of the Turks have more

<sup>11</sup> The variable is constructed using the population statistics in CBS.

**Table 3** Descriptive statistics of social network composition and ethnic concentration at province level across ethnicity for cross-sectional data, adult immigrants. *Source:* SPVA and CBS

	Turks	Moroccans	Surinamese	Antilleans
During free time: more contact with Dutch	0.09	0.12	0.22	0.41
During free time: equal contact	0.27	0.44	0.45	0.37
During free time: more contact with co-ethnics	0.64	0.44	0.33	0.22
Ethnic concentration at province level	0.05	0.05	0.07	0.01

The social network variable is dichotomous with a value of either 0 or 1. The figures in the table are the percentage of respondents who fit the description of the first column within each ethnic group. The ethnic concentration is measured by the percentage of the respondent's ethnic group in the resident population of the province

Sample size: 13998

co-ethnic contacts than Dutch contacts, while Antilleans demonstrate the lowest level of co-ethnic networking. However, the ethnic concentration level evidences a different pattern. Surinamese people, who have a historic colonial tie with the Netherlands, demonstrate the highest level of ethnic concentration (7%) in the case population. In contrast, Antilleans demonstrate the lowest level of ethnic concentration (1%) in the case population.<sup>12</sup>

The second dataset from CBS provides the conditions of the labour market.  $\alpha$  is proxied by vacancies per every thousand jobs in each province between the years of 1992 and 2001.  $\delta$  is proxied by the percentage of inflow into unemployment benefits in each province (unit: percentages) between 1992 and 2001. The wage information ( $\bar{w}_1, w_1, \bar{w}_2, w_2$ ) is proxied by the average wage rates of representative sectors in both the ethnic labour market and the host labour market (unit: euros per month) between the years of 1960 and 2001. Wage distribution in the ethnic labour market was determined using the following sectors: (1) industry and energy and (2) trade, transport, hotels, and restaurants. Meanwhile, wage distribution in the host labour market was determined using the following sectors: (1) information and communication; (2) financial services; (3) rental and commercial property; (4) business services; (5) government and care; and (6) culture, recreation, and other services.

Merging these datasets enables us to identify how the conditions of the local labour market in the year of the immigrant's first job search impacts her decisions about social networking and ethnic concentration. Labour market parameters are matched to each immigrant in the micro-data, with job search year and province as identifiers.<sup>13</sup> The model assumes that the conditions of the labour market during the job search year play a formative role in the immigrant's decisions about social networking. In SPVA, I use the year that the first job was obtained in the

<sup>12</sup> In Appendix 1, Table 6 shows a list of all variables in SPVA, with their detailed definitions and coding, and Table 7 presents descriptives for the demographic variables.

<sup>13</sup> For sector wage rates, there is no regional difference, and hence the job search year is the only identifier.

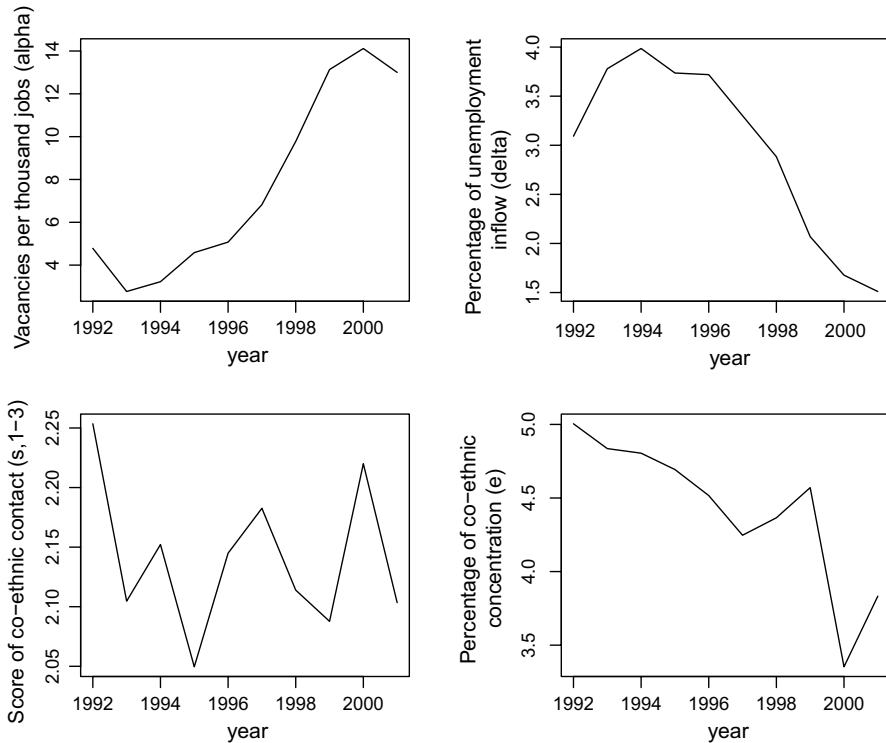


Fig. 1 Year trend of  $\alpha$ ,  $\delta$ ,  $s$ , and  $e$  on average

Netherlands.<sup>14</sup> The analysis includes all Dutch provinces: Groningen, Friesland, Drenthe, Overijssel, Flevoland, Gelderland, Utrecht, Noord-Holland, Zuid-Holland, Zeeland, Noord-Brabant, and Limburg.

Figure 1 shows a time series of the key variables from year 1992 to 2001. The upper panels are proxies for  $\alpha$  and  $\delta$ , respectively. An increasing trend for vacancies and decreasing trend for the percentage of unemployment inflow are evident. The lower panels are proxies for  $s^*$  and  $e^*$ , respectively. There is not a clear pattern of how  $s^*$  and  $e^*$  fluctuates with the years. To better identify the impacts of local labour market conditions on  $s^*$  and  $e^*$ , the next subsection considers the structural-form specification.

### 3.2 Simultaneous equations and instrumental variables

The structural-form specification of the model is a system of two equations, where  $s^*$  and  $e^*$  are interdependent of each other and both dependent on a set of labour market parameters and individual parameters, written as:

$$S_{i,t} = c_{11} + c_{12}X_{i,t} + c_{13}LM_{i,t_0} + c_{14}E_{i,t} + \varepsilon_{1,t}, \quad t = 1, \dots, T \quad \text{and} \quad i = 1, \dots, I, \quad (8)$$

<sup>14</sup> While year of entry could also be an option, it cannot proxy the job search year for immigrants who moved to the Netherlands at a younger age.

$$E_{i,t} = c_{21} + c_{22}X_{i,t} + c_{23}LM_{i,t_0} + c_{24}S_{i,t} + \varepsilon_{2,t}, \quad t = 1, \dots, T \quad \text{and} \quad i = 1, \dots, I, \tag{9}$$

where  $i$  stands for individuals;  $t$  stands for survey years;  $t_0$  is the search year of the first job;  $S$  is the social network variable;  $E$  is the ethnic concentration;  $X$  are a set of individual characteristics;  $LM$  are labour market variables (at time  $t_0$ );  $\varepsilon_1$  and  $\varepsilon_2$  are disturbance terms.

$S_{i,t}$  and  $E_{i,t}$  are jointly endogenous variables by construction. If  $\varepsilon_{1,t}$  increases, then  $S_{i,t}$  increases. Assuming  $c_{24} > 0$ ,  $E_{i,t}$  would increase,  $\varepsilon_{1,t}$  and  $E_{i,t}$  are positively correlated. Because  $\varepsilon_{1,t}$  is unobserved, all increases in  $S_{i,t}$  are attributed to  $E_{i,t}$ , which causes an overestimation in  $c_{14}$ . Similarly,  $c_{24}$  would also be overestimated due to this feedback channel (assuming  $c_{14} > 0$ ).

I use a feasible generalised least squares version of the 2SLS estimation to get asymptotically more efficient estimates. This model is generally called ‘three-stage least squares (3SLS)’ (Zellner and Theil 1962). This estimation procedure mitigates the bias with valid instrumental variables (IV) and further takes into account inter-temporal correlations between disturbance terms of equations. In our case, the contemporaneous correlation between  $\varepsilon_{1,t}$  and  $\varepsilon_{2,t}$  is likely to emerge, as some unobserved personal traits might simultaneously correlate with co-ethnic network formation and ethnic concentration.

I use the cultural diversity index at the province level as the instrument for ethnic concentration  $E$ . Much of the literature (see e.g. Bakens et al. 2013; Ottaviano and Peri 2005; Wang et al. 2016) uses an index of fractionalisation to measure cultural diversity, written as:

$$Div_j = 1 - \sum_{g=1}^{G} \text{share}_{gj}^2, \quad g = 1, \dots, G \quad \text{and} \quad j = 1, \dots, J, \tag{10}$$

where  $\text{share}_{gj}$  is the share of ethnic group  $g$  over the total population in a specific region  $j$ .  $Div$  is region-specific and measures the probability that two randomly selected individuals from a given area will not belong to the same group. The higher the index, the more culturally diverse the region. I believe that immigrants not only value their own ethnic group but also appreciate the presence of other foreigners in their place of residence. By definition, this numerical value is not related to the relative intensity of the amount of time the migrant spends on co-ethnic friendship and Dutch friendship because the cultural diversity index is computed with the population of different ethnic groups.

To instrument for social network variable  $S$  at the year of survey, an instrumental variable should be correlated with  $S$  but not directly correlated with  $E$ . Here, I use Dutch language proficiency at the year of survey. It is a categorical variable with (1) do not speak Dutch or find it very difficult, (2) not very well, sometimes find it difficult, (3) very well, never find it difficult. I convert it into values 0, 1, 2.<sup>15</sup> As language is the fundamental medium of communication and network creation, this variable captures the fact immigrants more fluent in Dutch may spend more time

<sup>15</sup> Although Surinamese and Antilleans have much higher levels of Dutch language proficiency than Turks and Moroccans, the variations of the proficiency levels exist.

engaging with natives, and learn more about Dutch culture, life style, values and beliefs. They may thus be more confident in moving to a province with a low level of ethnic concentration. To be sure, one might worry about the correlation between the ethnic concentration and the Dutch language proficiency. On the one hand, being in a non-ethnically concentrated area would improve a migrant's proficiency in Dutch. However, this positive impact is only very likely during childhood. Approximately 5% of our sample migrated before age 10. 85% of the respondents migrated after age 15. If they ever started learning Dutch, they took language courses instead of just learning from their neighbours. On the other hand, migrants with a low level of proficiency are unlikely to be attracted to an area where everyone speaks the local language (Bauer et al. 2005). This direct channel is true at a disaggregate level of spatial units, such as neighbourhood and district. When it comes to the city or province level, the probability of meeting a person speaking a local language is relatively large for all regions. Accordingly, the impact of local language proficiency on location choice ( $E$ ) is more likely to operate via social networks ( $S$ ) established after migration. Therefore, the location choice is based less on whether the individuals can communicate and more on whether they can grow their existing networks. Note that the ethnic concentration variable is measured at the year of survey, which can reflect the change of location after migration.

### 3.3 Estimation results

Table 4 shows the results of the simultaneous estimation for a sample of immigrants who obtained their first job in the Netherlands between the years of 1992 and 2001, where  $\alpha$  and  $\delta$  are the main explanatory variables. I use the Engle's autoregressive conditional heteroscedastic (ARCH) test to check whether there is a dynamic conditional variance process (Engle 1982). The null hypothesis is homoscedasticity. It is a Lagrange multiplier test, and it does not reject the null hypothesis at the 5% level for both equations (8% for  $S$  equation and 28% for  $E$  equation).

Column (1) is for social networking, and column (2) is for ethnic concentration. In column (1), the intensity of co-ethnic networking is positively associated with a high vacancy rate (0.015). It is also evident that a high unemployment inflow percentage leads to less time spent in co-ethnic networks ( $-0.114$ ). The findings above confirm hypothesis  $H_1$ . In column (2), the ethnic concentration is the dependent variable. The coefficient is positive for vacancies per thousand jobs (0.085). The negative association between the ethnic concentration and the unemployment inflow percentage ( $-0.619$ ) is also confirmed. These findings therefore confirm hypothesis  $H_2$ .

The lower panel of Table 4 presents the estimates in the first stage. The coefficient for Dutch language proficiency is expected to be negative, implying that immigrants with local language skills allocate less time to co-ethnic contacts, *ceteris paribus*. The coefficient for the regional cultural diversity index is positive, implying that that migrants prefer to reside with co-ethnic networks and other foreign-born groups.

Table 5 shows the results of the simultaneous estimation for a sample of immigrants who obtained their first job in the Netherlands between 1969 and 2001, where  $\underline{w}_1, \overline{w}_1, \underline{w}_2$ , and  $\overline{w}_2$  are the main explanatory variables. The ARCH test does not reject

**Table 4** Simultaneous equations model for social network and ethnic concentration ( $\alpha$  and  $\delta$  as the main explanatory variables), job search year 1992–2001

	$s^*$	$e^*$
Number of vacancies ( $\alpha$ )	0.015 (0.006)**	0.085 (0.018)***
Unemployment inflow percentage ( $\delta$ )	-0.114 (0.055)**	-0.619 (0.183)***
Residential preference ( $\sigma$ )	0.050 (0.028) *	0.161 (0.106)
Moroccans ( $\beta$ )	-0.198 (0.088)**	-0.036 (0.434)
Surinamese ( $\beta$ )	-0.004 (0.129)	1.603 (0.418)***
Antilleans ( $\beta$ )	-0.796 (0.169)***	-4.322 (0.640)***
Years since migration ( $\beta$ )	-0.009 (0.006)	-0.010 (0.025)
Primary education ( $\beta$ )	-0.262 (0.123)**	-0.454 (0.540)
Lower education ( $\beta$ )	-0.191 (0.124)	-0.049 (0.505)
Intermed. education ( $\beta$ )	-0.081 (0.121)	0.170 (0.416)
Higher education ( $\beta$ )	-0.182 (0.127)	-0.044 (0.505)
Constant	3.241 (0.357)***	11.092 (3.710)***
First stage estimates		
Instrumental variable	Dutch language proficiency	Regional cultural diversity
Coefficients	-0.102 (0.005)**	4.102 (0.393)***
Weak instrument $F$ test, $p$ value	0.027	7.34e-14
Num. obs.	1360	1360

The dependent variable of column (1) the social network measure in numerical values: (1) more contact with the natives; (2) equal contact with the natives and the co-ethnics; (3) more contact with the co-ethnics. The dependent variable of column (2) is the percentage of the immigrant's own ethnic group in her living municipality.

The reference category for each categorical variable is as follows. Education: no education.

The regressors not included in the table are ethnicity, gender, marital status, number of children, age at migration, working experience in the Netherlands, and monthly income. The time trend effect is controlled for as well

\*\*\* $p < 0.01$ ; \*\* $p < 0.05$ ; \* $p < 0.1$

the null hypothesis of homoscedasticity at the 5% level for both equations (82% for  $S$  equation and 83% for  $E$  equation).

The average wage rates of representative sectors in the ethnic labour market and the host labour market are included as independent variables to proxy for  $\frac{w_1}{\bar{w}_1}$ ,  $\frac{w_2}{\bar{w}_2}$ , and  $\bar{w}_2$ . Here, column (1) is for social networking and column (2) for ethnic concentration. Column (1) makes clear that the intensity of co-ethnic networking is positively associated with high average wage rates in the host labour market (0.176), and negatively associated with high average wage rates the ethnic labour market (-0.218). The higher the wage difference between the ethnic labour market and the host labour market, the more time the immigrant spends in developing a co-ethnic network. The coefficients are significant for most of the individual characteristics. In column (2), the ethnic concentration is positively associated with a higher wage difference between the ethnic labour market and the host labour market (0.602). These findings confirm hypotheses  $H_3$  and  $H_4$ . Similarly, the lower panel of Table 5 presents the first stage in IV estimation.

**Table 5** Simultaneous equations model for social network and ethnic concentration ( $\underline{w}_1, \bar{w}_1, \underline{w}_2, \bar{w}_2$  as the main explanatory variables), job search year 1969–2002

	$s^*$	$e^*$
Ethnic labour market ( $\underline{w}_1, \bar{w}_1$ )	– 0.218 (0.095)**	– 0.413 (0.407)
Host labour market ( $\underline{w}_2, \bar{w}_2$ )	0.176 (0.065)***	0.602 (0.288)**
Residential preference ( $\sigma$ )	0.040 (0.014)***	0.192 (0.062)***
Moroccans ( $\beta$ )	– 0.279 (0.042)***	– 0.012 (0.284)
Surinamese ( $\beta$ )	– 0.276 (0.044)***	0.725 (0.281)***
Antilleans ( $\beta$ )	– 0.707 (0.072)***	– 5.187 (0.585)***
Years since migration ( $\beta$ )	– 0.014 (0.003)***	– 0.022 (0.017)
Primary education ( $\beta$ )	– 0.072 (0.052)	0.021 (0.209)
Lower education ( $\beta$ )	– 0.037 (0.053)	0.261 (0.205)
Intermed. education ( $\beta$ )	– 0.052 (0.054)	0.321 (0.209)
Higher education ( $\beta$ )	– 0.120 (0.059)**	0.075 (0.248)
Constant	2.634 (0.251)***	8.620 (2.368)***
First stage estimates		
Instrumental variable	Dutch language proficiency	Regional cultural diversity
Coefficients	– 0.107 (0.002)***	4.373 (0.185)***
Weak instrument $F$ test, $p$ value	6.19e–6	< 2e–16
Num. obs.	5712	5712

The dependent variable of column (1) the social network measure in numerical values: (1) more contact with the natives; (2) equal contact with the natives and the co-ethnics; (3) more contact with the co-ethnics. The dependent variable of column (2) is the percentage of the immigrant's own ethnic group in her living municipality.

The reference category for each categorical variable is as follows. Ethnicity: Turks. Education: no education.

The regressors not included in the table are gender, marital status, number of children, age at migration, working experience in the Netherlands, and monthly income. The time trend effect is controlled for as well

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

With regard to the residential preference parameter  $\sigma$ , Tables 4 and 5 unambiguously show that both  $s$  and  $e$  are positively associated with  $\sigma$ . With regard to individual characteristics  $\beta$ , for example, having a lower level of education is associated with a higher level of co-ethnic networking. The ethnicity variable itself reflects the cultural distance between the home country and the Netherlands. Intuitively, Surinamese and Antilleans have lower cost of networking with natives due to historical ties with the Netherlands, and hence  $s^*$  and  $e^*$  are lower.

## 4 Concluding remarks

The compositions of the social networks that immigrants build in their new countries are meaningful both for their own economic performances in the destination country and for the dynamics of integration in their new society. This case study explored the ways in which the labour market conditions of the host country determine the



social networks immigrants build upon arriving, with a focus on the experiences of immigrants to the Netherlands.

In brief, I developed a job and residential search model for an unemployed immigrant who has just arrived in her destination country. The immigrant has the choice of how much time she will spend in each of two social networks, the co-ethnic network and the local Dutch network, as well as the choice of where she will reside. I derived the optimal time spent in co-ethnic networking and native networking as well as the optimal level of ethnic concentration. I tested the comparative statics of co-ethnic networks, native networks, and ethnic concentration with respect to local labour market conditions with data about Dutch immigrants. The empirical analysis supports the hypotheses from the theoretical framework, where I used instrumental variables to partially address the endogeneity in the simultaneous equations model.

This paper's novelty is its finding that immigrants seem to spontaneously assimilate less into their host society when the host economy is strong. When a buoyant labour market exists, immigrants do not have a strong motive to build networks with natives. Immigrants are able to consume more of their ethnic goods when the economy is doing well. In contrast, an economic recession lowers the opportunity cost of developing native networks and therefore encourages immigrants to network more intensely with natives to better their employment prospects. This incompatibility sheds light on the fact that current policies encouraging migrants to pursue social integration might overlook migrants' own motivations of creating networks depending on the local labour market.

While my empirical analysis focuses on a sample of immigrants to the Netherlands, the theoretical model of social network formation this paper presents may be applied to all immigrant-receiving countries, such as the UK, Canada, and Germany. Moving forward, researchers might do well to conduct a cross-country comparison, if, of course, such data exist about social contacts. Moreover, researchers may also explore the dynamic formation and impact of social networks. Battisti et al. (2016) investigated the short-term and long-term impacts of co-ethnic networks developed by an immigrant after arrival on the immigrant's economic success. Although immigrants with larger co-ethnic networks at arrival are more likely to be employed before those with smaller or no such networks, such immigrants also have a lower probability of investing in human capital, a trend which yields lower wages in the long run. In addition, it may also prove informative to modify the theoretical model in the context of sequential decisions on choice of location and social network formation in a way that takes into account the locked-in effect of living in an ethnic enclave. It is also helpful to note that bridging this topic to literature on urban economies will supplement the elements missing from the current model, e.g. urban amenities, housing price, cost of living, etc. The interdependent relationship between urban characteristics and social interaction is worthy of much more attention, especially given that costs of communication are decreasing and that job seekers are increasingly using networking as a strategy for finding employment.

**Acknowledgements** I would like to acknowledge the helpful comments and advice given by Kristian Behrens, Elise S. Brezis, Xiaoming Cai, Barry R. Chiswick, Steven N. Durlauf, Antonio Di Paolo, Jia-Ping Huang, Matthew O. Jackson, Or Levkovich, Cezen Ozgen, Roberto Patuelli, Jacques Poot, Matthew

Roskruege, Jos van Ommeren, Yang Yang, Min Qiang Zhao, an anonymous referee, journal editors, and the thoughts of the seminar participants at George Washington University; the Tinbergen Institute, Amsterdam; the Vrije Universiteit Amsterdam; the 61st NARSC Conference, Washington D.C.; the 55th ERSA Conference, Lisbon; the 62nd NARSC Conference, Portland; the RSAI/ERSA 2015 Barcelona Workshop; the 2015 International Symposium on Contemporary Labor Economics, Xiamen; and the 3rd Summer School 'Social Interactions and Urban Segregation', Rennes. I am also particularly grateful to Thomas de Graaff and Peter Nijkamp for their guidance and support.

## Compliance with ethical standards

**Conflict of interest** The author declares that they have no conflict of interest.

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## Appendix 1

See Tables 6 and 7.

**Table 6** The definitions and coding of the variables in 'social position and use of public facilities by immigrants' (SPVA)

Variables	Questions asked in the survey and coding
Contact composition during free time	'In your spare time, do you have more contact with Dutch people or do you have more contact with people from your own ethnic group?' 1-More co-ethnic contact 2-Both equally 3-More contact with Dutch people
Monthly income	'What is your total net monthly income?' In year 2002, the currency changed from Dutch guilders to Euros. The exchange ratio 2.2:1 is used to unify the monetary unit across four waves
Education	'What is the highest degree you have completed?' 0-No degree 1-Degree in primary education (LO) 2-Degree in secondary education (LBO/MAVO) 3-Degree in intermediate education (MBO/HAVO/VWO) 4-Degree in higher education (HBO/WO)
Work experience in NL	'How long have you worked in total in the Netherlands?'
Dutch language proficiency	'When you are in a conversation, do you have any difficulty in using Dutch language?' 0-Yes, very difficult/ do not speak Dutch at all 1-Yes, sometimes 2-No, never
Residential preference	'Do you prefer to live in a neighborhood where many people of your own ethnic group live?'

**Table 6** (continued)

Variables	Questions asked in the survey and coding
	1-Strong dislike
	2-Rather not
	3-It does not matter
	4-Rather well
	5-Strong preference
Ethnicity	'What is your ethnic group?'
	1-Turks
	2-Moroccans
	3-Surinamese
	4-Antilleans
Province	Registered residence province
	1-Amsterdam
	2-Rotterdam
	3-Den Haag
	4-Utrecht
	5-Eindhoven
	6-Enschede
	7-Almere
	8-Alphen aan den Rijn
	9-Bergen op Zoom
	10-Hoogezand-Sappemeer
	11-Delft
	12-Dordrecht
	13-Tiel
	Leeuwarden, Spijkenisse, Zwiendrecht and Gornichem are recoded in SPVA 1991, but not in other waves. And hence we drop the observations in these municipalities
Nationality	'What is your nationality?'
	1-Origin country's nationality
	2-Dutch nationality
	3-Both the origin country's and Dutch nationalities
	4-Others
	The answers are recoded to a dichotomous variable which equals 1 if the respondent reported having Dutch nationality, and 0 otherwise
Married	'What is your marital status?'
	1-Married
	2-Divorced
	3-Widow/widower
	4-Never been married
Number of children	'How many children are there living in the house?'
	'How many children are not living in the Netherlands?'
	These two answers are summed up.
Years since migration	'What is your length of stay in the Netherlands?'

**Table 7** Descriptive statistics for cross-sectional data, adult immigrants. *Source:* SPVA 1991, 1994, 1998, 2002

Statistic	<i>N</i>	Mean	SD	Min	Max
Male	13,961	0.68	0.47	0	1
Age	13,998	39.99	10.40	25	64
Turks	13,968	0.28	0.45	0	1
Moroccans	13,968	0.26	0.44	0	1
Surinamese	13,968	0.28	0.45	0	1
Antilleans	13,968	0.19	0.39	0	1
Dutch nationality	13,998	0.61	0.49	0	1
YSM (in years)	13,760	16.31	9.64	0.00	52.50
Married	13,998	0.65	0.48	0	1
Number of children	13,998	2.35	2.20	0	17
No edu.	13,425	0.22	0.42	0	1
Primary edu.	13,425	0.28	0.45	0	1
Lower edu.	13,425	0.22	0.41	0	1
Intermed. edu.	13,425	0.18	0.38	0	1
Higher edu.	13,425	0.10	0.30	0	1
Do not speak Dutch	13,838	0.20	0.40	0	1
Dutch: not very well	13,838	0.30	0.46	0	1
Dutch: very well	13,838	0.51	0.50	0	1
Exp. in NL (in years)	13,855	10.34	8.57	0.00	48.00
Income (in Dutch guilders)	11,744	1867.34	825.66	0.00	16,508.26
Residential preference parameter	10,432	2.65	0.94	1	5
Year of first job	8567	1982.71	9.31	1953	2002
Ethnic concentration	11,382	4.79	2.81	0.26	9.73
Year of survey: 1991	13,998	0.18	0.39	0	1
Year of survey: 1994	13,998	0.18	0.39	0	1
Year of survey: 1998	13,998	0.37	0.48	0	1
Year of survey: 2002	13,998	0.26	0.44	0	1

Respondents are those reported as the household head by the household members.

Income is measured as monthly net income in Dutch guilders, adjusted by CPI.

Residential preference parameter indicates the degree of preference for ethnic concentration.

Ethnic concentration is measured in percentages.

## Appendix 2

This appendix illustrates how Eq. (1) is simplified to (3).

From Eq. (2) (the inflow value of being employed at wage rate  $w$ ),  $W(w_r)$  is derived using the reservation wage identity  $W(w_r) = U$ ,

$$W(w_r) = U = \frac{w_r + R(s, e)}{r}. \quad (11)$$

Substitute Eqs. (11) into (2) to obtain the following:

$$W(w) - U = \frac{w - w_r}{r + \delta}. \tag{12}$$

Then substituting Eqs. (12) into (1), it becomes:

$$\begin{aligned} rU = & b + R(s, e) + \frac{s\alpha_1}{r + \delta} \int_{w_r}^{\bar{w}_1} (w - w_r) f_1(w) dw \\ & + \frac{(1-s)\alpha_2 G(e)}{r + \delta} \int_{w_r}^{\bar{w}_2} (w - w_r) f_2(w) dw - C(s). \end{aligned} \tag{13}$$

Using the theorem of integration by parts,

$$\begin{aligned} \int_{w_r}^{\bar{w}_i} (w - w_r) f_i(w) dw &= \{(w - w_r) F_i(w)\}_{w_r}^{\bar{w}_i} - \int_{w_r}^{\bar{w}_i} F_i(w) dw \\ &= (\bar{w}_i - w_r) - \int_{w_r}^{\bar{w}_i} F_i(w) dw \\ &= \int_{w_r}^{\bar{w}_i} [1 - F_i(w)] dw, \end{aligned}$$

where  $Q_i$  is the surplus function of  $F_i(w)$ :  $Q_i = \int_{w_r}^{\bar{w}_i} (1 - F_i(w)) dw$ . And this is the whole exposition for the derivation of Eq. (3).

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