Immigration, Search, and Loss of Skill

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This article develops and estimates an on-the-job search model of the entry of highly skilled immigrants from the former Soviet Union into the Israeli labor market. The estimated parameters of the model, together with information on the wages of immigrants from earlier waves, imply that, on average, immigrants can expect lifetime earnings to fall short of the lifetime earnings of comparable natives by 57%. Of this figure, 14 percentage points reflect frictions associated with nonemployment and job distribution mismatch, and 43 percentage points reflect the gradual adaptation of imported schooling and experience to the local labor market.

I. Introduction

Starting in late 1989, Israel has experienced a major immigration wave of highly skilled workers from the former Soviet Union (USSR). About 600,000 immigrants entered Israel during the period 1990–95. The average level of schooling of these immigrants is high, 14.7 years of schooling for males and 14.3 for females. This wave is without precedent in terms of

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the imbalances that it created in some high-skill occupations. As a result of the large-scale immigration, the stock of physicians and engineers in Israel almost doubled during the period 1990–93. Under these circumstances, it is not surprising that many highly skilled immigrants were forced into low-skill occupations. Among males who were 25–55 years old on arrival, only 26% of those who worked as scientists or engineers in the former USSR found similar jobs within the first 3 years of their stay. The extent of occupational downgrading among females and older males was even higher.[1]

The purpose of this article is to investigate the observed short-run adjustment process in immigrant occupational choices and wages and to infer some long-run implications. The main focus is on the loss of human capital suffered by the immigrants and the implications of this loss to the immigrants themselves and to the Israeli economy. With this purpose in mind, a model of on-the-job search is constructed and estimated, using panel data on 1,086 male immigrants who reported their labor market experience during the period 1990–95. The model is designed to describe the process of matching immigrants with jobs in Israel, where workers differ in skills and jobs vary by skill requirements. The various jobs in the economy are considered to be arranged in a "job hierarchy,"[2] where, in each occupation, jobs can be ranked according to the minimal level of schooling required to perform the job. Finding a suitable job, which maximizes the immigrant's output (and wages) given his schooling endowment, requires a search. An immigrant who meets a particular employer will be qualified for the job only if his schooling exceeds the minimal requirement. A highly skilled immigrant may accept job offers in low-skill occupations because offers in high-skill occupations are more rare, and he can continue to search on the job. Generally, workers will select occupations and job acceptance rules that do not fully exploit their formal schooling. However, with time, immigrants find better matches, and their wages rise.

The panel data on recently arrived immigrants from the former USSR are used to estimate the distribution of wage offers and job-offer arrival

[1] A downgrading of skills was also observed among immigrants who came from the former USSR during the years 1970–80. The skills and occupational composition of these immigrants were similar to the current wave, but their number was smaller, about 150,000 (see Flug, Kasir, and Ofer 1992).

[2] The approach was suggested by Melvin Reder (1957). In his view, jobs are arranged in a "job hierarchy," in which workers search for the best jobs for which they are qualified but, failing to find them, may end up in a less preferred job. In a favorable labor market (for workers), job seekers find it relatively easy to move up the job hierarchy toward better jobs and vice versa. This occurs because fewer workers compete for the good jobs and also because firms relax their hiring standards.

rates in different occupations in Israel, assuming that immigrants choose jobs according to the optimal solution of a dynamic programming problem under uncertainty. Based on the estimates, the loss of human capital is computed, where loss is defined as the difference between the expected actual lifetime earnings and the expected potential lifetime earnings that the immigrant would have obtained had he been employed at the same jobs and earned the same wages as comparable Israelis. We find substantial loss. An upper-bound estimate for the difference between actual earnings and potential lifetime earnings is US$253,200, which constitutes 57% of the present value of potential earnings over the remaining working life (25 years, on average). Nearly 75% of this estimated loss can be attributed to the fact that, in each job, immigrants initially earn wages that are about a third of the wages of comparable Israelis. Wages of immigrants rise sharply with time in Israel but do not fully catch up with the wages of natives (after 30 years in Israel, immigrants are predicted to earn 15% less on the same jobs). The remaining 25% of the loss can be attributed to frictions associated with nonemployment and job distribution mismatch.

While the focus of this article is on a particular episode—recent immigration to Israel—the methods developed here can be applied to other situations in which there is a major occupational restructuring, resulting from aggregate labor market shocks such as technological innovations and changing trade patterns.[3] In the model, losses in human capital occur as workers with a predetermined level of schooling find themselves with no jobs and are willing to compromise and accept jobs with schooling requirements below their schooling endowment. Even in a smoothly operating economy, in which individuals can select their schooling and firms can choose their job offers, the model predicts some "natural" loss of skills, akin to the natural rate of unemployment.[4]

II. Background

The mass immigration of Jews from the former USSR to Israel, which started toward the end of 1989, amounted to 600,000 immigrants by the end of 1995. The Israeli population at the end of 1989 was 4.56 million, and the premigration population growth rate during the 1980s was be-

[3] Several recent studies analyze the unemployment spells and wage losses following displacement because of plant closure. See, e.g., Jacobson, LaLonde, and Sullivan (1993); Carrington and Zaman (1994); and Neal (1995). These studies find a substantial and long-lasting loss of wages.

[4] Sicherman (1991, p. 15) noted the prevalence of overeducation using the Panel Study of Income Dynamics. When asked, "How much formal education is required to get a job like yours?" about 40% of the respondents reported a number that was lower than their own schooling attainment (only 16% of the respondents reported a higher number). The author ascribes this discrepancy to a variety of reasons, including temporary mismatching and career mobility.

tween 1.4% and 1.8% per annum. The 1990–91 wave of immigration increased the population by 7.6% in 2 years, which is more than twice the normal population growth. The slower immigration flow between 1992 and 1995 contributed 1.3% a year in population growth. By the end of 1995, the recent immigrants constituted 11% of the total population and 12.1% of the population ages 15 and above. Compared with immigration to the United States and other receiving countries, this wave stands out in its magnitude.

Immigrants from the former USSR were highly skilled, as indicated by their high level of education and prior experience in academic jobs. Those who arrived during 1989–91 possessed an average of 14.5 years of schooling, compared with 12.6 years among Israeli workers in 1991. About 70% of the immigrants worked in high-skill and medium-skill occupations in the USSR, compared with only 30% among Israeli workers.[5] Immigrants in this wave are also older than Israeli workers by 4 years. This is in contrast with most immigrations, where immigrants tend to be relatively young. This latter feature reflects the exogenous relaxation of emigration from the former USSR and the free entry of Jews to Israel. Thus, this immigration wave is less governed by self-selection.

Immigrants from the former USSR entered the Israeli labor force quickly, willing to accept almost any available job. The occupational distribution of first jobs among immigrants is similar to the distribution of jobs in the Israeli economy, implying a substantial occupational downgrading.[6] Following this initial phase, there is a second phase in which highly educated immigrants gradually upgrade their positions by finding better jobs within low-ranked occupations or move to jobs within high-ranked occupations. Consequently, there is a rather sharp increase in wages as a function of time spent in Israel. During the period 1990–95, the annual growth rate in real wages among immigrants was 6.4%.[7] As immigrants spend more time in Israel, the variability in wages across schooling groups and occupations rises, suggesting improved matching of workers to positions and rising returns for skills acquired abroad (see Eckstein and Weiss 1998; Friedberg 2000). This process has occurred

[5] By the end of 1993, 57,400 immigrant engineers and 12,200 immigrant physicians had arrived. There were 30,200 native engineers and 15,600 native physicians in Israel in 1989.

[6] Of the 112,000 immigrants who arrived during 1990–91 with 16 or more years of schooling, 75% worked in low-skill occupations, and only 13% found jobs in high-skill occupations within their initial stay in Israel (2.9 years on average).

[7] A sharp increase of wages among immigrants is a common finding in most studies of immigration, although the reasons are not always clear. See Chiswick (1978) and the surveys by Borjas (1994) and LaLonde and Topel (1997). Green (1999) describe the process of occupational upgrading among immigrants to Canada.

Table 1
Yearly Occupational Distribution in Israel, Males Ages 25–55 on Arrival (%)

	Occupation 1	Occupation 2	Occupation 3	No Job	*N*
Occupation in Israel:					
Year 1	11.6	5.6	56.6	26.2	1,058
Year 2	17.4	6.9	57.7	17.9	929
Year 3	22.3	7.2	57.5	13.0	793
Year 4	27.6	7.5	52.7	12.2	583
Year 5	36.7	7.8	47.7	7.8	218
Occupation in the former USSR	84.3	4.6	11.0	.0	1,086

NOTE.—USSR = Soviet Union.

without much effect on the employment and wages of natives (see Friedberg 2001; Eckstein and Weiss 2002), because of inflows of capital and increased exports.[8] In some professions, such as medicine, collective wage bargaining yielded substantial wage hikes for natives, despite the sharp increase in supply (see Sussman and Zakai 1998).

III. Data

The data sources for this study are two surveys conducted by the Brookdale Institute. The first survey, conducted in April–August 1992, consists of a random sample of 1,118 immigrants who had arrived from the former USSR after 1989. Of this representative sample, 910 immigrants were surveyed again during 1994. The second survey, conducted in June–December 1995, consists of a random sample of 1,432 immigrants who arrived after 1989 and who reported being engineers in the former USSR. The two samples are pooled, and the analysis is restricted to males between the ages of 25 and 55 at the time of arrival, yielding a sample of 1,086 immigrants. The respondents' length of stay in Israel ranges from 6 to 77 months. Each immigrant supplied information on his occupational and educational background in the former USSR and a detailed history of his work experience in Israel. Sample averages for the variables used in the analysis are presented in table A1.

Occupations in Israel and the former USSR are classified into three broad categories, based on their schooling requirements: (1) scientific and academic occupations, including government officials; (2) other professional occupations, including technical workers, teachers, nurses, and artists; and (3) all others. Table 1 displays the occupational distribution of immigrants in the sample, in the former USSR and in Israel. The basic pattern is an initial transition by many immigrants down the occupational ladder from occupations 1 and 2 in the former USSR to occupation 3 in

[8] Weak effects of immigration on the wages of natives have also been found in the United States. See Altonji and Card (1991); Card (2001).

Table 2
Average Minimal Schooling Requirements of Jobs Held by Immigrants by Year and Schooling Acquired in the USSR, Males Ages 25–55 on Arrival (Years)

	Schooling Acquired in USSR				
	5–12	13–14	15	16	17–22
Immigrants:					
Year 1	8.9	9.6	10.6	10.7	10.2
Year 2	9.0	9.8	11.3	11.5	10.7
Year 3	9.1	9.8	11.7	11.9	10.9
Year 4	9.2	10.0	12.1	12.5	11.4
Year 5	9.5	10.5	12.5	13.1	11.7
Year 6	. . .	11.3	12.3	13.7	12.8
Israelis	9.9	11.4	12.0	13.3	14.4

Israel, followed by a gradual recovery. Most of the immigrants, 75%, started their work career in Israel as unskilled workers. However, with the passage of time, the proportion of immigrants working in occupation 1 rises sharply from 11.6% in month 12 to 36.7% in month 60. Nonemployment also declines sharply from 26.2% in month 12 to 7.8% in month 60.

Within each broad occupational category, immigrants hold jobs that require some minimal level of schooling. The minimum schooling requirement on a reported two-digit occupation is empirically defined as the second decile of the native Israeli distribution of completed schooling levels in that same two-digit occupation.[9] Table 2 reports the average schooling requirements of the jobs that immigrants hold, in comparison with their imported schooling endowment and the average schooling requirements of jobs held by Israelis with the same schooling. The figures show that immigrants improve their jobs steadily, and after 6 years in Israel, the average requirements are similar to those of comparable Israelis. An exception is immigrants in the 17–22 years of schooling category.[10]

The transition rates associated with the changes in the occupational and job distributions are reported in table 3. The transition rates are produced by averaging monthly transitions out of each occupation over sample months. The figures indicate that entry into occupation 1 is mainly from nonemployment. There are also substantial flows from occupations 2 and

[9] The native Israeli distribution of completed schooling in each two-digit occupation is based on pooled cross-sectional data from the Israel Central Bureau of Statistics (CBS) during the period 1991–95. The native distributions are assumed to be in a steady state.

[10] Panel data on the occupational upgrading of natives who are new entrants to the Israeli labor market are not available for comparison purposes. The CBS data suggest that occupational upgrading among natives is slower than among immigrants (see Eckstein and Weiss 1998, table A3).

Table 3
Monthly Transitions across Occupations (Averaged, Months 1–71)

	Month $t + 1$			
Month t	Occupation 1	Occupation 2	Occupation 3	No Job
Occupation 1	.994	.000	.001	.005
Occupation 2	.006	.975	.003	.015
Occupation 3	.002	.001	.978	.019
No Job	.018	.009	.093	.881

3 into nonemployment. Thus, occupational upgrading most often occurs indirectly through a spell of nonemployment.

Although immigrants change jobs quite frequently, most of the immigrants reported an accepted wage only once in their employment history. Of the 697 immigrants in the engineers' sample, 571 reported wages at the survey date. Of the 389 immigrants in the representative sample, 102 reported wages once and 233 reported their accepted wages twice or more, yielding another 646 wage observations.[11] The total number of wage observations is 1,217. Approximately 45% of the reported wages are net of taxes.[12] Mean wages, by years of stay in Israel, are displayed in table 4. The figures show that immigrants who work in occupations 1 and 2 obtain higher wages than those who work in occupation 3. There is also a sharp increase in real wages within the sample period. By the sixth year in Israel, the average real wage is 78% higher than the average real wage in the first year. The overall wage growth results from wage growth within jobs and the gradual shift to higher paying jobs and occupations.

Before specifying the model and estimation procedure, it is useful to present descriptive regressions that illustrate some important features of the data. The ordinary least squares (OLS) results in table 5 illustrate that imported skills, such as schooling and work experience, have virtually no effect on wage outcomes during the early years in Israel. Instead, the determining factors are the occupation and job that the immigrant holds while in Israel. It is, therefore, important to model explicitly the process by which immigrants find jobs as well as the decision to accept job offers. The results also show that if one controls for the (endogenous) occupational variables, the knowledge of Hebrew has a small and insignificant effect on wages. Moreover, the knowledge of Hebrew is highly correlated with occupational history in Israel, suggesting that language acquisition

[11] The representative sample was surveyed twice, in 1992 and 1995. The second wave includes retrospective wage data.

[12] The questions in each survey slightly differed. Consequently, 26% of the reported wages in the engineers' sample are net of taxes, while in the representative sample 61% of the reported wages are net of taxes.

Table 4
Average Monthly Reported Wages of Immigrants by Occupation and Years since Arrival, Males Ages 25–55 on Arrival (1995 Israeli Shekels = 0.33 U.S. Dollars)

	Occupation in Israel							
	Occupation 1		Occupation 2		Occupation 3		All Occupations	
Year	*N*	Wage	*N*	Wage	*N*	Wage	*N*	Wage
1	6	3,856	1	2,764	71	2,322	78	2,445
2	26	3,422	32	2,764	189	2,416	247	2,567
3	33	3,623	11	3,288	155	2,732	199	2,911
4	41	4,562	14	3,337	163	2,861	218	3,211
5	92	5,047	29	3,575	202	3,413	323	3,893
6	57	5,340	10	4,263	83	3,688	150	4,354

might also be endogenous.[13] Given the lack of sufficient information on changes in the knowledge of Hebrew, the information on language ability is not incorporated into the analysis.

IV. The Model

The process by which immigrants gradually find a proper use for their imported skills is described through a model of on-the-job search. The search model is cast as a finite horizon discrete choice dynamic programming problem under uncertainty and corresponds to the decision problem of a single individual. Individuals are allowed to be heterogeneous, however, in both observed and unobserved dimensions.

Suppose that immigrants vary in their skill endowments and that local jobs vary in their minimal skill requirements. The output achieved by employing a particular worker on a particular job depends on the match between the worker and the job. Specifically, a worker with less skill than the required minimum cannot perform the job. A worker with more than the required minimum can perform the job and receives a wage that depends both on the minimal requirement and the worker's skill level.

Workers meet employers randomly and receive job offers. The arrival rate of job offers and the distribution of jobs differ across occupations. Jobs within each occupation j are ranked according to the job's minimal skill requirement, s, where $s = 0, 1, \ldots, S$. Occupations are also ranked from 1 to J, based on the frequency distribution of jobs, where 1 is the occupation containing the highest frequency of jobs with high minimal

[13] Immigrants reported whether they can understand, speak, write, and read professional material at the time of survey in both samples. The representative sample also reports speaking ability on arrival. There is no effect of such ability on wage outcomes. The knowledge of Hebrew variable does not distinguish much among immigrants because of the availability of publicly provided language courses.

Table 5
OLS Monthly Wage Regressions

	Log Wage			
	Hebrew Excluded		Hebrew Included	
Variable Name	Coefficient	*t*-Statistics	Coefficient	*t*-Statistics
Constant	7.729	64.460	7.754	62.977
Months in Israel	.0058	8.322	.0056	7.897
Job requirement	.0275	3.223	.0258	2.996
Occupation 1	.1836	3.025	.1853	3.022
Occupation 2	.0196	.445	.0155	.338
Schooling_0	−.0071	−1.484	−.0061	−1.227
Experience_0	.0006	.105	−.0024	−.044
Experience_0^2	−.0002	−1.418	−.0001	−.964
Physician_0	−.1586	−2.273	−.1755	−2.480
Engineer_0	.0129	.034	.0137	.377
Representative sample	−.0950	−2.547	−.0970	−2.506
Representative sample × net	−.1307	−4.274	−.1246	−4.016
Engineers sample × net	−.2084	−6.328	−.2071	−6.307
Knowledge of Hebrew	. . .	. . .	.0172	.659
N	1,217		1,164	
Adjusted R^2	.3548		.3503	

NOTE.—OLS = ordinary least squares. A variable with a subscript of 0 indicates value on arrival. The variable net indicates the reported wage is net of taxes.

skill requirements. Occupation J is the occupation with no skill requirements and a single wage, interpreted as the nonemployment state. Firms in different occupations offer a different wage for a given s, depending on technology and demand conditions. A local employer in occupation j with job s who meets a worker with skill s^* extends a job offer if and only if $s^* \geq s$. If the worker is acceptable to the firm, the worker may choose whether to accept the offer.

Workers have a finite working life, T, and time is discrete, $t = 1, 2, \ldots, T$. In any period, a worker can be in one of $J \times S$ employment states. In any given state, the worker receives a flow of wages and nonmonetary returns. He may also receive an alternative job offer or a notice of immediate job termination. It is assumed that, at most, one job offer arrives each period. This offer may be from any one of the $J \times S$ jobs. The probability of receiving a job offer in any period t is modeled as the product of three components, λ_{jkt}, $P_k(s)$, and $\Phi_k(s^* \geq s)$.

The first component of the job offer probability, λ_{jkt}, is the probability of meeting an employer in occupation k, given the current employment state is in a job in occupation j. Specifying the probability of meeting an employer in occupation k as a function of the previous occupation j incorporates state dependence.[14] When $j = k$, λ_{jkt} is the probability of

[14] The choice of occupation is equivalent to the choice of subsequent search intensity. For reasons of computational tractability, the choice of search intensity within occupations is not modeled.

meeting a different employer in the same occupation. An immigrant may be more likely to meet a new employer in the same occupation in which he currently works. There is also a positive probability, given by

$$1 - \sum_{j=1}^{J} \lambda_{jkt},$$

that a person in occupation j does not meet another employer in period t.

The second component of the job offer probability, $P_k(s)$, is the probability that the minimal skill requirement for the job is s. This component is conditional on having met an employer in occupation k. The last component of the job offer probability, $\Phi_k(s^* \geq s)$, is the probability that the worker is acceptable to the firm, or $s^* \geq s$. If a job offer arrives, which occurs with probability $\lambda_{jkt} P_k(s) \Phi_k(s^* \geq s)$, the individual decides whether to accept the offer by comparing its discounted present value with the discounted present value of other feasible alternatives. The other feasible alternatives are nonemployment and the current job, unless terminated. Job termination is stochastic and occupation specific. The job termination probability is denoted as δ_j.

The current period returns on each job are specified as the sum of a job-specific wage, w_{sjt}, and a job-specific monetary equivalent of nonmonetary returns, n_{sjt}. The value of future wages plus nonmonetary returns is not known at time t; only the distribution is known. The worker thus faces a problem of decision under uncertainty in several dimensions. It is assumed that in each period the worker seeks to maximize his remaining expected lifetime income, inclusive of the monetary value of nonmonetary returns.

The remaining expected lifetime income of the individual, in each state at time t, can be calculated recursively, using the following system of Bellman equations:

$$\begin{aligned} V_{sjt} = {} & w_{sjt} + n_{sjt} + \Delta(1 - \delta_j) \\ & \left(\sum_{k=1}^{J-1} \lambda_{jk,t+1} \sum_{s^0=0}^{S} P_k(s') \{ \Phi_k(s^* \geq s') E_t \max(V_{sj,t+1}, V_{s^0k,t+1}, V_{J,t+1}) \right. \\ & \qquad + [1 - \Phi_k(s^* \geq s')] E_t \max(V_{sj,t+1}, V_{J,t+1}) \} \\ & \left. \qquad + \left(1 - \sum_{k=1}^{J-1} \lambda_{jk,t+1} \right) E_t \max(V_{sj,t+1}, V_{J,t+1}) \right) \\ & + \Delta\delta_j \left(\sum_{k=1}^{J-1} \lambda_{jk,t+1} \sum_{s^0=0}^{S} P_k(s') \{ \Phi_k(s^* \geq s') E_t \max(V_{s^0k,t+1}, V_{J,t+1}) \right. \\ & \left. + [1 - \Phi_k(s^* \geq s')] E_t(V_{J,t+1}) \} + \left(1 - \sum_{k=1}^{J-1} \lambda_{jk,t+1} \right) E_t[V_{J,t+1}) \right). \end{aligned} \tag{1}$$

Expression V_{sjt} denotes the discounted present value of remaining lifetime income in job s in occupation j in month t. Expression $\Delta = 1/(1 + r)$ is the discount factor, and r is the monthly interest rate. The first term in large parentheses is the value of expected future returns given that the current job has not been terminated, and the second term in large parentheses is the value of expected future returns given the current job has been terminated.

The process of transitions from the initial state of nonemployment to subsequent jobs, implied by the dynamic optimization problem, has several salient features. The first feature is that transitions lead to improvements in income (broadly defined to include both wages and nonmonetary returns) as long as the worker can maintain his current state. The second feature is that it is possible for a worker to accept a job with a lower wage or nonmonetary returns if he is compensated in terms of expected future income. In choosing jobs, workers examine not only current income, but also future income prospects, which depend on wage growth and alternative job offer and layoff probabilities. Finally, because of the frictions embedded in the model, and the possibility of on-the-job search, a worker will usually not wait until he gets the best job for which he is qualified but will accept jobs for which he is overqualified. Thus, the model naturally captures the phenomenon of occupational downgrading and loss of skill, but in a dynamic context, allowing for a gradual climb up the occupational ladder.

It should be noted that the model is nonstationary, since wages rise with time, and there is a finite horizon.[15] These features are crucial for the understanding of the behavior of immigrants who arrive in Israel with different skills and at different stages of their life cycle. The rewards that immigrants obtain for their imported skills are initially very low but then rise as they adapt to the new labor market.

V. Implementation of the Model

The length of each period t is assumed to be a month. Job offers and job terminations occur at the beginning of each month, and wage offers adjust accordingly. The length of the planning period is the remainder of the immigrant's working life (65 − age at immigration). However, the model is solved for each individual, for only the first 72 months since arrival in Israel. Terminal values at month 73 are specified to approximate the value of anticipated events in subsequent periods. Since it is difficult, in general, to find analytical solutions to dynamic programs of this type, the model is solved numerically by backward recursion.

[15] There are few empirical applications of on-the-job search models in a nonstationary environment. Wolpin (1992) and Sauer (1998) are two recent studies of this type.

In each month, the immigrant's employment state is assumed to be in one of four broad occupational categories. The four occupational categories are academic ($j = 1$), technical ($j = 2$), blue-collar ($j = 3$), and nonemployment ($j = 4$). The first component of the job offer probability λ_{jkt} is specified as

$$\lambda_{jkt} = \frac{\exp(a_{jk}x_{it})}{1 + \sum_{k=1}^{3} \exp(a_{jk}x_{it})} \tag{2}$$

for $j = 1,2,3,4$ and $k = 1,2,3$, where x_{it} is a vector of individual characteristics and a_{jk} is a vector of parameters. The measured characteristics in x_{it} are immigrant's occupation in the former USSR, whether the immigrant was an engineer in the former USSR, whether the immigrant was a physician in the former USSR, age at immigrant's arrival in Israel, and year of immigrant's arrival in Israel (cohorts 1989–90, 1991, and 1992–95). Expression x_{it} also contains permanent unmeasured characteristics. Each immigrant can be one of three unobserved discrete types. The effects of being a type 1 immigrant or a type 2 immigrant are estimated relative to the benchmark case of being a type 0 immigrant.[16]

Schooling is used as the skill relevant to employers for assessing the quality of the job-worker match. Each broad occupational category thus includes a hierarchy of jobs indexed by their minimal schooling requirement, s, where s is assumed to range from 0 to 21. As noted earlier, the second decile of the native Israeli distribution of completed schooling levels within each two-digit occupation in Israel determines the minimum schooling requirement for that two-digit occupation.[17] The resulting empirical frequency of minimum schooling requirements in broad occupational category j defines $P_j(s)$. The second component of the job offer probability is thus estimated separately from the model.[18]

The third component of the job offer probability $\Phi_j(s^* \geq s)$ is the probability that the immigrant's "true" schooling endowment, s^*, exceeds the required minimum s of the local employer in occupation j. Each employer's assessment of the immigrant's "true" schooling level is idiosyn-

[16] Three types are sufficient to distinguish between absolute and comparative advantages in the unobserved ability of immigrants in different occupations.

[17] We attempted to estimate the model without empirically defining the minimum schooling requirement. However, this introduces a form of serial correlation that necessitates high dimensional integrations.

[18] The minimum schooling requirements and their empirical frequencies are reported in Weiss, Sauer, and Gotlibovski (2001). Expression $P_j(s)$ varies greatly by broad occupational category j.

cratic and assumed to be a linear function of the immigrant's imported schooling s_0.[19] That is,

$$\Phi_j(s^* \geq s) = \Pr(\alpha + \beta_j s_0 + u \geq s) = \frac{\exp\left(\frac{\beta_j s_0}{v} - \frac{s}{v} + \frac{\alpha}{v}\right)}{1 + \exp\left(\frac{\beta_j s_0}{v} - \frac{s}{v} + \frac{\alpha}{v}\right)}, \tag{3}$$

where u is assumed to be logistically distributed with zero mean and variance $v^2\pi^2/3$. The parameters α and β_j provide a simple linear translation of schooling acquired abroad into equivalent local units. Thus, the expected "true" schooling of an immigrant, who acquired s_0 in the former USSR, and who meets an Israeli employer in occupation j, is given by

$$s^* = \alpha + \beta_j s_0 \tag{4}$$

years.

It is important to note that the probability that an immigrant receives a job offer requiring s could simply be modeled as one component over the 18 empirically defined jobs in the choice set, say, $\lambda_{js_0s_0}$. The identification of the offer probabilities in this case would be driven by the employment decisions and accepted wages of the immigrants themselves. However, the frequency of the distinct jobs among natives in each occupation, $P_j(s)$, is an important determinant of the frequency by which immigrants meet employers. The second component of the job offer probability adjusts the immigrant job offer arrival rates for this consideration.[20] The third component, $\Phi_j(s^* \geq s)$, reflects the sequential nature of obtaining a final job offer and the unique importance of imported schooling levels in that process. Expression $\lambda_{jkt}P_k(s)$ could thus be thought of as the probability of obtaining an interview after which the true schooling endowment of the immigrant and, hence, the quality of the match is determined by the employer. The exclusion of s_0 from λ_{jkt} and the restriction of equal intercepts in $\Phi_j(s^* \geq s)$ aid in the separate identification of the parameters in this latter component.

The wage offer in a job requiring a minimum of s years of schooling, in occupation j at month t, is given by

$$w_{sjt} = \exp(\gamma_{0j}s + \gamma_{1j}x_t), \tag{5}$$

where γ_{0j} is the impact of the minimal schooling requirement on output in occupation j, x_t is a vector of individual characteristics, and γ_{1j} is a

[19] For analytical simplification, employers do not update their beliefs regarding true schooling levels.

[20] One drawback of introducing the separately estimated $P_j(s)$ is the effect on the standard errors of the estimates of the model. Correcting the standard errors could be accomplished by bootstrapping. However, in this setting, it is not computationally practical.

vector of coefficients. The measured characteristics in the wage offer function are the schooling and experience the immigrant acquired in the former USSR, the immigrant's occupational category in the former USSR, whether the immigrant was an engineer in the former USSR, whether the immigrant was a physician in the former USSR, the year of arrival in Israel (cohorts 1989–90, 1991, and 1992–95) and the time (months) since arrival. Expression x_t also contains indicators for being a type 1 or type 2 immigrant, thus incorporating permanent unobserved heterogeneity in the wage offer functions.

Uncertainty in current period returns is assumed to arise from independently and identically distributed shocks to the nonmonetary benefits in each employment state, given by

$$n_{sjt} = b_{jt} + \nu\varepsilon_{sjt}, \tag{6}$$

where $b_{jt} = (e^{k_j} - 1)w_{sjt}$ and $j = 1,2,3$. This specification forces the deterministic component of nonmonetary returns to remain a fixed proportion of the wage in each period. In nonemployment, $j = 4$ and

$$b_{jt} = 580e^{k_{41}occ_01 + k_{42}occ_02}.$$

This latter specification implies that low-skill immigrants, who worked in occupation 3 in the former USSR, receive nonemployment benefits of 580 New Israeli Shekels (NIS) per month.[21] Immigrants with more skills are allowed to have a higher value of nonemployment, mainly because they can exploit the period of nonemployment for training. It is thus possible to estimate the implicit average value of training for immigrants who worked in occupations 1 and 2 in the former USSR.[22]

The error terms ε_{sjt}, in equation (6), take different values in each of the 19 ($J \times S$) elements of the choice set in month t, enter linearly in the value functions, and are assumed to follow the type 1 extreme value distribution, with zero mean and variance $\pi^2/6$. These assumptions enable the use of a closed-form expression for expected maximum future returns. Specifically,

$$E_t \max(V_{sj,t+1}, V_{s^0k,t+1}, V_{4,t+1})$$

$$= \nu \ln\left[\exp\left(\frac{\overline{V}_{sj,t+1}}{\nu}\right) + \exp\left(\frac{\overline{V}_{s^0k,t+1}}{\nu}\right) + \exp\left(\frac{\overline{V}_{4,t+1}}{\nu}\right)\right], \tag{7}$$

[21] The amount 580 NIS is the average level of unemployment benefits received by the immigrants during the sample period. A particular number is needed for identification purposes.

[22] Eckstein and Cohen (2000) explicitly model the choice to participate in an immigrant training program.

where $\overline{V}_{sjt}$ denotes the mean value of being in job s in occupation j at period t, and ν is a parameter that regulates the relative importance of nonmonetary returns or the variance of the shocks (see Rust 1994).

Note that uncertainty in current period returns could have been modeled as a multiplicative shock to the wage function rather than as a linear shock to nonmonetary returns. However, this strategy would rule out the use of the exact closed form in equation (7) and necessitate the use of Monte Carlo integration techniques to approximate the expected maximum return function.[23] Another alternative is to have the wage function enter linearly in the value functions and to interpret the shock as affecting wages instead of nonmonetary returns. However, this latter strategy does not ensure that wage offers will always be greater than zero.

The terminal value functions for each element in the choice set are assumed to be proportional to the current period returns in month 73, with a correction for finite life, or retirement at age 65. Specifically,

$$V_{sj73} = \frac{1 + q^T}{1 - q}(w_{sj73} + n_{sj73}) \exp(\gamma_j) \tag{8}$$

for $j = 1,2,3$, where $q = 1/(1 + r)$, $(1 + q^T)/(1 - q) = \sum_{t=1}^{T}(1 + r)^{t-1}$, and $T = 65 -$ age at immigration. The monthly interest rate is fixed at 6%. This relatively high rate is chosen to reflect the fact that immigrants had almost no initial assets and face borrowing constraints.[24] The proportionality constants γ_j and $j = 1,2,3$ are estimable parameters and parsimoniously capture the implicit value of future events.

The model is estimated by maximum likelihood. For a given vector of trial parameters, the dynamic program is solved by backward recursion for each immigrant-type combination. Given the type-specific expected value functions for each individual in every state in each month, the estimation problem is reduced to a static panel data multinomial logit with a discrete distribution for individual effects (Heckman and Singer

[23] The incorporation of endogenously accumulated job or occupation-specific work experience in the model is also economically desirable but would similarly necessitate the use of approximate solution techniques to solve the dynamic program (see Keane and Wolpin 1994). Approximate solution techniques have the drawback of requiring stronger conditions for consistent estimation.

[24] We attempted to estimate the interest rate along with the other parameters of the model but were not successful. The interest rate could not be separated from the arrival rates of job offers.

1984). The assumptions on ε_{sjt} allow the choice probabilities to be calculated according to the closed form

$$\Pr(V_{s^0kt} \geq V_{sjt}, V_{s^0kt} \geq V_{4t})$$

$$= \left\{ \frac{\exp[(\overline{V}_{s^0kt} - \overline{V}_{4t})/\nu]}{1 + \exp[(\overline{V}_{sjt} - \overline{V}_{4t})/\nu] + \exp[(\overline{V}_{s^0kt} - \overline{V}_{4t})/\nu]} \right\}. \quad (9)$$

Observed wages on accepted jobs are incorporated into the estimation by multiplying the choice probability in month t by the measurement error density in the reported wage. Measurement error in reported wages is assumed to be lognormally distributed with estimable variance σ^2. The mean of the measurement error is specified as a linear function (with interactions) of the subsample from which the observation was taken (engineer or representative), and as a dummy for whether the reported wage is net of taxes.[25]

The individual's unconditional likelihood contribution is constructed by computing a weighted average over the individual's three type-specific likelihood contributions. The weights are specified to be a multinomial logistic function of the subsample indicator, thus allowing for heteroscedasticity in the distribution of mass points. The parameters of the model are recovered by solving the dynamic program and constructing the likelihood contributions for each iteration of the optimization algorithm. The solution to the dynamic program, the inclusion of permanent unobserved heterogeneity, and the joint estimation of the wage functions and choice probabilities correct the wage function estimates for biases resulting from self-selection.

VI. Results

This section discusses specific parameter estimates of interest and highlights the main features of the model. The parameter estimates and their associated standard errors are presented in table A2.[26]

A. Wages

The estimated parameters of the wage offer functions indicate that the returns that immigrants obtain in Israel for potential work experience in the former USSR are very small in occupations 1 and 3. In occupation 2, returns are relatively higher but still small in magnitude. By contrast, experience accumulated in Israel during the first 6 years, as proxied by

[25] The subsample indicator and the net wage indicator thus appear in the density of the measurement error, not in the wage offer functions.

[26] There are 104 estimated parameters. Standard errors are calculated by using numerical derivatives and the outer product approximation to the Hessian.

time in Israel, has a substantial positive effect of 0.00665 per month (8.0% annually) in occupations 1 and 2. In occupation 3, experience accumulated in Israel has a slightly smaller but still substantial positive effect of 0.00649 per month (7.8% annually).

The impact of imported schooling on wages, on any given job for which schooling exceeds the minimal requirement, is negligible in occupation 3, slightly negative in occupation 1, and somewhat more negative in occupation 2. However, higher imported schooling levels are associated with a higher probability of obtaining a job with a greater minimal schooling requirement. Imported schooling is thus quite important in determining lifetime earnings. Immigrants who find jobs with higher schooling requirements obtain a wage increase of 3.3% per year of required schooling in occupations 1 and 2 and 1.1% in occupation 3.[27] The model thus captures the two main features of the wage data: increasing mean wages over time and rising inequality. The rising inequality results from the gradual move of immigrants with higher schooling levels into jobs that have higher minimal schooling requirements.

The effects of other imported characteristics on wage offers are generally not statistically significant. The exceptions are the significant positive effect in occupation 2 of having been an engineer and the significant negative effect of having been a physician in occupations 1 and 3. The results also indicate that unobserved types 1 and 2 obtain substantially lower wages than unobserved type 0 in all occupations. Type 1 is penalized mainly in occupations 2 and 3, while type 2 is penalized mainly in occupations 1 and 3.

B. Nonmonetary Returns

The variance component v of nonmonetary returns is estimated to be 3,267 NIS. Thus, a nonmonetary shock of one standard deviation, which under the extreme value distribution occurs with a probability of about 13%, has an effect that is approximately equal to the mean wage in the sample, 3,304 NIS. This suggests that nonmonetary shocks can play an important role. One feature of the data that influences this result is the presence of transitions, mainly within occupation 3, into jobs with lower minimal schooling requirements and lower wages.

The estimates for the deterministic component of nonmonetary returns, $k_j, j = 1,2,3$, imply that mean nonmonetary benefits are zero for jobs in occupation 1, 16% of the wage in occupation 2, and 18% of the wage in

[27] A linear projection of first-period expected value functions on imported schooling and age on arrival yields a highly significant return to schooling of 4.3%. The return to imported schooling remains highly significant but decreases in magnitude to 1.6% when the other imported characteristics, except occupation in the former USSR, are added to the regression.

Table 6
Predicted Meeting and Choice Probabilities by Occupation and Type

	Occupation 1 Type			Occupation 2 Type			Occupation 3 Type			No Job Type		
	0	1	2	0	1	2	0	1	2	0	1	2
	Meeting Probabilities											
Prior occupation:												
Occupation 1	.032	.002	.013	.003	.000	.002	.003	.001	.003	...	...	...
Occupation 2	.016	.001	.005	.023	.003	.019	.014	.003	.018	...	...	...
Occupation 3	.005	.000	.002	.004	.000	.003	.039	.008	.049	...	...	...
No job	.032	.002	.011	.013	.002	.011	.125	.029	.158	...	...	...
	Choice Probabilities											
Month:												
12	.164	.017	.048	.055	.015	.060	.564	.168	.583	.216	.800	.309
24	.229	.034	.066	.060	.027	.092	.627	.245	.643	.085	.694	.200
36	.278	.050	.080	.058	.038	.115	.610	.298	.654	.054	.615	.151
48	.333	.067	.099	.056	.049	.147	.569	.321	.645	.042	.563	.109
60	.386	.083	.109	.056	.059	.175	.520	.301	.634	.037	.557	.081

occupation 3. However, the $\hat{k}_j$'s are not significantly different from zero.[28] The estimate of k_{41} implies that immigrants from occupation 1 in the former USSR value nonemployment benefits by 45% more than unskilled immigrants from occupation 3. The estimate of k_{42} implies that immigrants from occupation 2 value nonemployment benefits by 5.3% more than unskilled immigrants. The additional benefit among skilled immigrants may reflect the value of training programs in which many of these workers participated.[29]

C. Job Offer and Job Termination Probabilities

The first panel of table 6 presents the estimated average values of λ_{jkt} for each unobserved type of immigrant.[30] There are large differences in these probabilities. The estimates imply that type 0 immigrants meet substantially more employers in occupation 1. Type 1 and type 2 immigrants

[28] This is because of correlation with the terminal value parameters, which also influence the value of a job within the sample period. The terminal value parameters are highly significant.

[29] Approximately 60% of male immigrants from occupations 1 and 2 in the former USSR participated in job training programs. Immigrant job training is provided by the government and lasts 6 months, on average.

[30] The meeting probabilities, choice probabilities, and predicted quantities for assessing model fit are calculated by drawing from the distributions of the model's random elements, simulating a choice history for each individual 10,000 times and averaging over all simulations and individuals.

meet employers mainly in occupation 3. The meeting probabilities are generally higher from nonemployment for all types.[31]

The estimated values of λ_{41t} for types 0, 1, and 2 are 0.032, 0.002, and 0.011, respectively. The estimated values of λ_{43t} are much higher, 0.129, 0.029, and 0.165 for the three types, respectively. Thus, from nonemployment, a type 0 immigrant's expected waiting time to meet an employer in occupation 1 is 29 months, while his expected waiting time to meet an employer in occupation 3 is only 8 months. These estimates reflect the market conditions that immigrants face on entry. It is much easier for them to find jobs as unskilled workers.

Based on the estimated parameters of λ_{jkt}, it is further noted that older individuals, and those who arrived in Israel in later years, face lower probabilities of meeting employers in occupations 1 and 2. This reflects possible changes in cohort quality and "congestion" effects in Israel. As expected, the occupational category in the former USSR is an important signal for Israeli employers. Immigrants who worked in occupation 1 in the former USSR meet substantially more employers in occupation 1 in Israel. In comparison with all others who worked in occupation 1 in the former USSR, engineers meet fewer employers in occupation 1, while physicians meet more.

The estimated $\Phi_j(s^* \geq s)$, the probability of being accepted to a job having already met an employer, yields the following quality adjustment for imported schooling:

$$\begin{aligned} s_1^* &= 10.072 + 0.456 s_0, \\ s_2^* &= 10.072 + 0.270 s_0, \\ s_3^* &= 10.072 + 0.080 s_0. \end{aligned} \tag{10}$$

The marginal effects of imported schooling are thus 0.456 in occupation 1, 0.270 in occupation 2, and 0.080 in occupation 3. The corresponding "break even" levels are 19, 14, and 11 years of schooling in occupations 1, 2, and 3, respectively. For comparability with Israelis, imported schooling is adjusted downward (upward) if it is above (below) the break-even level.

The estimated acceptance probabilities, which depend also on the estimated variances, imply that, in occupation 1, immigrants are accepted with probability close to one into jobs that require less than their imported schooling, s_0. They are also accepted with a positive probability into jobs requiring slightly more schooling than they possess. For example, an immigrant with 15 years of imported schooling is accepted with proba-

[31] For example, the probability of meeting an employer in occupation 1 is higher from nonemployment than from jobs in occupation 3 and occupation 2 ($\hat{\lambda}_{41t} > \hat{\lambda}_{31t} > \hat{\lambda}_{21t}$).

bilities of 0.909, 0.451, and 0.063 to jobs requiring 16, 17, and 18 years of schooling, respectively.

These results reflect the fact that, in the former USSR, one could become an engineer (physician) by going to elementary and high school for 10 years, followed by 5 (6) years of university training. Immigrants who find jobs in occupation 1 as doctors or engineers are treated as if they have schooling comparable with Israelis, that is, 16 (18) years of schooling. In occupation 3, practically everyone is accepted to jobs requiring 10 years or less, but the best jobs in this occupation, requiring 12 years of schooling, are generally not available to immigrants, even with a high level of schooling. Similarly, immigrants with a high level of schooling have only a small probability of being in jobs requiring 16 years of schooling in occupation 2. Stated differently, immigrants have a lower probability than Israelis for receiving the top offers in occupations 2 and 3.

The estimates of δ_j, the probabilities of involuntary job separation, are 0.0035, 0.0081, and 0.0052 in occupations, 1, 2, and 3, respectively. The termination probabilities are small but highly significant. The estimates imply that immigrants can hold on to their jobs for long periods of time (24, 10, and 16 years, respectively) unless they decide to quit.

D. Choice Probabilities and Types

The second panel of table 6 displays the predicted occupational choice distribution by unobserved type for selected months after immigration. The figures show that, in occupation 1, the proportion of each type of immigrant grows over time but that there is a much higher proportion of type 0 immigrants in each month. Moreover, the proportion of type 0 immigrants increases at the fastest rate. The strong selection on unobservables is illustrated by the prediction that, in month 60, 89% of those working in occupation 1 are type 0 immigrants. The estimated probabilities of being a type 0 immigrant are 0.55 in the representative sample and 0.76 in the engineers' sample.

In occupation 2, the proportion of type 2 immigrants is the highest in each month and grows at the fastest rate. In occupation 3, the proportion of each type of immigrant rises to a peak and subsequently falls. The peak occurs earlier for type 0 and type 2 immigrants. In nonemployment, the proportion of type 1 immigrants is clearly the highest. Nonemployment falls sharply for type 0 and type 2 and only gradually for type 1 immigrants. In month 60, 42% of those in nonemployment are type 1 immigrants. The probabilities of being a type 1 immigrant are 0.04 and 0.07 in the representative sample and the engineers' sample, respectively.

The choice frequency patterns are explained by the willingness of a nonemployed type 0 immigrant to accept almost any job offer in the early months after arrival. However, as his occupational status in Israel im-

proves, he accepts fewer offers outside of occupation 1. A type 1 immigrant is reluctant to accept offers from occupation 3 in which his wage penalty is highest. A type 1 immigrant waits for offers in occupation 1, but these offers arrive with a very low frequency. In contrast, a type 2 immigrant accepts offers mainly from occupation 2, in which his wage penalty is the lowest.

Based on the sign patterns of the model's estimated parameters, type 0 may be considered the high-ability type, type 1 the low-ability type, and type 2 the intermediate-ability type. Type 0 immigrants obtain higher wages and receive more job offers in occupation 1. The penalties for lower ability, in terms of lower wages or fewer job offers, are substantial. Despite an absolute disadvantage in occupation 1, type 1 has a comparative advantage in this occupation, while type 2 has a comparative advantage in occupation 2.

VII. Model Fit

Figure 1 displays the actual and predicted choice frequencies in each occupation over the first 60 months since arrival.[32] The model captures quite well the sharp decline in nonemployment, the sharp rise and subsequent fall in the proportion of workers in unskilled jobs, and the gradual increase in the proportion of skilled workers. The sharp decline in nonemployment results from the willingness of skilled workers to accept employment in unskilled jobs. The subsequent fall in the proportion of workers in unskilled jobs results from the eventual occupational upgrading of skilled workers. Unadjusted χ^2 test statistics indicate that differences between the actual and predicted choice frequencies over the four occupations are not significant, at the 5% level, in 54 out of 72 months.[33]

The model is also capable of reproducing the observed transitions between occupational states reported in table 3.[34] The time patterns in the actual and predicted transition rates to and from nonemployment, over the first 60 months since arrival, are illustrated in figure 2. Note that the decline in the exit rate from nonemployment and the decline in the reentry rate into nonemployment are captured without relying on time effects in the arrival rate of job offers. The decline in the reentry rate into nonemployment occurs as wages rise sharply over time and the opportunity cost

[32] The sample size between months 61 and 72 is much smaller than prior to month 60.

[33] A single χ^2 test over the 72 months indicates that the actual and predicted choice distributions are significantly different. This mainly results from the misses in months 1–8 and 16–23.

[34] On the basis of a χ^2 test, the hypothesis that the actual and predicted transition matrices are identical is not rejected.

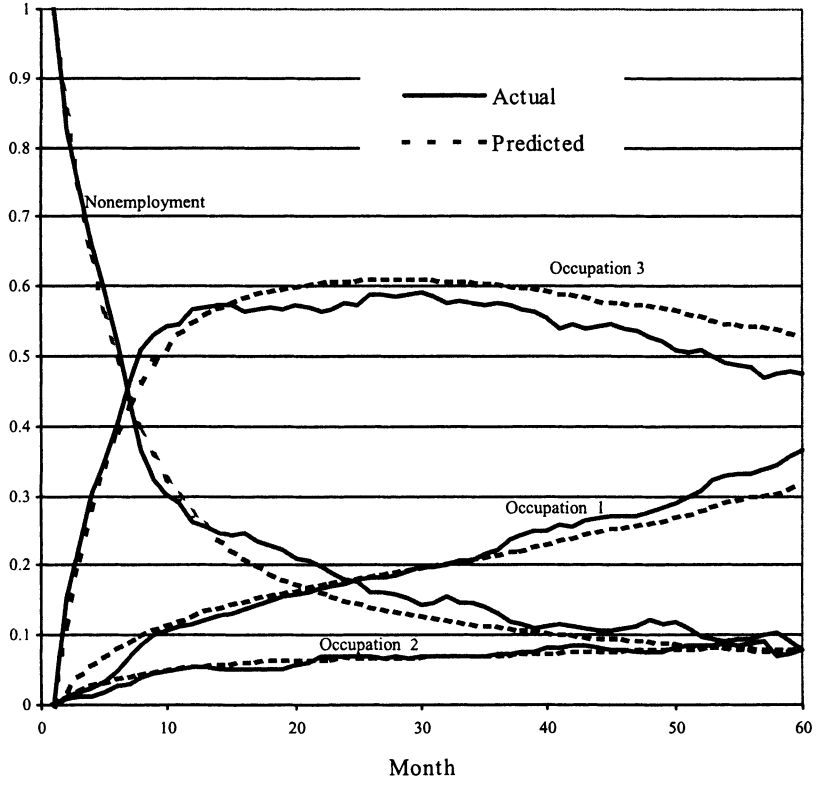

FIG. 1.—Actual and predicted choice frequencies

of searching efficiently in nonemployment rises.[35] The decline in the exit rate from nonemployment is a result of the changing mix of unobserved types in the population of the nonemployed over time. Type 0 and type 2 immigrants have relatively high exit rates. Thus, in the later months, the population of the nonemployed consists mainly of low-exit-rate type 1 immigrants. Chi-square tests indicate that the actual and predicted exit rates from nonemployment are not significantly different in 63 out of 72 months.[36] The actual and predicted reentry rates into nonemployment are not significantly different in 68 out of 72 months.[37]

[35] Layoffs and random shocks to nonmonetary returns induce transitions into nonemployment. Voluntary transitions into nonemployment reflect, in part, participation in training programs.

[36] A single χ^2 test over the 72 months indicates that actual and predicted transitions out of nonemployment are significantly different. This mainly results from misses in months 2–9.

[37] A single χ^2 test over the 72 months indicates that the actual and predicted reentry rates into nonemployment are not significantly different.

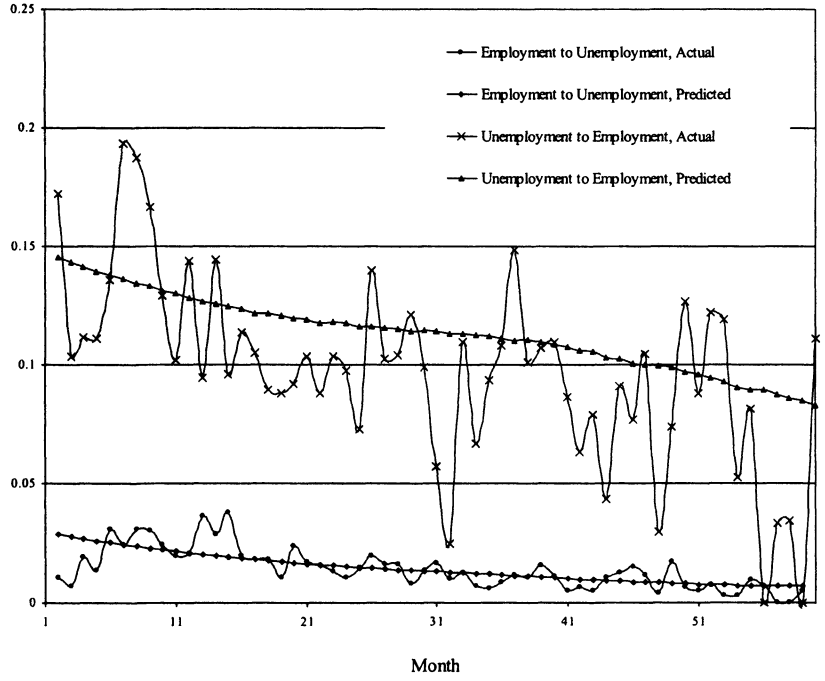

FIG. 2.—Actual and predicted transitions to and from nonemployment

Table 7 presents the actual and predicted mean accepted wages in each occupation-job category as well as predicted mean accepted wages by type. Predicted wages track observed wages quite well for the cells in which there are a substantial number of wage observations. The simple correlation between actual and predicted wages is 0.602 in logs. Although the maximum likelihood estimation adjusts the coefficients of the wage functions to fit both the wages and occupational choices, it yields a wage fit that exceeds the fit of a reduced-form log-linear regression of wages on the same exogenous variables that appear in the structural model (0.519 in logs). For comparison purposes, the predicted values from the second OLS regression specification in table 5, which includes the endogenous job choice variables, are also displayed.[38]

Finally, it should be noted that the model mimics quite well the average proportions of stayers and movers from period t to period $t + 1$.[39] Stayers

[38] The OLS regression is similar but not identical to the wage functions estimated in the model. For example, the regression is not estimated separately for each occupation and does not include controls for unobserved heterogeneity. The corresponding measure of fit is 0.592 in logs.

[39] The actual and predicted figures are reported in Weiss et al. (2001).

Table 7
Actual and Predicted Monthly Wages by Occupation, Job and Type (1995 Israeli Shekels = 0.33 U.S. Dollars)

Occupation and Job	No. with Wages > 0	Actual Wages	Predicted Wages				
			Type 0	Type 1	Type 2	All	OLS
3,2	5	2,023	2,920	1,004	2,070	2,587	3,047
3,6	3	2,983	3,093	1,058	2,193	2,734	2,538
3,8	294	2,649	3,193	1,080	2,250	2,855	3,043
3,9	126	3,184	3,252	1,092	2,287	2,928	3,353
3,10	304	2,909	3,315	1,106	2,329	2,999	3,308
3,11	116	3,178	3,377	1,118	2,374	3,073	3,472
3,12	15	3,656	3,429	1,130	2,419	3,145	3,818
2,12	82	3,290	3,521	1,726	2,996	3,267	3,517
2,14	14	3,421	3,857	1,848	3,227	3,617	3,120
2,16	1	2,742	3,983	1,913	3,323	3,761	2,871
1,12	12	3,761	3,861	3,465	2,568	3,738	4314
1,15	11	3,878	4,355	3,823	2,957	4,210	4,125
1,16	209	4,799	4,568	3,960	3,107	4,426	4,485
1,17	6	4,908	4,752	4,089	3,216	4,618	3,606
1,18	17	3,950	4,850	4,173	3,269	4,708	3,496

NOTE.—OLS = ordinary least squares.

are defined as those immigrants who do not change their jobs. Movers are subdivided into job changers within and across occupations. Movers within occupations have a predicted average monthly wage growth of 2%, and movers across occupations have a substantial average wage growth of 18.3%. However, such switches are rare and occur in only 1.1% of the time periods. The average annual growth rate in wages for employed workers is 8.82% a year. Approximately 18% of the annual wage growth can be attributed to job switches. The predicted impact of job changes on wage growth is thus quite large.[40]

VIII. Loss of Human Capital

In order to assess the magnitude of the costs of immigration associated with frictions and imperfect transferability of skills, the mean simulated earnings (actual earnings) of each immigrant, in each period, is compared with two hypothetical values. The first hypothetical value (potential1 earnings) is the mean potential earnings of the immigrant, in each period, over a counterfactual job distribution. The counterfactual job distribution is the distribution of minimal schooling requirements among native Israeli workers with the same years of schooling as the "true" schooling endowment of the immigrant, s^*. The predicted wages on each job in the counterfactual job distribution is computed according to the estimated

[40] These results are similar to reduced form estimates, based on pooled cross-section data for the period 1991–95, presented in Eckstein and Weiss (1998). Apart from the differences in the samples, the main methodological difference in the study presented here is that occupational switches are endogenously determined.

immigrant wage offer functions.[41] The second hypothetical value (potential2 earnings) is the mean potential earnings of the immigrant, over the same counterfactual job distribution as in potential1 earnings, but with predicted wages on each job computed according to the parameters of a native Israeli wage regression.[42] The difference between potential1 earnings and actual earnings is a measure of earnings loss resulting from frictions (job distribution mismatch), and the difference between potential2 earnings and potential1 earnings is a measure of earnings loss resulting from a lower market valuation of imported skills.

The actual and potential earnings of each immigrant are computed from their age when they arrived in Israel until retirement at age 65. The methodology used to solve the dynamic program past month 72 (the horizon of the model) is outlined in appendix B. Figure 3 displays the time paths of simulated actual and potential earnings for immigrants who worked in occupation 1 in the former USSR, by age group at arrival. The simulated actual earnings of immigrants are always below their simulated potential earnings, but the gap closes with the duration of time in Israel. The change over time in potential2 earnings is driven by the immigrants' increase in local work experience, where the impact of total work experience (imported plus local) is evaluated using the native Israeli regression coefficients. The sharp rise in potential1 earnings reflects the higher return that immigrants obtain for local work experience using the coefficients of the immigrant wage functions.[43] The even sharper rise in simulated actual earnings occurs as the distribution of jobs that immigrants hold changes over time. That is, the strong wage growth is accompanied by a movement into higher paying jobs and occupations.

There are marked differences in the time paths of actual and potential earnings between age groups. Younger immigrants (younger than age 40 on arrival) initially earn half of their potential but gradually close the gap. After 25 years in Israel, these immigrants earn 70% of what they would have earned as native Israelis. The gap in earnings in year 25 is evenly divided between job distribution mismatch and a lower market valuation of imported skills. Older immigrants (older than 40 on arrival) initially

[41] Since s^* is occupation specific, there is a counterfactual job distribution and corresponding mean wage in each occupation. The potential wage is thus defined as the maximum over the mean wages in each occupation. In order to not overstate this maximum, restrictions were imposed according to the occupation of the immigrant in the former USSR.

[42] The regression parameters are estimated by nonlinear least squares using data on 8,178 workers (selected from the Israel CBS Income Surveys 1991–94). The regression specification and results are reported in Weiss, Sauer, and Gotlibovski (2001).

[43] The higher return mainly results from rising returns to imported skills and complementarity between local and imported human capital (see Eckstein and Weiss 1998).

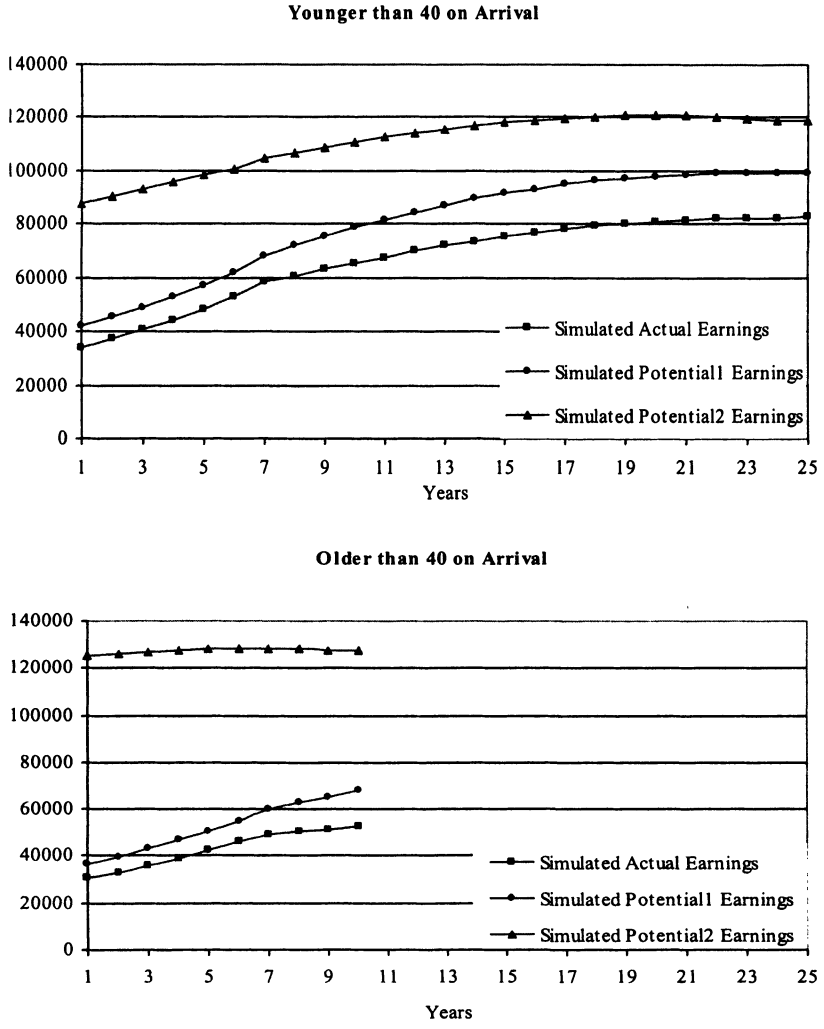

FIG. 3.—Simulated actual and potential earnings of immigrants (1995 Israeli shekels = .33 in U.S. dollars).

earn the same as younger immigrants, but these earnings constitute only a third of their potential, indicating negligible initial returns to imported work experience. As time since immigration advances, the rewards for imported skills rise for both younger and older immigrants, but the occupational status of older immigrants is substantially lower. Among older immigrants who worked in occupation 1 in the former USSR, 20% are predicted to be employed in occupation 1 in Israel 5 years after immi-

Table 8
Discounted Present Value of Lifetime Earnings Loss Males Ages 25–55 Arrival (1995 Israeli Shekels = 0.33 U.S. Dollars)

Sample Attributes	Loss Resulting from Frictions		Loss Resulting from Prices		Total Loss	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
Years of schooling:						
5–12	95,478	12.09	199,138	25.22	294,616	37.31
13–14	107,339	10.71	388,671	38.77	496,010	49.48
15	217,551	16.16	463,901	34.47	681,452	50.63
16	201,460	14.44	597,821	42.85	799,281	57.29
17–22	191,544	12.38	797,774	51.54	989,318	63.92
Occupation in the former USSR:						
1	211,498	14.63	619,855	42.88	831,353	57.51
2	112,560	10.12	531,082	47.77	643,642	57.89
3	46,930	5.91	282,630	35.58	329,560	41.49
Engineer	215,763	14.94	606,737	42.01	822,500	56.95
Physician	150,934	9.46	880,462	55.18	1,031,396	64.64
Age on arrival:						
≤ 40	219,501	15.35	445,472	31.15	664,973	46.50
40 +	160,201	12.4	702,088	54.36	862,289	66.76
Year of arrival:						
1989–90	184,479	13.39	564,693	40.99	749,172	54.38
1991	171,185	13.23	557,145	43.06	728,330	56.29
1992–95	214,196	15.44	625,247	45.07	839,443	60.51
All:						
$r = .06$	188,759	13.89	578,506	42.59	767,265	56.48
$r = .03$	262,438	14.37	722,253	39.55	984,691	53.92

NOTE.—USSR = Soviet Union.

gration. After 10 years, only 30% are predicted to work in occupation 1.[44] Thus, after 10 years in Israel, older immigrants earn only half as much as comparable native Israelis.

Because of the sharp changes in earnings with time in Israel and the endogeneity of wages and jobs, whereby currently low wages may be traded for higher wages in the future, the appropriate summary statistic of earnings loss is the difference in the expected discounted present value of actual and potential earnings over the immigrants' remaining working life. Table 8 describes the main findings for this summary measure. The estimated lifetime earnings loss (potential2 − actual) is US$253,200. This loss constitutes 57% of the lifetime earnings that these immigrants would have obtained had they been native Israelis with the same measured attributes. The estimated lifetime loss is thus quite substantial. Most of the loss, US$190,900, can be attributed to the fact that immigrants are paid lower wages than Israelis on the same jobs, especially in the early years

[44] The corresponding figures for younger immigrants are 34%, 46%, and 60% predicted to be working in occupation 1 in Israel 5, 10, and 25 years, respectively, after immigration.

after arrival. This loss constitutes 43% of total potential lifetime earnings. The lifetime loss of earnings because of frictions in the labor market (nonemployment and job distribution mismatch) is US$62,300, which constitutes 14% of total potential lifetime earnings.

The estimated lifetime earnings loss varies substantially among immigrants. Immigrants with more schooling tend to have higher total losses. Given the strong correlation between schooling levels and occupation, immigrants who worked in occupations 1 and 2 in the former USSR also suffer higher total losses. The figures show that physicians have higher losses than engineers, older immigrants have higher losses than younger immigrants, and losses increase with later arrival cohorts.

In order to gauge the relative importance of job distribution mismatch and a lower market valuation of imported skills, the table decomposes the total loss into the loss resulting from frictions and the loss resulting from prices. The estimates indicate that the loss resulting from prices is, generally, far more important. This mainly results from the lower returns to imported schooling.[45] The difference between the loss resulting from frictions and the loss resulting from prices is greatest for physicians. Immigrant physicians obtain jobs in the medical profession rather quickly but earn much lower wages than do native physicians.[46] The smallest difference between the loss resulting from frictions and the loss resulting from prices is for engineers. The large number of immigrants with engineering degrees nearly doubled the total stock of engineers in Israel. This group thus faces special difficulties obtaining engineering jobs.[47]

The lifetime earnings loss calculations aim at estimating the social loss of output to the receiving country associated with the movement of human capital across labor markets. For this reason, the loss calculations do not include the benefits that immigrants receive when nonemployed nor the monetary value of nonmonetary benefits when employed. Further, the wages of Israelis are used as a benchmark. Although the model contains an equivalence scale that transforms the schooling of immigrants to local schooling, there may still be unaccounted for differences in the quality of schooling acquired locally and abroad. Moreover, the counterfactual exercises do not account for possible macroeffects on the Israeli labor

[45] Other studies have also found a higher rate of return for locally acquired schooling; see Eckstein and Weiss (1998) and Friedberg (2001).

[46] The national health system considerably expanded in the wake of the mass immigration from the former USSR.

[47] Immigrants with 13–14 years of schooling (that generally come from occupation 2 in the former USSR) suffer higher relative losses because of prices than do immigrants with 15 years of schooling. This results from the relatively lower actual earnings of the former group in occupation 3 in Israel, the occupation in which many of these immigrants find employment.

market and wage structure.[48] For these reasons, the potential earnings of the recent immigrants may be overstated when they are attributed to the current earnings of natives with the same observable characteristics. Therefore, the estimated losses among the different groups are an upper bound on actual losses.[49] We thus have more confidence in the ranking of the losses across groups of immigrants with different attributes than in the actual magnitude of the loss.

Recall that the model assumes a high annual real discount rate of 6% to capture the borrowing constraint facing immigrants who came to Israel with no assets. This fact should not prevent the use of an appropriate "social" discount rate to evaluate the social loss associated with immigration. As displayed in the last two rows of table 8, the relative losses are only slightly affected by using an annual real discount rate of 3% to evaluate the discounted present value. However, if immigrants had better access to the capital market and had faced an interest rate of 3%, there would have been a marked effect on their choices and the estimated parameters of the model.

IX. Conclusions

This article examines the process of entry of highly skilled immigrants into the Israeli labor market, using panel data on several cohorts of recent immigrants from the former USSR. The main emphasis in the article is on the occupational choices of immigrants who arrive with different skills and at different points in their life cycle. This study does not investigate the reasons for wage growth within occupations and jobs but explicitly models how immigrants adjust their choices to the expected rise in their wages with the passage of time.

As has been demonstrated, a simple on-the-job search model, cast as a finite-horizon discrete choice dynamic programming problem under uncertainty, captures quite well the observed dynamics of occupational choice during the first 6 years in Israel. The dynamics consist of a speedy entry into the labor force and an initial phase of work at low-skill occupations followed by a gradual occupational upgrading. The model explains the changing proportions of immigrants working in different occupations in Israel without relying on time effects in job offer probabilities. The sharp increase in the proportion of immigrants working in low-skill jobs results from the willingness of immigrants with high schooling levels and previous work experience in high-skill occupations in the former USSR to work in low-skill jobs in Israel. The subsequent decrease in the proportion working in low-skill jobs results from the

[48] The behavioral model is cast in a partial-equilibrium framework.

[49] Biases in the separately estimated immigrant and native wage functions, because of selection or unmeasured characteristics, also reduce our estimates' accuracy.

gradual transitions of these highly skilled immigrants to jobs in high-skill occupations. Permanent unobserved heterogeneity among immigrants is important in explaining the observed declining exit rates from nonemployment. Immigrants with high exit rates from nonemployment constitute the majority without jobs in the early months after immigration. As these immigrants leave nonemployment, the population of the nonemployed is increasingly made up of immigrants with very poor employment prospects. The model is also capable of explaining the declining reentry rates into nonemployment. Nonemployment reentry rates decline over time as wage growth on the job raises the opportunity cost of searching efficiently for better job opportunities from nonemployment.

The estimated parameters of the behavioral model, together with information on the wages of immigrants from earlier waves, are used to examine the speed of wage convergence between immigrants and natives. The simulation of an occupational path and associated wages for each immigrant on arrival to the host country and until retirement suggests that the earnings of recently arrived immigrants will slowly approach the earnings of comparable natives. However, the sharp growth in earnings combined with the heterogeneity in age at entry suggest the use of the discounted present value of lifetime earnings as a better summary measure of economic performance in the new country. The lifetime earnings predicted by the model are thus compared with the hypothetical lifetime earnings that immigrants would have obtained had their imported observable skills been valued, from the time of arrival, in the same way as skills of comparable natives with the same labor market experience and schooling. The results indicate a large gap between actual and potential lifetime earnings measures. On average, immigrants from the former USSR to Israel can expect lifetime earnings to fall short of the lifetime earnings of comparable natives by 57%. Of this figure, 14 percentage points reflect frictions associated with nonemployment and job distribution mismatch, and 43 percentage points reflect the gradual adaptation of schooling and experience imported from the former USSR to the Israeli labor market.

Our interpretation of these findings is that because of the lack of information that employers have on the quality of newly arrived immigrants and that immigrants have of their opportunities in the new labor market, and because of the need for complementary local capital (such as language, social connections, and familiarity with local institutions), there is, necessarily, a gradual process of adjustment and adaptation. The speed of adjustment depends on market conditions and the choices made by the immigrants, which interact in a complicated way. It is not clear whether, and to what extent, there are market failures in this process and whether there is some policy that could reduce the social loss. It is possible that limited borrowing capacity prevents immigrants from making the required local investment in on-the-job training, which should be the main vehicle for

the acquisition of local general human capital. There is, however, no simple way to ascertain the quantitative importance of this latter consideration.

Appendix A

Table A1
Sample Means and Standard Deviations

Variable Name	Representative Sample		Sample of Engineers		Combined Sample	
	Mean	SD	Mean	SD	Mean	SD
Schooling_0	14.6	2.7	16.4	1.6	15.8	2.2
Experience_0	16.6	8.3	18.6	8.4	17.8	8.4
Age_0	38.5	8.3	42.0	8.7	40.8	8.7
$\text{Age}_0 > 40$	40.1		58.4		51.8	
Occupation_0 1	56.3		100.0		84.3	
Occupation_0 2	12.9		.0		4.6	
Occupation_0 3	30.8		.0		11.1	
Engineer_0	25.7		100.0		73.4	
Physician_0	5.7		.0		2.0	
Cohort 1989–90	59.4		41.5		47.9	
Cohort 1991	37.8		19.5		26.1	
Cohort 1992–95	2.8		19.0		26.0	
Knowledge of Hebrew	76.8		69.3		71.5	
Months in Israel	41.4	14.6	46.7	16.5	44.8	16.0
Months having no job	11.7	10.3	11.4	10.9	11.5	10.7
Months in occupation 1	5.1	12.4	9.3	18.1	7.8	16.4
Months in occupation 2	3.0	9.3	2.5	9.3	2.7	9.3
Months in occupation 3	21.6	18.0	23.5	19.3	22.8	18.8
Wage observations = 0	54		126		180	
Wage observations = 1	102		571		673	
Wage observations > 1	233		0		233	
Average monthly wage	2,919	1,392	3,740	1,738	3,305	1,616
Wage observations	646		571		1,217	
Net wages (%)	60.8		26.3		44.6	
No. of immigrants	389		697		1,086	

NOTE.—A variable with a subscript of 0 indicates value on arrival.

Table A2
Maximum Likelihood Estimates and Asymptotic *t* Values

	Wage Offer Functions Nonmonetary Returns Terminal Value Functions (w_{sjt}, n_{sjt}, V_{sj73})							
	Occupation 1		Occupation 2		Occupation 3		No Job	
	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
$\ln w_{sjt}$:								
Constant	7.64762	13.13	7.70313	40.23	7.79090	76.02	. . .	. . .
Job (s)	.03308	3.63	.03308	. . .	.01059	4.46	. . .	. . .
Month (t)	.00665	4.93	.00665	. . .	.00649	7.52	. . .	. . .
Type 1	−.15661	−.42	−.73910	−1.65	−1.12593	−11.41	. . .	. . .
Type 2	−.38857	−10.00	−.16286	−2.02	−.35763	−13.07	. . .	. . .
Schooling_0. (s_0)	−.01363	−2.01	−.02899	−2.58	−.00540	−1.05	. . .	. . .
Experience_0	.00370	.58	.01354	1.82	.00190	.35	. . .	. . .
Experience_0^2	−.00037	−2.13	−.00064	−2.83	−.00023	−1.59	. . .	. . .

Table A2 (*Continued*)

	Wage Offer Functions, Nonmonetary Returns, Terminal Value Functions (w_{sjt}, n_{sjt}, V_{sj73})							
	Occupation 1		Occupation 2		Occupation 3		No Job	
	Coefficient	t	Coefficient	t	Coefficient	t	Coefficient	t
Occupation_0 1	.19038	.33	.05910	.90	.06580	1.81	...	...
Occupation_0 2	.03306	.05	.05190	.64	−.09450	−1.91	...	...
Engineer_0	.05546	1.29	.23359	3.79	.06949	1.83	...	...
Physician_0	−.21246	−1.94	.02834	.10	−.24827	−2.42	...	...
1991_0	.00117	.05	.00117	...	−.00116	−.05	...	...
$>1991_0$	.00162	.05	.00162	...	.01011	.28	...	...
Representative sample	.08997	2.33	.08997	...	.08997	...	...	...
Representative sample × net	−.13315	−3.86	−.13315	...	−.13315	...	...	...
Engineers' sample × net	−.20042	−5.80	−.20042	...	−.20042	...	...	...
$\ln(\sigma)$	−1.08153	−21.53	−1.32353	−12.79	−1.27618	−46.52	...	...
n_{sjt}:								
k_j	.00387	.01	.15442	.36	.16576	.40	...	...
k_{41}	...	...	...	...	...	...	.36891	1.24
k_{42}	...	...	...	...	...	...	.05173	.12
ν	3,267	2.03	3,267	...	3,267	...	3,267	...
V_{sj73}: γ_j	−1.49330	−6.38	−1.51262	−5.85	−1.40043	−6.39	...	...

	Job Offer Probabilities, Job Termination Probabilities (λ_{jkt}, $\Phi_j(s^* \geq s)$, δ_j)					
λ_{jkt}:						
No job	−5.19917	−5.61	−3.84230	−9.86	−1.69416	−19.57
Occupation 1	−5.52473	−5.93	−5.51386	−8.88	−5.51386	...
Occupation 2	−6.10825	−6.68	−3.55543	−7.79	−3.94459	−8.83
Occupation 3	−7.19802	−7.66	−5.25765	−12.68	−3.01802	−33.34
Type 1	−2.83216	−2.85	−2.05430	−2.56	−1.60270	−9.15
Type 2	−1.02175	−3.05	−.24861	−.83	.21600	2.62
$\text{Age}_0 > 40$	−.27582	−2.57	−.36479	−1.98	−.02991	−.56
Occupation_0 1	2.48364	2.65	−.01723	−.03	−.28822	−2.90
Occupation_0 2	.62551	.51	.52499	1.20	−.04304	−.36
Engineer_0	−.27344	−1.40	.00486	.01	−.15502	−1.83
Physician_0	.12819	.35	−.05532	−.09	−1.21266	−3.87
1991_0	.00737	.05	−.40283	−1.86	.33688	5.94
$>1991_0$	−.28445	−1.79	−.34133	−1.21	.47355	6.60
$\Phi_j(s^* \geq s)$:						
α	10.07162	34.73	10.07162	...	10.07162	...
β_j	.45638	22.26	.27028	9.96	.08005	4.28
ν	.40057	4.85	.40057	...	.20905	10.68
δ_j: α_j	−5.62635	−24.63	−4.50681	−20.17	−5.14436	−22.72

	Type Probabilities			
	Type 1		Type 2	
	Coefficient	t	Coefficient	t
Constant	−2.43253	−10.28	−1.51139	−5.36
Representative sample	−.05924	−.14	1.21765	3.77

NOTE.—Representative sample and engineers' sample are indicators for the sample from which the wage observation was taken. Net indicates net of taxes. Representative sample, engineers' sample, and net appear in the measurement error density, not in w_{sjt}. $n_{sjt} = b_{jt} + \nu\varepsilon_{sjt}$, where $b_{jt} = (e^{k_j} - 1)w_{sjt3}$, $j = 1,2,3$ and $b_{4t} = 580e^{k_{41}\text{occ}_0 1 + k_{42}\text{occ}_0 2}$. $V_{sj73} = [(1+q^T)/(1-q)](w_{sj73} + n_{sj73})\exp(\gamma_j)$. $\lambda_{jkt} = \exp(a_{jk}x_{it})/[1 + \sum_{k=1}\exp(a_{jk}x_{it})]$, $\Phi_j(s^* \geq s) = \exp(\beta_{j'0}/v - s/v + \alpha/v)/[1 + \exp(\beta_{j'0}/v - s/v + \alpha/v)]$, $\delta_j = \exp(\alpha_j)/[1 + \exp(\alpha_j)]$, and the type probabilities are multinomial logit.

Appendix B

Dynamic Program for Out of Sample Predictions

In order to calculate actual and potential earnings beyond the sample period, in a computationally practical way, a period length of 1 year is assumed in the simulation of the model beyond month 72 and until retirement at age 65. Further, since it is not possible to identify quadratic effects on wage growth within the sample period and, thus, to predict wage offers reliably beyond month 72, the wage offer functions in the yearly model are replaced by wage functions estimated separately, using data on the annual earnings of previous waves of immigrants from the former USSR. The regression specification is reported in Weiss et al. 2001. In the out-of-sample predictions, there are no pure time effects. The growth in wages is attributed to accumulation of experience and the rising prices of imported skills.

The imported wage functions in the yearly model do not contaminate the simulated job choices in months. The monthly model and the yearly model are disconnected by separate backward recursions. The backward recursion and subsequent simulation of the monthly model uses the terminal value functions, as in estimation. The estimated monthly wage offer functions do, however, influence job choices in the yearly model. The ratio of the wage offer in each job in month 73, according the estimated monthly model, to the wage offer in each job in month 73, according to the out-of-sample regression, is used to adjust the yearly wage offers. Let this ratio be denoted by w^m_{sj73}/w^y_{sj73}. The yearly wage offers in each job, in each year, are multiplied by w^m_{sj73}/w^y_{sj73}.

Estimated monthly job offer probabilities must also be transformed into yearly equivalents for the yearly model. We transformed the monthly job offer probabilities into yearly job offer probabilities as follows: let q be the probability of meeting an employer in a particular month where $q = 1 - \lambda_{j1t} - \lambda_{j2t} - \lambda_{j3t}$. The probability that the person will meet an employer in occupation k once during the year (i.e., in one of n months) is $\lambda_{jkt}(1 + q + q^2 + \cdots + q^{n-1}) = \lambda_{jkt}[(1 - q^n)/(1 - q)]$. The probability that the person will receive no offer is q^n. Clearly,

$$\lambda_{j1t}\left(\frac{1-q^n}{1-q}\right) + \lambda_{j2t}\left(\frac{1-q^n}{1-q}\right) + \lambda_{j3t}\left(\frac{1-q^n}{1-q}\right) + q^n = 1,$$

since $q = 1 - \lambda_{j1t} - \lambda_{j2t} - \lambda_{j3t}$. The other two components of the job offer probability, $P_j(s)$ and $\Phi_j(s^* \geq s)$, are not dependent on the length of the period and, therefore, do not require adjustment.

It is interesting to note that connecting the monthly and yearly models by a full backward recursion starting from age 65 does not substantially change the simulation results. The terminal value functions estimated in the model are thus consistent with the value functions generated using the imported wage functions, with correction factor w^m_{sj73}/w^y_{sj73}, and the transformed monthly job offer probabilities.

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