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**Working Paper**

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Working Paper, No. 140

**Provided in Cooperation with:**

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*Suggested Citation:* Weiss, Yoram; Eckstein, Zvi (1998) : The Absorption of Highly Skilled Immigrants: Israel, 1990 - 1995, Working Paper, No. 140, The University of Chicago, Center for the Study of the Economy and the State, Chicago, IL

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**Working Paper No. 140**

**THE ABSORPTION OF HIGHLY SKILLED  
IMMIGRANTS: ISRAEL, 1990 - 1995**

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# The Absorption of Highly Skilled Immigrants: Israel, 1990-1995\*

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February 5, 1998

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\*We would like to thank Joe Altonji, Gary Becker, Tom MaCurdy, Sherwin Rosen and Ken Wolpin for their comments. Sarit Cohen, Chemi Gotlibovski and Giovanni Oppenheim provided excellent research assistance and many important suggestions and comments on this work. We obtained financial support from the John M. Olin Foundation through a grant to the George J. Stigler Center for the Study of the Economy and State at the University of Chicago and from the GIF grant No I-084-118.02/95.

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### Abstract

This paper develops a descriptive methodology for the analysis of wage growth of immigrants, based on human capital theory. The sources of the wage growth are: (i) the rise of the return to imported human capital; (ii) the impact of accumulated experience in the host country; and, (iii) the mobility up the occupational ladder in the host country. We formulate a non-linear model which is estimated, using repeated cross section data. Using data on immigrants from the former Soviet Union to Israel, we find: Upon arrival, immigrants receive no return for imported skills. In the five years following arrival, wages of highly skilled immigrants grow at 8.13 % a year. Rising prices of skills, occupational transitions, accumulated experience in Israel, economy-wide rise in wages and repeated sampling account for 4.3, 3.1, 1.6, 1.2 and -2 percent each. There is convergence to natives in the occupational distribution, but not in wages. In the long run, the return for schooling converges to 0.044 and 0.027 for immigrants in high and low skill occupations, respectively, substantially below the .073 for natives. The return for experience converges to that of Israelis, and immigrants receive higher return for their unmeasured skills.

## 1. Introduction

Immigration is an important part the adjustment of labor markets to varying economic circumstances, as individuals try to move to where they can get the highest rewards for their skills. Typically, immigrants start at a low wage and then experience a relatively fast earning growth (see the surveys by Borjas, 1994 and Lalonde and Topel, 1997). The rise in earnings is an outcome of several complementary forces. First, immigrants learn the local language and become familiar with local institutions and local market conditions as a by-product of spending time in the new country and, at the same time, employers become less uncertain of the immigrant's quality (see Chiswick, 1978). Second, as time passes immigrants find a better match with local employers (see Weiss and Gotlibovski, 1995). These two processes combine to provide immigrants with rising rewards for their imported skills. In addition, immigrants invest in the acquisition of local skills, through schooling and on the job training. Expecting wages to grow, they have special incentive to invest in human capital and to "try harder". Consequently, immigrants often overtake natives of comparable skills, who have a weaker incentive to invest.

In this paper we develop a descriptive methodology of analyzing the wage growth of immigrants. We implement this methodology, using data on a large wave of immigration from the former Soviet Union to Israel. This group of immigrants is of particular interest, because of its relative magnitude (about 13 percent of the labor force) and high level of skill (14.5 years of schooling, on the average). We distinguish three sources of wage growth for immigrants: (i) the rise of the return to imported human capital; (ii) the impact of accumulated experience in the host country; and, (iii) the mobility up the occupational ladder in the host country.<sup>1</sup> We provide a simple framework, based on human capital theory, to explain the connections between rising prices of skills and investment in human capital and describe the conditions under which the earnings of immigrants will convergence to the earnings of comparable natives. Based on this framework, we formulate a non-linear model which is estimated, using repeated cross section data that includes immigrants with different

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<sup>1</sup>We use three occupations as follows: Occupation 1 includes engineers, physicians, professors, other professionals with an academic degree and managers; Occupation 2 includes teachers, technicians, nurses, artists and other professionals; Occupation 3 includes blue collar and unskilled occupations.

durations of time in Israel, observed in the years 1991 to 1995. The estimation is done in two steps: First, a wage equation is estimated for Israelis and the estimated coefficients are used to predict earnings for immigrants. Then, the difference between actual and predicted earnings for immigrants is explained by imported skills and their interaction with time spent in Israel.

We find that upon arrival, immigrants receive no return for imported human capital in terms of schooling and experience. The prices of these skills rise with time spent in Israel, but a large gap remains between the prices that immigrants and natives obtain in the Israeli labor market. This is mainly reflected in a low return for schooling acquired abroad, which we estimate to be, in the long run, 0.044 and 0.027 for immigrants in high and low skill occupations, respectively, substantially below the .073 for natives (Freidberg, 1992, reports a similar finding). Immigrants eventually obtain the same return on experience as natives, but the convergence is slow. The market "penalty" on observed imported skills is partially compensated by a premium on the unobserved characteristics of immigrants. The importance of unobserved skills declines sharply with time spent in Israel, but even in the long run, a large gap remains in favor of immigrants.

We find evidence for reduced quality for more recent cohorts of immigrants from the former USSR. This trend holds for both observable skills, such as schooling and occupation and for unobservable skills. Accounting for this effect, we find that conditional on occupation, there is no convergence of wages of immigrants to natives. In academic occupations the final gap is small, but immigrants who remain in unskilled jobs receive lower wages than comparable Israelis even after a long stay in Israel.

We use panel data from a sample of immigrant engineers from the former USSR to examine the process of occupational transitions in the early phase of the absorption process. Extrapolating the transition matrices from this panel of engineers, we can predict quite well the occupational distribution for different age groups in the pooled cross sections. We can thus break the convergence process into two parts, wage growth within occupations and wage growth due to occupational transitions.<sup>2</sup>

<sup>2</sup>This separation is somewhat tentative, because we do not model here the decisions related to occupational mobility. We are now in the process of estimating a structural model in which search and investment decisions are jointly determined.

In the initial five years following arrival, wages of immigrants grow at a fast rate of 6.4 percent a year (8.13 percent for immigrants with academic degree). Half of this growth can be ascribed to rising prices of skills. Occupational transitions account for a growth of 3.1 percent per year among immigrants with 16+ years of schooling. For these immigrants, accumulated experience in Israel and the economy wide rise in wages account for about 1.7 and 1.2 percent, respectively, per year. Repeated sampling of the same cohort and changes in sample composition account for -2 percent. In the long run, the occupational distribution of immigrants tends to converge to this of Israeli workers and after 15 years in Israel, immigrants have a similar probability of employment in the high skill occupation as equally qualified natives. However, because of lack of convergence within occupations, convergence is not attained even when we allow occupations to adjust. An immigrant who arrives at age 30 with 16+ years of schooling, initially earns, on the average, only half the wage of a comparable Israeli. By age 50, the same immigrant earns a wage which is 17 percent lower than the wage of a comparable native worker.

## 2. Background

The mass immigration of Jews from the former Soviet Union to Israel which started towards the end of 1989, amounted to a total of about 600 thousand immigrants between 1990 and the end of 1995 (see Table 1). The Israeli population at the end of 1989 was 4.56 million and the pre-migration population growth rate during the 1980's was between 1.4% and 1.8% per annum. The 1990-91 wave of immigration increased the population by 7.6%, in two years, which is more than twice the normal population growth. The reduced immigration flow between 1992 and 1995 has contributed about 1.3 percent a year in population growth. By the end of 1995, the recent immigrants from the USSR constitute about 11% of the total population and 12.1% of the population of age 15 and above. Compared with the immigration into the US and other receiving countries, this wave stands out in its magnitude.

While the flow of new workers from the Israeli established population is mainly comprised of young inexperienced workers, the flow of immigrants is of workers of all ages, who acquired some work experience in their home country. On the average, immigrants are older than Israeli workers by four years. This is contrast to most immigrations, where immigrants tend

to be relatively young. This feature reflects the exogenous relaxation of emigration from the USSR and the free entry to Israel. Thus, this immigration wave is less governed by self-selection.

Another important feature of this wave of immigration is the exceptionally high level of education and the prior experience in academic jobs (see Table 2). Those who arrived before the end of 1993 possessed an average of 14.5 years of schooling, and half of them had held academic and managerial positions before immigrating; 57,400 of those who arrived until the end of 1993 defined themselves as engineers and 12,200 as medical doctors. These numbers should be compared with 30,200 engineers and 15,600 doctors in Israel in 1989. Under these circumstances, it is not surprising that many highly skilled immigrants work in Israel in occupations that require less skill than they possess. Of the 332,616 immigrants who arrived during 1990-91, 75 percent worked in low-skill occupations, and only 12.8 found jobs in high-skill occupations within their initial stay in Israel (2.9 years on the average).

A more detailed picture of the occupational downgrading can be seen in Table 3, which describes the occupational and employment status of immigrants from a cohort which arrived in 1990, by their occupation in the former USSR. As seen, among the immigrants who were employed in high-skill occupations (occupation 1) in the former USSR, only 27.4 percent found jobs at the same occupational level, after 3 years in Israel. Immigrants gradually improve their occupational standing. Initially, the main inflow into the high skill occupations is from the ranks of unemployed. Later, the main inflow is from those who first found jobs at low-skill occupations.

Despite the high unemployment rate in Israel at the outset of the immigration wave of 9.4 percent (see Table 4) and the large immigration inflow, immigrants found jobs quite quickly and they have done so mainly by occupational downgrading (see Table 3). At the aggregate level, convergence is slower because of the entry of new immigrants with initial unemployment rate which far exceeds the unemployment of native Israelis (see Table 4). Notice that the entry of immigrants had no adverse effect on the unemployment or employment of natives.

There is a rather sharp increase in wages as a function of time spent in Israel. The figures in Table 5 show that recent immigrants, with experience in Israel of 5 years or less, earn less than Israeli workers with the same experience in Israel (who are, on the average, 14 years younger), suggesting that experience acquired abroad is of little value. In contrast,

immigrants who have spent in Israel more than 5 years earn, on the average, about the same wage as native Israelis with the same experience in Israel (who are, on the average, 8 years younger). 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.

To summarize, immigrants enter the labor force quickly and initially accept any available job, with somewhat higher unemployment among the highly educated. The occupational distribution of first jobs among immigrants is very similar to the distribution of jobs in the Israeli economy, implying a substantial occupational downgrading. Following this initial phase, there is a second phase in which the highly educated immigrants gradually upgrade their positions by finding better jobs within the low-ranked occupations or move to jobs within a high-ranked occupations. As a result, there is a substantial wage growth and inequality among immigrants rises, as they obtain higher returns for their imported skills.

At the aggregate level, we note some further adjustments. First, the immigration flow tends to decline with time, as the initial backlog has been exhausted. Second the average skills of immigrants from the former USSR decline. At the same time, the quality of Israeli workers rises, reflecting the rise in schooling investments (See Appendix Table A1). Despite the large size of this immigration wave, there were no noticeable effects on the wages or employment of Israeli natives, both continued to rise during the period 1991-1995 (see Tables 4 and 7).

### 3. A Framework for Analysis

We now present a simple human capital model which describes the development of earnings for immigrants and natives and allows us to compare their patterns. In particular, we are interested in the forces which determine the convergence of the earnings of immigrants to those of Israelis.

An immigrant brings with him a fixed set of marketable skills such as schooling, occupation and work experience acquired abroad. As time passes, these skills are gradually adapted to the Israeli market, and their quality and market value rises. The immigrant may also augment his skills or acquire new skills in Israel. The acquisition of new skills requires

some sacrifice of current earning. Thus, each immigrant is faced with an investment problem in which he compares the benefits from investment in terms of higher future earnings to the costs in terms of forgone current earnings. The investment decisions interact with the changes in the market value of the immigrant's skills and together determine his earning growth. An Israeli worker faces a similar investment problem, except that he does not have skills which were acquired abroad.

Let  $x_s$  be quantity of skill  $s$ ,  $s = 1, 2, \dots, S$ , that an individual possesses. Human capital is an aggregate which summarizes individual skills in terms of productive capacity. We assume that human capital,  $K$ , may be written as

$$K = F(\sum \theta_s x_s), \quad (1)$$

where  $\theta_s$  are non negative parameters and  $F(\cdot)$  is an increasing function. The marginal rate of substitution in production between any two skills  $r$  and  $s$  is given by  $\frac{\theta_s}{\theta_r}$ . The concavity of  $F(\cdot)$  determines whether skills are gross substitutes or complements.<sup>3</sup>

Firms reward individual skills indirectly by renting human capital at the market determined rental rate,  $R$ . The earning capacity of a worker is given by

$$Y = RK. \quad (2)$$

Thus,  $\frac{\theta_s}{\theta_r}$  also represents the relative price of skills in the market. When skills are measured in terms of the time spent acquiring them, then an exponential specification for  $F(\cdot)$ , such that  $K = \exp(\sum \theta_s x_s)$ , seems consistent with the observed relation between earning and skills. In this case, the parameter  $\theta_s$  is the proportional increase in earning capacity associated with a unit increase in skill  $x_s$ . Because  $\theta_s$  is independent of skill acquisition, each individual may view it as the implicit "price" (or "rate of return") of skill  $s$ .<sup>4</sup>

<sup>3</sup>The cross partial derivatives are  $F''(\cdot)\theta_s\theta_r$ .

<sup>4</sup>Since the coefficients  $\theta_s$  are defined within a context of production function they may also be interpreted as quality parameters, objective or perceived, which change as the immigrant's imported skills become more applicable to local market conditions. For the present analysis, the distinction between price and quality makes no difference. Following recent literature (e.g., Juhn et al., 1993) we shall use the term price. A more general specification would allow these prices to depend on the aggregate stocks of skills (see Heckman et al., 1997).

A worker can augment his skills by training in school or on the job. Let  $\iota_s$  and  $\omega_s$  be the proportions of available time (which is normalized to 1) spent learning skill  $s$  in school and on the job, respectively. Then

$$\dot{x}_s = \beta_s \iota_s + \gamma_s \omega_s - \delta, \quad (3)$$

where  $\beta_s$  and  $\gamma_s$  are learning coefficients,  $\beta_s > \gamma_s$ , and  $\delta$  is a depreciation rate. Time spent on training is withdrawn from working time and involves a loss of earnings. In the case of schooling or formal training, each hour of training causes a corresponding loss of an hour of work. In training on the job, the loss is smaller (as some learning is joint with work) but the learning coefficient is usually smaller. The actual earning of the individual,  $y$ , equal to his earning capacity,  $Y$ , multiplied by "effective" working time,  $h$ . That is,

$$y = Yh = Y(1 - T_s - c(T_w)), \quad (4)$$

where  $T_s = \sum \iota_s$  is the proportion of total time spent in school,  $T_w = \sum \omega_s$  is the proportion of time spent training on the job and  $c(\cdot)$  is a convex increasing function with  $c(0) = 0$  and  $c(1) \leq 1$ .

Individuals maximize their life-time earnings. In each point in time, a worker must decide which skill to augment and how much of it to acquire. Because all schooling activities are equally costly, an individual who invests in schooling will augment only the skill with the highest contribution to the growth of human capital (i.e., the highest  $\theta_s \beta_s$ ). Similarly, because all training activities are equally costly, an individual who invests in training on the job will augment only the skill with the highest  $\theta_s \gamma_s$ .

For the analysis of immigrants' earnings, it is important to partition skills into two groups: locally acquired skills and imported skills. The imported skills are fixed in quantity, but an immigrant may acquire local skills. A basic feature that we wish to introduce is that the prices of imported skills rise with time spent in Israel, relative to the prices of locally acquired skills. This rise in prices, which reflects gradual adoption of imported skills to local market conditions, may influence the local investment decisions.

We may partition the set of skills into two subsets, skills acquired abroad,  $S_1$  and skills acquired locally,  $S_2$  and assume that for all  $s \in S_1$ , the quantities  $x_s$  are fixed at  $x_s(0)$ , but prices,  $\theta_s$ , are allowed to vary with time in Israel, while for all  $s \in S_2$ , prices are fixed, but quantities can vary. In fact, each immigrant will choose to invest only in that member of  $S_2$

which maximizes the growth rate. We denote this maximal element by  $x$  and its price by  $\theta$ . Based on these definitions, the exponential aggregation rule,  $K = \exp(\sum \theta_s x_s)$ , yields a simple accounting framework for the growth in human capital,

$$\frac{\dot{K}}{K} = \theta \dot{x} + \sum_{s \in S_1} x_s(0) \dot{\theta}_s.$$

That is,  $\frac{\dot{K}}{K}$ , can be partitioned into the change arising from local investment decisions, and the change due the rising prices of imported skills.

We may approximate the optimal local investment pattern for an immigrant by

$$\theta \dot{x} \simeq a \left( \sum_{s \in S_1} x_s(0) \dot{\theta}_s + \frac{\dot{R}}{R} \right) + b - c(\tau_0 + t - t_0), \quad (5)$$

where,  $t$  is calendar time,  $t_0$  is time of arrival,  $\tau_0$  is the immigrant's age (or work experience) upon arrival and  $a, b$  and  $c$  are some fixed positive parameters.<sup>5</sup> The earning of an Israeli born worker follows a similar process, except that he has no imported skills and the date and age of leaving school replace the date and age of arrival. Equation (5) captures two basic results from human capital theory: investment declines as the individual becomes older and approaches the end of his working career, and current investment is higher if the individual expects an increase in the price of skills. The first result follows from the fact that value of human capital depends on the expected period of utilization. The second result follows from the observation that investment in human capital involves a sacrifice of current earning capacity in favor of increased future earning capacity.

The amount of effective hours,  $h$ , is a function of the amount of local investment  $\theta \dot{x}$  which is obtained by inverting  $c(T_w)$ . We shall approximate this relationship by writing

<sup>5</sup> Approximation is required because in general there is no closed form solution for the optimization problem. An exception is when  $F(\cdot)$  is exponential and  $c(T_w) = 1 - (1 - T_w)^\alpha$ , where  $0 < \alpha < 1$ . In this case, the investment policy can be derived explicitly as a function of the future prices relative to their current values. Earning growth assumes a very simple piecewise constant form:  $\frac{\dot{y}}{y} = 0$  when the individual specializes in schooling,  $\frac{\dot{y}}{y} = \frac{g + \theta \gamma - r - \alpha - \delta}{1 - \alpha}$  when he invests on the job, and  $\frac{\dot{y}}{y} = g - \delta$  in the last phase of no investment, where  $g = \sum x_s(0) \dot{\theta}_s + \frac{\dot{R}}{R}$  is the change in prices,  $\theta \gamma$  is the maximal learning coefficient (on the job) and  $r$  and  $\delta$  are the depreciation and interest rates, respectively. The duration of each phase is determined endogenously. These results are derived in the Appendix.

$$\ln h \simeq \xi \theta \dot{x}, \quad (6)$$

where  $\xi$  is a negative parameter which depends on the function  $c(T^w)$ . Equations (5) and (6) together determine the effect of investment on earning.<sup>6</sup>

We can now compare the earning paths of immigrants and native Israelis. The basic difference between natives and immigrants is that immigrants bring with them skills which are not immediately applicable to the local market conditions. As time passes the imported skills become more valuable as immigrants adopt to local market conditions. Thus, at the early stage of stay in Israel, immigrants display higher growth in earnings than similar Israelis. Assuming that after sufficient time in Israel, prices of imported skill converge to some constant values, the earning growth rates of immigrants and natives will eventually converge. However, convergence in growth rates does not necessarily imply convergence in levels. Earnings of immigrants will *overtake* the earnings of natives if the prices of imported skills converge to the *same* price as obtained by natives for locally produced skills, because increasing prices imply higher investments. However, if imported skills are of inherently lower quality, and their long run price falls short of the price of locally acquired skills, then earnings of immigrants may never catch up with those of natives.

A simple parameterization for the behavior of prices will help to illustrate the general point. Let  $t - t_0$  be the duration of time that the immigrant has been in Israel, then the market value of imported skill  $s$  at time  $t$  is  $\theta_s(t - t_0)$ . We assume that

$$\dot{\theta}_s = \lambda(\bar{\theta}_s - \theta_s(t - t_0)), \quad (7)$$

where  $\bar{\theta}_s$  is the long run value of  $\theta_s(t - t_0)$  and  $\lambda$  is a parameter indicating the speed of adjustment.<sup>7</sup> If  $\lambda > 0$  then, as the immigrant spends more time in Israel, the price of each imported skill component approaches  $\bar{\theta}_s$ . In contrast, skills acquired in Israel by natives or immigrants, have constant value,  $\theta_s$ .

<sup>6</sup>The approximations in (5) and (6) have been used by Mincer (1974) to derive the quadratic earning function. We extend his analysis by adding time effects into the investment decision.

<sup>7</sup>The model can easily accommodate different  $\lambda$  for different skills. However, for the estimation it is useful to impose the constraint of uniform  $\lambda$ . To simplify the exposition we impose this constraint at the outset.

Recall that different immigrants arrive in different dates, at different ages and with different market skills. Consider an immigrant who is observed in year  $t$  and at age  $\tau$ . Let us denote the date of arrival by  $t_0$  and the age (or experience) on arrival by  $\tau_0$ . Assuming that  $F(\cdot)$  is exponential, so that  $\ln K = \sum \theta_s x_s$ , the immigrant's level of earnings, implied by equations (5), (6) and (7), is

$$\begin{aligned} \ln(y_{im}(\tau, t)) = & \sum \theta_s(0) x_s(0) + (1+a) \sum (\bar{\theta}_s - \theta_s(0)) (1 - e^{-\lambda(t-t_0)}) x_s(0) \\ & (b\tau - \frac{c\tau^2}{2}) - (b\tau_0 - \frac{c\tau_0^2}{2}) + a(\ln R(t) - \ln R(t-t_0)) \\ & + \ln R(t) + \ln(h_{im}(\tau, t)). \end{aligned} \quad (8)$$

The earnings of a comparable native Israeli, who is observed in year  $t$  and age  $\tau$ , and had the same bundle of skills  $x(0)$  (including the same level of completed schooling) when he left school on age  $\tau_s$ , be written as

$$\begin{aligned} \ln(y_n(\tau, t)) = & \sum \theta_s x_s(0) + (b\tau - \frac{c\tau^2}{2}) - (b\tau_s - \frac{c\tau_s^2}{2}) \\ & a[\ln R(t) - \ln R(t-t_s)] + \ln(h_n(\tau, t)) + \ln R(t), \end{aligned} \quad (9)$$

where,  $t_s$  and  $\tau_s$  are, respectively, the time and age of leaving school.<sup>8</sup> Since the only cause for the difference in the investment policy of immigrants and native Israelis is the effect of the changing value of imported skills, we use the approximation

$$\ln(h_{im}(\tau, t)) - \ln(h_n(\tau, t)) \simeq \xi a \sum (\bar{\theta}_s - \theta_s(0)) \lambda e^{-\lambda(t-t_0)} x_s(0). \quad (10)$$

Taking the difference between (8) and (9), using (10), we obtain

$$\begin{aligned} \ln(Y_{im}(\tau, t)) - \ln(Y_n(\tau, t)) = & \sum [(\bar{\theta}_s - \theta_s) + a(\bar{\theta}_s - \theta_s(0))] x_s(0) \\ & + (1+a+\lambda\xi) \sum (\bar{\theta}_s - \theta_s(0)) e^{-\lambda(t-t_0)} x_s(0) \\ & + [(b\tau_0 - \frac{c\tau_0^2}{2}) - (b\tau_s - \frac{c\tau_s^2}{2})] \\ & + a[\ln R(t-t_0) - \ln R(t-t_s)]. \end{aligned} \quad (11)$$

<sup>8</sup>Using the approximation in (6), we can eliminate  $\ln(h_n(\tau, t))$  from equation (9), yielding, (9')  
 $\ln(y_n(\tau, t)) = \sum \theta_s x_s(0) + (b\tau - \frac{c\tau^2}{2}) - (b\tau_s - \frac{c\tau_s^2}{2}) + \xi(b-c\tau)a[\ln R(t) - \ln R(t-(\tau-\tau_s))] + a\xi \frac{\bar{R}(t)}{R(t)} + \ln R(t).$

Equation (11) allows us to describe the parameters governing the convergence of immigrants to natives. The terms in the first sum determine the long term differences in the level of earnings. As seen, for  $a > 0$ , convergence in prices (i.e.,  $\bar{\theta}_s = \theta_s$ ) would imply that the earning level of immigrants will eventually *exceed* the earnings of comparable native Israelis. This is because of the added incentive to acquire local human capital caused by the rising prices of imported skills. However, to the extent that an imported skill is of inherently lower quality and  $a$  is not too large (i.e.,  $(1 + a)\bar{\theta}_s < \theta_s$ ), its long term value will be lower for immigrants and their earning level may be lower in the long run. The terms in the second sum determine the speed of convergence, where higher positive values of  $\lambda$  indicate a faster adjustment. Clearly, if the adjustment is slow then immigrants who entered at an old age will never catch up with similar Israeli within their working lifetime. If  $\lambda < 0$ , the earning differences diverge. We thus obtain a flexible specification which *allows* for convergence but does not impose it.

The positive interaction between rising prices for imported skills and the incentive to invest in local human capital provides a simple answer to a query raised by Borjas (1994, p. 1672) "why would immigrants accumulate more human capital than natives?" within the context of standard human capital theory. There is no need to rely on heterogeneity or self selection to explain overtaking. Immigrants may "try harder", simply because they have stronger market incentives to invest in human capital.<sup>9</sup>

An important source of earning growth of immigrants, which we have not discussed yet, is their gradual climb up the occupational scale. The analysis can be extended to incorporate occupation specific capital stocks,  $K_j = F(\sum \theta_{sj}x_s)$ , where  $\theta_{sj}$  is the price of skill  $x_s$  in occupation  $j$ , allowing immigrants to change occupation when a suitable job offer arrives. The prospect of the arrival of job offers with higher wages also influence current investments in human capital. In general the arrival rate of jobs offers depends on the individual's search

<sup>9</sup>It should be noted that this result depends on the functional form assumptions. Alternative specifications yield different conclusions concerning overtaking. For instance, if one adopts a Ben-Porath specification, where  $F(\cdot)$  and  $C(\cdot)$  are linear and  $\dot{x}_s = g(K(\beta_s\iota_s + \gamma_s\omega_s))$ , where  $g(\cdot)$  is increasing and concave, the local investment policy is independent of prices, so that there is convergence, but no overtaking. It seems that some degree of complementarity, or non-neutrality, is required for overtaking. Related results on overtaking appear in the literature on endogenous growth with both physical and human capital (See Caballe and Santos, 1993, and Brezis et al., 1993).

effort and skills, and on market conditions (see, e.g., Weiss and Gotlibovski (1995)). However, in this paper we focus on investment decisions and assume that occupational transitions are exogenous.

#### 4. Data on Earnings

For the analysis of earning, we use the CBS survey of income from the years 1991 to 1995, which are random annual surveys of the whole Israeli population. Using these data we construct a sample of native Israelis and a sample of immigrants from the former USSR. Our basic sample includes only Jewish men and women of ages 26 to 65 who worked more than two weeks during the last month and more than 25 hours per week. We exclude immigrants from the former Soviet Union that arrived at age below 14. We also exclude all individuals with no information on age, no information on the number of years of schooling and with more than 31 years of schooling. The wage and hours of work are the average during the several weeks before the survey. For immigrants, we can separate the number of years of schooling and experience of work between those acquired in the former Soviet Union and those accumulated in Israel. We have data from five consecutive cross sections on native Israelis and immigrants from the former Soviet Union. Because of the large recent inflow of immigrants from the former USSR, most of the immigrants in the sample have been in Israel only few years.

Table 6 shows the summary statistics of the two samples. The difference in the average monthly wage between native Israelis and immigrants males is 55% and the difference in the average hourly wage is 51%. The corresponding differences among females, are 26% and 33%, respectively. On the average, immigrants are about 3 years older than Israelis and have one year more of education. The occupational distribution of working immigrants is quite similar to the occupational distribution of working Israelis, although there are proportionally less male immigrants in occupations 1 and 2 which require academic and technical education. This is striking, given the substantially higher proportions of immigrants who were employed in these occupations in the former USSR.

Table 7 shows the average real wage of immigrants and natives during the period of the mass immigration. The lack of trend in the average wage of immigrants reflects the opposing

forces of individual wage growth and increased proportion of newly arrived immigrants. In contrast, the average wage of native Israelis is less affected changes in sample composition and tracks general labor market conditions. The general trend has been for wages of Israeli workers to rise slightly during the period 1991-1995.

## 5. Implementation and Results on Wage Convergence

We use the CBS income surveys 1991-1995 to compare the time patterns in the wages of immigrants and natives. To identify the main forces which cause these patterns, we make some simplifying assumptions. We allow for time effects but assume that they are the same for immigrants and natives, reflecting a common rental rate for human capital which may vary over time. The contribution of specific skills to productivity are assumed constant for natives, but allowed to vary with time spent in Israel for immigrants. Similarly, cohort effects are allowed for immigrants but not for natives. Observed skills like schooling and experience are assumed to have the same return in three broad occupational categories for Israelis, but we allow the returns to schooling to differ by occupation for immigrants. To narrow down the possible investments in Israel, we analyze earnings of immigrants who entered Israel at age 26 or more, so that all schooling of immigrants is acquired abroad. For these immigrants we assume that investment in Israel takes place on the job.

We follow a simple two stage estimation procedure. We first use a sample of Israeli natives to estimate a wage equation for Israeli workers. We use these estimates to predict what each immigrant would earn in Israel if he could sell his observed skills for the same prices as native Israelis. We then form the differences between actual and predicted earning for immigrants and estimate equation (11), adding a constant term which depends on the date of entry to Israel. We also add interaction term between schooling and low skill employment to allow for the fact that immigrants who are "trapped" in low skill occupations, receive a lower return for schooling acquired abroad.

The observed imported skills in this analysis are schooling and experience acquired abroad. Schooling is measured simply by the total time spent in school. However, experience is not simply the accumulated time spent at work, but rather the amount of human capital or skills accumulated in work. This quantity is given by the expression  $[b \exp - \frac{c \exp^2}{2}]$ ,

where *exp* denotes experience, defined in the usual way (age-schooling -6-military service). We normalize by setting the price (in terms of log earnings) which is paid to Israelis for their "true" experience to unity. We shall define the "true" work experience that immigrant import as  $[b \exp_0 - \frac{c \exp_0^2}{2}]$ , using the same values for *b* and *c* as for Israelis.<sup>10</sup> We then estimate the time pattern of the price  $\theta_2(t - t_0)$  which immigrants receive for this quantity at time *t*.

### 5.1. Regression Results for Israelis

Table 8 presents the estimation results of the wage equation for native Israelis. The yearly dummies represent the difference from the wage in 1995. We find that, despite the mass immigration, the wage per hour for Israelis is *increasing* during the period. Controlling for schooling, occupation and experience, the hourly wage in 1991 is about six percent lower than in 1995 (1992 is an exception where wage per hour is almost as that of 1995). The wages in occupation 1 and occupation 2 are, respectively, about 27 and 22 percent higher than in occupation 3. There is a 4.5 percent increase of the hourly wage with the first year of experience and about 7 percent increase of the hourly wage with a year of education. These estimates and the fit ( $R^2 = 0.32$ ) of the model are very close to equivalent regressions for Israeli population and other samples in other countries. We use this equation as the benchmark for evaluating the convergence properties of wages of immigrants as it is described in the model above.<sup>11</sup>

### 5.2. Regression Results for Immigrants

To estimate equation (11) we use the data for immigrants only. The dependent variable is the difference between the observed log wage of each immigrant and his predicted log

<sup>10</sup>If both the parameters *b* and *c* differ between Israelis and immigrants, one cannot separate "quantity" from "price". It is possible, however, for one parameter, to differ across these groups. We have estimated the model, allowing the coefficient *c* to differ. We found that this coefficient was  $-.00061$  for immigrants and  $-.00066$  for Israelis. The difference between the two estimates is statistically insignificant.

<sup>11</sup>In estimating the model we used many alternative specifications in order to study the robustness of our results. Monthly wages provided the same results, but with positive yearly dummies. There is evidence in favor of different values for the schooling coefficients by occupation. However, we have decided to use the more conventional specification for the native Israelis wage equation. The results on wage convergence are robust with respect to the specification of the native Israelis wage regression.

wage, using the estimated parameters in Table 8. The explanatory variables are schooling acquired abroad, interacted with occupation, experience acquired abroad, time since arrival to Israel, occupation in Israel and year of immigration (cohort). To isolate the impact of mass immigration in 1990-1991, we distinguish the following three cohorts: immigrants who arrived before 1990, during 1990-1991 and during 1992-1995. Specifically, we estimate the nonlinear regression

$$\begin{aligned}
 D_i = & b_{cons} + d_{cons}e^{-\lambda(t-t_{0i})} + [b_{con\_cohrt<90}cohort_{<90} \\
 & + b_{con\_cohrt92-95}cohort_{92-95}] \\
 & + [(b_{con\_occ1}occ1 + d_{con\_occ1}e^{-\lambda(t-t_{0i})}occ1 \\
 & + b_{con\_occ2}occ2 + d_{con\_occ2}e^{-\lambda(t-t_{0i})}occ2)] \\
 & + [(b_{exp} + d_{exp}e^{-\lambda(t-t_{0i})})(.045 - .0007exp_i)exp_i] \\
 & + [(b_{school\_occ1\&2}(occ1 + occ2) + b_{school\_occ3}occ3 + d_{school}e^{-\lambda(t-t_{0i})})school_i],
 \end{aligned} \tag{12}$$

where  $D_i$  is the residual from the first stage,  $t - t_{0i}$  is potential experience in Israel,  $exp_i$  is potential experience in former USSR,  $school_i$  is the number of years of schooling in the USSR,  $occ1_i$ , and  $occ2_i$  are dummies that take the value 1 if immigrant works in occupations 1 or 2, respectively, (occupation 3 is the reference group) and  $cohort_{<90}$  and  $cohort_{92-95}$  are dummy variables that take the value 1 if the immigrant entered Israel, before 1990 and between 1992 and 1995, respectively. The value of  $[(.045 - .0007exp_i)exp_i]$  is the accumulated human capital associated with the market labor experience that the immigrant imported, using the estimated coefficients for experience and experience<sup>2</sup> for Israelis in Table 8. Note that we restrict the speed of convergence of the coefficients of the human capital indicators,  $\lambda$ , to be the same for all the parameters.<sup>12</sup>

<sup>12</sup>The coefficients  $b_s$  and  $d_s$  in the estimated equation (12) are related to the structural parameters in equation (11) through the definitions  $b_s = [(\bar{\theta}_s - \theta_s) + a(\bar{\theta}_s - \theta_s(0))]$  and  $d_s = (1 + a + a\lambda\xi)(\bar{\theta}_s - \theta_s(0))$ . The parameters  $\theta_s$ ,  $b$ ,  $c$  and  $\xi$  can be identified from the regression for Israelis. The parameter  $\lambda$  can be estimated directly from the residual equation. A sufficient condition for identification is that the price that immigrants receive for some skill,  $s$ , say experience, converges to the price that native Israelis obtain, so that  $\bar{\theta}_s = \theta_s$ . We can then identify  $a$  and  $\theta_s(0)$  for imported experience from the estimates of  $b_{exp}$  and  $d_{exp}$ . Having an estimate for  $a$ ,  $\lambda$  and  $\xi$ , we can then obtain  $\bar{\theta}_s$  and  $\theta_s(0)$  for schooling from the estimates of  $b_{school}$  and  $d_{school}$ .

In Table 9, we present two alternative versions of equation (12), without and with schooling-occupation interaction. The basic logic of compensating wage differentials would suggest that, the return for schooling is the same wherever a person works. However, immigrants have not chosen their schooling based on market conditions in Israel. The return which they receive in the Israeli market is, therefore, affected by demand conditions, and immigrants who cannot find high skill jobs are less likely to receive full reward on their schooling endowment. In describing our results, we shall mainly rely on the specification with a schooling-occupation interaction.

The estimated speed of adjustment,  $\lambda$ , is .0953 per year, implying that within a period of ten years each price is adjusted by 62 percent of the initial distance from its long run value. However, convergence also depends on the long term difference between the prices that Israelis and immigrants obtain for their skills.<sup>13</sup> We shall, therefore, discuss each of the prices, for schooling, experience and unobserved skills, separately.

The initial difference, upon arrival, in the price (rate of return) of schooling between immigrants and Israeli is  $b_{school\_occ1\&2} + d_{school} = -.0290 - .0359 = -.0649$  in occupations 1 and 2 and  $b_{school\_occ3} + d_{school} = -.0455 - .0359 = -.0814$  in occupation 3. Given the estimated rate of return of .0728 for native Israelis, the initial reward for schooling is slightly positive for an immigrant working in occupation 1 or 2 and slightly negative (but not significantly different from zero) for an immigrant working in occupation 3. The long run difference in the rate of return for schooling in occupations 1 and 2 is  $b_{school\_occ1\&2} = -.0290$  and  $b_{school\_occ3} = -.0455$  in occupation 3. Hence, the rate of return that immigrants can expect in the long run is only  $.0728 - .0290 = .0438$  in occupations 1 and 2 and  $.0728 - .0455 = .0273$  in occupation 3. This substantial gap between natives and immigrants suggests that schooling acquired in the former USSR is not fully transferable to Israel, either because differences in quality or informational frictions which cause immigrants to "give up" in their search for better jobs (see Weiss and Gotlibovski 1995). The rate of increase in the return that immigrants in occupations 1 and 2 (occupation 3) obtain for their schooling is such that, after ten years, the rate of return reaches .0299 (.0134) which is about 68 (49) percent of its long run value.

<sup>13</sup> Under our assumptions, the difference in the prices that Israelis and immigrants obtain for skill  $s$  is  $\theta_s - \theta_s(t - t_0) = (\theta_s - \bar{\theta}_s) + (\bar{\theta}_s - \theta_s(0))\lambda e^{-\lambda(t-t_0)}$ .

The initial difference, upon arrival, in the value of experience acquired abroad is  $b_{exp} + d_{exp} = -.233 - 1.014 = -1.247$ . Since the price of accumulated experience that Israelis obtain is normalized to one, this means that the initial return for accumulated experience is  $1 - 1.247 = -.247$ . This means that, initially, experience accumulated in the former USSR has negative value in the Israeli labor market. With time, however, the price rises to  $1 - b_{exp} = 1 - .233 = .767$ , which, given the high standard error on  $b_{exp}$ , is not significantly different from 1. Thus, we cannot reject the hypothesis that, in the long run, immigrants obtain the same rate of return for experience as native Israelis. The adjustment, is rather slow and within 10 years this price attains 49 percent of its long run value.<sup>14</sup>

The occupational dummies show that immigrants who work in the high skill occupations 1, and in occupation 2, obtain higher premia (relative to occupation 3) than comparable Israeli workers. Using the specification without a schooling-occupation interaction, these premia are, in the short run,  $.272 + (.368 - .242) = .398$  and  $.215 + (.212 - .155) = .272$ , in occupations 1 and 2, respectively. In the long run, these premia are even higher:  $.272 + .368 = .640$  and  $.215 + .212 = .427$ . However, a large part of these occupational effects is a consequence of the lower rate of return for schooling in occupation 3. When a schooling-occupation interaction is added, it is seen that the occupational effects are reduced to .127 and .021, in the short run, and to .378 and .194 in the long run. The remaining occupational effects suggest that, in the long run, workers who were lucky to find jobs in the high skill occupations, or had some unobserved characteristic which made them more suitable for employment there, given their experience in schooling, fare substantially better than those immigrants who remain in the low skill occupation.

We now turn to the discussion of the constant terms which summarize the *average* impact of unmeasured characteristics of immigrants. As seen in Table 9, for both specification, the coefficients  $b_{cons}$  and  $d_{cons}$  are positive and large, indicating that, in the short run, there is not much to distinguish between immigrants with different human capital indicators. However, with time, the constant term declines and more weight is shifted to observable characteristics,

<sup>14</sup>If we allow for a different values of  $c$  in the definition of "true" experience, yielding  $c = -.00066$  for natives and  $c = -.00061$  for immigrants, we obtain essentially the same patterns for the price of experience. The only difference is that, in this case, the initial price effect, given by  $1 - b_{exp} - d_{exp} = -0.148$ , is not significantly different from zero.

since their prices rise. Note that the cohort dummies indicate a reduction in the unmeasured quality of immigrants. Holding measured characteristics constant, immigrants who came before 1990 earn 6.2 percent more than immigrants who came in 1990-1991 (the omitted group), who earn 5.7 percent more than immigrants who came in 1992-1995. This pattern is consistent with the observed deterioration, in terms of observed characteristics, reported in Table 1A. As noted by Borjas (1985), under the circumstances of declining cohort quality, control for cohort effects reduces the estimated effect of time spent in Israel.

### 5.3. Convergence of mean earnings

As noted above, the separate price effects operate in different way. The price of unobserved skills decline while the price of observed skills rises with the time spent in Israel. Figures 1a to 1c summarize the combined impact of these factors and address the question of whether or not the wage of immigrants converge to those of native Israelis. These figures show the predicted wage-age profiles for an immigrant with 16 years of schooling who arrived to Israel, during the period 1990-1991 at the age of 30, and for an equivalent native Israeli. We consider three such comparisons, one for each occupation category.

As seen in these figures, the immigrant's wage-age profile are generally below those of the native Israeli. In occupations 1 and 2 there is a narrowing of the gap, but no convergence or overtaking. In occupation 3, the gap widens with time spent in Israel, suggesting that immigrants who stay there, for a long time are of increasingly lower quality. The predicted gaps at age 55 for the 1990-1991 cohort are 8%, 20% and 34% in occupations 1,2, and 3, respectively.

### 5.4. Convergence of residual distributions

The residuals from the wage regressions for natives and immigrants capture the effect of unobserved skills on the wages. The variance of these residuals can be interpreted as the "price" of this unobserved skills (see Juhn, Murphy and Pierce, 1993 and Blau and Kahn, 1992). We shall now compare the distribution of residuals for Israelis and immigrants, based on the regressions in Tables 8 and 9, respectively. We performed Kolmogorov-Smirnov (K-S)

and Kruskal-Wallis (K-W) tests for equality of distributions.<sup>15</sup> Both tests reject the null hypothesis of equality of distributions. To examine the role of time in Israel, we divide the sample into two subsamples, those with less than 5 years experience in Israel and those with more than 5 years in Israel. Within each experience group, we test again for equality between natives and immigrants. The null hypothesis of equality of distribution is strongly rejected for the less experienced immigrants (p value of zero for K-S test and p value of 0.0077 for K-W test). Figure 2 compares the two distributions in this case. We can observe clearly that the residual distribution on the immigrants has a lower variance.<sup>16</sup> On the other hand, the test for equality of the residuals distributions of natives to that of immigrants that are in Israel more than 5 years is not rejected (p value of 0.811 for K-S test and p value of 0.758 for K-W test). Figure 3 compares the two distributions in this case. The closeness of the distribution as well as the slightly lower variance for immigrants are clearly observed. These residual patterns hold whether or not cohort effects are included in the regression for immigrants.

The results show a tendency for the residuals distributions of natives and immigrants converge as time in Israel exceeds five years. As immigrants arrive, their wages are (relatively) equally distributed, but later on the wage distribution, conditioned on human capital characteristics, become more dispersed. The rising variability in residuals among immigrants, with the passage of time spent in Israel, may be interpreted as a rise in the price of their unobserved skills, mimicking the patterns which we have reported for the prices of observed skills.

## 6. Occupational Distribution and Transitions

Our finding that wages of immigrants do not converge to the wages of Israelis, conditional on schooling and occupation may be reversed if we compare the wages of immigrants and native Israelis conditioned only on schooling. If, in the long run, immigrants are more likely to work in occupation 1, their earning may converge or overtake the earnings of Israelis with the same schooling. In order to predict the unconditional wage of immigrants, we have to

<sup>15</sup>The tests were performed using the STATA software.

<sup>16</sup>The null hypothesis of normality is rejected for both groups.

predict their future transitions among occupations.

As we have shown in the previous section, the occupation at which an immigrant is employed has a strong impact on his wages. Therefore, the rate at which immigrants find jobs in the high skill occupations is an important determinant of wage growth. Because of market frictions and lack of information, immigrants do not immediately find jobs which suit their qualifications and skills. Instead, they start at the bottom of the occupational ladder and gradually climb up. In this section, we present data on occupational transitions of immigrants, based on two recent panels. We also describe the occupational distribution of immigrants who work in Israel as function of time in Israel. We shall compare the results from these panels to the occupational distribution in the CBS income surveys 1991-1995 which we used to analyze earnings.

The Brookdale Institute of Gerontology and Human Development has conducted a survey in the summer of 1992 on a random sample of 1,200 immigrants from the former USSR who entered Israel between October 1989 and January 1992. About 900 of these immigrants were resampled in 1995. We refer to this survey as Brookdale Survey (BS). The original sample consists of immigrants in working-ages (25-69) residing in 30 different locations in Israel. These immigrants reported their location, occupation and schooling in the former USSR. The survey contains a complete history of jobs held from the date of arrival to Israel until the last interview. It also provides information on wages in each job and the knowledge of Hebrew and English in the two survey years and participation in training programs. In addition, the Brookdale Institute has surveyed in 1995 about 1,400 immigrants with an engineering diploma who arrived to Israel during the years 1990-94. We refer to this survey as Engineers Survey (ES). This survey has the same information as the other employment survey by Brookdale with some additional questions on training and work. Almost all the individuals in this survey have 16 or more years of schooling.

As we did for earning, we limit our analysis of occupational transitions to male immigrants who were relatively young upon arrival (26 to 45 in this case). We concentrate on immigrants which have at least 16 years of schooling, or worked in academic professions in the former USSR, because we are mainly interested in the matching of qualified workers to high skill occupations.

As a benchmark for this analysis, let us first look at the occupational distribution of native

Israelis by age. Table 10, shows that the proportion working in occupation 1 increases with education and age, while the proportion working in occupation 3 declines. About 20 percent of working Israeli men of age 35 to 39 work in occupation 1, while among those who have 16+ years of schooling the proportion is 64 percent. For the age group 45-50, the corresponding figures are 28 and 76 percent. Table 11 shows the occupational distribution by years in Israel for male immigrants of age 26 to 45 with at least 16 years of schooling. We observe a substantial move into occupation 1. Initially, only 27 percent of these immigrants work in occupation 1, 13 percent work in middle-skill jobs and 60 percent work in unskilled jobs. After 15 years, 68 percent of these immigrants work in occupation 1. These figures are quite similar to the proportions of Israeli workers of similar age and education, suggesting a convergence of the occupational distributions of immigrants to that of native Israelis. However, given the small sample size it is important to examine additional sources of data.

A similar pattern of a quick rise in the proportion of immigrants employed in occupation 1 is observed in Tables 12a to 12d, which display the change in occupational distribution during the first 4 to 5 years in Israel for the recent wave of immigrants, using data from the panel surveys by Brookdale and the CBS. The different sources tell the same story, initially about 20 percent of the immigrants found a high skilled job, while after 4.5 years this proportion rises to about 40 percent.

One can use transition matrices to describe the dynamics of the occupational distribution and to generate predictions for the proportion of immigrants who will work in each occupation in the long run. The two Brookdale surveys enable us to study the flows between different labor market states, which specify whether and where an immigrant is employed. Because of its larger size, we use the sample of Engineers to estimate the transition rates. Table 13a shows the distribution of all engineers (16+ years of education) who were 26 to 45 of age upon arrival to Israel, for the first four and half years in Israel. The distribution is for four states: employment in one of the three occupational categories and non-work (which includes unemployment and training). The new feature here is the large initial level and the fast reduction in the proportion of immigrants who are not working (unemployed or in training). At the same time, the proportion of immigrants who find work in occupation 1 is rapidly increasing. Some increase in the proportion in occupation 2 can also be noted.<sup>17</sup>

<sup>17</sup>The data of the Brookdale survey show the same pattern, unconditional on education, but we do not

Table 13b presents the annual transition probabilities matrix among the four states. Using the monthly data, we calculate for each month the annual transition rate (12 months ahead) and then take monthly average for immigrants who were in Israel between 30 to 42 months. The table shows that the probability of leaving occupation 1 within a year is less than 4 percent. More than 21 percent of the non-working men go directly to occupation 1 within a year. In contrast, the rates of upward mobility from occupation 2 and 3 to occupation 1 are only 9 and 6 percent, respectively. Hence, many immigrants are either in training or unemployed before they receive and accept a job in occupation 1. Note that these estimates are the average for immigrants who have been more than two and a half years in Israel, so that most of the people who are not working are unemployed and only few are in training programs.

Under the strong assumption of stationary transition rates, we can use the transition probabilities matrix of Table 13b to forecast the future occupational distribution of the immigrants with 16+ years of schooling who are engineers.<sup>18</sup> Table 13c presents the resulting forecast of 5 to 35 years ahead occupational and non-working distribution for men who arrive to Israel at age 26 to 45. After 35 years, the proportion employed in occupation 1 (from all employed workers) is  $68.7/97.2 = 71\%$ , a forecast which is very close the figure 68.3 in Table 11. These predictions for the proportion employed in Occupation 1, are also presented in Figure 5, where they are compared to predictions based on logit estimation from the CBS, for immigrants and Israelis. As seen, the predictions from the sample for engineers are somewhat lower, but also suggest a fast narrowing of the occupational gap. The agreement of the predictions from panel data with the proportions in the pooled cross sections results suggests that we can use, with some confidence, the occupational state probabilities in Table 13c to generate an expected wage profiles which are not conditioned on occupation.<sup>19</sup>

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present it here.

<sup>18</sup> Given that the transition matrix is from the early period in Israel, it is likely that the off diagonal probability of upwards mobility are biased upwards as estimates for the transitions in the later years.

<sup>19</sup> Note that the predicted proportions of the other occupations and for unemployment are also consistent with the findings from the Income Surveys. We are currently engaged in further examination of this issue, using the Labor Force annual survey of the CBS.

## 7. Wage and Occupational Convergence

Do earnings received by immigrants in the host country converge, overtake, or fall short of those of native Israelis? To answer this question, we now bring together our results on the dynamics of the wages received by immigrants and the dynamics of occupational transitions by immigrants. The analysis of the wage dynamics has shown that there is a substantial increase in the return to human capital brought by immigrants. At the time of arrival to Israel, the value of imported human capital in the form of schooling and experience had about a zero effect on the wages received by immigrants. With time in Israel, the market value of these human capital indicators increases but the return for schooling converges to a level that is significantly below that of native Israelis, especially for immigrants who remain in the unskilled occupations. The impact of imported experience on the earning of immigrants approaches the corresponding effect for Israelis, but at a slow rate.

The wage received by immigrant is also affected by the unobserved skills that are captured (in average) by the constant of the estimated wage regression. This constant is different in the three point occupational distribution that we used. Given the large positive impact on wages of working in occupation 1 or 2 rather than occupation 3, the predicted occupation at each point in time is an important determinant of the expected wage.

Figure 4 follows the predicted wage of an immigrant with 16 years of schooling, who arrived to Israel at age 30. We combine here the dynamic effects from the estimated wage equations reported in Tables 8 and 9 with the occupational distribution predicted in Table 13. To calculate the wage conditioned on working for immigrants, we use the predicted occupational probabilities, excluding unemployment. Similarly, in tracing out the native Israeli wage we weighted the wage by the proportion of native Israelis with 16+ years of schooling in the three occupations. Figure 4 shows that the wage of an immigrant who is 30 years old upon arrival is about one half of the wage of an equivalent Israeli (9.5 vs. 18 NIS of 1991). This gap is reduced over time, and 20 years after arrival (at age 50) it reaches the level of 5.3 NIS of 1991, which is 17.8% below the wage of the native Israeli.

Table 14 provides a partition of the wage growth of immigrants in a synthetic cohort into five components: time, experience, price effects, occupational changes and differences in observed characteristics. Specifically, we select from the 1991 and 1995 cross sections

immigrants who entered Israel in 1990. Averaging log wages for each cross section and taking the difference (divided by 5) yields the "average annual growth rate" for the 1990 synthetic cohort during the period 1991-1995. For each person in these two cross sections we can create a prediction based on *his* characteristics and occupation and generate the "average predicted growth rate". We then partition this prediction using the estimated coefficients in Tables 8 and 9. This exercise is performed for the whole sample of entrants in 1990 and to subsamples classified by schooling and age at arrival.

The time effect is derived directly from the 1991 year effect in Table 8. The experience effect is the difference in the average accumulated "true" experience in Israel between the two cross sections. The price effect is defined as the average change in predicted residuals, *holding occupation constant* at the 1991 level. The occupation effect is the difference in the predicted residuals, in 1995, for the 1991 and 1995 cross sections. Since time in Israel is held constant in this comparison, the experience and price effects are accounted for and the remaining factor is the difference in occupational choices.<sup>20</sup> The last term accounts for the fact that the immigrants of the 1990 cohort who are observed in 1991 and 1995 are *not* the same individuals.

The results in Table 14 show that increasing prices of skills are the most important factor in explaining wage growth during the initial five years following immigration. Of an average annual wage growth of 6.4 percent, half is due to rising prices. Of course, this factor is more important the more schooling or experience the immigrant has. Changing occupation is an important factor for qualified immigrants with 16+ years of schooling, but is unimportant for others. For these immigrants experience accounted for 1.65 percent of the average annual growth and the aggregate growth of wages accounted for 1.2 percent. As expected, experience effects are more important for younger immigrants. The results show that the model under (over) predicts the wage growth of young (old) immigrants. This suggest that age plays an independent role which is not captured by investment and accumulation of experience.<sup>21</sup>

<sup>20</sup> In the 1991 cross section, 12.8 percent worked in occupation 1, 12.0 per cent worked in occupation 2 and 75.2 percent worked in occupation 3. The corresponding figures in 1995 were 20.4, 13.8 and 65.7.

<sup>21</sup> A possible explanation is that employers are reluctant to hire and test old immigrants. Therefore, the probability of receiving wage offers in occupation 1 is lower for such workers (see Weiss and Gotlibovski, 1995).

## 8. Summary and Conclusions

It is well known that immigrants enjoy a high wage growth during the initial phase after arrival. The novel aspect of this work is the attempt to identify the sources of this wage growth. We distinguish three sources of wage growth for immigrants: (i) the rise of the return to imported human capital; (ii) the impact of accumulated experience in the host country; and, (iii) the mobility up the occupational ladder in the host country. We find that increased price of skills account for about half of the 6.4 annual wage growth during the first five years. Occupational transitions are important only for the high skill immigrants who came with academic degrees, accounting for about 3.1 percent out of an annual wage growth of 8.13 percent. For these immigrants experience accounted for 1.65 percent annual growth and aggregate wage growth account for about 1.2 percent.

The prices that immigrants receive for their imported schooling and experience are initially zero or negative. These prices rise with time spent in Israel, but never reach the prices obtained by native Israelis. The market "penalty" on observed imported skills is partially compensated by a premium on the unobserved characteristics of these immigrants. As immigrants spend more time in Israel, the increase in prices of skill slows down and occupational transitions become more important. Initially, there is a substantial occupational downgrading and only 30 percent of the immigrants who worked in academic jobs in the USSR find similar jobs in Israel. However, based on the observed transition rates in the initial phase, the occupational distribution of immigrants is, expected to converge to the distribution of comparable Israelis, within a period of 15 years. Despite this apparent tendency towards occupational convergence, wages of immigrants are not expected to converge to the wages of comparable Israelis, mainly because the long run price that immigrants obtain for their imported schooling a substantially lower return (0.044 and 0.027 for immigrants in high and low skill occupations, respectively) than that which Israelis obtain (7.2 percent).

The large gap in the "rates of return for schooling" between immigrants and native Israelis, which was also documented by Friedberg 1992, may reflect either an inherent difference in quality of schooling or frictions in the labor market which cause qualified immigrants to "give up" in their search for suitable jobs (see Weiss and Gotlibovski, 1995).

Somewhat surprisingly, we cannot reject the possibility that immigrants will obtain, in

the long run, the same price for their imported experience as Israelis (and immigrants) obtain for experience acquired locally. One would have expected that experience is less transferable than schooling.

The suggested partition of wage growth into within occupations and across occupations components cannot be accomplished with sufficient precision using only cross section data on wages, because we do not know where a particular immigrant who now works in, say, occupation 1, has worked in the past. Therefore, we used the panel data to form the estimates of the transition probabilities. However, even with panel data, it is not possible to provide a satisfactory partition without a structural model in which search is allowed to interact with on the job investments and quality changes. We are in the process of constructing such a model. The present framework is only a first step in this direction.

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## Appendix

In this appendix we present the solution of the optimal investment problem, using specific functional form for the time costs of investment on the job. Let

$$c(T_w) = 1 - (1 - T_w)^\alpha, \quad (\text{A1})$$

where  $0 < \alpha < 1$ . Equations (1) and (2) in the text imply that

$$\frac{\dot{K}}{K} = \sum (\theta_s (\beta_s \iota_s + \gamma_s \tau_s - \delta)). \quad (\text{A2})$$

We may normalize by setting  $\sum \theta_s = 1$ . The Hamiltonian function is

$$H = e^{-rt} K \{ R(-\sum \iota_s + (1 - \sum \tau_s)^\alpha) + \psi(\sum \theta_s (\beta_s \iota_s + \gamma_s \tau_s - \delta)) \}, \quad (\text{A3})$$

where  $\psi$ , represents the value of an additional unit of human capital. This shadow price evolves according to

$$\dot{\psi} = (\tau + \delta)\psi - [R(-\sum \iota_s + (1 - \sum \tau_s)^\alpha) + \psi(\sum \theta_s (\beta_s \iota_s + \gamma_s \tau_s))] \quad (\text{A4})$$

and satisfies

$$\psi(T) = 0. \quad (\text{A5})$$

The control variables,  $\iota_s$  and  $\tau_s$ , satisfy the constraints

$$\iota_s, \tau_s \geq 0, \quad (\text{A6})$$

and

$$\sum \iota_s + \sum \tau_s \leq 1, \quad (\text{A7})$$

Maximizing the Hamiltonian function with respect to the control variables, yields the following first order conditions:

$$\begin{aligned}
-R + \psi\theta_s\beta_s &\leq 0, \text{ if } \iota_s = 0, \\
-R + \psi\theta_s\beta_s &= 0, \text{ if } 0 < \iota_s < 1, \\
-R + \psi\theta_s\beta_s &\geq 0, \text{ if } \iota_s = 1.
\end{aligned} \tag{A8}$$

and

$$\begin{aligned}
-R\alpha(1 - \sum \tau_s)^{\alpha-1} + \psi\theta_s\gamma_s &\leq 0, \text{ if } \tau_s = 0, \\
-R\alpha(1 - \sum \tau_s)^{\alpha-1} + \psi\theta_s\gamma_s &= 0, \text{ if } 0 < \tau_s < 1,
\end{aligned} \tag{A9}$$

The marginal benefit from training in equations (A8) and (A9) it is seen to equal the contribution of training time to a particular skill (given by  $\beta_s$  or  $\gamma_s$ ) multiplied by the contribution skill acquisition to human capital,  $\theta_s$ , multiplied by the value of human capital,  $\psi$ . The marginal opportunity costs of training time is given by  $R$  in the case of schooling and by  $R\alpha(1 - \sum \tau_s)^{\alpha-1}$  in the case of on the job training. The worker never specializes in on the job training because the marginal costs become infinitely high when  $\tau_s$  approaches 1.

Because all schooling activities are equally costly, an individual who invests in schooling will augment only the skill with the highest contribution to the growth of human capital (i.e., the highest  $\theta_s\beta_s$ ). Similarly, because all training activities are equally costly, an individual who invests in training on the job will augment only the skill with the highest  $\theta_s\gamma_s$ . Without loss of generality let us assume that  $\theta_s\beta_s$  is highest for  $s = 1$  and that  $\theta_s\gamma_s$  is highest for  $s = 2$ . The assumption that  $\beta_s > \gamma_s$  for all  $s$  implies that  $\theta_1\beta_1 > \theta_2\gamma_2$ .

The decision whether to acquire schooling or training and at what intensity depends on the ratio  $\psi/R$  which determines the value of human capital in relation to the opportunity costs. Comparing the value of the Hamiltonian function under the alternative policies of schooling acquisition and on the job training, we see that these two options are equivalent if

$$\psi\theta_1\beta_1 = R(1 - \tau_2)^\alpha + \psi\theta_2\gamma_2\tau_2. \tag{A10}$$

Using (A9) to determine the maximizing value of  $\tau_2$ , condition (A10) may be rewritten as

$$(1 - \tau_2) = \frac{\theta_1\beta_1 - \theta_2\gamma_2}{\theta_2\gamma_2} \frac{\alpha}{1 - \alpha} = \left[ \frac{\psi\theta_2\gamma_2}{\alpha R} \right]^{\frac{1}{\alpha-1}}. \tag{A11}$$

Condition (A11) determines a unique value of  $\psi/R, \psi_c/R_c$ , such that for  $\psi/R > \psi_c/R_c$  the individual specializes in schooling, for  $\alpha/\theta_2\gamma_2 \leq \psi/R \leq \psi_c/R_c$  the individual acquires some on the job training and for  $\psi/R < \alpha/\theta_2\gamma_2$  he acquires or no training at all.

A necessary condition for indifference is that  $\alpha\theta_1\beta_1 < \theta_2\gamma_2$ , which means that the ratio of marginal benefits to marginal costs is higher than for on the job training than for schooling, when the level of investment is sufficiently small. Also, since  $\tau_2 = 0$  is a feasible choice, the maximizing value of  $\tau_2$  must yield a value for the *RHS* of (A10) which exceeds  $R$ . Therefore, at the point of indifference, we have  $\psi\theta_1\beta_1 > R$  and the individual specializes in schooling.

The time pattern of the shadow price of human capital,  $\psi$ , is determined endogenously and depends on the time pattern of  $R$ . The time pattern of the rental rate,  $R$ , is exogenous, and we assume that  $\frac{\dot{R}}{R}$  is non negative and non increasing. We shall then prove that  $\psi/R$  must *decline* along the optimal path. The proof proceeds by assuming the pattern and proving that it satisfies all the necessary conditions.

Under the assumption that  $\psi/R$  declines, the life cycle is divided into 3 different phases: in the first phase, the individual invests only in schooling, in the second phase he invests in on the job training and in the last phase he does not invest at all.

Consider, first, the last phase with no investment in training. In this phase (A4) becomes

$$\dot{\psi} = (r + \delta)\psi - R. \quad (\text{A12})$$

Using the boundary condition (A5), we can solve (A12) to obtain

$$\psi(t) = \int_0^{T-t} e^{-(r+\delta)x} R(t+x) dx. \quad (\text{A13})$$

Dividing both sides of (A13) by  $R(t)$ , we see that  $\psi(t)/R(t)$  must decrease with time because the horizon,  $T - t$  gets shorter and, under the assumption that  $\frac{\dot{R}}{R}$  is non increasing,  $R(t+x)/R(t)$  declines in  $t$  (or remains constant) for every  $x$ .

Consider, next, the region with on the job training and let  $z = (1 - \tau_2)$  be the share of earning capacity which the individual retain while he is training on the job. Differentiating (A9) with respect to  $t$  and using equation (A4), we obtain

$$\frac{\dot{z}}{z} = \frac{\dot{R}}{R} \frac{1}{1-\alpha} + \frac{\theta_2\gamma_2 - (r+\delta)}{1-\alpha} + \frac{\theta_2\gamma_2 z}{\alpha}. \quad (\text{A14})$$

We assume that, investment on the job can yield a growth in human capital which exceeds the interest rate, that is,  $\theta_2\gamma_2 - (r + \delta) > 0$ , (otherwise, such investment is not profitable). We also assume that  $\frac{\dot{R}}{R} \geq 0$ . Therefore, investment time declines and the share of retained earning rises when the individual invests in training on the job. Since, by (A9),  $z(t)$  and  $\psi(t)/R(t)$  are inversely related it follows that  $\psi(t)/R(t)$  must also decline.

Consider, finally the region of specialization in schooling. In this phase we have

$$\dot{\psi} = (r + \delta - \theta_1\beta_1)\psi. \quad (\text{A15})$$

Since schooling is more productive than training, our assumption that  $\theta_2\gamma_2 - (r + \delta) > 0$  implies that  $r + \delta - \theta_1\beta_1 < 0$ . Hence  $\psi$  must decline during the schooling phase. Since  $\frac{\dot{R}}{R} \geq 0$ ,  $\psi(t)/R(t)$  must also decline.

We conclude that the incentive for investment, as represented by the ratio  $\psi(t)/R(t)$ , declines throughout the individual's career. This result reflects two basic forces: the usual effect of shortening the period over which human capital is utilized and the additional force of worsening terms of trade between current costs and future benefits,  $R(t+x)/R(t)$ , implied by the assumption that  $\frac{\dot{R}}{R}$  is non negative and non increasing.

The model implies a very simple pattern of life time earnings. During the initial phase, the individual, specializes in schooling and his observed earnings are zero. His earning capacity, however grows at the constant  $\theta_1\beta_1$ . Earnings in the second phase are given by  $y(t) = R(t)K(t)z(t)^\alpha$ . Using (A11), we see that when the individual enters the second phase, at time  $t_0$ , his initial earnings are given by

$$y(t_0) = R(t_0)K e^{\theta_1\beta_1 t_0} \left[ \frac{\theta_1\beta_1 - \theta_2\gamma_2}{\theta_2\gamma_2} \frac{\alpha}{1 - \alpha} \right]^\alpha. \quad (\text{A16})$$

Differentiating  $y(t)$  with respect to  $t$ , using (A2) and (A14) his earnings grow during the second phase at the rate

$$\frac{\dot{y}}{y} = \frac{\frac{\dot{R}}{R} + \theta_2\gamma_2 - r\alpha - \delta}{1 - \alpha}. \quad (\text{A17})$$

During last phase, which starts at  $t_1$  and ends at  $T$ , investment is zero and earnings are given by  $y(t) = R(t)K(t)$  implying a growth rate

$$\frac{\dot{y}}{y} = \frac{\dot{R}}{R} - \delta. \quad (\text{A18})$$

One can also obtain an explicit solution for the investment path. In the initial schooling phase,  $\frac{\dot{K}}{K} = \theta_1\beta_1 - \delta$ . During the period of investment on the job,  $\frac{\dot{K}}{K} = \theta_2\gamma_2\tau_s - \delta = \theta_2\gamma_2 - \delta - \theta_2\gamma_2 z$ , where  $z$  is determined by the solution to the differential equation A14, that is,

$$z(t) = \frac{\left[\frac{R(t)}{R(t_0)}\right]^{\frac{1}{1-\alpha}} e^{a(t-t_0)}}{1 - b \int_0^{t-t_0} \left[\frac{R(t+x)}{R(t_0)}\right]^{\frac{1}{1-\alpha}} e^{ax} dx} z(t_0), \quad (\text{A19})$$

where  $a = \frac{\theta_2\gamma_2 - r - \delta}{1-\alpha}$ ,  $b = \frac{\theta_2\gamma_2}{\alpha}$  and by A11,  $z(t_0) = \frac{\theta_1\beta_1 - \theta_2\gamma_2}{\theta_2\gamma_2} \frac{\alpha}{1-\alpha}$ . During the last period of non investment  $\frac{\dot{K}}{K} = -\delta$ . Note that the behavior of investment over time depends only on the relative values of  $R(t)$  at different points in time

The length of each of the investment phases are easily determined. The entry date into the last phase,  $t_1$ , occurs when or  $\psi(t)\theta_2\gamma_2 = \alpha R(t)$  or

$$\theta_2\gamma_2 \int_0^{T-t} e^{-(r+\delta)\tau} R(t+x) dx = \alpha R(t). \quad (\text{A20})$$

This equation has a unique solution in  $t$ ,  $t_1$  which is *independent* of past history. Given  $t_1$ , we can calculate  $t_0$ , exploiting the fact that during the second phase  $z(t)$  traverses from  $z(t_0) = \frac{\theta_1\beta_1 - \theta_2\gamma_2}{\theta_2\gamma_2} \frac{\alpha}{1-\alpha}$  to  $z(t_1) = 1$ , satisfying the differential equation (A14). Using (A19) and (A14), we obtain

$$z(t_1) = \frac{\left[\frac{R(t_1)}{R(t_0)}\right]^{\frac{1}{1-\alpha}} e^{a(t_1-t_0)}}{1 - b \int_0^{t_1-t_0} \left[\frac{R(t+x)}{R(t_0)}\right]^{\frac{1}{1-\alpha}} e^{ax} dx} z(t_0) = 1. \quad (\text{A21})$$

Given the solved values of  $t_1$  and  $z(t_0)$ , one can solve for  $t_0$  from equation A21. Note that the value of  $t_0$  which solves (A21) is also independent of past history. This independence of the investment decisions from initial conditions is an outcome of the multiplicative form of the accumulation equation (A2) which allows us to factor  $K$  out of the Hamiltonian function (see Weiss[1986]).

This model can be applied to describe the accumulation of Human capital both in Israel by Native Israeli and immigrants, but it is more appropriate for immigrants. In the case of

native Israelis, the only source of exogenous variation is changes in  $R$ , due to changing market conditions, for instance. However, it is not clear why changing market conditions will satisfy the model's assumptions that  $\frac{\dot{R}}{R}$  is non negative and non increasing (unless the economy is stationary with  $\frac{\dot{R}}{R} = 0$ ). For immigrants, there is the additional change due to changing values of imported skills which we summarized by  $K_1$ , where we define  $\ln K_1 = \sum_{s \in S_1} \theta_s(t) x_s(0)$ , where the summation is taken over the set of *fixed* imported characteristics. Using equation (4) in the text, we obtain

$$\frac{\dot{K}_1}{K_1} = \sum x_s \lambda_s (\bar{\theta}_s - \theta_s(t)), \quad (\text{A22})$$

which is positive and nonincreasing under our maintained assumptions that  $\theta_s(0) < \bar{\theta}_s$  and  $\lambda_s > 0$ .

We can use the model to compare two individuals with the same initial skills and the same learning abilities: A native who has a constant rental rate,  $R^1$ , and an immigrant who faces an exogenously rising rental rate converging to  $R^1$  from below, some time before  $t_1$ . It is seen from equation (A14) that  $\frac{\dot{z}}{z}$  is higher at any  $z$  for the person with  $\frac{\dot{R}}{R} > 0$ . Since the two individuals must reach the value  $z = 1$  at the *same* time,  $t_1$ , and they both start investing with the same  $z(t_0)$ , it follows that the person with  $\frac{\dot{R}}{R} > 0$  will start to training later (i.e., at a larger  $t_0$ ), with a higher value of  $K(t_0)$ , and will have a lower value of  $z(t)$  throughout this interval, implying a higher value of  $\frac{\dot{K}}{K}$ . Thus, this person will have a higher value of  $K$  throughout his career. From equation (A17), we see that he will also have a higher earning growth on the interval  $[t_0, t_1]$ . Therefore, his earning level will be higher some time before  $t_1$ , implying overtaking.

**Table 1: Total Immigration and Immigration From the Former USSR, 1990-1995**  
(Thousands)

|            | 1990 |              | 1991 |              | 1992 |              | 1993 |              | 1994 |              | 1995 |              | Total<br>90-95 |              |
|------------|------|--------------|------|--------------|------|--------------|------|--------------|------|--------------|------|--------------|----------------|--------------|
| Immigrants | Num. | % of<br>Pop. | Num. | % of<br>Pop. | Num. | % of<br>Pop. | Num. | % of<br>Pop. | Num. | % of<br>Pop. | Num. | % of<br>Pop. | Num.           | % of<br>Pop. |
| USSR.      | 185  |              | 148  |              | 65   |              | 66   |              | 68   |              | 65   |              | 597            |              |
| All        | 200  | 3.84         | 176  | 2.92         | 77   | 1.25         | 77   | 1.24         | 80   | 1.24         | 76   | 1.15         | 686            | 10.6         |
| Age 15+    |      |              |      |              |      |              |      |              |      |              |      |              |                |              |
| USSR       | 143  |              | 117  |              | 52   |              | 53   |              | 55   |              | 52   |              | 472            |              |
| All        | 153  | 4.47         | 134  | 3.43         | 60   | 1.46         | 61   | 1.43         | 64   | 1.44         | 61   | 1.34         | 533            | 12.1         |

Source: Israeli Central Bureau of Statistics, *Statistical Abstracts*, 1990-1995.

**Table 2: Occupation and Schooling of Israeli Workers (1990) and Immigrants<sup>1</sup> (percent)**

|                      | Occupation <sup>2</sup> |      |      | Schooling |       |      |
|----------------------|-------------------------|------|------|-----------|-------|------|
|                      | 1                       | 2    | 3    | 0-12      | 13-15 | 16+  |
| Israeli Workers      | 14.8                    | 18.1 | 67.1 | 74.8      | 14.5  | 10.7 |
| Immigrants In USSR   | 35.5                    | 32.6 | 35.6 | 47.3      | 41.4  | 11.3 |
| Immigrants In Israel | 12.9                    | 12.0 | 75.1 |           |       |      |

1. Occupation in USSR and education of immigrants is according to the distribution among those arrived in 1991 (see table1A). Occupation of immigrants in Israel is according to the average distribution in 1991-5 for those arrived in 1990-1 (Source: CBS Income Surveys 1991-95).

2. Occupation 1 includes engineers, physicians, professors, other professionals with an academic degree and managers; Occupation 2 includes teachers, technicians, nurses, artists and other professionals; Occupation 3 includes blue collar and unskilled workers.

**Table 3: Employment Status of Immigrants by Year and Occupation in the former USSR (1990 Cohort, Males ages 25-55)<sup>1</sup> (percent)**

| Occ. in the USSR | Sample Year | Work Status in Israel |             |             |            |                    |
|------------------|-------------|-----------------------|-------------|-------------|------------|--------------------|
|                  |             | Emp. Occ. 1           | Emp. Occ. 2 | Emp. Occ. 3 | Unemployed | Out of Labor Force |
| 1                | 92          | 17.1                  | 6.0         | 55.3        | 11.5       | 10.1               |
| 1                | 93          | 27.4                  | 9.1         | 52.1        | 5.0        | 6.4                |
| 1                | 94          | 36.1                  | 8.7         | 50.2        | 1.8        | 3.2                |
| 2                | 92          | 3.5                   | 15.5        | 67.9        | 11.9       | 1.2                |
| 2                | 93          | 8.2                   | 21.2        | 65.9        | 2.3        | 2.4                |
| 2                | 94          | 7.0                   | 20.9        | 69.8        | -          | 2.3                |
| 3                | 92          | 2.3                   | 2.3         | 87.9        | 5.2        | 2.3                |
| 3                | 93          | 6.2                   | 4.6         | 84.4        | 3.2        | 1.6                |
| 3                | 94          | 6.2                   | 6.2         | 84.0        | 1.0        | 2.8                |

1. Source: CBS panel surveys 1991-1994

**Table 4: Employment and Unemployment of Native Israelis<sup>1</sup> and Immigrants<sup>2</sup>**

|      | Unemployment Rate (%) |            | Employed (thousands) |            |
|------|-----------------------|------------|----------------------|------------|
|      | Native Israelis       | Immigrants | Native Israelis      | Immigrants |
|      |                       | 9.4        |                      | 1,491.9    |
| 1991 | 8.8                   | 38.6       | 1,523.8              | 59.3       |
| 1992 | 9.3                   | 28.2       | 1,540.4              | 109.8      |
| 1993 | 8.3                   | 19.1       | 1,595.7              | 155.4      |
| 1994 | 6.8                   | 13.6       | 1,672.7              | 198.4      |
| 1995 | 5.8                   | 9.6        | 1,735.7              | 232.3      |

Source: Israeli Central Bureau of Statistics, various publications.

1. Native Israelis include only Jews, excluding immigrants.
2. Immigrants include all immigrants entered to Israel after October 1989.

**Table 5: Wages of Immigrants and Natives by Work Experience in Israel**

| Years of<br>Schooling   | (Males ages 25-55) <sup>1</sup> |            |                     |            |                     |            |
|-------------------------|---------------------------------|------------|---------------------|------------|---------------------|------------|
|                         | All Workers                     |            | Work Experience ≤ 5 |            | Work Experience > 5 |            |
|                         | Natives                         | Immigrants | Natives             | Immigrants | Natives             | Immigrants |
| 0-12                    | 3084                            | 2095       | 2056                | 1782       | 3179                | 2841       |
| 13-15                   | 4141                            | 2401       | 2472                | 1954       | 4714                | 4322       |
| 16+                     | 5556                            | 3066       | 3379                | 2342       | 6400                | 5461       |
| Occupation<br>in Israel |                                 |            |                     |            |                     |            |
| 1                       | 5949                            | 3945       | 3717                | 2978       | 6394                | 5903       |
| 2                       | 4246                            | 3264       | 3060                | 2571       | 4548                | 4518       |
| 3                       | 3050                            | 2018       | 2183                | 1749       | 3195                | 3073       |
| Age                     |                                 |            |                     |            |                     |            |
| 25-40                   | 3276                            | 2276       | 2698                | 2019       | 3441                | 3474       |
| 41+                     | 4514                            | 2663       | 2287                | 1980       | 4632                | 4218       |
| All Imm.                | 3759                            | 2704       | 2645                | 2001       | 3965                | 3941       |

1. Source: CBS Income Surveys 1991-95.

**Table 6: Summary Statistics<sup>1</sup>**

|                          | <i>Israelis</i> |            | <i>Immigrants</i> |            |
|--------------------------|-----------------|------------|-------------------|------------|
|                          | Males           | Females    | Males             | Females    |
| Monthly Wages            | 3,865.04        | 2,325.47   | 2,498.94          | 1,835.35   |
| (1991 NIS)               | (2,894.88)      | (1,501.38) | (1,719.02)        | (1,326.56) |
| Hourly Wages             | 18.80           | 14.36      | 12.50             | 10.69      |
| (1991 NIS)               | (12.98)         | (8.30)     | (8.38)            | (7.65)     |
| Experience (Total)       | 17.39           | 16.35      | 21.38             | 20.24      |
|                          | (9.74)          | (9.66)     | (10.32)           | (9.11)     |
| Experience Abroad        | —               | —          | 15.23             | 12.83      |
|                          |                 |            | (10.48)           | (8.95)     |
| Experience in Israel     | —               | —          | 6.15              | 7.47       |
|                          |                 |            | (6.86)            | (7.45)     |
| Age                      | 39.06           | 38.27      | 42.74             | 41.65      |
|                          | (9.13)          | (8.84)     | (9.95)            | (8.80)     |
| Age at Arrival           | —               | —          | 36.18             | 33.76      |
|                          |                 |            | (10.84)           | (9.49)     |
| Schooling                | 12.58           | 13.08      | 13.63             | 13.78      |
|                          | (3.15)          | (2.94)     | (3.31)            | (2.82)     |
| Schooling at Arrival     | —               | —          | 13.40             | 13.49      |
|                          |                 |            | (3.37)            | (2.95)     |
| <i>Occupations (%)</i> : |                 |            |                   |            |
| Sector 1                 | 19.73           | 11.67      | 16.41             | 12.22      |
| Sector 2                 | 12.72           | 24.19      | 10.19             | 19.55      |
| Sector 3                 | 67.55           | 64.14      | 73.40             | 68.23      |
| No. of Obs.              | 8,186           | 6,264      | 2,109             | 1,473      |

1. Source: CBS Income Surveys, 1991-1995.

**Table 7: Wages in 1991 NIS<sup>1</sup>**

|                      | <i>Israelis</i> |         | <i>Immigrants</i> |         |
|----------------------|-----------------|---------|-------------------|---------|
|                      | Males           | Females | Males             | Females |
| <i>Monthly Wages</i> |                 |         |                   |         |
| 1991                 | 3,607           | 2,151   | 2,657             | 1,897   |
| 1992                 | 4,034           | 2,306   | 2,489             | 1,928   |
| 1993                 | 3,790           | 2,232   | 2,313             | 1,767   |
| 1994                 | 3,981           | 2,511   | 2,514             | 1,759   |
| 1995                 | 3,918           | 2,398   | 2,555             | 1,860   |
| <i>Hourly Wages</i>  |                 |         |                   |         |
| 1991                 | 17.41           | 13.16   | 13.22             | 10.94   |
| 1992                 | 19.35           | 14.12   | 12.45             | 11.28   |
| 1993                 | 18.30           | 13.70   | 11.37             | 10.13   |
| 1994                 | 18.98           | 15.11   | 12.31             | 9.94    |
| 1995                 | 19.94           | 15.47   | 13.22             | 11.21   |
| <i>No. Obs.</i>      |                 |         |                   |         |
| 1991                 | 1,731           | 1,243   | 283               | 182     |
| 1992                 | 1,636           | 1,241   | 403               | 248     |
| 1993                 | 1,452           | 1,084   | 417               | 283     |
| 1994                 | 1,638           | 1,302   | 478               | 337     |
| 1995                 | 1,729           | 1,394   | 528               | 423     |

1. Source: CBS Income Surveys, 1991-1995

**Table 8: Wage Regression for Israeli Men Years 1991-1995**  
(Age 25-65 Years)

Dependent Variable: Log Hourly Wage (1991 NIS)

| <i>Variable</i>           | <i>Coefficient</i> | <i>St.Dev.</i> |
|---------------------------|--------------------|----------------|
| Constant                  | 1.2726             | 0.0360         |
| 1991                      | -0.0614            | 0.0160         |
| 1992                      | -0.0083            | 0.0162         |
| 1993                      | -0.0437            | 0.0167         |
| 1994                      | -0.0223            | 0.0162         |
| Occ1                      | 0.2718             | 0.0165         |
| Occ2                      | 0.2150             | 0.0170         |
| Experience                | 0.0451             | 0.0018         |
| (Experience) <sup>2</sup> | -0.0007            | 0.00004        |
| Schooling                 | 0.0728             | 0.0022         |
| $R^2$                     | 0.3215             |                |
| No. of obs.               | 8,186              |                |

**Table 9: Nonlinear Regression on Residuals for Immigrant Men,  
Age at Arrival > 25 Years. Years 1991-1995.**  
Dependent Variable: Residuals from Wage Regression in Table 8

| <i>Coefficient</i>         | Without schooling-occupation interaction |                | With schooling-occupation interaction |                |
|----------------------------|--|----------------|---------------------------------------|----------------|
|                            | <i>Estimate</i>                          | <i>St.Dev.</i> | <i>Estimate</i>                       | <i>St.Dev.</i> |
| $b_{cons}$                 | 0.3917                                   | 0.2114         | 0.4233                                | 0.2103         |
| $b_{cohort < 90}$          | 0.0625                                   | 0.0468         | 0.0621                                | 0.0467         |
| $b_{cohort 92-95}$         | -0.0562                                  | 0.0274         | -0.0574                               | 0.0274         |
| $d_{cons}$                 | 0.5743                                   | 0.2582         | 0.5766                                | 0.2565         |
| $\lambda$                  | 0.0941                                   | 0.0344         | 0.0953                                | 0.0348         |
| $b_{con\_occ1}$            | 0.3679                                   | 0.0851         | 0.1062                                | 0.1595         |
| $d_{con\_occ1}$            | -0.2426                                  | 0.1151         | -0.2513                               | 0.1146         |
| $b_{con\_occ2}$            | 0.2116                                   | 0.0980         | -0.0209                               | 0.1550         |
| $d_{con\_occ2}$            | -0.1553                                  | 0.1359         | -0.1734                               | 0.1357         |
| $b_{exp}$                  | -0.2372                                  | 0.2618         | -0.2333                               | 0.2605         |
| $d_{exp}$                  | -1.0013                                  | 0.2876         | -1.0142                               | 0.2858         |
| $b_{school}$               | -0.0423                                  | 0.0119         | -                                     | -              |
| $b_{school\_occ1 \& occ2}$ | -  | -              | -0.0290                               | 0.0136         |
| $b_{school\_occ3}$         | -  | -              | -0.0454                               | 0.0119         |
| $d_{school}$               | -0.0371                                  | 0.0141         | -0.0359                               | 0.0139         |
| Mean Dependent Var         | -.6106                                   | .4822          | -.6106                                | .4822          |
| Sum of Sq. Residuals       | 234.307                                  |                | 233.799                               |                |
| Log-Likelihood             | -724.262                                 |                | -722.369                              |                |
| $R^2$                      | 0.7780                                   |                | 0.7767                                |                |
| No. of obs.                | 1,744                                    |                | 1,744                                 |                |

**Table 10: Occupational Distribution of Israelis**  
(Percentage)

|               | Age Groups |       |       |       |       |       |       |       |
|---------------|------------|-------|-------|-------|-------|-------|-------|-------|
|               | 25-29      | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-60 | 61-64 |
| All Israelis  |            |       |       |       |       |       |       |       |
| 1             | 9.4        | 16.5  | 19.9  | 22.0  | 28.1  | 24.5  | 25.1  | 31.4  |
| 2             | 14.3       | 15.0  | 12.4  | 12.0  | 11.4  | 11.2  | 9.6   | 8.6   |
| 3             | 76.3       | 68.5  | 67.7  | 66.0  | 60.5  | 64.3  | 65.3  | 60.0  |
| Total Obs.    | 1424       | 1533  | 1538  | 1411  | 1128  | 605   | 398   | 140   |
| Schooling 16+ |            |       |       |       |       |       |       |       |
| 1             | 47.4       | 54.6  | 64.4  | 64.1  | 75.6  | 68.0  | 75.7  | 80.7  |
| 2             | 24.9       | 26.8  | 19.8  | 18.3  | 11.2  | 16.8  | 14.9  | 12.9  |
| 3             | 27.7       | 18.6  | 15.8  | 17.6  | 13.2  | 15.2  | 9.4   | 6.5   |
| Total Obs.    | 173        | 306   | 278   | 273   | 242   | 125   | 74    | 31    |

Source: Income surveys, 1991-1995.

**Table 11: Occupational Distribution of Male Immigrants  
(Age at Arrival 26-45)**

| Occupation         | After 1<br>Year |            | After 2<br>Years |            | After 3<br>Years |            | After 4<br>Years |            | After 5-15<br>Years |            | After 15+<br>Years |            |
|--------------------|-----------------|------------|------------------|------------|------------------|------------|------------------|------------|---------------------|------------|--------------------|------------|
|                    | All             | Sch<br>16+ | All              | Sch<br>16+ | All              | Sch<br>16+ | All              | Sch<br>16+ | All                 | Sch<br>16+ | All                | Sch<br>16+ |
| 1                  | 7.5             | 27.3       | 13.5             | 30.9       | 16.7             | 25.6       | 19.7             | 42.9       | 26.8                | 58.2       | 26.8               | 68.3       |
| 2                  | 8.3             | 12.7       | 8.5              | 13.2       | 7.9              | 10.5       | 14.1             | 14.3       | 14.0                | 15.2       | 14.1               | 13.4       |
| 3                  | 84.2            | 60.0       | 78.0             | 55.9       | 75.4             | 63.9       | 66.2             | 42.8       | 59.0                | 26.6       | 59.1               | 18.3       |
| Total Observations | 265             | 55         | 259              | 68         | 240              | 86         | 198              | 63         | 220                 | 79         | 199                | 60         |

Source: CBS Income Surveys 1991-1995.

**Table 12a: Occupational Distribution of Male Immigrants  
(Engineers, age at arrival 26-45)**

| <b>Occupation</b>  | <b>After<br/>.5 Year</b> | <b>After<br/>1.5 Years</b> | <b>After<br/>2.5 Years</b> | <b>After<br/>3.5 Years</b> | <b>After<br/>4.5 Years</b> |
|--------------------|--------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Occupation 1       | 18.7                     | 26.0                       | 32.9                       | 39.8                       | 42.6                       |
| Occupation 2       | 4.3                      | 6.7                        | 12.3                       | 12.9                       | 12.4                       |
| Occupation 3       | 77.0                     | 67.3                       | 54.8                       | 47.3                       | 45.0                       |
| Total Observations | 230                      | 315                        | 301                        | 264                        | 202                        |

Source: Brookdale Engineers Survey 1995.

**Table 12b: Occupational Distribution of Male Immigrants  
(1990 Cohort, Occupation 1 in USSR, age at arrival 26-45)**

| <b>Occupation</b>  | <b>After<br/>1.5 Years</b> | <b>After<br/>2.5 Years</b> | <b>After<br/>3.5 Years</b> |
|--------------------|----------------------------|----------------------------|----------------------------|
| Occupation 1       | 22.3                       | 30.3                       | 37.2                       |
| Occupation 2       | 7.6                        | 10.1                       | 9.3                        |
| Occupation 3       | 70.1                       | 59.6                       | 53.5                       |
| Total Observations | 157                        | 188                        | 215                        |

Source: CBS Immigrant Survey of 1990 Cohort (panel) 1994.

**Table 12c: Occupational Distribution of Male Immigrants  
(1990-1992 Cohort, All Occupations in USSR, age at arrival 26-45)**

| <b>Occupation</b>  | <b>After<br/>.5 Year</b> | <b>After<br/>1.5 Years</b> | <b>After<br/>2.5 Years</b> | <b>After<br/>3.5 Years</b> | <b>After<br/>4.5 Years</b> |
|--------------------|--------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Occupation 1       | 9.0                      | 19.9                       | 18.2                       | 23.9                       | 36.8                       |
| Occupation 2       | 10.0                     | 13.4                       | 8.6                        | 8.9                        | 7.3                        |
| Occupation 3       | 81.0                     | 66.7                       | 73.2                       | 67.2                       | 55.9                       |
| Total Observations | 189                      | 201                        | 198                        | 180                        | 68                         |

Source: Brookdale Surveys.

**Table 12d: Occupational Distribution of Male Immigrants  
(1990-1992 Cohort, Occupation 1 in USSR, age at arrival 26-45)**

| <b>Occupation</b>  | <b>After<br/>.5 Year</b> | <b>After<br/>1.5 Years</b> | <b>After<br/>2.5 Years</b> | <b>After<br/>3.5 Years</b> | <b>After<br/>4.5 Years</b> |
|--------------------|--------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Occupation 1       | 16.3                     | 34.3                       | 30.5                       | 37.3                       | 50.0                       |
| Occupation 2       | 12.0                     | 15.7                       | 11.4                       | 8.8                        | 10.0                       |
| Occupation 3       | 71.7                     | 50.0                       | 58.1                       | 53.9                       | 40.0                       |
| Total Observations | 92                       | 102                        | 105                        | 102                        | 40                         |

Source: Brookdale Surveys.

**Table 13a: Occupational Distribution of Male Immigrants  
(Engineers, age at arrival 26-45)**

| <b>Occupation</b>  | <b>After<br/>.5 Year</b> | <b>After<br/>1.5 Years</b> | <b>After<br/>2.5 Years</b> | <b>After<br/>3.5 Years</b> | <b>After<br/>4.5 Years</b> |
|--------------------|--------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Occupation 1       | 10.6                     | 21.5                       | 29.0                       | 37.6                       | 40.6                       |
| Occupation 2       | 2.5                      | 5.5                        | 10.8                       | 12.3                       | 11.8                       |
| Occupation 3       | 43.8                     | 55.5                       | 48.2                       | 44.8                       | 42.9                       |
| Not Working        | 43.1                     | 17.5                       | 12.0                       | 5.4                        | 4.7                        |
| Total Observations | 404                      | 382                        | 342                        | 279                        | 212                        |

Source: Brookdale Engineers Survey 1995

**Table 13b: Average Transition Matrix of Male Immigrants  
(Engineers, age at arrival 26-45)**

| <b>Occupation</b> | <b>Occupation 1</b> | <b>Occupation 2</b> | <b>Occupation 3</b> | <b>Not Working</b> |
|-------------------|---------------------|---------------------|---------------------|--------------------|
| Occupation 1      | 96.4                | 1.4                 | 1.2                 | 1.0                |
| Occupation 2      | 9.4                 | 79.9                | 5.9                 | 4.8                |
| Occupation 3      | 6.0                 | 1.7                 | 88.6                | 3.7                |
| Not Working       | 21.4                | 6.3                 | 38.1                | 34.3               |

Source: Brookdale Engineers Survey 1995.

**Table 13c: Forecasted Occupational Distribution of Male Immigrants  
(Engineers, age at arrival 26-45)**

| <b>Occupation</b> | <b>After Number of Years</b> |          |           |           |           |           |
|-------------------|------------------------------|----------|-----------|-----------|-----------|-----------|
|                   | <b>5</b>                     | <b>7</b> | <b>10</b> | <b>15</b> | <b>20</b> | <b>35</b> |
| Occupation 1      | 38.6                         | 45.0     | 52.1      | 59.7      | 64.0      | 68.7      |
| Occupation 2      | 10.2                         | 9.5      | 8.7       | 8.0       | 7.8       | 7.6       |
| Occupation 3      | 46.3                         | 41.6     | 35.7      | 29.1      | 25.2      | 20.9      |
| Not Working       | 4.9                          | 3.9      | 3.5       | 3.2       | 3.0       | 2.8       |

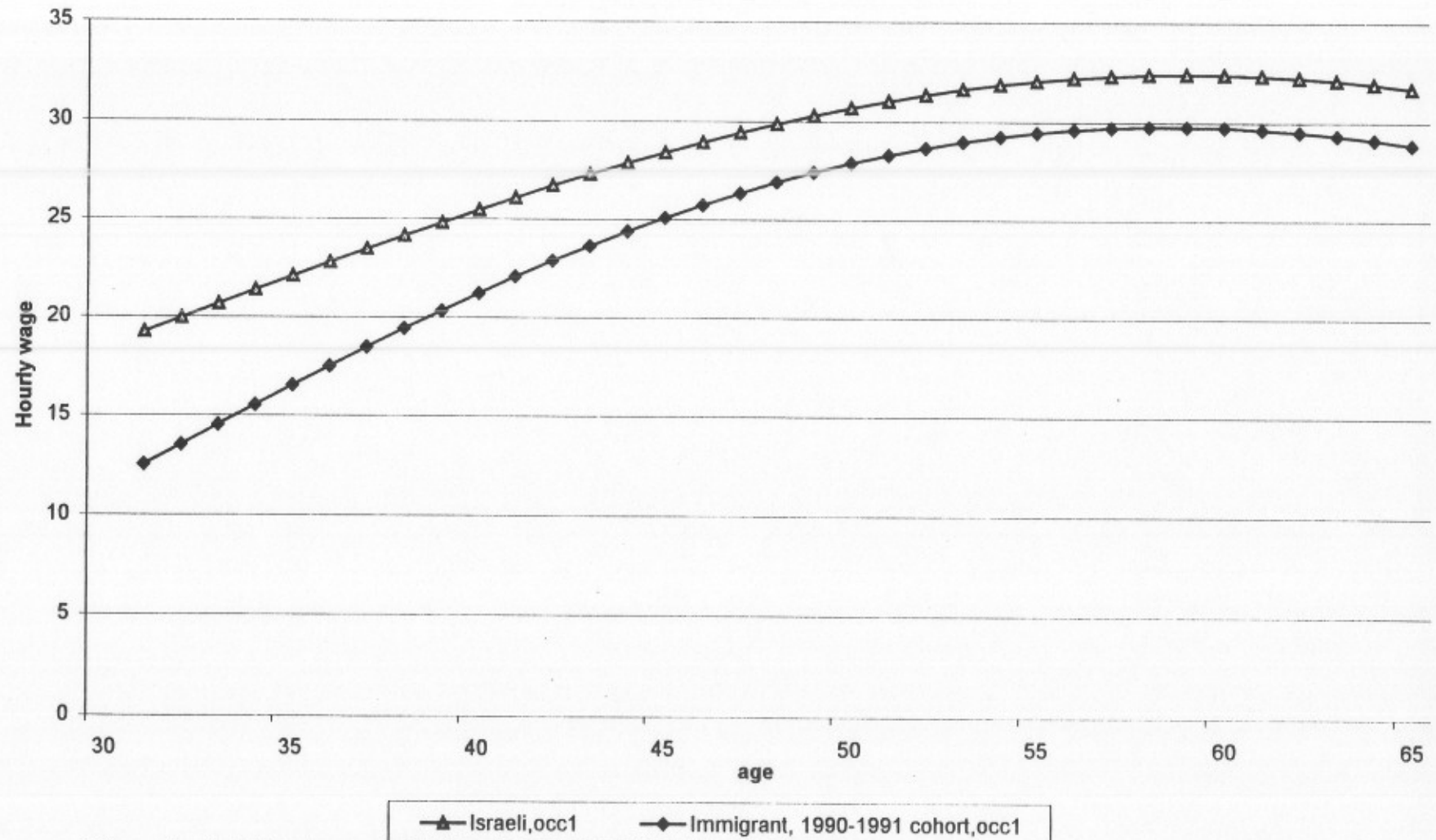
Source: Brookdale Engineers Survey 1995

**Table 14: Components of Annual Wage Growth During 1991-1995 For the 1990 Cohort, Males, Age at Arrival > 25**

|                              | All Immigrants | Schooling 13-15 | Schooling 16+ | Age at arrival<br>25-40 | Age at arrival<br>41+ |
|------------------------------|----------------|-----------------|---------------|-------------------------|-----------------------|
| Actual                       | 0.0641         | 0.0566          | 0.0813        | 0.0822                  | 0.0426                |
| Predicted                    | 0.0674         | 0.0637          | 0.0828        | 0.0669                  | 0.0658                |
| Time <sup>1</sup>            | 0.0123         | 0.0123          | 0.0123        | 0.0123                  | 0.0123                |
| Experience <sup>2</sup>      | 0.0141         | 0.0128          | 0.0165        | 0.0202                  | 0.0057                |
| Prices <sup>3</sup>          | 0.0317         | 0.0318          | 0.0433        | 0.0240                  | 0.0396                |
| Occupation <sup>4</sup>      | 0.0076         | -0.0014         | 0.0312        | 0.0031                  | 0.0053                |
| Characteristics <sup>5</sup> | 0.0017         | 0.0082          | -0.0205       | 0.0073                  | 0.0029                |
| Sample size 1991             | 125            | 52              | 30            | 63                      | 62                    |
| Sample size 1995             | 137            | 51              | 48            | 77                      | 60                    |

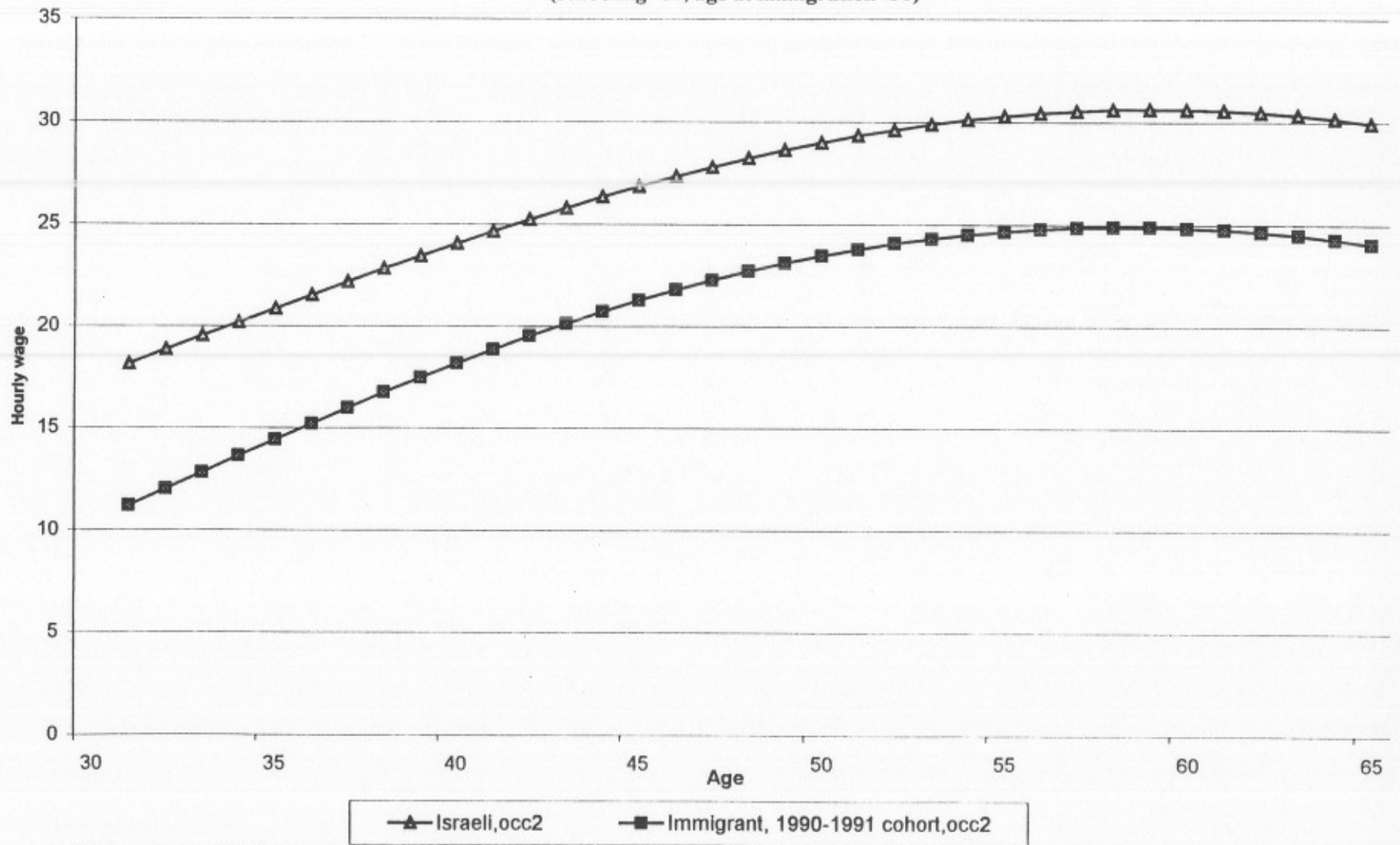
1. The time effect is the 1991 dummy in Table 8, divided by 5.
2. The experience effect is the difference in the average accumulated experience in Israel between the two cross sections (divided by 5), where accumulated experience is defined as  $[b(\exp_0 + t - t_0) - \frac{c}{2}(\exp_0 + t - t_0)^2]$ ,  $t - t_0$  equals 5 and 1 for members of the 1995 and 1991 cross sections, respectively, the coefficients  $b$  and  $c$  are taken from the wage equation for Israelis in Table 8 (i.e.,  $b = .0451$  and  $c/2 = .0007$  and  $\exp_0$  is the experience accumulated abroad by the immigrant).
3. For each immigrant in the 1991 cross section, we form predicted residuals for 1991 and 1995, *holding occupation constant* at the 1991 level. We then take averages of these two predictions (for 1995 and 1991) over all observations in the 1991 cross section and divide by 5.
4. For each immigrant in the 1995 cross section we predict his wage, based on his observed occupation. For each immigrant in the 1991 cross section we form a predicted wage for 1995, based on his 1991 occupation. We then take the difference in the average of these predictions and divide by 5.
5. For each immigrant, we take the experience and schooling he brought from the USSR, multiply by the corresponding coefficients from the wage equation for Israelis in Table 8 (.0451, -.0007 and .0728), then average within cross sections, calculate the difference and divide by 5.

Figure 1a  
Simulated Wage-Age Profiles in Occupation 1 for an Israeli and an Immigrant,  
(schooling=16, age at immigration=30)\*



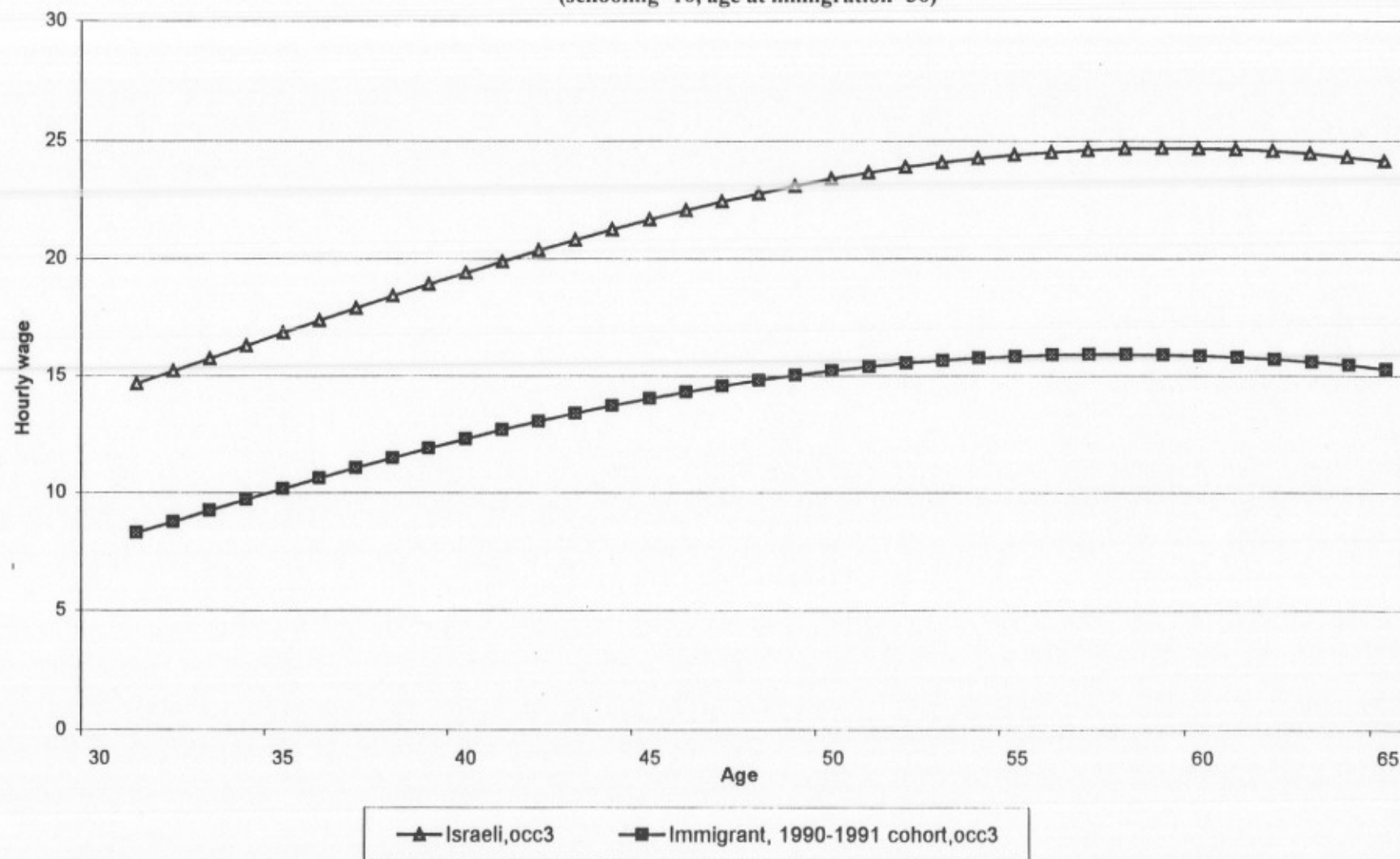
\* Wage per hour in 1991 NIS. Based on the regressions in tables 8 and 9.

**Figure 1b**  
**Simulated Wage-Age Profiles in Occupation 2 for an Israeli and an Immigrant,**  
**(schooling=16, age at immigration=30)\***



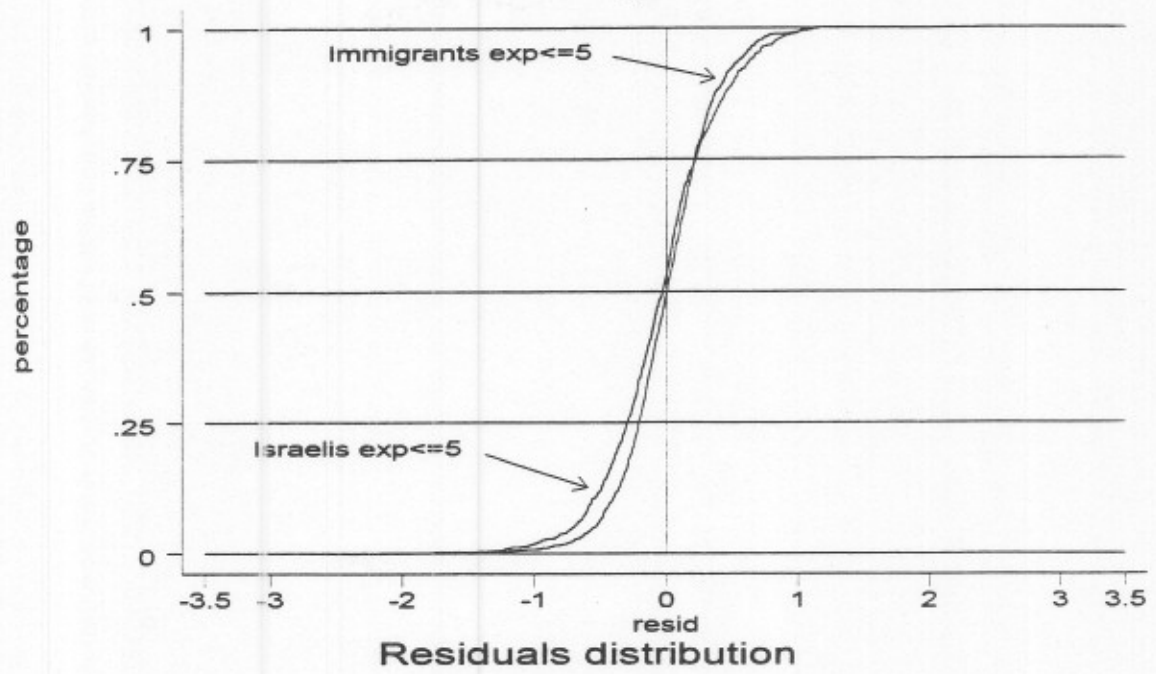
\* Wage per hour in 1991 NIS. Based on the regressions in tables 8 and 9.

Figure 1c  
 Simulated Wage-Age Profiles in Occupation 3 for an Israeli and an Immigrant,  
 (schooling=16, age at immigration=30)\*



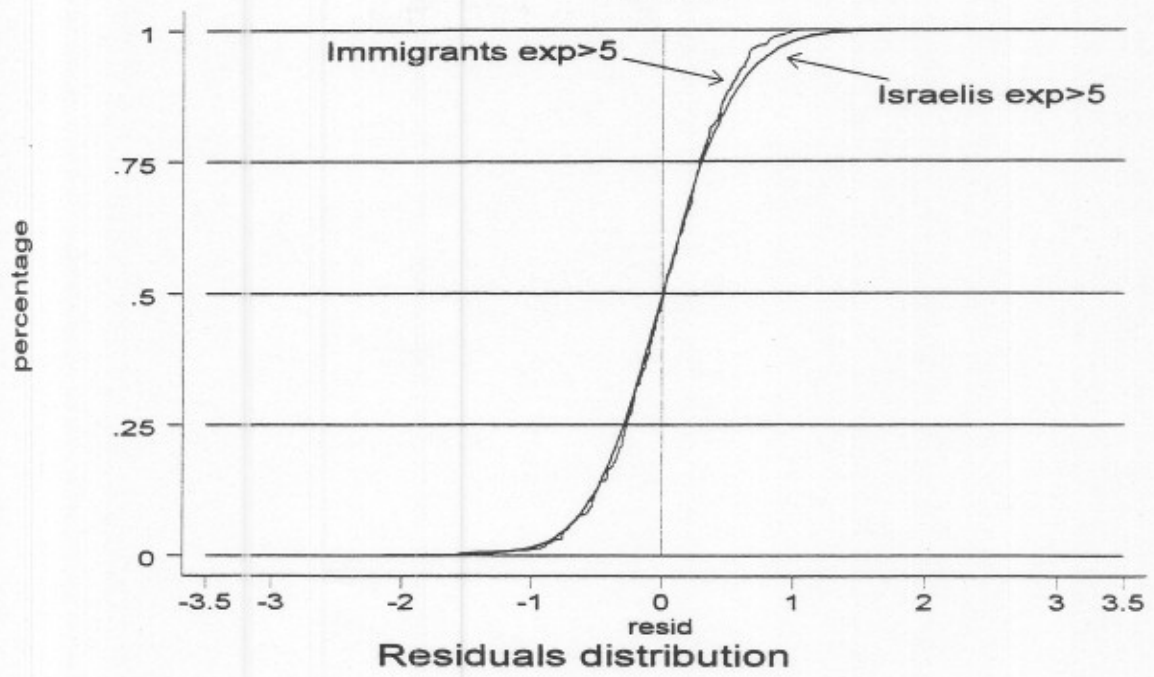
\* Wage per hour in 1991 NIS. Based on the regressions in tables 8 and 9.

Figure 2



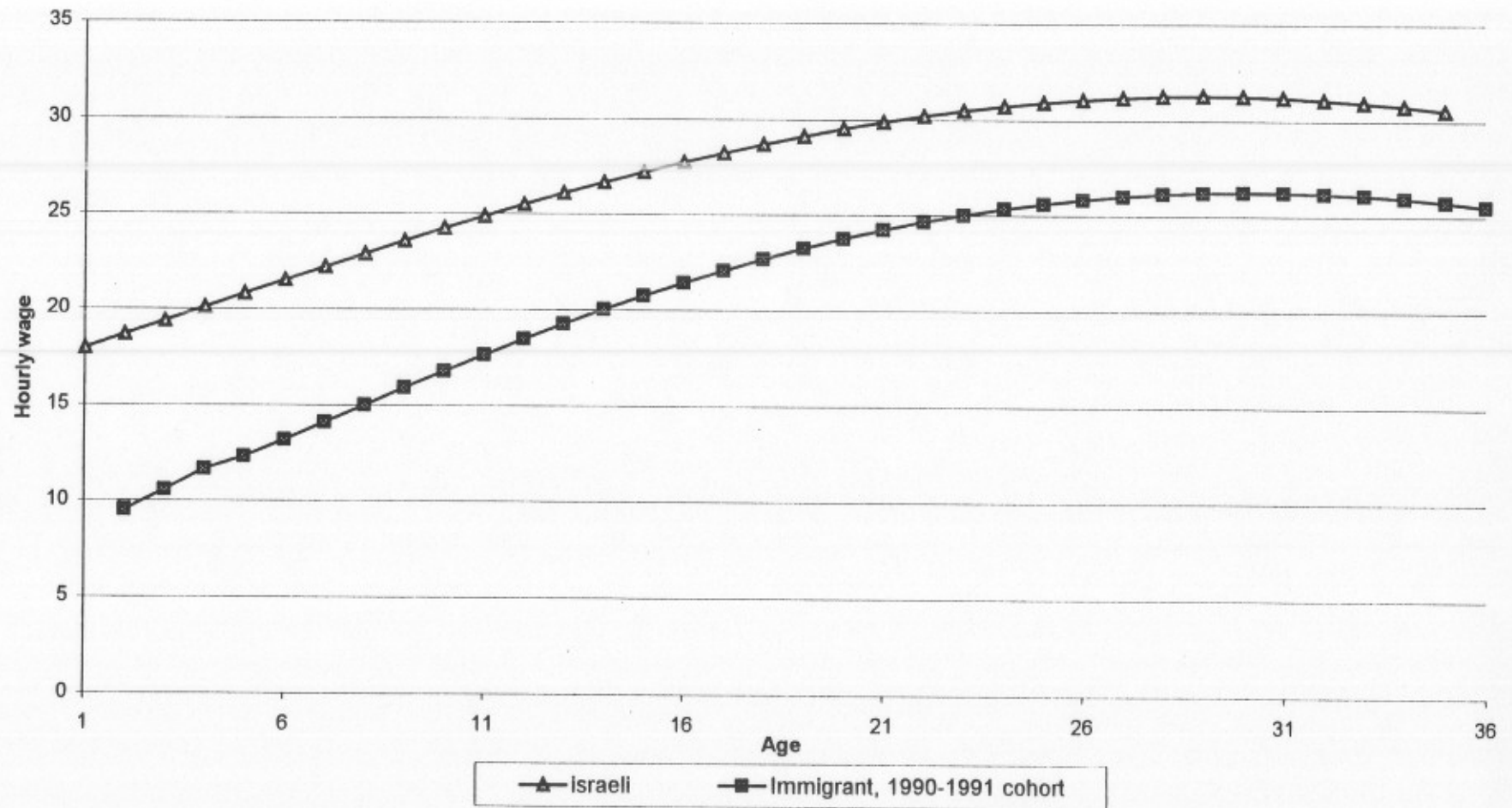
STATISTICAL

Figure 3



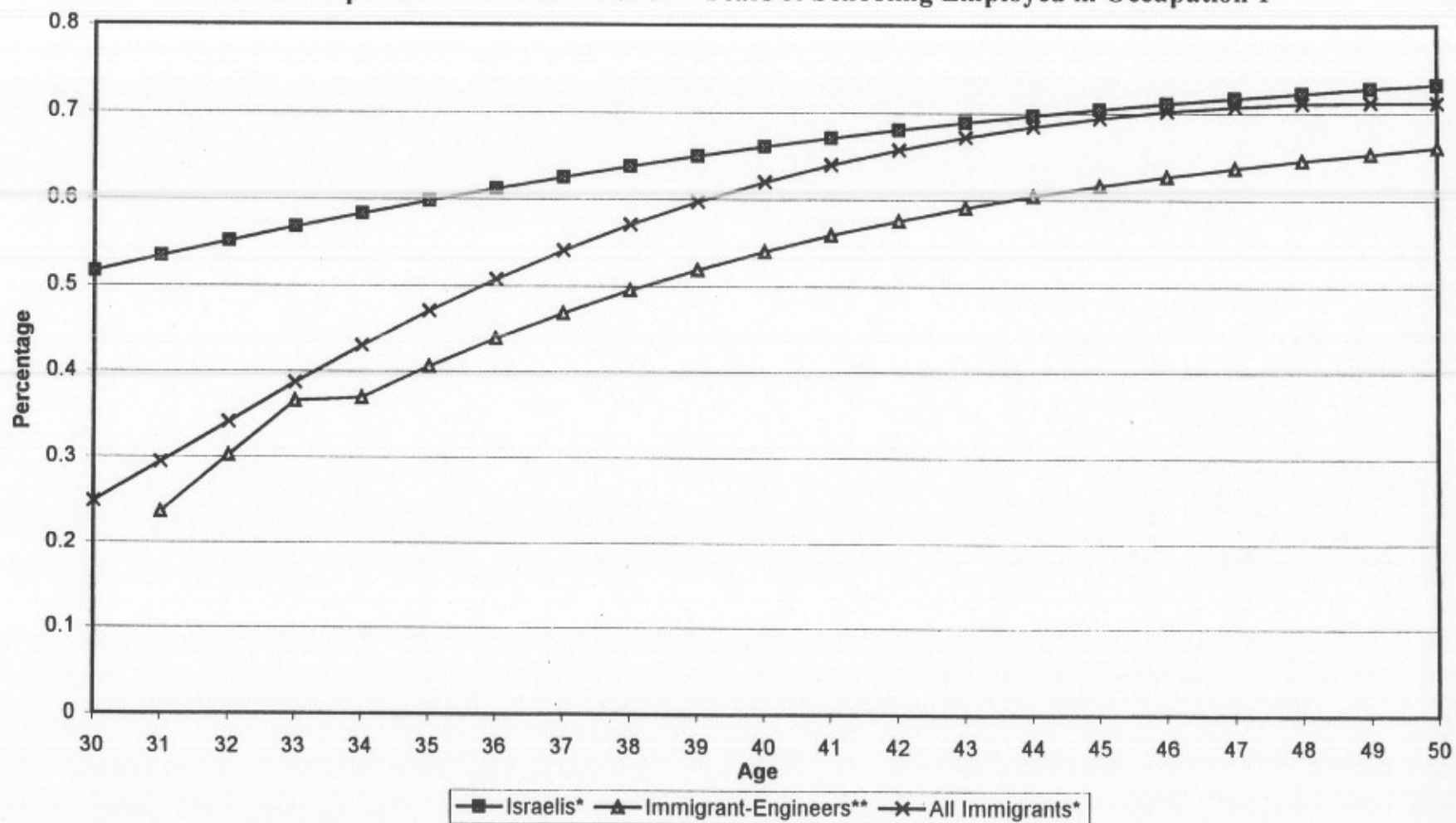
STATISTICAL

Figure 4  
Simulated Wage-Age Profiles, Averaged over Occupations, for an Israeli Worker and an Immigrant,  
(schooling=16, age at immigration=30)\*



\* Wage per hour in 1991 NIS. Simulations are based on the regressions in tables 8 and 9. The occupational distribution for Native Israelis is based on Logit estimation (CBS, income surveys 1991-95). Occupational distribution for Immigrants is based on the transition matrix in table 13b.

**Figure 5**  
**Predicted Proportion of Workers with 16+ Years of Schooling Employed in Occupation 1**



\* Israelis-based on Logit estimation (CBS, income surveys 1991-95).

\* All Immigrants-based on Logit estimation (CBS, income surveys 1991-95).

\*\*Immigrant Engineers-based on the transition matrix in table 13b.