CIRPÉE
Centre interuniversitaire sur le risque, les politiques économiques et l'emploi

Cahier de recherche/Working Paper **04-30**

A Life-Cycle Model of Outmigration and Economic Assimilation of Immigrants in Germany

Charles Bellemare

Novembre/November 2004

Bellemare: Département d'économique and CIRPÉE, Pavillon J.-A.-DeSève, Université Laval, Québec (QC), Canada G1K 7P4 and IZA
cbellemare@ecn.ulaval.ca

I would like to thank Arthur van Soest, Sabine Kröger, Pierre-Carl Michaud, Christian Dustmann, Jan van Ours, Lynda Khalaf, and seminar participants at the Immigration and Economics Workshop in Tilburg University, and at Laval, Penn State, IZA, Bocconi, Warwick, and York University for useful comments and suggestions.

Abstract:
This paper estimates a structural dynamic model of outmigration which incorporates several features of existing outmigration theories but distinguishes itself by introducing uncertainty about future earnings and preferences which allows immigrants to revise their duration decisions throughout their migration experience. Estimation results indicate that outmigration does not depend exclusively on earnings differentials. Immigrants are found to be forward looking decision makers, and simulations show that predicted migration durations can be very sensitive to changes in the economic environment, and differ considerably from those of a myopic model.

Keywords: Outmigration, Structural dynamic programming models

JEL Classification: J61, C61

1 Introduction

The increasing importance of immigrants leaving their host country, which we refer to as outmigration, is a world wide phenomena (see Dustmann, 2003 and the references therein). The case of Germany is interesting as migration out of Germany has been particularly important in the last decades (see Böhning, 1987; Glytsos, 1988 for stylized facts). These massive movements of human capital pose substantial problems for policy makers who must forecast inflows and outflows of immigrants in order to adjust their immigration policies to fit the future needs of their labor markets. Moreover, it has recently been argued both theoretically and empirically that estimation of existing measures of the economic assimilation of immigrants based on possibly non-random samples of immigrants observed not to leave the country (e.g. Schultz, 1998; Edin, LaLonde, and Aslund, 2000). For both these reasons, a growing body of literature has investigated the motives behind outmigration.

Theories of outmigration typically build upon neo-classical static choice models of migration (Sjaastad, 1962; Harris and Todaro, 1970) by assuming that an immigrant's decision to outmigrate is based on the comparison of his current expected earnings and those of a potential new destination, often assumed to be the immigrant's home country. A popular mechanism underlying this paradigm is the notion that immigrants improve their earning position in the home country while being abroad by investing in home-country specific skills (Dustmann, 1994). Outmigration is then triggered when the relative increase in the returns to human capital in the home country is sufficient for the expected earnings in the home country to exceed those in the host country.

However, there is empirical evidence indicating that outmigration does occur despite persistently higher expected earnings in the host country (e.g. Carrington, Detragiache and Vishwanath, 1996). In order to reconcile these empirical facts, theories of outmigration have shifted away from the assumption of expected earnings comparisons to a more general decision process involving expected utility comparisons (Djajic and Milbourne, 1988). This subtle change allows outmigration to occur despite having relatively higher earnings in the host country, as long as the marginal utility of consumption is sufficiently higher in the new destination than in the original host country. Several extensions of the expected utility framework have provided new and interesting insights into outmigration behavior. In a recent contribution, Dustmann (2003) shows that a neo-classical approach based on earnings differentials has sufficient flexibility to explain outmigration. Using a life-cycle framework and assuming that the marginal utility of consumption is higher in the home than in the host country, he finds that migration durations may in fact decrease when earnings in the host country are high enough, keeping constant earnings in the home country.

A different trend of the literature has highlighted the role of non-pecuniary motives in shaping outmigration decisions. This literature draws on sociological evidence suggesting that expected earnings comparisons alone may not be sufficient to adequately characterize outmigration behavior. Among the most frequently cited non-pecuniary benefits for remaining in the host country are whether or not the spouse or children of immigrants live in the host country, health and income satisfaction, perceptions of being socially integrated and financial dependance of relatives back in the native country (Stark, 1998).

In this paper, we specify and estimate the a structural dynamic discrete choice model in which earnings, work and outmigration are jointly determined. In our model, forward looking immigrants make sequential decisions on work and outmigration behavior in order to maximize expected discounted lifetime utility. Most existing life-cycle theories of outmigration introduce uncertainty about economic outcomes in such a way that migration durations result from an optimization process where immigrants simultaneously choose once and for all their duration of stay in the host country *before* migrating to a new region. Pessino (1991) relaxes this assumption and develops a model where an immigrant's uncertainty about his labor market prospects dissipates after having actually migrated, a feature shown to be sufficient to cause outmigration. The idea that uncertainty is removed upon arrival is intuitively appealing but it is difficult to conceive that all uncertainty disappears upon an immigrant's arrival in the host country, if only because immigrants in western countries constitute a group more prone to occupy temporary and unstable jobs. Our model distinguishes itself by allowing for uncertainty about future work and earnings in both the host and home country all through an immigrant's stay in a foreign country. An important consequence of this is that immigrants in our model can continuously revise their migration duration in the host country as their information set is updated through time. Another attractive feature of our model is that we incorporate this extra level of uncertainty while embedding both economic and sociological motives for outmigration in a common framework. Specifically, we allow outmigration to depend on different marginal utilities of consumption and labor market earnings in the host and home country, remittances, and several other non-pecuniary benefits including feelings of social integration, income satisfaction, age at immigration and whether the spouse lives in the host country or not. Given these elements are imbedded in our model, we can directly test the validity of some of the motives put forward to explain outmigration.

An additional contribution of our approach is that both the migration duration and the work decisions are endogenous variables. This generalization has interesting implications for outmigration behavior, as barriers to entry in the host labor market have the potential to lower considerably welfare, thus making outmigration an attractive option. Cohen and Ecktein (2002) for instance find that improving access to the Israelian labor market gives Russian immigrants higher welfare gains than increasing their potential labor market earnings. The extent to which lower job market access is associated with outmigration has recently been addressed in Bellemare (2004) who finds that immigrants in Germany leaving the country have a 30% lower probability of working than immigrants who remained in the host country.

This paper also makes an important methodological contribution to the empirical literature on outmigration. One of the main obstacles which has prevented the estimation of economic models of outmigration is the difficulty in obtaining accurate micro-level data on outmigration behavior (see Dustmann (2000) for a related discussion of this problem). Here, we develop an econometric framework which (nonparametrically) identifies the conditional outmigration probability in our sample without having to actually observe actual outmigration decisions. This approach draws on previous work (Bellemare, 2004) and is based on using sample attrition as a baseline proxy variable for outmigration and incorporating in the model the probability that sample attrition is confounded for outmigration, a probability which is parameterized and estimated. We show that this approach is sufficient to recover consistent estimates of our structural parameters.

The model is estimated using data drawn from the German Socio-Economic Panel (GSOEP) Public use file. The estimated model is shown to fit the data well. Immigrants are found to have a time horizon slightly greater than 20 years. The outmigration rate is predicted to be approximately 3% per year and matches well stylized facts, suggesting that the model successfully separates outmigration based attrition from other forms of attrition. Several explanations of existing life-cycle models appear to be consistent with our data. Specifically, we find that returning money back to the native country, satisfaction with income, feelings of social integration and earnings differentials have a significant impact on outmigration decisions. Simulation results show that for some immigrants, predicted migration durations are very sensitive to both changes in returns and in the stock of human capital. Predicted migration durations are found to be very sensitive to whether a myopic rather than a forward-looking model is used.

The rest of the paper is organized as follows. Section 2 presents the life-cycle model. Section 3 discusses the approach used to estimate the structural model. Section 4 presents the data used in the paper and sketches the state of immigration in Germany and the historical policies that have been implemented to favor and curb immigration flows. Section 5 discusses the results and presents simulations to asses both the performance and the life-cycle implications of the model. Section 6 concludes.

2 Economic model

We have a measure of N immigrants in period t =1, where immigrant i remains in the panel for T_i periods The control variables $(d_{it}^1, d_{it}^2, d_{it}^3)$ summarize the decisions taken in each period. An immigrant can choose to work in Germany ($d_{it}^1 = 1$), not work but stay in Germany ($d_{it}^2 = 1$) or outmigrate ($d_{it}^3 = 1$). When an immigrant works and stays in Germany, he enjoys non-pecuniary direct (dis)utility δ_{it}^1 and utility derived from his consumption c_{it}. The marginal utility of consumption in Germany is denoted by θ^G. When he does not work, the immigrant receives non-pecuniary direct utility δ_{it}^2, which reflects utility derived from leisure. Finally, we assume that an immigrant who leaves the country finds work and receives direct (dis)utility δ_{it}^3 and utility from consumption, where the marginal utility of consumption in his home country is denoted by

θ^N.[1] Each decision is mutually exclusive (i.e. $d_{it}^1 + d_{it}^2 + d_{it}^3 = 1$). We assume that outmigration is irreversible which implies that the control variable d_{it}^3 acts as a stopping rule.[2] Every decision is made at the beginning of the period and is based on the information set $\boldsymbol{\Omega}_{it}$ in period t. An immigrant maximizes the following discounted expected lifetime utility by choosing the sequence $\{d_{it}^{*1}, d_{it}^{*2}, d_{it}^{*3}\}_{t=1}^{T}$ over a finite horizon T

$$(1) \quad \boldsymbol{E}\left[\sum_{t=1}^{T} \beta^{t-1}\left(d_{it}^1\left[\delta_{it}^1 + \theta^G c_{it}\right] + d_{it}^2\delta_{it}^2 + d_{it}^3\left[\delta_{it}^3 + \theta^N c_{it}\right]\right)\middle| \boldsymbol{\Omega}_{i1}\right]$$

$\boldsymbol{E}$ denotes the expectation taken over the joint distribution of the stochastic future state variables (see below) and $\beta \in [0, 1]$ is the subjective discount factor. Equation (1) is maximized subject to the immigrant's budget constraint, which is assumed to be satisfied in each period, and is given by

$$(2) \quad c_{it} = w_{it}^G d_{it}^1 + w_{it}^N d_{it}^3$$

where w_{it}^G is the log earnings of immigrants in Germany, while w_{it}^N denotes their log earnings in the home country.[3] Equation (2) implies that immigrants do not save, an admittedly restrictive assumption in light of recent theoretical and empirical models of asset accumulation and return migration (e.g. Dustmann and Kirchkamp, 2002). One of the reasons we maintain this assumption is that information on savings was available mid-way through our observation window. Another reason is relaxing this assumption requires that we deal with a considerable expansion of the choice set and the state space which, given the associated computational burden, is beyond the scope of this paper. Nevertheless, as will be shown below, rather than being linked through savings, future consumption depends on current period choices as immigrants who remain in the host country and/or work increase their levels of human capital, thus affecting their future earnings and consumption levels. The functions δ_{it}^1, δ_{it}^2 and δ_{it}^3 are allowed to depend on individual

[1] In this paper, we treat return migration and outmigration as equivalent concepts since most of the outmigration movements are believed to be return movements. However, the model above does not rule out other departure destinations.

[2] In our data, reversible outmigration is negligible (Pannenberg, 1998). In other countries however, the assumption of non reversible outmigration is not likely to be satisfied. Jasso and Rosenzweig (1990) find that reversible outmigration of Mexican immigrants living in the United States is particularly important.

[3] Outmigration costs do not enter the budget constraint associated with outmigration, reflecting the fact that the German federal government reimbursed outmigration costs from 1984 to 1992 (see Section 4 for details). We do not model the regime change after 1992.

characteristics

$$
\begin{aligned}
(3)\quad \delta^1_{it} &= \alpha_{10} + \alpha_{11} Sendcash_{it-1} + \alpha_{12} Incomesa_{it-1} + \alpha_{13} Intfeel_{it-1} \\
&\quad + \alpha_{14} Educ_{it-1} + \alpha_{15} Exper_{it-1} + \alpha_{16} Exper^2_{it-1} + \alpha_{17} Ysm_{it-1} + \varepsilon^1_{it} \\
\delta^2_{it} &= \varepsilon^2_{it} \\
(4)\quad \delta^3_{it} &= \alpha_{30} + \alpha_{31} Sendcash_{it-1} + \alpha_{32} Incomesa_{it-1} + \alpha_{33} Intfeel_{it-1} \\
&\quad + \alpha_{34} Ageatim_i + \alpha_{35} Wifeinge_{it-1} + \varepsilon^3_{it}
\end{aligned}
$$

Sendcash is a binary indicator taking a value of 1 if the immigrant returns money to the host country, *Ageatim* denotes the age at arrival in Germany, *Intfeel* captures the subjective perception of being integrated in the society, and *Wifeinge* is a binary indicator taking a value of 1 when the wife of the immigrant lives in Germany. *Incomesa* denotes reported satisfaction with income earned in Germany. This is included in both the work and the outmigration non-pecuniary benefits to capture the additional utility accruing to financial security which is not due to pure earnings consumption. *Educ* corresponds to the total number of years of education, *Exper* denotes the total number of years of labor market experience while *Ysm* represents the number of years since immigration. The triplet $(\varepsilon^1_{it}, \varepsilon^2_{it}, \varepsilon^3_{it})$ consists of time specific shocks to utility. In order to deal with the fact that the individual characteristics of immigrants who drop out of the panel in period t are not observed, all observable time varying individual characteristics enter as lags. Working with predetermined variables also avoids having to deal with potential simultaneity between some of the background characteristics and the choice process.

The specification of the earnings equation in Germany follows those used in the literature on economic assimilation of immigrants (Borjas, 1999)

$$
\begin{aligned}
(5)\quad w^G_{it} &= \varphi_0 + \varphi_1 Educ_{it-1} + \varphi_2 Gspeak_{it-1} + \varphi_3 Unemp_{it} \\
&\quad + \varphi_4 Exper_{it-1} + \varphi_5 Exper^2_{it-1} + \varphi_6 Ysm_{it-1} + \eta^G_{it}
\end{aligned}
$$

Earnings depend on education, years of labor market experience, years since immigration, speaking fluency of immigrants in German *Gspeak*, and on the unemployment rate in the province of residence *Unemp*. The returns to human capital and the province specific localization are captured by the φ parameters while η^G_{it} captures shocks to earnings.

It is important to highlight that the level of education, the years of labor market experience and the number of years since migration affect the utility of working in the host country via two channels–one through a direct effect on δ^1_{it} *keeping earnings fixed*, and one via an indirect effect on the utility of consumption $\theta^G w^G_{it}$ due to changes in earnings w^G_{it}. The signs of the direct and indirect effects which follow from changing either of these variables need not be the same. Keeping earnings fixed, higher educated individuals may have relatively greater disutility from working in the host country if they take on jobs associated with greater responsibilities. The direct and indirect effects of *Exper* and *Ysm* can also have similar opposing effects on the overall utility of each alternative, a feature which can partly account for retirement from the labor force in the later part of the life-cycle. This will be the case if, as it typically is the case, labor market earnings profile level off at high levels of labor market experience, which implies that working an extra year in the host labor market will have a very small effect on utility via changes in consumption. Immigrant will then have an incentive to retire from the labor force if they suffer greater direct disutility from working an additional year in the host country, keeping earnings constant.

The earnings in the home country are determined by

$$(6) \quad w_{it}^{N} = \gamma_0 + \gamma_1 Educ_{it-1} + \gamma_2 Exper_{it-1} + \gamma_3 Exper_{it-1}^{2} + \eta_{it}^{N}$$

where the γ parameters capture the returns to human capital and η_{it}^{N} is an unobserved stochastic shock.

In any given period, $\boldsymbol{\Omega}_{it}$ contains all state variables entering the earnings and the utility of each choice, as well as all shocks $\left(\varepsilon_{it}^{1}, \varepsilon_{it}^{2}, \varepsilon_{it}^{3}, \eta_{it}^{G}, \eta_{it}^{N}\right)$. This set is updated over time as decisions are made. The two endogenous state variables, $Exper_{it-1}$ and Ysm_{it-1}, have the following laws of motion: $Exper_{it-1} = Exper_{it-2} + d_{it-1}^{1}$ and $Ysm_{it-1} = Ysm_{it-2} + \boldsymbol{Max}[d_{it-1}^{1}, d_{it-1}^{2}]$, with $Exper_{i0} = Ysm_{i0} = d_{i0}^{1} = d_{i0}^{2} = d_{i0}^{3} = 0$. All other variables are assumed to be exogenous which implicitly assumes that immigrants are in some sense myopic and cannot foresee any updating of their characteristics over time.

3 Estimation procedure

Given some distributional assumptions on the stochastic parts of the model, it is in principle straightforward to test different life-cycle hypothesis by estimating several specifications, each obtained by maximizing the complete likelihood function which combines the choice and earnings data in a single step. Given the numerical burden of estimating a dynamic programming model, this direct approach is computationally demanding. In this paper, we use the three step estimation strategy proposed by van der Klaauw (1996). In the first step, a reduced form dynamic programming model is estimated using the choice data. The parameter estimates of the first step are then used to estimate the parameters of the wage equation for Germany, controlling for sample selection due to the decision to work and to remain in the home country. In the third step, a Minimum Distance Estimator (MDE) is used to recover the structural parameters of the economic model. We discuss in more detail each step, starting with the reduced form dynamic programming model.

To proceed, we divide $\boldsymbol{\Omega}_{it} = \left[\boldsymbol{Y}_{it}, \left(\varepsilon_{it}^{1}, \varepsilon_{it}^{2}, \varepsilon_{it}^{3}, \eta_{it}^{G}, \eta_{it}^{N}\right)\right]$ into a set $\boldsymbol{Y}_{it}$ containing all state variables assumed to be observed by the econometrician. When incorporating the earnings equations (5) and (6) in the budget constraint (2), and the budget constraint in the objective function (1), we can express the contemporary utility of choosing each alternative through reduced form equations

$$\begin{aligned}
U^1(\mathbf{Y}_{it}) + \epsilon^1_{it} &= \alpha_{10} + \alpha_{11} Sendcash_{it-1} + \alpha_{12} Incomesa_{it-1} + \alpha_{13} Intfeel_{it-1} \\
&\quad + \alpha_{14} Educ_{it-1} + \alpha_{15} Exper_{it-1} + \alpha_{16} Exper^2_{it-1} + \alpha_{17} Ysm_{it-1} \\
&\quad + \theta^G \{\varphi_0 + \varphi_1 Educ_{it-1} + \varphi_2 Gspeak_{it-1} + \varphi_3 Unemp_{it-1} + \varphi_4 Exper_{it-1} \\
&\quad + \varphi_5 Exper^2_{it-1} + \varphi_6 Ysm_{it-1} + \eta^G_{it}\Big\} + \varepsilon^1_{it} \\
&= \lambda_{10} + \lambda_{11} Sendcash_{it-1} + \lambda_{12} Incomesa_{it-1} + \lambda_{13} Intfeel_{it-1} \\
&\quad + \lambda_{14} Educ_{it-1} + \lambda_{15} Gspeak_{it-1} + \lambda_{16} Unemp_{it} \\
&\quad + \lambda_{17} Exper_{it-1} + \lambda_{18} Exper^2_{it-1} + \lambda_{19} Ysm_{it-1} + \epsilon^1_{it}
\end{aligned}$$

$$U^2(\mathbf{Y}_{it}) + \epsilon^2_{it} = \epsilon^2_{it}$$

$$\begin{aligned}
U^3(\mathbf{Y}_{it}) + \epsilon^3_{it} &= \alpha_{30} + \alpha_{31} Sendcash_{it-1} + \alpha_{32} Incomesa_{it-1} + \alpha_{33} Intfeel_{it-1} + \alpha_{34} Ageatim_i \\
&\quad + \alpha_{35} Wifeinge_{it-1} + \theta^N \Big\{\gamma_0 + \gamma_1 Educ_{it-1} + ... + \eta^H_{it}\Big\} + \varepsilon^3_{it} \\
&= \lambda_{30} + \lambda_{31} Sendcash_{it-1} + \lambda_{32} Incomesa_{it-1} + \lambda_{33} Intfeel_{it-1} + \lambda_{34} Ageatim_i \\
&\quad + \lambda_{35} Wifeinge_{it-1} + \lambda_{36} Educ_{it-1} + \lambda_{37} Exper_{it-1} + \lambda_{38} Exper^2_{it-1} + \epsilon^3_{it}
\end{aligned}$$

where the vector $\boldsymbol{\lambda} = [\lambda_{10}, \lambda_{11}, ...\lambda_{38}]'$ will be used to denote the reduced form parameters. We follow van der Klaauw (1996) by assuming that the composite error terms

$$\begin{aligned}
\epsilon^1_{it} &= \theta^G \eta^G_{it} + \varepsilon^1_{it} \\
\epsilon^2_{it} &= \varepsilon^2_{it} \\
\epsilon^3_{it} &= \theta^H \eta^H_{it} + \varepsilon^3_{it}
\end{aligned}$$

are have conditional mean zero and are independently distributed over time and individuals and follow an extreme-value type I distribution.

The model presented above does not admit an analytical solution. Using the terminal conditions and the distributional assumptions on the stochastic components of the model, it is possible to solve numerically for the set of optimal decisions using backward induction for a given set of reduced form parameters $\boldsymbol{\lambda}$ and β. Using Bellman's principle of optimality (Bellman, 1957), the solution of (1) can be decomposed as the solution of T separate problems where, for each $t = 1, 2, ..., T$, one solves

$$\left\{ \max_{d^1_{it}, d^2_{it}, d^3_{it}} \left(d^1_{it} \left[V^1_t(\mathbf{Y}_{it}) + \epsilon^1_{it} \right] + d^2_{it} \left[V^2_t(\mathbf{Y}_{it}) + \epsilon^2_{it} \right] + d^3_{it} \left[V^3_t(\mathbf{Y}_{it}) + \epsilon^3_{it} \right] \right) \right\} \quad (7)$$

where $V^j_t(\mathbf{Y}_{it})$ are value functions associated with choice $j = 1, 2, 3$. The value functions associated with the first two decisions ($j = 1, 2$) given the information at time t is given by

$$V^j_t(\mathbf{Y}_{it}) = U^j(\mathbf{Y}_{it}) + \beta \boldsymbol{EMax} \left\{ V^1_{t+1}(\boldsymbol{\Omega}_{it+1}), V^2_{t+1}(\boldsymbol{\Omega}_{it+1}), V^3_{t+1}(\boldsymbol{\Omega}_{it+1}) \,|\mathbf{Y}_{it}, d^j_{it} = 1 \right\} \quad (8)$$

where $\boldsymbol{EMax}$ represents the expected value of the maximal future value function, where expectation is taken over the triplet $\left(\epsilon^1_{i,t+1}, \epsilon^2_{i,t+1}, \epsilon^3_{i,t+1}\right)$ contained in the information set $\boldsymbol{\Omega}_{it+1}$. Finally, the outmigration decision acts as a terminal control variable whose associated value function has the following simple form

$$V^3_t(\boldsymbol{Y}_{it}) = U^3(\boldsymbol{Y}_{it}) + \beta \boldsymbol{E}\left\{V^3_{t+1}(\boldsymbol{\Omega}_{it+1}) \,|\boldsymbol{Y}_{it}, d^3_{it} = 1\right\}$$

with $\boldsymbol{E}\left\{V^3_{t+1}(\boldsymbol{\Omega}_{it+1}) \,|\boldsymbol{Y}_{it}, d^3_{it} = 1\right\}$ defined as

$$\sum_{j=t+1}^{T} \beta^{j-(t+1)} \left(\lambda_{30} + \lambda_{31} Sendcash_{it-1} + \lambda_{32} Incomesa_{it-1} + \lambda_{33} Intfeel_{it-1} + \lambda_{34} Ageatim_i \right.$$
$$\left. + \lambda_{35} Wifeinge_{it-1} + \lambda_{36} Educ_i + \lambda_{37} Exper_{it-1} + \lambda_{38} Exper^2_{it-1} + \xi\right)$$

where ξ is Euler's constant. In the finite horizon case, the solution of the value functions (8) are computed by backward recursion starting in the terminal period T. At every time period t, the goal is to compute $V^j_t(\boldsymbol{Y}_{it})$ for every value of $\boldsymbol{Y}_{it}$ that could enter the choice probabilities at time t or are needed during the recursion in equation (8) to compute the choice-specific value functions in the periods $t-1, t-2, ..., 1$.[4] The primary task is evaluating the $\boldsymbol{EMax}$ functions in equation (8). Given our distributional assumptions, the expected value functions turn out to have a convenient analytical solution (Rust, 1988)

$$\boldsymbol{EMax}\left\{V^1_{t+1}(\boldsymbol{\Omega}_{it+1}), V^2_{t+1}(\boldsymbol{\Omega}_{it+1}), V^3_{t+1}(\boldsymbol{\Omega}_{it+1}) \,|\boldsymbol{Y}_{it}, d^j_{it} = 1\right\}$$
$$= \xi + \log\left(\sum_{k=1}^{3} \exp\left(V^k_{t+1}(\boldsymbol{\Omega}_{it+1})\right)\right)$$

Given we have solved the value function problem for each individual and each time period in our sample for a given set of parameter values, it is straightforward to compute the likelihood function. Each immigrant i is observed for T_i time periods. In each time period, we observe for each i in period t the event $\underline{d}_i(t) = \left[d^1_{it}, d^2_{it}, d^3_{it}\right]$. The observable choice sequence of i over all sample periods is denoted by $\boldsymbol{d}_i = [\underline{d}_i(t), ..., \underline{d}_i(T_i)]$. The sample likelihood function of the reduced form model is given by

$$\text{(9)} \quad \prod_{i=1}^{N} \Pr[\boldsymbol{d}_i|\boldsymbol{\lambda}, \beta] = \prod_{i=1}^{N} \Pr[\underline{d}_i(T_i) \,|\underline{d}_i(T_i-1), ..., \underline{d}_i(2), \underline{d}_i(1)] \cdots \Pr[\underline{d}_i(2) \,|\underline{d}_i(1)] \Pr[\underline{d}_i(1)]$$

From equation (9) we see that the choice probability at time T_i depends on all past choices of the individual, a fact which is reflected through the information set $\boldsymbol{Y}_{it}$. Given that the Bellman

[4]As is well known, solving the dynamic programming problem is computationally demanding. Optimizing the likelihood function presented below took more than one month on a 2.66 GHz pentium 4 processor. On the other hand, maximization of the likelihood function assuming immigrants are myopic agents took less than a minute.

equations have been solved for a given set of parameter values, and given the decision rule (7), the choice probabilities entering (9) can be expressed as functions of the value functions

$$\Pr\left(d_{it}^{j}=1|\boldsymbol{\Upsilon}_{it}\right)=\Pr\left(V_t^j\left(\boldsymbol{\Upsilon}_{it}\right)+\epsilon_{it}^{j}>V_t^l\left(\boldsymbol{\Upsilon}_{it}\right)+\epsilon_{it}^{l};\ \text{for all } l\neq j\right)$$

Combined with our distributional assumptions, these probabilities have a familiar closed form expression

$$\begin{aligned}&\Pr\left(V_t^j\left(\boldsymbol{\Upsilon}_{it}\right)+\epsilon_{it}^{j}>V_t^l\left(\boldsymbol{\Upsilon}_{it}\right)+\epsilon_{it}^{l};\text{for all } l\neq j\right)\\ =\;&\frac{\exp\left(U^j\left(\boldsymbol{\Upsilon}_{it}\right)+\beta\boldsymbol{EMax}\left\{V_{t+1}^1\left(\boldsymbol{\Omega}_{it+1}\right),V_{t+1}^2\left(\boldsymbol{\Omega}_{it+1}\right),V_{t+1}^3\left(\boldsymbol{\Omega}_{it+1}\right)|\boldsymbol{\Upsilon}_{it},d_{it}^{j}=1\right\}\right)}{\sum_{k=1}^{3}\exp\left(U^k\left(\boldsymbol{\Upsilon}_{it}\right)+\beta\boldsymbol{EMax}\left\{V_{t+1}^1\left(\boldsymbol{\Omega}_{it+1}\right),V_{t+1}^2\left(\boldsymbol{\Omega}_{it+1}\right),V_{t+1}^3\left(\boldsymbol{\Omega}_{it+1}\right)|\boldsymbol{\Upsilon}_{it},d_{it}^{k}=1\right\}\right)}.\end{aligned}$$

So far, we have assumed that d_{it}^3 was perfectly observed. However, in most data sets, outmigration is either not observed or badly measured. What is usually perfectly observed is whether an immigrant drops out of the panel, which is denoted here by the indicator d_{it}^{3o} which takes a value of 1 when the immigrant drops out of the panel and 0 otherwise. One approach is simply to use d_{it}^{3o} as a proxy for d_{it}^3. However, measurement error of a discrete left hand side variable can lead to severely biased parameters and variance estimates in non-linear models (see Bound, Brown and Mathiowetz (2001) for a survey of this literature). Because the dynamic programming model used in this paper is highly non-linear, the obvious measurement error in d_{it}^{3o} is a non-trivial issue. We deal with the partial observability of outmigration in our data by extending the method proposed in Bellemare (2004). The approach rests on the idea that an immigrant who outmigrates necessarily leaves the panel, which suggests that panel attrition carries some information on outmigration behavior. To extract the information on outmigration contained in panel attrition, we start by expressing the attrition probability. conditional on $\boldsymbol{\Upsilon}_{it}$, as

$$\begin{aligned}(10)\quad \Pr\left(d_{it}^{3o}=1|\boldsymbol{\Upsilon}_{it}\right) &= \Pr\left(d_{it}^{3o}=1|d_{it}^{3}\neq 1\right)\Pr\left(d_{it}^{3}\neq 1|\boldsymbol{\Upsilon}_{it}\right)\\ &\quad+\Pr\left(d_{it}^{3o}=1|d_{it}^{3}=1\right)\Pr\left(d_{it}^{3}=1|\boldsymbol{\Upsilon}_{it}\right)\\ &= \alpha_{3,12}\left\{\Pr\left(d_{it}^{1}=1|\boldsymbol{\Upsilon}_{it}\right)+\Pr\left(d_{it}^{2}=1|\boldsymbol{\Upsilon}_{it}\right)\right\}\\ &\quad+\Pr\left(d_{it}^{3}=1|\boldsymbol{\Upsilon}_{it}\right)\end{aligned}$$

where $\alpha_{3,12}\equiv\Pr\left(d_{it}^{3o}=1|d_{it}^{3}\neq 1\right)$ represents the probability of observing an immigrant leaving the panel given that he remained in Germany, either working or not.[5] The last equality in (10) follows from the fact that $\Pr\left(d_{it}^{3o}=1|d_{it}^{3}=1\right)=1$ whereby an immigrant who outmigrates will

[5]This is closely related to the class of discrete choice models proposed by Hausman, Abrevaya and Scott-Morton (1998), where the endogenous discrete outcome is either misclassified or misreported. Our approach differs from this literature as only one of the realizations of the binary outcome is partly observed.

leave the panel with probability 1. The parameter $\alpha_{3,12}$ can be directly incorporated in the likelihood function above and estimated. In the end, we solve the following problem

$$\max_{\lambda,\beta,\alpha_{3,12}} \log\left(\prod_{i=1}^{N} \Pr\left[\boldsymbol{d}_i|\boldsymbol{\lambda},\beta,\alpha_{3,12}\right]\right)$$

The procedure used above to identify the conditional outmigration probability is motivated on the basis that the information on outmigration behavior contained in panel attrition can be sizeable. To see this, note that from equation (10), $\Pr\left(d_{it}^{3o}=1|\boldsymbol{Y}_{it}\right)$ is equal to $\alpha_{3,12}$ for the subgroup of immigrants with characteristics $\boldsymbol{\tau}_{it}$ such that $\Pr\left(d_{it}^{3}=1|\boldsymbol{Y}_{it}=\boldsymbol{\tau}_{it}\right)=0$, indicating that the value of $\alpha_{3,12}$ is nonparametrically identified from the sample of immigrants with observable characteristics such that their outmigration probability is close to zero. [6] If the model is well specified, the assumption that there exists a subgroup of immigrants with observable characteristics yielding an outmigration probability close to zero can be checked by computing the share of predicted sample outmigration probabilities which are close to zero. Apart from providing us with a sound motivation to deal with the partial observability of outmigration related attrition, the nonparametric nature of this identification result suggests that model estimates should not depend heavily on our parametric assumptions.

The reduced form estimates of the dynamic programming model are used to estimate the earnings equation (5) correcting for selectivity due to work and attrition. Dubin and McFadden (1984) show that when the errors are extreme-valued and under the assumption that the conditional expectation $\boldsymbol{E}\left(\eta_{it}^{G}|\varepsilon_{it}^{1},\varepsilon_{it}^{2},\varepsilon_{it}^{3}\right)$ is linear in $\varepsilon_{it}^{1},\varepsilon_{it}^{2}$ and ε_{it}^{3}, the conditional expected earnings of immigrants who work in Germany is given by

$$\begin{aligned}\boldsymbol{E}\left(w_{it}^{G}|d_{it}^{1}=1,\boldsymbol{Y}_{it}\right) \quad = \quad & \varphi_0+\varphi_1 Educ_{it}+\varphi_2 Exper_{it-1}+\varphi_3 Exper_{it-1}^2+\varphi_4 Ysm_{it-1}\\ & +\varphi_5 Gspeak_{it}+\varphi_6 Unemp_{it}\\ & +\tau_2\left[\frac{\Pr\left(d_{it}^{2}=1|\boldsymbol{Y}_{it}\right)\log\left(\Pr\left(d_{it}^{2}=1|\boldsymbol{Y}_{it}\right)\right)}{1-\Pr\left(d_{it}^{2}=1|\boldsymbol{Y}_{it}\right)}+\log\left(\Pr\left(d_{it}^{1}=1|\boldsymbol{Y}_{it}\right)\right)\right]\\ & +\tau_3\left[\frac{\Pr\left(d_{it}^{3o}=1|\boldsymbol{Y}_{it}\right)\log\left(\Pr\left(d_{it}^{3o}=1|\boldsymbol{Y}_{it}\right)\right)}{1-\Pr\left(d_{it}^{3o}=1|\boldsymbol{Y}_{it}\right)}+\log\left(\Pr\left(d_{it}^{1}=1|\boldsymbol{Y}_{it}\right)\right)\right]\end{aligned}$$

The parameters of this equation can be consistently estimated using OLS provided we can obtain consistent estimates of the choice probabilities which enter the selection terms (see van der Klaauw, 1996). Here, we replace $\Pr\left(d_{it}^{1}=1|\boldsymbol{Y}_{it}\right)$, $\Pr\left(d_{it}^{2}=1|\boldsymbol{Y}_{it}\right)$ and $\Pr\left(d_{it}^{3}=1|\boldsymbol{Y}_{it}\right)$ by estimates from the reduced form dynamic programming model.

Finally, in the third stage, given consistent estimates of $\left[\widehat{\beta},\widehat{\alpha}_{3,12},\widehat{\boldsymbol{\lambda}}',\widehat{\boldsymbol{\varphi}}',\widehat{\tau}_2,\widehat{\tau}_3\right]'\equiv\widehat{\boldsymbol{p}}$, consistent

[6] It is possible to allow the attrition parameter $\alpha_{3,12}$ to depend on observable individual characteristics. Using the same data set, Bellemare (2004) finds little variation in the attrition probability across individuals with different characteristics. In light of this result and the numerical complexity of the present model, we did not attempt to estimate attrition probabilities conditional on observable characteristics.

estimates of the structural parameters ψ are obtained using a minimum distance estimator (Chamberlain, 1984). We define the MDE as

$$\min_{\boldsymbol{\psi}} \left(\widehat{\boldsymbol{p}} - g\left(\boldsymbol{\psi}\right)\right)' \boldsymbol{C}^{-1} \left(\widehat{\boldsymbol{p}} - g\left(\boldsymbol{\psi}\right)\right)$$

where the function g imposes the restrictions specified by the structural model on the reduced form parameter estimates.[7] $\boldsymbol{C}$ denotes the covariance matrix of $\widehat{\boldsymbol{p}}$ which can be computed using the estimated covariance matrices and the outer-product of the scores from the estimates of the first two steps (see van der Klaauw, 1996). The resulting estimate of $\boldsymbol{\psi}$, $\widehat{\boldsymbol{\psi}} \overset{a.s}{\to} \boldsymbol{\psi}_0$ and

$$\sqrt{N}\left(\widehat{\boldsymbol{\psi}} - \boldsymbol{\psi}_0\right) \overset{d}{\to} N\left(0, \left(\boldsymbol{H}'\boldsymbol{C}^{-1}\boldsymbol{H}\right)^{-1}\right)$$

where $\boldsymbol{H} = \partial g\left(\boldsymbol{\psi}\right) / \partial \boldsymbol{\psi}'$ and $\boldsymbol{\psi}_0$ is the true value of $\boldsymbol{\psi}$.

We now briefly discuss identification of the structural parameters. As is well known, the discount factor β is identified from the assumption that time preferences are additive. The parameters of the earnings equation in the host country are identified from the observable earnings data. Given these and the fact that because the utility of leisure is normalized to zero, reduced form $\boldsymbol{\lambda}$ parameters are identified from the choice data, thus θ^G is identified from the exclusion of $Gspeak_{it}$ and $Unemp_{it}$ from the direct utility of working. As will be shown, these restrictions are not rejected at usual confidence levels. Moreover, the identification of the reduced form $\boldsymbol{\lambda}$ parameters also implies that $\{\alpha_{31}, \alpha_{32}, \alpha_{33}, \alpha_{34}, \alpha_{35}\}$ are identified. Identification of the parameters of the earnings function in the home country (6) would require data on immigrant earnings upon their return. Because our data does not contain this information (see section 4), we cannot separately identify θ^N and all γ parameters. Instead, our data identifies $\left\{\alpha_{30} + \theta^N\gamma_0, \theta^N\gamma_1, \theta^N\gamma_2, \theta^N\gamma_3\right\}$ which nevertheless reveals some information on the coefficients of the earnings equation of w_{it}^N. More precisely, all four $\theta^N\gamma$ parameters are non-zero if and only if θ^N and the parameter γ are separately non-zero. Under the assumption that $\theta^N \neq 0$, the signs of the γ parameters as well as ratios of γ_j are identified.

Given the parameters which are identified, some of the existing outmigration theories can be tested in a straightforward way. The neo-classical assumption that outmigration decisions are entirely based on earnings differentials can be evaluated by testing whether the parameters determining the non-pecuniary benefits in equations (3) and (4) are jointly equal to zero. The hypothesis that immigrants are myopic decision makers can be evaluated by testing whether the discount factor β is equal to zero, while each non-pecuniary motive can be evaluated by testing the significance of the corresponding parameters of the direct utility functions δ_{it}^1 and δ_{it}^3.

[7] Examples of restrictions are $\lambda_{10} = \alpha_{10} + \theta^G\varphi_0$ and $\lambda_{13} = \theta^G\varphi_2$.

4 Data

The data used in this paper is extracted from the immigrant sample of the public use file of the GSOEP and covers the 1985-1999 period. The sample consists of an oversample of immigrants living in West-Germany coming from countries which had signed a bilateral migration agreement with Germany in the 1950s and 1960s namely Greece, Italy, Spain, Turkey and Yugoslavia[8]. Data on speaking fluency, feelings of being socially integrated, intended length of stay and remittances where given in consecutive waves from 1984 until 1987. Starting in 1987, this information was gathered every other year. In order to keep a constant time interval between observations, we have chosen to keep the 8 waves of the panel where detailed information on immigrants was available, each spanned by one year, starting in 1985 and ending in 1999. We restrict our attention to males between 18-64 years of age during the 1985 and 1999 period. Excluded from the sample are individuals who died during the observation period and individuals who gave incomplete information on any single variable entering the empirical model in any of the 8 waves. This leaves us with a sample of 732 immigrants starting in 1985.

Figure 1 presents the proportions of immigrants in the sample which were working, not working or left the panel in each wave from 1987 to 1999.[9] Changes over time can be broken down to three sub-periods. The 1987 to 1991 period saw the percentage of working immigrants increase from 68% in 1987 to 73% in 1991. At the same time, the proportion of non-working immigrants increased from 12% in 1987 to 16% in 1991. The movements in employment and unemployment were matched by a general decline in the attrition rates, from 20% in 1987 to just over 10% in 1991. The period from 1991 to 1995 is characterized by the general economic downturn which followed reunification. The percentage of the immigrant population working declined steadily to 58% in 1995 while the proportion of non-workers and the proportion of who left the panel increased respectively by 8 and 6 percentage points. In the final sub-period (1995-1999), the proportion of working immigrants slightly increased to 63% in 1997 before declining to 58% in 1999, while the proportion of non-working immigrants increased to 26% in 1997 before falling to 22% in 1999. As a result, the attrition rate decreased in 1997 before increasing in 1999.

Table 1 gives variable descriptions and summary statistics for the 1985 and 1999 waves. We see that the average age of immigrants was 39.8 years in 1985 and 44.5 years in 1999, a five year increase over a 14 year interval which indicates that the relatively older immigrants left the panel. The average number of years of labor market experience increased by 3.3 years over the 14 year period, which is consistent with the fact that the proportion of working immigrants fell in the 1990's.

Most immigrants migrated to Germany early in their productive lives, a fact reflected by an average age at immigration of nearly 24 years, a figure consistent through out the observation

[8]Immigrants of Portuguese nationality are not included in the panel.

[9]The 1985 choice data is omitted from the figure as no attrition took place by construction.

period, indicating that most immigrants were in the age to autonomously decide to move to Germany. The average year of immigration in our data was 1969 in the 1985 wave, but increased to 1979 in the 1999 wave, indicating that the earlier cohorts are most susceptible to have dropped out of the panel. As the earlier cohorts contain the migrants with the higher number of years since migration in 1985, it is not surprising to see that average years since immigration increases relatively less than the 14 year time span, passing from 15.75 in 1985 to 19.63 in 1999. Reported feelings on integration in the German society and reported speaking fluency improved over time while health satisfaction deteriorated, the latter likely capturing an aging effect. Finally, 73% of immigrants reported having a spouse living outside Germany in 1985 while as little as 1% still do so in 1999. This severe drop can be interpreted in two different ways. First, spouses may have eventually migrated to Germany during the time period. Second, it might be that immigrants whose spouse was living abroad were more likely to outmigrate.

5 Estimation results for the structural model

The model was estimated by setting the time horizon, T, at 65 years of age. In this section, we will compare two specifications, a myopic (static) model which sets β equal to 0, and a forward-looking (dynamic) model where β is estimated. In the later case, β converged to an estimated value of 0.655, which is statistically significant at the 5% level. Given a two year span between each period, this implies a yearly discount factor of 0.809, indicating that immigrants are reasonably forward looking decision makers. Accordingly, we will focus our analysis of the results using the forward looking specification and make references to the myopic model when necessary.

Structural estimates and asymptotic standard errors of the myopic and forward-looking models are presented in Table 2.[10] All parameter estimates are fairly similar across both models. Starting with the estimates of the earnings equation in Germany, we find the usual positive effects of the number of years of education and labor market experience, and the concave relationship between earnings and labor market experience in both the myopic and forward-looking models. Furthermore, increases in the number of years since migration and improvements in the speaking fluency of immigrants have a positive and significant effect on labor market earnings. Living in provinces of Germany with relatively higher unemployment rates has a small but significant negative influence on earnings of immigrants, reflecting the presence of labor market externalities. Immigrant earnings are found to increase by 1.1% with every extra year spent in the host country, which suggest that economic assimilation in the sense of LaLonde and Topel (1992) is taking place.

The impact on earnings of self-selection into work and staying in the host country can be gauged by comparing the slope coefficients of the dynamic structural model which accounts for both selection effects, to those of the OLS estimator. The last two columns of Table 2 present OLS

[10]The corresponding estimates of the reduced form choice and earnings parameters are presented in Table 5 in the appendix.

estimates of the earnings equation. Apart from the effect of the unemployment rate on the expected earnings which becomes insignificant, all coefficients have the same magnitude and levels of significance across both specifications, suggesting little self-selection bias of the earnings equation coefficients.

We now turn to the estimates of the utility function parameters in Table 2. We find the marginal utility of consumption is positive and significant, indicating that earnings differential play a significant impact on the utility of working and staying in Germany. Neo-classical models of outmigration assume that outmigration is exclusively driven by earnings differentials between the host and home country. Hence, the relevant null hypothesis to test is whether all non-pecuniary rewards entering δ_{it}^1 and δ_{it}^3 are jointly equal to zero. Our empirical results show that this null hypothesis is strongly rejected. Increased satisfaction with income, higher feelings of being integrated in Germany and sending money back to the native country all significantly increase the utility of working in Germany relative to not working but remaining in Germany. Sending money back to the native country also has a significant and positive effect on the utility of outmigration, relative to not working. Because $\alpha_{12} > \alpha_{32}$, returning money back to the native country has a negative net effect on outmigration in the myopic model. Satisfaction with income is found not to affect δ_{it}^3, the utility of outmigration relative to not working in the host country. Given that higher satisfaction with income was shown to lead to increases in the utility of working in the host country, it is clear that this will lead to a lower outmigration probability. Finally, psychic costs of working were captured by including education, labor market experience and years since migration in the direct utility of working. We find that keeping earnings constant, the disutility from work in the host country increases with the number of years of education, which can be explained by the fact that individuals with higher levels of education tend to take jobs with more responsibilities, raising their psychic costs of working. Similarly, we find that the psychic costs quickly increase with the number of years of labor market experience. Because the marginal earnings gain from an extra year of labor market experience is small, while psychic costs are high, at high values of labor market experience, we expect that immigrants with relatively higher migration and work experience retire progressively from the labor force. Furthermore, we find that the disutility from working in the host country increases with the migration duration. Because the increase in earnings which accrues to one extra year in the host country are small, this suggests that the outmigration probability may in fact increase as the number of years since immigration increase. Some other results of interest are that higher age at immigration is associated with a higher utility of outmigrating, which could reflect that older migrants have less time to integrate and establish solid roots and networks in Germany.

Turning now to parameter estimates of the earnings equation in the home country, it is important to recall that without observations on the earnings of outmigrants in the home country, the returns to human capital in the home country are not separately identified from θ^N , nor are they separately identified from direct effects on utility δ^3_{it} such as those found to affect the utility of working in Germany. However, under the realistic assumption that θ^N is positive[11] and the (a priori strong) assumption that the level of education and the number of years of labor market experience in the host country do not affect the direct utility of outmigration other than through earnings, the signs of γ_1, γ_2 and γ_3 are identified. If both assumptions hold jointly, we expect that education enters positively ($\gamma_1 > 0$), while experience enters with the usual concave relationship ($\gamma_2 > 0, \gamma_3 < 0$). If keeping earnings constant individuals with higher levels of education or a higher number of years of labor market experience also suffer greater disutility from outmigrating, then estimated signs of the parameters may be overturned. We find that education has a familiar positive and statistically significant effect on outmigration, indicating that more educated immigrants have higher utility from outmigrating relative to not working but remaining in the host country. However, contrary to what one would expect from a typical tenure profile, the relationship between the number of years of labor market experience and outmigration utility is convex rather than concave. Starting from no labor market experience, the utility of outmigration is predicted to rapidly decrease as labor market experience increases, reaching a minimum at 25.43 years of labor market experience. For an immigrant with labor market experience higher than 25.43 years, the utility of outmigration progressively increases as years of labor market experience are accumulated. Because we can assume that $\theta^N > \widehat{\theta}^G = 4.906$ (see footnote), we rule out the possibility that the convex pattern be explained by a negative value of θ^N. It seems more probable that the convex pattern reflects unidentified psychic costs/gains associated with outmigration similar to those found affecting the direct utility of working in the host country.

Our inferences on outmigration behavior rely on an identification strategy which allowed us to extract information on outmigration behavior from sample attrition by introducing in the likelihood function the parameter $\alpha_{3,12}$ which accounts for the possibility that part of the overall attrition is not related to outmigration. The estimated value of $\alpha_{3,12}$ is 0.102, which represents the probability of attrition which is not due to outmigration. The difference between the overall attrition rate, of the level of 17% per two years, and $\alpha_{3,12}$, suggests an average outmigration rate of 6% per two years, or 3% per year, remarkably close of the corresponding value reported in Bellemare (2003). The robustness of this value to whether we estimate a reduced form or a structural model, or whether we estimate a structural myopic model or a forward-looking model, is an indirect indication that nonparametric identification of this quantity holds. This belief is further reinforced by the simulation evidence presented below which indicates that the majority of immigrants in our sample are predicted to have an outmigration probability close to 0, satisfying one of the essential requirements for nonparametric identification of $\alpha_{3,12}$. To show that this estimated value matches well stylized facts, we compare the average attrition rate in our sample of immigrants with that of a representative sample of native Germans. Table 3 is taken from Bellemare (2003) and presents

[11]The literature (see e.g. Djajic and Milbourne, 1988; Stark, 1998) typically assumes that $\theta^N > \theta^G$. Given our estimated value of θ^G is 4.906 (see table 2), it follows that $\theta^N > 0$ will hold.

the attrition rates per wave for both immigrants and native German samples. Averaging over the sample period, we find that the attrition rate in the sample of Germans is 11.6% (per two years) compared to 17.2% in the immigrant sample. If the proportion of immigrants leaving the panel but remaining in Germany is of the same magnitude to that of Germans, than the difference between attrition rates would represent an average outmigration rate of 3% as implied by our model. We do not have direct information indicating that immigrants have the same normal attrition rate than natives. However, apart from outmigration and deaths, panel attrition occurs either because individuals decide to stop participating in the survey project, or individuals move within Germany and cannot be tracked by the survey institution. Clark and Drever (2001) find that immigrants in the GSOEP sample are not more likely to move within Germany than natives while Pischke and Velling (1997) find that immigrants in the western parts of Germany live in regions with a high concentration of ethnic minorities. Both results imply that, if anything, immigrants are easier to track than natives; hence the proportion of immigrants dropping out and staying in Germany should be of similar magnitude to that of Germans and suggests that $\alpha_{3,12}$ should be no greater than 11.6%, which is what we find in the data.

Before illustrating the implications of these estimates in terms of individual differences in life-cycle patterns of outmigration, we first present evidence that the model explains our data reasonably well. We do so by simulating for each individual 1000 choice sequences from the first period to each individual's final observation period. Yearly predicted proportions for each of our three decisions were then obtained by averaging simulated choices in each period over all draws and all individuals. The top panel of Figure 2 shows the corresponding simulated (S) and real (R) frequencies of the choice to work in Germany along with the choice to stay in Germany without working. We see that our model fits the data well over our time horizon. Specifically, the model is able to capture both the decline in the work participation and the associated rise in the proportions of non-workers which occurred after 1991. The bottom panel of Figure 2 shows the simulated and real attrition rates together with the predicted outmigrated rate for each wave. Our model slightly under predicts attrition in 1987 and 1989 but fits the data well after that. The under prediction at the start of the sample period is consistent with the fact that attrition rates for native Germans were also higher in the first waves of the panel (see table 3), a fact which can be traced back to the early survey methodology (Pannenberg, 1998). Finally, the predicted outmigration rate rises from 2.5% in 1987 to 3.5% in 1995, at the peak of the economic downturn. Subsequently, the outmigration rate is predicted to fall slightly from 1995 onwards, a drop which is consistent with the stabilization of the increase in the proportion of immigrants' unemployed.

5.1 Implications for life-cycle behavior

The estimates in Table 2 show that both the myopic and forward looking models yield very similar parameter estimates. However, because changes in model parameters will additionally perturb the ***Emax*** functions entering the value functions of the forward looking model, and because immigrants are found to be forward looking, predicted life-cycle patterns may differ substantially across both models. In this section, we perform some comparative static exercises to quantify these differences. As the outmigration probability of an average sample immigrant is very low, performing comparative static exercises on a representative immigrant does not induce sufficient variation in his migration behavior to appreciate the implications of the model. Instead, we take as a benchmark an immigrant at the margin of moving and staying in Germany. He his defined as a 30 year old immigrant, who migrated to Germany four years ago, has 10 years of education, 8 years of experience, does not return money to his native country, speaks below average German (4 on the scale from 1 to 5), is not married, has a reported satisfaction with income of 3 (on the scale from 0 to 10), lives in a province with an unemployment rate of 8% and has average labor market monthly earnings of 1000 DM in 1985. We chose a benchmark of 8 years of experience in order to be 6 years below the potential number of years of experience.[12] In this way, we model an immigrant who experienced periods of unemployment upon his arrival in the host country. We simulated predicted migration durations from 1985 onwards by simulating 10000 choice sequences for our marginal immigrant from 1985 to the time he exits the country, using the parameters reported in Table 2. We then alter successively either one variable or parameter and compare the new distribution of predicted migration durations to the benchmark case.

Table 4 reports, for both the dynamic and myopic model, predicted total migration durations (all durations include 4 years since immigration assumed at the start in 1985) averaged over all simulations. The forward-looking model benchmark predicts an average migration duration of 14.95 years. We simulate a tax relief by permanently increasing the net average monthly labor market earnings of immigrants by the lump-sum value of 100 DM per month. Our simulations show that this tax relief increases the migration duration by 65.75% to 24.78 years, a considerable increase relative to the amount given. Integration policies aimed at boosting human capital levels can take different forms. Governments can offer language courses to speed up proficiency of immigrants, or they may offer training which could raise the returns to labor market experience of immigrants. Both policies are predicted to have sizeable consequences for migration durations. Increasing speaking fluency from "Below average" to "Very good" increases migration duration by 71.51% to 25.64 years, which reflects that immigrants with better speaking fluency have higher expected earnings. Offering training courses which would raise the returns to labor market experience by 25% results in average migration durations of 29.83 years, almost twice that of the benchmark case. Alternatively, governments can reduce the barriers to entry in the host labor market by offering internships or other programs aimed at increasing an immigrant's labor market experience. Such a measure is simulated by increasing the number of years of labor market experience of our marginal immigrant in 1985 by 4 years. We find that the migration du-

[12] In this case, the number of potential years of experience are 30-10 years of education -6 = 14.

ration increases relatively less than all previous changes, increasing average duration by 34.18% to just above 20 years. Increasing the satisfaction with labor income from 3 to 6 on the scale has a surprisingly important impact on the migration durations, which average 30.22 years, 102.14% higher than the baseline case. Finally, returning money to the native country increases migration durations by 59.8% to an average of 23.89 years, which is consistent with the predictions of recent models of remittance behavior of Mesnard (2001).

The results of table 4 focus on the mean of the predicted migration duration distributions. Because our simulations put an upper bound of 40 years on the possible migration duration, the comparisons described above may be affected by this censoring. Quantiles of the migration duration distribution on the other hand are robust to this type of censoring. For this reason, and also because our empirical model allows sufficient non-linearities with respect to accumulated labor market experience, it is of interest to investigate how other points of the migration duration distribution are affected by changes in the economic environment. Figure 3 presents the distribution of the simulated migration durations for some of the relevant cases discussed in Table 4. Interestingly, the distribution of the migration durations in the benchmark case is split between very low and very high durations. The migration duration probabilities decline rapidly between 4 and 20 years of stay in the host country. The probability that the migration duration lasts anywhere between 22 and 32 years is very small. However, we find a small increase in the probabilities of having migrations beyond 32 years, and a 12% probability that our marginal immigrant enters retirement age (after 40 years in the host country) while in Germany. The U-shape pattern of the migration duration distribution is consistent with parameter estimates of the structural model discussed earlier. There, we found a U-shape relation between labor market experience and the utility of outmigration, which implies that both immigrants with the lowest and highest levels of labor market experience have a higher probability of leaving the country. It is interesting to see that the main impact of our comparative static exercises is to shift probability mass from the lower hand of the distribution to the upper hand, wiping out middle durations. The probability that our marginal immigrant reaches retirement age in Germany increases from 12% in the benchmark case to a little more than 40% in the case of a permanent tax relief of 100 DM. The effect of other changes are similar, all leading to substantial increases in the probability of reaching retirement age in Germany. One exception concerns increasing the number of years of labor market experience in 1985. We find that this lowers low migration durations but increases migration durations between 16 and 38 years, a change consistent with our parameter estimates which suggested that immigrants with more years of labor market experience suffer greater disutility from working in the host country, and lower disutility from outmigration.

The second column of Table 4 reports statistics for the same set of simulations, this time using the myopic model. The magnitude and directions of the comparative static effects differ enormously between both models. First, we find that the predicted average migration duration in the benchmark case are substantially lower, with an average duration of 6.19 years. This is consistent with the fact that myopic immigrants do not discount future utility changes as their economic position improves. Accordingly, we find that a tax relief of 100 DM increases the average migration duration relative by 11.78% relative to the benchmark case, a little less than an extra year. Improvements in speaking fluency and returns to labor market experience have the same positive effect on migration duration than in the forward looking model but, again, of much smaller magnitude (raising migration durations by 12.92% and 15.99% respectively). The most surprising differences between the forward-looking model and the myopic model concerns the effect of increasing immigrant satisfaction with income and the effect of returning money to the native country. While increasing satisfaction with income doubled the average migration duration in the forward-looking model, it has a very small effect on the migration durations in the myopic model. Similarly, while returning money increased migration durations by 59.79% in the forward-looking model, they are found to increase migration durations in the myopic model by only 2.56%. The shape of the predicted migration durations in the myopic model is also very different from those of the forward-looking model. Figure 4 presents the simulated migration duration distributions for the myopic model. The benchmark distribution is heavily skewed to the left, and the probability of staying in Germany for longer than 26 years is in all practical sense zero. All other graphs have a similar shape and make clear that the myopic model predicts that our marginal immigrant would never enter retirement age in the host country, a clear distinction with the forward looking model.

6 Conclusions

This paper is a first attempt to estimate a structural dynamic model of work and outmigration decisions that immigrants make over their life-cycle. The optimization problem of immigrants has the structure of a dynamic programming problem, which can be solved recursively by backward induction. The model in this paper distinguishes itself from the existing literature by allowing immigrants to progressively revise their migration duration decisions during the migration period. Despite this difference, the model is general enough to incorporate several determinants of outmigration put forward in the existing literature, namely differences in earnings and marginal utilities of consumption between the home and host country, returning money back to the native country, feelings of social integration and satisfaction with income. The estimates of the model are used to predict changes in the life-cycle patterns of outmigration decisions due to changes in feelings of being integrated in the host country, income satisfaction, labor taxes, and returns to labor market experience. We estimate the model using the immigrant sample of the GSOEP, which contains a rich amount of information on the social and economic well being of immigrants during the 1985-1999 period. The model was shown to fit the data reasonably well.

Our findings confirm the hypothesis recently put forward in the literature that outmigration is not entirely driven by earnings differentials. Specifically, we find that immigrants who feel integrated in the German society, those who are satisfied with their income, and those who return money to their native country are less likely to outmigrate. The results of this paper also highlighted the importance of incorporating the work decision along with the migration duration decision of immigrants, a feature previously ignored in the outmigration literature. We found that both immigrants with relatively low and high labor market experience have a greater overall utility of outmigration, which suggests a U shape relation between labor market experience and the overall utility to outmigrate. The decrease in overall outmigration utility starting from low levels of experience is consistent with increasing psychic costs associated with outmigration. The convex increase in overall outmigration utility predicted to occur beyond 25 years of labor market experience is consistent with progressively lower psychic costs of outmigration and diminishing returns to labor market experience in the host country. These results are interesting given that most of the outmigration literature has analyzed outmigration within an earnings differential paradigm which orients policy recommendations towards measures aimed at influencing the earnings differential between the host and home country. Clearly our results do not rule out the important role played by labor market earnings in determining migration durations. However, they do indicate that for some immigrants, the shape of the migration duration distribution is determined by past work decisions, indicating that much can be gained from an analysis in which work decisions are endogenously determined. Moreover, the foregoing analysis indicates that policies aimed at improving access of immigrants to the host labor market upon their arrival may also play an important role in determining migration durations.

The bimodal shape of the migration duration distribution of newly arrived immigrants was found to be robust to realistic changes in model parameters. Our simulation results indicate that changes in the economic environment have strong repercussions on migration durations of immigrants at the margin between staying in Germany and leaving, suggesting that small policy changes may lead these immigrants to substantially revise their intended migration duration. Because immigrants in our sample discount substantially the future, the impact of several policy changes on predicted migration durations based on a forward looking model were shown to be much more sensitive to changes in the economic environment as opposed to a purely static, myopic model. Moreover, the predicted migration duration distribution in the myopic model is unimodal, suggesting that the same immigrants would never establish themselves permanently in the host country, a feature in sharp contrast with the predictions of the forward-looking model. These results illustrate the need for a careful evaluation of immigrant subjective discount rates when discussing the impact of policy changes.

Finally, this paper has shown that the approach used to separate outmigration from attrition performs well in the structural setting developed in this paper. Estimates of the probability of confounding immigrants who leave the panel but remain in the host country with outmigrants were found to be robust to our stochastic environment and match well stylized facts, an indication that they are relatively well identified. As several panel data sets follow immigrants over time but very few possess information on micro-level outmigration decisions, we hope that this paper is a first step towards more structural tests of life-cycle models of outmigration behavior.

	1985	1999	Variable description
Age	39.78	44.53	
Experience	24.49	27.81	Number of years of labor market experience
Education	9.34	10.04	Number of years
Income satisfaction	6.14	5.80	0= unsatisfied,...,10 totally satisfied
Wife in Germany	0.73	0.01	1 if yes, 0 otherwise
Integration feeling	3.94	2.93	Do you feel German ?, 5=Totally, ..,1=Not at all
German speaking fluency	2.65	2.30	1 = bad, 5 = excellent
Intended length of stay	2.18	0.59	1 = Within 1 year,2 = After a few years,3 = Never
Age at immigration	24.03	24.90	
Years since immigration	15.75	19.63	
Immigration year	1969	1979	
Number Obs.	732	393	

Table 1: Descriptive statistics, 1985 and 1999

Parameter	Variable	Myopic		Dynamic		OLS	
		Estimate	SE	Estimate	SE		
		Utility of working in Germany					
α_{10}	Constant	-36.176	9.709***	-38.640	7.923***		
α_{11}	Sendcash	1.041	0.111***	1.089	0.119***		
α_{12}	Incomesa	0.441	0.022***	0.449	0.023***		
α_{13}	Intfeel	0.186	0.042***	0.211	0.043***		
α_{14}	Educ /10	-1.323	0.538**	-1.254	0.394***		
α_{15}	Exper /10	0.594	0.484	0.599	0.452		
α_{16}	Exper^2 /1000	-1.911	0.888**	-1.766	0.802**		
α_{17}	Ysm / 10	-0.889	0.196***	-0.949	0.161***		
θ^G	Marg. utility cons.	4.624	1.344***	4.906	1.086***		
		Utility of outmigrating					
$\alpha_{30} + \theta^H \gamma_0$	Constant	-4.229	1.712**	-3.900	1.961**		
α_{31}	Sendcash	0.965	0.370**	0.784	0.324**		
α_{32}	Incomesa	0.023	0.086	0.059	0.070		
α_{33}	Intfeel	0.294	0.182	0.121	0.141		
α_{34}	Ageatim	0.795	0.379**	0.773	0.319**		
α_{35}	Wifeinge	0.442	0.258*	0.181	0.208		
$\theta^H \gamma_1$	Educ /10	6.578	1.257***	3.252	0.971***		
$\theta^H \gamma_2$	Exper /10	9.611	7.753	-2.934	0.858***		
$\theta^H \gamma_3$	Exper^2 /1000	-5.834	8.337	5.743	1.507***		
		Earnings function in Germany					
φ_0	Constant	7.369	0.069***	7.384	0.067***	7.31	0.05***
φ_1	Educ /10	0.284	0.042***	0.252	0.037***	0.25	0.03***
φ_2	Gspeak	-0.054	0.008***	-0.056	0.008***	-0.06	0.01***
φ_3	Unemp	-0.004	0.002**	-0.005	0.002**	0.00	0.00
φ_4	Exper /10	0.333	0.034***	0.359	0.036***	0.37	0.01***
φ_5	Exper^2 /1000	-0.581	0.062***	-0.635	0.064***	-0.65	0.04***
φ_6	Ysm /10	0.112	0.011***	0.111	0.011***	0.11	0.01***
		Auxiliary parameters					
$\alpha_{3,12}$	Partial obs. prob.	0.103	0.028***	0.102	0.028***		
β	Discount factor	0	-	0.655	0.302**		
Log-L (step1)		-3015.6		-3002.73			
Distance MDE		0.078		0.074			

Table 2: Minimum distance estimation of structural model. Asymptotic standard errors in parenthesis. ***,**,* denote respectively significance at the 10, 5 and 1 percent level

	West-Germans			Immigrants		
	N	% 1985	Attrition rate	N	% 1985	Attrition rate
1985	1987	100	-	732	100	-
1987	1648	82.9	17.1	583	79.6	20.4
1989	1408	70.8	14.6	473	64.6	18.9
1991	1253	63.1	11.0	416	56.8	12.1
1993	1122	56.4	10.5	355	48.4	14.7
1995	1002	50.4	10.7	291	39.7	18.0
1997	919	46.3	8.3	242	33.1	16.8
1999	834	41.9	9.3	195	26.7	19.4
Mean 1985-1999			11.6			17.2

Table 3: Panel attrition for West-German and Immigrant samples 1985-1999.

	$\beta = 0.655$		$\beta = 0$	
	Mean	%$\triangle$ with baseline	Mean	%$\triangle$ with baseline
Baseline	14.95	-	6.19	-
100 DM per month extra	24.78	65.75	6.92	11.78
Speaking fluency "Very good"	25.64	71.51	6.99	12.92
Satisfaction with income 6 out of 10	30.22	102,14	6.47	4.56
Returns to experience 25% higher	29.83	99.53	6.18	15.99
Labor market experience 4 years higher	20.06	34.18	6.39	3.23
Returning money to native country	23.89	59.79	6.35	2.56

Table 4: Simulated migration durations in years. Baseline represents as a 30 year old immigrant, who migrated to Germany four years ago, has 10 years of education, 8 years of experience, does not return money to his native country, speaks below average German (4 on the scale from 1 to 5), is not married, has a reported satisfaction with income of 3 (on the scale from 0 to 10), lives in a province with unemployment rate of 8

Parameter	Variable	Myopic		Dynamic	
		Estimate	SDE	Estimate	SDE
λ_{10}	Constant	-1.203	0.426**	-1.804	0.543***
λ_{11}	Sendcash	0.999	0.112***	1.045	0.121***
λ_{12}	Incomesa	0.428	0.022***	0.435	0.023***
λ_{13}	Intfeel	0.108	0.044**	0.118	0.046**
λ_{14}	Educ /10	0.034	0.248	0.039	0.254
λ_{15}	Gspeak	-0.191	0.061***	-0.204	0.063***
λ_{16}	Unemp	-0.091	0.018***	-0.096	0.019***
λ_{17}	Exper /10	2.090	0.178***	2.555	0.321***
λ_{18}	Exper^2 /1000	-4.541	0.324***	-5.157	0.516***
λ_{19}	Ysm /10	-0.392	0.075	-0.442	0.078***
λ_{30}	Constant	-14.467	19.806	-6.239	2.386**
λ_{31}	Sendcash	0.571	0.388	0.626	0.332*
λ_{32}	Incomesa	0.089	0.091	0.094	0.071
λ_{33}	Intfeel	0.275	0.182	0.166	0.143
λ_{34}	Ageatim	0.437	0.418	0.549	0.338
λ_{35}	Wifeinge	0.420	0.258*	0.147	0.209
λ_{36}	Educ /10	5.254	1.354***	2.786	0.976**
λ_{37}	Exper /10	-1.505	8.529	-1.338	1.021
λ_{38}	Exper^2 /1000	5.768	9.339	3.586	1.609**
$\alpha_{3,12}$	Partial obs. prob.	0.117	0.033***	0.112	0.031***
β	Discount factor	0	-	0.618	0.342*
Log-L		-3015.6		-3002.73	
φ_0	Constant	7.754	0.220***	7.568	0.242***
φ_1	Educ / 10	0.229	0.045***	0.240	0.037***
φ_2	Gspeak	-0.054	0.008***	-0.054	0.008***
φ_3	Unemp	0.007	0.003**	0.007	0.003**
φ_4	Exper / 10	0.367	0.050***	0.349	0.048***
φ_5	Exper / 1000	-0.669	0.102***	-0.622	0.097***
φ_6	Ysm / 10	0.126	0.011***	0.126	0.011***
τ_2	Work selection	0.239	0.091**	0.169	0.101*
τ_3	Outmigration selection	-0.038	0.009***	-0.044	0.009***

Table 5: Maximum likelihood estimates of reduced form model. Asymptotic standard errors in parenthesis. ***,**,* denote respectively significance at the 10, 5 and 1 percent level

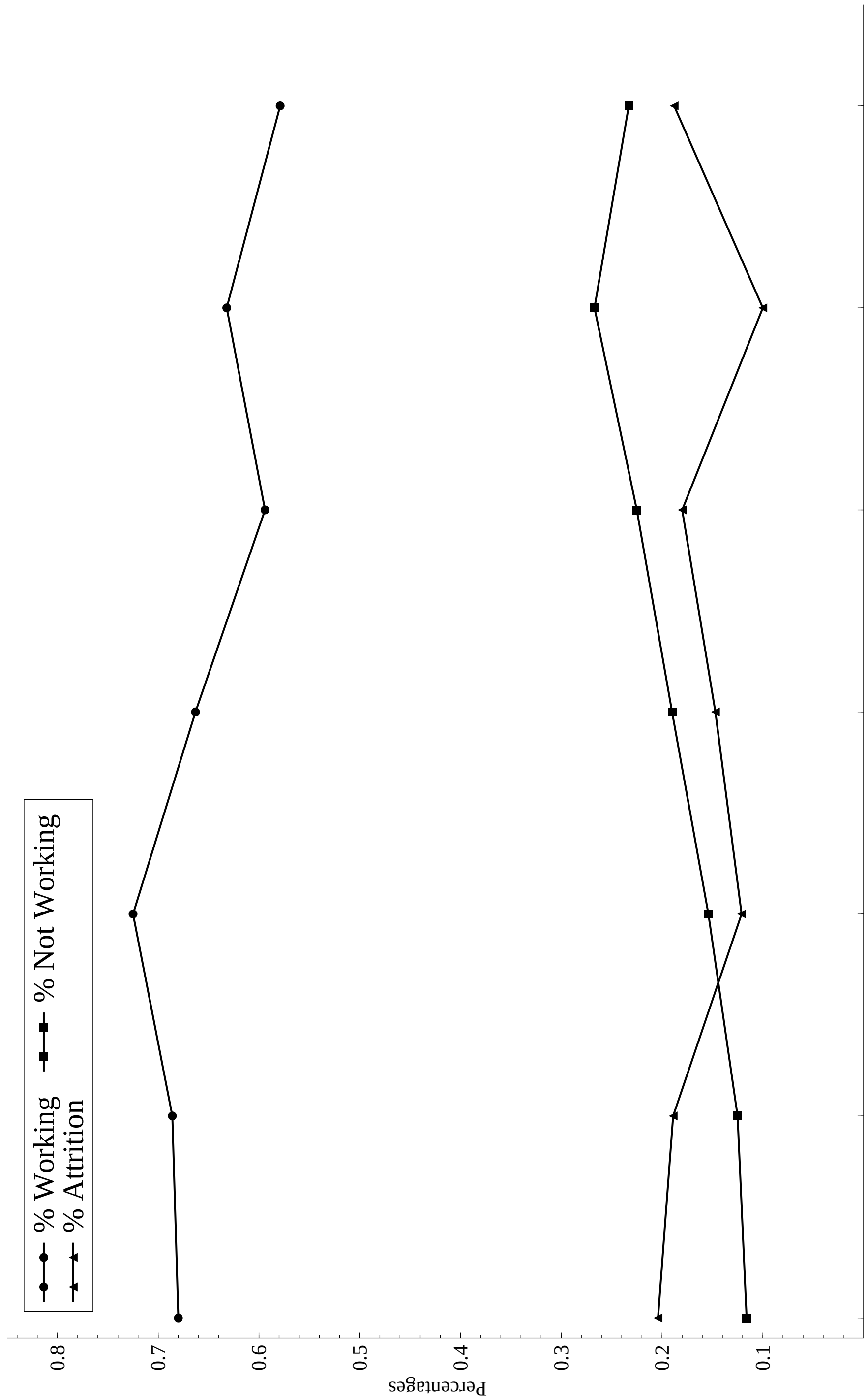

Figure 1: Proportions of immigrants working in Germany, not working and attrition per time period, 1987-1999.

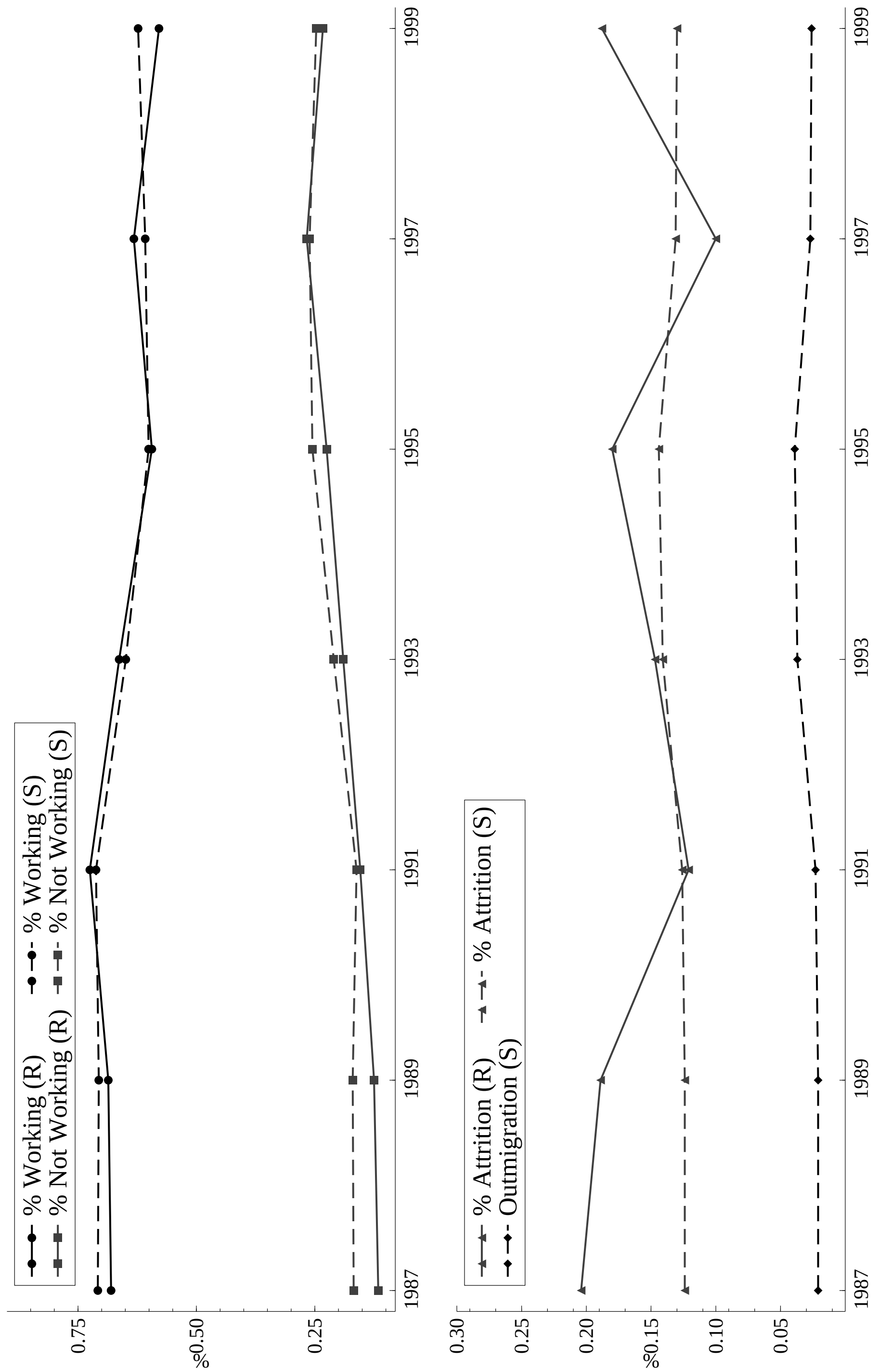

Figure 2: Goodness of fit of the model. Real (R) and simulated (S) frequencies of each alternative over the 1987 and 1999 period. Simulations are performed by taking for each individual and each time period 1000 draws from the extreme-value distribution. The simulations are obtained by averaging over individuals and draws the predicted frequency of each choice.

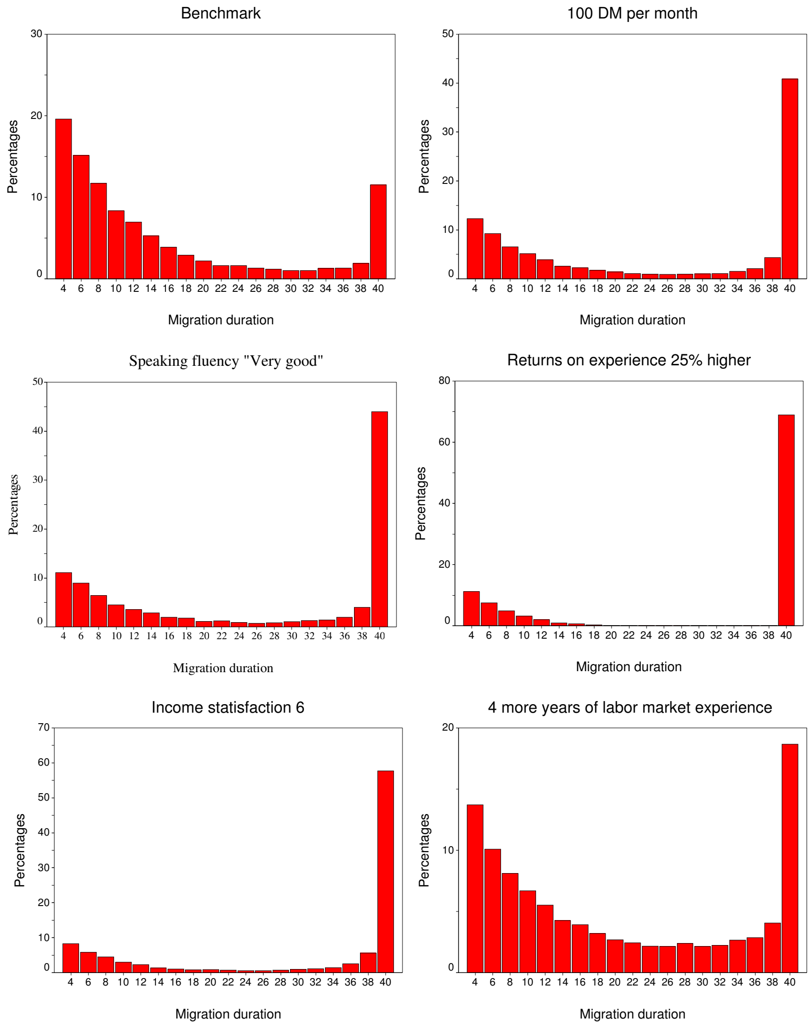

Figure 3: Simulated distributions for the forward looking model. Percentages are obtained by simulating 10000 choice sequences and averaging the predicted migration durations over all sequences. Benchmark is a 30 year old immigrant, who migrated to Germany four years ago, has 10 years of education, 8 years of experience, does not return money to his native country, speaks below average German (4 on the scale from 1 to 5), is not married, has a reported satisfaction with income of 3 (on the scale from 0 to 10), lives in a province with unemployment rate of 8% and has an average earnings of 1000 DM.

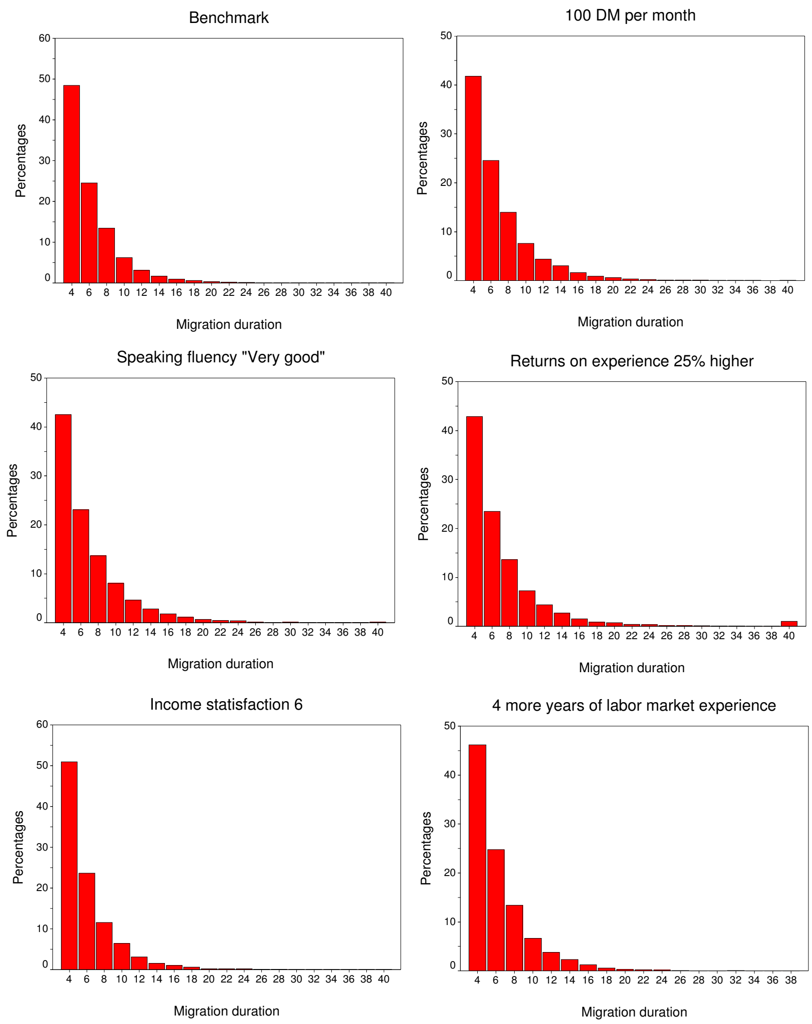

Figure 4: Simulated distributions for the myopic looking model. Percentages are obtained by simulating 10000 choice sequences and averaging the predicted migration durations over all sequences. Benchmark is a 30 year old immigrant, who migrated to Germany four years ago, has 10 years of education, 8 years of experience, does not return money to his native country, speaks below average German (4 on the scale from 1 to 5), is not married, has a reported satisfaction with income of 3 (on the scale from 0 to 10), lives in a province with unemployment rate of 8% and has an average earnings of 1000 DM

References

BELLEMARE, C. (2004): "Identification and Estimation of Economic Models of Outmigration Using Panel Attrition," Working paper, IZA Discussion Paper no. 1065.

BELLMAN, R. (1957): *Dynamic Programming*. Princeton University Press, Princeton.

BÖHNING, W. (1987): *Studies in International Migration*. St. Martin's Press, New-York.

BOUND, J., C. BROWN, AND N. MATHIOWETZ (2001): *Measurement Error in Survey Data*vol. 5, chap. 59, pp. 3705–3843. Elsevier, North-Holland.

CARRINGTON, W. J., E. DETRAGIACHE, AND T. VISHWANATH (1996): "Migration with Endogenous Moving Costs," *American Economic Review*, 86(4), 909–930.

CHAMBERLAIN, G. (1984): *Panel Data*vol. 2 of *Handbook of Econometrics*, chap. 22, pp. 1248–1318. North-Holland.

CLARK, W. A., AND A. I. DREVER (2001): "Do Immigrants Improve their Housing Quality When They Move ? Evidence from the German Socio-Economic Panel," *Vierteljahrshefte Zur Wirtschaftsforschung*, 70, 87–94.

COHEN, S., AND Z. ECKSTEIN (2002): "Labor Mobility of Immigrants: Training, Experience, Language and Opportunities," *Working paper, Tel-Aviv University*.

DJAJIC, S., AND R. MILBOURNE (1988): "A General Equilibrium Model of Guest Worker Migration," *Journal of Internation Economics*, 25, 335–351.

DUBIN, J., AND D. MCFADDEN (1984): "An Econometric Analysis of Residential Electric Appliance Holdings and Consumption," *Econometrica*, 52, 345–362.

DUSTMANN, C. (1994): "Return Intentions of Migrants: Theory and Evidence," Discussion paper, CEPR Discussion paper no. 906.

——— (2003): "Return migration, wage differentials, and the optimal migration duration," *European Economic Review*, 47, 353–369.

DUSTMANN, C., AND O. KIRCHKAMP (2002): "The Optimal Migration Duration and Activity Choice After Re-Migration," *Journal of Development Economics*, 67, 351–372.

EDIN, P.-A., R. J. LALONDE, AND O. ASLUND (2000): "Emigration of Immigrants and Measures of Immigrant Assimilation: Evidence from Sweden," *Swedish Economic Policy Review*, 7, 163–204.

GLYTSOS, N. P. (1988): "Remittances and Temporary Migration: A Theoritical Model and its Testing with the Greek-German Experience," *Weltwirtschafliches Archiv*, 124, 524–549.

HARRIS, J. R., AND M. P. TODARO (1970): "Migration, Unemployment, and Development: A Two-Sector Analysis," *American Economic Review*, 60, 126–142.

HAUSMAN, J., J. ABREVAYA, AND F. SCOTT-MORTON (1998): "Misclassification of a Dependent Variable in a Discrete Response Setting," *Journal of Econometrics*, 87, 239–269.

PANNENBERG, M. (1998): "Documentation of Sample Sizes and Panel Attrition in the German Socio Economic Panel," DIW Discussion Paper No. 172.

PESSINO, C. (1991): "Sequential Migration Theory and Evidence from Peru," *Journal of Development Economics*, 36, 55–87.

PISCHKE, J.-S., AND J. VELLING (1997): "Employment Effects of Immigration to Germany: An Analysis Based on Local Labor Markets," *Review of Economics and Statistics*, 79, 594–604.

RUST, J. (1988): "Maximum Likelihood Estimation of Discrete Control Processes," *SIAM Journal on Control and Optimization*, 26, 1006–1023.

SCHULTZ, T. P. (1998): "Immigrant Quality and Assimilation - A Review of the US Literature," *Journal of Population Economics*, 11(2), 239–252.

SJAASTAD, L. (1962): "The Coststs and Returns of Human Migration," *Journal of Political Economy*, 70(Suppl.), 80–93.

STARK, O. (1998): *On the Microeconomics of Return Migration*chap. 3, pp. 32–41.

VAN DER KLAAUW, W. (1996): "Female Labour Supply and Marital Decisions: A Life-Cycle Model," *Review of Economic Studies*, 63(2), 199–235.