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# Identification and Estimation of the Economic Performance of Outmigrants using Panel Attrition

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**Abstract:** This paper presents conditions providing semiparametric identification of the conditional expectation of economic outcomes characterizing outmigrants using data on immigrant sample attrition. The approach does not require that individual immigrant departures be observed. Outcomes of interest are labor market earnings, labor force participation, and labor supply. We present a panel model which extracts the information on outmigrant performance from sample attrition and estimate it using German data. We find strong evidence of self-selection of outmigrants based on unobserved individual characteristics. Simulations are performed to quantify the gap in labor market earnings and labor force participation rates between immigrant stayers and outmigrants.

**Keywords:** Migration movements, Semiparametric identification, immigrant performance, Panel Data Models

**JEL Classification:** J24, C33, J61

# 1 Introduction

There has been a growing interest in understanding migration decisions of immigrants leaving their adoptive homelands, a phenomena often referred to as return migration or, more generally, as outmigration. A salient feature of theories of outmigration is that they do not trivially predict a specific composition of departing immigrants (c.f. e.g., Borjas and Bratsberg, 1996). It could be the case for example that persistently unsuccessful immigrants keep on searching for better labor market prospects and move to a new destination with higher expected outcomes (e.g., Harris and Todaro, 1970), while economically successful immigrants with a relatively higher marginal utility of consumption in their native country leave despite relatively lower earnings in that country (see e.g., Djajic and Milbourne, 1988, Dustmann and Kirchkamp, 2002). This indeterminacy requires careful forecasting of the quality of the migration flows for immigration policies to meet the future needs of the host labor market. Equally, the evaluation of potential policies requires simulating counterfactual states and predicting behavior in those states, which in turn requires to have a model of individual choice behavior.

In a life-cycle context, potential outmigrants base their decision on whether or not to remain in the host country on their future expected earnings and labor market prospects, which in turn depend on current levels of human capital, as well as on unobservable characteristics such as their intrinsic ability, or the quality of their social network. The presence of such unobservable differences warrants using panel data on immigrants followed over a relatively long period of time. As Dustmann (2002) recently pointed out, interesting empirical analysis is limited by the fact that panel data sets rarely contain information on outmigration decisions.[1] Rather, they typically contain information on sample attrition which may or may not be the result of selective outmigration. Existing empirical evidence is often tied to the strategy used to identify the economic parameters characterizing the performance of outmigrants without observing individual outmigration decisions. Jasso and Rosenzweig (1990) identify the direction of outmigration earnings selectivity by comparing the skill composition of specific cohorts over time. Hu (2000) and Lubotsky (2000) estimate the parameters of the earnings function of immigrants who remain in the country, controlling for non-random outmigration selectivity by matching cross-section data sets and longitudinal social security earnings records. These approaches provide interesting insights on self-selection patterns of outmigrants. However, as is well known, census data do not allow to incorporate unobserved time-invariant individual heterogeneity in the choice process, a problem which may be compounded by the fact that census and

[1] Only recently has such data become available. See Coleman and Wadensjoe (1999) for details on Danish data sources.

earnings records often contain little information on both the human capital level and sociological characteristics of migrants, which may increase the importance of unobservable individual differences in explaining variations in decision making.

In this paper, we show how survey data with sample attrition can be exploited to achieve semiparametric identification of the true outmigration probability and of any conditional expected outcome characterizing the performance of outmigrants when information on individual outmigration movements are not available. A notable interest feature our results is that they also apply to the analysis of native departures from under-developed countries, commonly referred to as the brain-drain problem (for a review, see e.g., Bhagwati and Wilson, 1989), or to migration movements within a country (e.g., Burda, Hardle, Muller, and Werwatz, 1998). These forms of migrations are of topical relevance for policy makers, but often share the same observational problem, namely that information of migration movements are not recorded at the individual level.

The "semiparametric" nature of our results stems from the fact that the underlying true outmigration propensity is allowed to depend on a finite number of parameters. We demonstrate nonparametric identification of all other parts of the model. We do not address the more difficult issue of developing semiparametric estimators of the conditional expected outcome and deriving their asymptotic properties. The later would require deriving asymptotic results for products and ratios of quantities estimated using nonparametric and semiparametric methods. Nevertheless, the proof of our identification result suggests a simple way to parametrically separate the overall attrition probability into a probability of outmigration and a probability of attrition which is unrelated to outmigration. The estimation of the later is obtained by extending models which have been developed to deal with misclassification of a discrete dependent variable (e.g. Hausman, Abrevaya, and Scott-Morton, 1998) to a more general multiple equations panel data setting. If true outmigration rates could be computed from the data or from other sources, it would be straightforward to test the performance of our identification approach by simply comparing true and predicted outmigration rates. In the more likely case where the outmigration rates are unknown, we propose to compare the estimated attrition probability which does not result from outmigration with the sample attrition rates for a population with a priori negligible outmigration. In this paper, comparison is made using a sample of individuals drawn from the native population and find that the estimated attrition probability which does not result from outmigration in our immigrant sample matches very well the attrition rate in the sample of natives.

We focus our empirical analysis on estimating a multiple equation panel data model where labor market earnings, outmigration decisions, and labor force participation are jointly determined by levels of human capital, several socioeconomic characteristics, and possibly correlated unobserved individual heterogeneity. Our empirical analysis uses 8 waves of the German Socio-Economic Panel which contains detailed information on immigrant performance and socioeconomic characteristics. Doing so, we contribute to the empirical literature on outmigration decision making by investigating the interactions between outmigration and labor force participation within the context of a panel data model. There exists indirect evidence suggesting that this interaction may in fact be as important as that between outmigration and labor market earnings. Cohen and Eckstein (2002) for example find that joblessness of immigrants in Israël leads to lower welfare loss than their relatively lower labor market earnings. In the present paper, we find substantial evidence of self-selection of outmigrants both in terms of potential labor market earnings and in terms of work propensities. Our simulation results indicate that average log earnings of outmigrants remained roughly 12% lower than those of immigrant stayers, a clear indication that outmigrants are drawn from the bottom of the income distribution. Moreover, outmigrants are shown to have labor force participation rates 25% to 45% lower than that of immigrant stayers over the period considered, signaling an important interaction between labor force participation and outmigration. These results extend those of Constant and Massey (2003) who model outmigration of immigrants living in Germany along with labor market earnings and labor force participation but do not control for the possibility that immigrants differ in terms of unobservable individual abilities or other characteristics. They find little evidence that outmigrants are a non-randomly selected group both in terms of earnings and labor force participation.

The rest of this paper is organized as follows. Section 2 presents our approach to identify the economic parameters of interest. Section 3 presents the econometric model used to model outmigration in conjunction with the work decision and labor market earnings. Section 4 presents the data used in the paper. Section 5 discusses the empirical results of the model and tests for the presence of outmigration bias. It further presents some simulation results used to evaluate the fit of the model and to quantify the economic performance of outmigrants. Section 6 concludes.

# 2 Identification of outmigration parameters

Each immigrant of a population living in the host country is characterized by the vector $(y, r^o, \boldsymbol{m})$ where $y$ denotes an economic outcome of interest such as labor market earnings, labor force participation or labor supply, $\boldsymbol{m}$ is a vector of observable characteristics, $r^o$ is a binary indicator taking a value of 1 when the immigrant is observed to have left the panel and 0 otherwise. In what follows, we will use the partition $\boldsymbol{m} = [\boldsymbol{w}, s]$ where $s$ denotes a continuous variable. We denote by $r^u$ a binary indicator taking a value of 1 when the immigrant leaves the country of residence, and 0 otherwise. We maintain throughout that $r^u$ is never observed. We are interested in making inferences on $\boldsymbol{E}\{y|r^u = 1, \boldsymbol{m}\}$, the conditional expected outcome for outmigrants. The inferential problem consist of identifying this quantity when, instead of observing outmigration, we observe a proxy variable $r^o$, panel attrition, which takes a value of 1 when the immigrant leaves the panel in the following period. Outmigration and attrition are related because an immigrant who leaves the country must also leave the panel with probability 1.

We make will maintain the following assumption throughout

**Assumption A1** $\boldsymbol{E}\{y|r^o, r^u, \boldsymbol{m}\} = \boldsymbol{E}\{y|r^u, \boldsymbol{m}\}$

This assumption says that, conditional on $\boldsymbol{x}$ and on the true outmigration indicator $r^u$, the measurement of the outmigration indicator does not affect the conditional expected outcome of interest. This is similar to the classical measurement error assumption that actual outcomes be independent of measurement errors made by researchers of survey agencies.

The role of this assumption can be seen by using iterated expectations to express the conditional expected labor market earnings of immigrants who leave the panel in the next period as

$$\begin{aligned}
\boldsymbol{E}\{y|r^o = 1, \boldsymbol{m}\} &= \boldsymbol{E}\{y|r^o = 1, r^u = 1, \boldsymbol{m}\} \cdot \Pr(r^u = 1|r^o = 1, \boldsymbol{m}) \\
&\quad + \boldsymbol{E}\{y|r^o = 1, r^u = 0, \boldsymbol{m}\} \cdot \Pr(r^u = 0|r^o = 1, \boldsymbol{m}) \\
&= \boldsymbol{E}\{y|r^u = 1, \boldsymbol{m}\} \cdot \Pr(r^u = 1|r^o = 1, \boldsymbol{m}) \\
&\quad + \boldsymbol{E}\{y|r^u = 0, \boldsymbol{m}\} \cdot \Pr(r^u = 0|r^o = 1, \boldsymbol{m}) \qquad (1)
\end{aligned}$$

where the second equality follows from assumption A1. This shows that the conditional expected outcome of outmigrants is a weighted average of the conditional expected earnings of outmigrants, our parameters of interest, mixed with the conditional outcome of immigrants who remain in the host country. The mixing probabilities and the differences in expected outcomes between immigrants who stay and those who leave control the size of the bias. The higher the probability to confound panel drop outs for outmigrants, the higher will be the bias, unless outmigrants and stayers have the same expected outcome. If every immigrant who leaves the panel also leaves the country, $r^o$ perfectly measures outmigration, and both $\Pr(r^u = 0|r^o = 1, \boldsymbol{m})$ and the bias are zero.

In the appendix, we show that $\boldsymbol{E}\{y|r^u = 1, \boldsymbol{m}\}$ can be expressed as a weighted sum of the conditional expected outcomes for immigrants who stay in the panel and the conditional expected outcome for immigrants who drop out of the panel in the following period, both of which are identified by the data. The weights attached to each conditional expected outcome are shown to be functions of the mixing probabilities in equation (1). We show that identification of these probabilities is equivalent to identification of the elements of the conditional attrition probability $\Pr(r^o = 1|\boldsymbol{m})$, which, using the law of total probability, can be expressed as

$$\Pr(r^o = 1|\boldsymbol{m}) = \alpha_{10}(\boldsymbol{m}) + [1 - \alpha_{10}(\boldsymbol{m})] \cdot \Pr(r^u = 1|\boldsymbol{m}) \tag{2}$$

where $\alpha_{10}(\boldsymbol{m}) = \Pr(r^o = 1|r^u = 0, \boldsymbol{m})$ denotes the probability of attrition which is unrelated to outmigration. The structure of equation (2) is mathematically equivalent to the class of models developed for binary choice models with misclassification of the dependent variable (see, e.g., Hausman, Abrevaya, and Scott-Morton, 1998, Lewbel, 2000). The main differences being that our "misclassification" is one-sided and the result of partial observability of the outcome rather than from a misclassification or misreport mechanism.

The following assumption, taken from Lewbel (2000), identify semiparametric versions of equation (2) where $\Pr(r^u = 1|\boldsymbol{m})$ is assumed to have a single index form $F(s\gamma + \boldsymbol{w}'\boldsymbol{\delta})$ where $F(\cdot)$ is treated as unknown, and where $\alpha_{10}(\boldsymbol{m})$ can depend on $\boldsymbol{m}$ in an arbitrary way.

**Assumption A2 (Lewbel, 2000)** Assume $\alpha_{10}(\boldsymbol{m}) = \alpha_{10}(\boldsymbol{w})$ and for all $\boldsymbol{w}$ that $0 \leq \alpha_{10}(\boldsymbol{w}) < 1$. Assume $s$, conditional on $\boldsymbol{w}$, is continuously distributed. Assume that $F(\boldsymbol{m})$ is three times differentiable with $f(\boldsymbol{m}) = dF(\boldsymbol{m})/d\boldsymbol{m}$ and $f'(\boldsymbol{m}) = df(\boldsymbol{m})/d\boldsymbol{m}$. Assume $|\gamma|$=1 and for all $\boldsymbol{\delta}^* \neq \boldsymbol{\delta}$, $prob([f'(s\gamma + \boldsymbol{w}'\boldsymbol{\delta})/f(s\gamma + \boldsymbol{w}'\boldsymbol{\delta})] \neq \boldsymbol{E}[f'(s\gamma + \boldsymbol{w}'\boldsymbol{\delta})/f(s\gamma + \boldsymbol{w}'\boldsymbol{\delta})]|s\gamma + \boldsymbol{w}'\boldsymbol{\delta}^*)$.

The first assumption says that a continuous variable $s$ must be excluded from the probability of attrition which is unrelated to outmigration. The role of this covariate is to generate low outmigration probabilities $F(\cdot)$ which identify $\alpha_{10}(\boldsymbol{w})$. This can be seen by noting from (2) that $\Pr(r^o = 1|\boldsymbol{w}, s) \to \alpha_{10}(\boldsymbol{w})$ for $F(\cdot) \to 0$. This type of exclusion restriction is a common approach to identify semiparametric models (see e.g., Powell, 1994, section 2.5). Imposing $|\gamma| = 1$ is an arbitrary free normalization, as long as $\gamma \neq 0$. The final condition is a parametric identification assumption to identify $\boldsymbol{\delta}$ from the score function if $f$ was known and there was no misclassification.

We can now state the main result of this section

**Lemma 1** *Under Assumption A1 and A2,* $\boldsymbol{E}\{y|r^u = 1, \boldsymbol{m}\}$ *is semiparametrically identified.*

The proof of this result can be found in the appendix.

Because attrition which is unrelated to outmigration and outmigration itself are very different processes, the later often modelled as a life-cycle event influenced by poor labor market performance, integration feelings, credit rationing in the home country and age at immigration, it seems possible to find realistic exclusion restrictions. In the case where a vector of variables $\boldsymbol{s}$ is available, identification of the model parameters requires that a linear combination of $\boldsymbol{s}$ generates low outmigration probabilities, given $\boldsymbol{m}$. Note that in practice, conditioning $\alpha$ on $\boldsymbol{m}$ will be important only if $\alpha$ varies substantially with $\boldsymbol{m}$. This can be verified for example by computing marginal effects from binary choice regressions on attrition outcomes for a sample of individuals who by construction do not outmigrate, and test if these effects are small. In the case of developed countries, natives living in the host country is one example of a sample not prone to outmigration.[2]

# 3 Parametric model and estimation method

The objective of the previous section was to give a sound motivation for our approach to identify parameters characterizing the economic performance of outmigrants using sample attrition, a fact reflected by the semiparametric nature of the approach proposed. In this section, we develop and estimate a parametric model which allows us to extract outmigration behavior from panel attrition. The choice to use a parametric model rather than a semiparametric model is threefold. First, deriving the asymptotic distribution of semiparametric estimators of the conditional expectations of interest potentially involves having to deal with the product and ratios of quantities estimated using both nonparametric and semiparametric methods, which is beyond the scope of this paper. Second, it is not uncommon to separate issues of identification from issues of estimation. Identification seeks to characterize the combination of assumptions and data availability needed to make the inferences required, assuming researchers have a sample of infinite size. In general, the less parametric are the assumptions needed for identification, the greater the credibility of the approach (Manski, 1995). Samples used in practice are however finite, which raises important issues of statistical inferences for the case at hand. In particular, it is well known that nonparametric and semiparametric estimators generate imprecise estimates when the dimension of the conditioning set is large, as will be the case in this section. Finally and perhaps more importantly, our preferred empirical model has the structure of a system of three equations, motivated by our desire to allow immigrants to select themselves into work and migration states based on their individual unobserved

[2]This condition is unlikely to hold in developing economies where brain drain is a likely occurrence and conductive of selective outmigration.

characteristics, which is hard to handle in a nonparametric or semiparametric framework.

For these reasons, we adopt the following parametric framework which first requires that researchers have a sample of $N$ immigrants in period 1, where immigrant $i$ remains in the panel for $T_i$ periods. For each immigrant $i$, we observe in period $t$, whether he works $p_{it}$, his monthly labor market earnings $e^{(y_{it})}$, and his attrition status $r^o_{it}$ in the next period. The log of the potential labor market earnings is assumed to be generated by a log linear earnings equation

$$y_{it} = \boldsymbol{x}'_{it}\boldsymbol{\beta} + \eta^1_i + \varepsilon^1_{it} \tag{3}$$

where $\boldsymbol{\beta}$ are unknown parameters, $\eta^1_i$ is an unobserved time invariant individual specific component of income while $\varepsilon^1_{it}$ represents a stochastic shock. These labor market earnings are only observable when an immigrant works. Labor force participation $p_{it}$ is assumed to be generated by a latent process

$$p^*_{it} = \boldsymbol{z}'_{it}\boldsymbol{\theta} + \eta^2_i + \varepsilon^2_{it} \tag{4}$$

where $\boldsymbol{\theta}$ are unknown parameters, $\eta^2_i$ is a time-invariant unobserved component and $\varepsilon^2_{it}$ represents some stochastic shock to the labor force participation propensity. Participation is determined by the observation rule $p_{it} = 1\left[p^*_{it} > 0\right]$. When $p_{it} = 1$, earnings $w_{it}$ are observed. Both $\eta^1_i$ and $\eta^2_i$ can be thought of capturing immigrants unobserved ability to generate higher earnings and to find jobs. They can also be thought of as including unobserved family background characteristics and preferences for work and leisure. Finally, an immigrant's unobservable outmigration propensity $r^*_{it}$ is assumed to be determined by another latent process

$$r^{*u}_{it} = \boldsymbol{s}'_{it}\gamma + \eta^3_i + \varepsilon^3_{it} \tag{5}$$

where $\gamma$ are unknown parameters, $\eta^3_i$ captures the individual specific attachment to his native country and $\varepsilon^3_{it}$ is a stochastic shock. The triplet $\left\{\eta^1_i, \eta^2_i.\eta^3_i\right\}$ is assumed to be observed by the immigrant who takes it into account when making his decisions but it is not observed by the econometrician. Let $r^u_{it} = 1\left[r^*_{it} > 0\right]$ be the decision rule governing the true outmigration decision in period $t+1$. Outmigration $r^u_{it}$ is unobservable. In our empirical application, we assume that $\alpha_{10}$ varies over time but is independent of other observable characteristics, which is the standard assumption made in the literature on binary choice models with misclassification of the responses (see e.g., Hausman, Abrevaya, and Scott-Morton, 1998; Abrevaya and Hausman, 1999; Dustmann and Van Soest, 2001, 2004), and implies the following choice probability

$$\Pr\left(r^o_{it} = 1|\boldsymbol{s}_{it}\right) = \alpha_{10}(t) + \left[1 - \alpha_{10}(t)\right] \cdot \Pr\left(r^u_{it} = 1|\boldsymbol{s}_{it}\right) \tag{6}$$

In order to check the validity of this assumption, we ran probit regressions of the attrition indicator for native Germans on a set of covariates including age, education and the number of months of labor market experience. Most variables were insignificant apart from age which had a significant and positive effect on the attrition propensity, but a small marginal effect on the attrition probability, suggesting that the probability of attrition which is not due to outmigration does not vary substantially across individuals.[3].

The earnings, work and outmigration outcomes are not likely to be independent of each other. This will not be independent if, for example, immigrants who find work very easily and/or who earn a high income are more reluctant to outmigrate. The unobserved heterogeneity components $\eta_i^1, \eta_i^2$ and $\eta_i^3$ can be treated either as fixed constants or as random variables. The main advantage of the fixed effect approach is that it does not require that included explanatory variables be strictly exogenous to the unobserved heterogeneity components $\left(\eta_i^1, \eta_i^2, \eta_i^3\right)$. However, estimation of fixed effects in multiple equations nonlinear models remains today a sizeable complication, with very little guidance in the choice of models (see the recent review of Arellano and Honoré, 2001). We therefore introduce these dependencies by assuming that the stochastic time-invariant effects are independent and identically normally distributed over time with mean 0 and covariance matrix

$$\boldsymbol{\Omega} = \begin{bmatrix} \sigma^2_{\eta^1} & \rho^\eta_{1,2}\sigma_{\eta^1}\sigma_{\eta^2} & \rho^\eta_{1,3}\sigma_{\eta^1}\sigma_{\eta^3} \\ \cdot & \sigma^2_{\eta^2} & \rho^\eta_{2,3}\sigma_{\eta^2}\sigma_{\eta^3} \\ \cdot & \cdot & \sigma^2_{\eta^3} \end{bmatrix}$$

where $\sigma^2_{\eta^j}$ denotes the variances of the unobserved heterogeneity components, and $\rho^\eta_{i,j}$ denotes their correlations.[4] These correlations are indicative of whether or not immigrants self-select themselves into work and into outmigration based on their unobservable individual characteristics. A significant and positive $\rho^\eta_{1,2}$ indicates that individuals who are more likely to work are also more likely to have higher earnings, give observed characteristics. $\rho^\eta_{1,3}$ has a similar interpretation and is indicative of outmigration bias. This coefficient will be negative (positive) if immigrants who have unobserved characteristics yielding below average monthly labor market earnings, conditional on $\boldsymbol{x}$, tend to be those whose unobserved characteristics yield higher (lower) probability of leaving the country in the following period. Finally, $\rho^\eta_{2,3}$ can be interpreted as measuring outmigration bias in the labor force participation decision and whose sign has a similar interpretation.

[3]Results are available upon request

[4]We have experimented with a flexible nonparametric mixture model which assumes that $\left(\eta_i^1, \eta_i^2, \eta_i^3\right)$ is drawn from a discrete distribution $h\left(\eta_{ik}^1, \eta_{ik}^2, \eta_{ik}^3\right) = \pi_k$ for $k = 1, ..., 8$ where $\sum_{k=1}^8 \pi_k = 1$. Results were very similar to those presented here. However, we had numerical difficulties in computing standard errors for some of the point masses. We thus did not pursue this area further.

Finally, we assume that the vector $\left[\varepsilon_{it}^{1}, \varepsilon_{it}^{2}, \varepsilon_{it}^{3}\right]'$ is i.i.d normally distributed with mean 0 and covariance matrix

$$\boldsymbol{\Sigma} = \begin{bmatrix} \sigma_w^2 & \rho_{1,2}^{\varepsilon}\sigma_w & \rho_{1,3}^{\varepsilon}\sigma_w \\ \cdot & 1 & \rho_{2,3}^{\varepsilon} \\ \cdot & \cdot & 1 \end{bmatrix}$$

where $\sigma_w^2$ is the variance of log earnings, while the variances of the unobserved stochastic shocks entering the work and outmigration equations are set to 1 for identification purposes. Contemporaneous correlations between the three stochastic components are captured by the correlation coefficients $\rho_{1,2}^{\varepsilon}$ $\rho_{1,3}^{\varepsilon}$ and $\rho_{2,3}^{\varepsilon}$.

To simplify the presentation of the likelihood function, we divide the observable characteristics of immigrant $i$ into a set $\boldsymbol{y}_i = \left\{p_{it}, r_{it}^{o}, w_{it} \cdot p_{it}\right\}_{t=1}^{T_i}$ of dependent variables, a set $\boldsymbol{X}_i = \{\boldsymbol{x}_{it}, \boldsymbol{z}_{it}, \boldsymbol{s}_{it}\}_{t=1}^{T_i}$ of exogenous variables, and a vector $\boldsymbol{\eta}_i = \left(\eta_i^1, \eta_i^2, \eta_i^3\right)$ containing unobserved time invariant heterogeneity. Moreover, we denote by $g(\cdot,\cdot,\cdot|\boldsymbol{\eta}_i)$ the trivariate normal density, conditional on the time invariant unobservable characteristics. Numerical approximation of the likelihood function proceeds in two steps. In the first step, the likelihood function is computed conditional on the time invariant unobserved individual characteristics. This first step density is given by

$$\begin{aligned} & f^{C}\left(\boldsymbol{y}_i|\boldsymbol{X}_i,\boldsymbol{\eta}_i;\boldsymbol{\beta},\boldsymbol{\theta},\gamma,\boldsymbol{\Sigma},\boldsymbol{\alpha}_{i,10})\right) \\ = & \prod_{t=1}^{T_i}\int_{\mathbb{Q}_{it}}\int_{\mathbb{C}_{it}}\left\{\left(1-r_{it}^{o}\right)\left(1-\alpha_{10}(t)\right)\int_{-\infty}^{0} g\left(p_{it}^{*}, r_{it}^{*}, w_{it};\boldsymbol{\Sigma}|\boldsymbol{\eta}_i\right)\,\mathrm{d}r_{it}^{*}\right. \\ & \left. +r_{it}^{o}\left[\int_{0}^{\infty} g(p_{it}^{*}, r_{it}^{*}, w_{it};\boldsymbol{\Sigma}|\boldsymbol{\eta}_i)\,\mathrm{d}r_{it}^{*}+\alpha_{10}(t)\int_{-\infty}^{0} g\left(p_{it}^{*}, r_{it}^{*}, w_{it};\boldsymbol{\Sigma}|\boldsymbol{\eta}_i\right)\,\mathrm{d}r_{it}^{*}\right]\right\}\,\mathrm{d}p_{it}^{*}\,\mathrm{d}w_{it} \end{aligned}$$

where $\boldsymbol{\alpha}_{i,10} = [\alpha_{10}(1), \alpha_{10}(2), ..., \alpha_{10}(T_i)]$. The case where outmigration is perfectly observed follows by setting all $\alpha_{10}(t)$ equal to 0. The sets $\mathbb{W}_{it}$ and $\mathbb{P}_{it}$ define the domain of integration over the wage and work spaces and vary over time as individuals make different choices in each period according to the following table

| Integration domains in period $t$ | | |
|---|---|---|
| | $\mathbb{Q}_{it}$ | $\mathbb{C}_{it}$ |
| Work | $-$ | $[0,\infty)$ |
| Not Work | $(-\infty,\infty)$ | $(-\infty,0]$ |

Income is integrated out in waves where individuals do not work. The integration domain for the work propensity follows from the labor force participation rule. In the second step, the unconditional likelihood function is obtained by integrating out the random individual effects over $\mathbb{R}^3$

$$f\left(\boldsymbol{y}_i|\boldsymbol{X}_i;\boldsymbol{\beta},\boldsymbol{\theta},\gamma,\boldsymbol{\Sigma},\boldsymbol{\Omega},\boldsymbol{\alpha}_{i,10}\right) = \int_{\mathbb{R}^3} f^{C}\left(\boldsymbol{y}_i|\boldsymbol{X}_i,\boldsymbol{\eta}_i;\boldsymbol{\beta},\boldsymbol{\theta},\gamma,\boldsymbol{\Sigma},\boldsymbol{\alpha}_{i,10}\right) h\left(\boldsymbol{\eta}_i;\boldsymbol{\Omega}\right)\mathrm{d}\boldsymbol{\eta}_i$$

where $h$ denotes the trivariate normal density function with mean vector **0** and covariance matrix $\boldsymbol{\Omega}$.

To solve the numerical integration problem, we approximate the integral by a simulated mean: a sequence of $r = 1, 2, ..., R$ i.i.d. draws $\boldsymbol{\eta}_i^{(r)} = \left(\eta_i^{1(r)}, \eta_i^{2(r)}, \eta_i^{3(r)}\right)$ is taken from the multivariate normal distribution $H$ at a given value of $\boldsymbol{\Omega}$.[5] For each draw, the conditional likelihood function $f^C$ is evaluated. The partial Maximum Simulated Likelihood estimator consists of replacing $f$ by the simulated mean

$$\frac{1}{N}\sum_{i=1}^{N} \log \left[\frac{1}{R}\sum_{r=1}^{R} f^C\left(\boldsymbol{y}_i|\boldsymbol{X}_i, \boldsymbol{\eta}_i^{(r)}; \boldsymbol{\beta}, \boldsymbol{\theta}, \gamma, \boldsymbol{\Sigma}, \boldsymbol{\alpha}_{i,10}\right)\right]$$

The resulting estimator is inconsistent for fixed R but will be consistent if R tends to infinity with the number of observations $N$. If $\sqrt{N}/R \rightarrow 0$ and with independent drawings across individuals, the method is asymptotically equivalent to maximum likelihood (Train, 2003).

A side product of our empirical model is that we can look into the recently debated issue of whether selective outmigration biases rates of immigrant economic assimilation. This possibility was noted among other by Schultz (1998)**?** and confirmed using Swedish data by Edin, LaLonde and Aslund (2000) **?** who find that their measure of assimilation is sensitive to selective outmigration. Contrary to that paper, we will compute assimilation rates using the most commonly used definition of assimilation (for an overview, see Borjas, 1999) defined as the differential in earnings between immigrants and natives with similar characteristics which results in one extra year in the host country

$$\left.\frac{\partial \boldsymbol{E}\left(w_{it}|\boldsymbol{x}_{it}\right)}{\partial t}\right|_{immig} - \left.\frac{\partial \boldsymbol{E}\left(w_{it}|\boldsymbol{x}_{it}\right)}{\partial t}\right|_{Germans} \tag{7}$$

Estimation of the derivative for immigrants is done using estimates of the returns to experience and the returns to an extra year in the Germany. For Germans, the passage of time is modelled as an increase in log earnings resulting from one year of labor market experience. To estimate this change in log earnings, we will model labor market earnings and work decisions of Germans using similar specifications of equations (3) and (4) and estimate the parameters using the simulation techniques described above.

# 4 Data

The data used in this paper is taken from the public use file of the GSOEP and covers the 1985-1999 period. Until 1990, the GSOEP consisted of a sample of households with

[5]In this paper, we use sequences of 100 Halton draws (see, e.g., Train, 2003).

German heads living in former West-Germany and an over-sample 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.[6] Data on speaking fluency, integration feelings of immigrants, intended length of stay and remittances directed to their family living outside Germany were given in consecutive waves from 1984 until 1987. Starting in 1987, this information was gathered every other year. In order to keep constant the time period 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 and 64 years of age during the 1985-1999 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 1987 native Germans and 732 immigrants starting in 1985.

The identification approach presented in section 2 relies on the information contained in panel attrition. It becomes instructive to contrast the attrition pattern of our immigrant sample with that of Germans whose attrition cannot obviously be attributed to outmigration. Table 1 contains information on the number of individuals observed along with the percentage of the original 1985 sample who remains in a given wave.[7] 41.9% of Germans and 26.7% of immigrants have been interviewed successfully in all the waves. The attrition rate in a given wave is defined as the percentage of individuals not observed in the given wave but observed in the preceding wave. Over our sample period, an average of 11.6% of the remaining Germans and 17.2% of immigrants drop out of the panel every two years. In the case of Germans, outmigration is de facto not an issue. Assuming that the difference in attrition rates is due to outmigration, a back of the envelope calculation implies that we would expect the outmigration rate in our sample of immigrants to be 6% every two years, or 3% per year, a number which would be in line with those reported in the literature (see Borjas and Bratsberg, 1996). Of course, this calculation relies on the assumption that attrition in the immigrant population which is not due to outmigration is of comparable magnitude to that of natives. We will come back to this in section 5 which reports indirect evidence suggesting that this is a plausible assumption.

The top panel of Figure 1 shows the average monthly gross income for working immigrants and Germans over the period covered. In 1985, the mean income of Germans was 3,357 DM per month compared to 2,690 DM per month for immigrants, giving an income

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

[7] Figures are adjusted for individuals truncated out of the sample as they reached 66 years of age.

ratio of 1.25 favoring Germans. The mean wage differential remaind relatively steady until 1991, after which, the mean income differential widened even more between the two groups to reach a ratio of 1.34 in 1999, with Germans receiving an average monthly wage of 5,848 DM while immigrants were receiving 4,348 DM per month. The diverging economic progress of Germans and immigrants after 1991 is also reflected in the work frequencies. The bottom panel of figure 1 shows the sample frequencies of individuals working in the month preceding the interview. We can see that until 1991, labor force participation was very similar for both Germans and immigrants. After 1991, we observe a steady decline in the work frequencies for both groups which coincides with the general deterioration of the labor market in West-Germany. During that period, the percentage of immigrants working remained steadily below that of Germans.

Definitions and summary statistics of all the independent variables we use are presented in Table 2. We see that immigrants migrated to Germany early in their productive lives, a fact reflected by an average age at immigration of nearly 24 years, indicating that most migrants were old enough to autonomously decide to move to Germany.

# 5 Results and simulations

Three specifications were estimated to separate the effect of work selection from the effect of outmigration selection on labor market earnings. The first specification consisted of a univariate model of labor market earnings equation with random effects. The second specification consisted of a bivariate model of labor market earnings and work. Comparison of the second specification with the first allows us to evaluate the role of work selection on labor market earnings ignoring possible outmigration selection. The third and final specification consisted of our complete model, where labor market earnings, labor force participation and outmigration decisions are simultaneously determined. Comparison of the third and second specification reveals the role played by outmigration selection when accounting for work selectivity. The regressors included in the earnings and work equations included education, labor market experience and its square, reported speaking fluency in German, and the number of years since immigration to Germany. We use reported health satisfaction as the exclusion restriction in the work equation. Reported health satisfaction is a valid exclusion restriction if health problems occur mostly at a time in which an individual is more likely to have found a stable job whose continuation depends on the worker's choices. Our choice of regressors for the outmigration equation is motivated by existing theoretical explanations for outmigration (see the Introduction). We included whether or not the wife of an immigrant lives in Germany to capture effects of family unity, reported feelings of belonging to the Germans society, reported health satisfaction, and self-reported expected length of stay in Germany, the later is included to capture part of the anticipatory behavior of migrants which is consistent with forward looking decision making. We also included age at arrival to capture incentives of immigrant's who arrive at a young age to acquire country specific human capital.

The effects of local labor market conditions and other macroeconomic fluctuations are captured by including in all equations the yearly state level unemployment rate and year fixed effects. We additionally experimented with an alternative specification of the outmigration equation which contained education, labor market experience and its square, speaking fluency, and years since immigration as regressors. A log-likelihood ratio test of the null hypothesis that these human capital variables have no joint effect on outmigration could not be rejected at conventional levels ($p$-value = 0.221).

## 5.1 Results

### 5.1.1 Outmigration and non-outmigration related attrition

The top panel of Figure 2 plots the sample attrition rates of the immigrant sample taken from Table 1 along side the estimated sample attrition rates, the later computed by averaging the predicted outmigration probabilities for immigrants in each relevant wave. We find that the model fit is very good for all waves considered. In particular, the model captures well the episode associated with a decrease in sample attrition rates between 1985 and 1991 and the episode associated with an increase in sample attrition which occurred between 1991 and 1999.

In order to get a feeling for the importance of outmigration in explaining both episodes, we broke down the estimated sample attrition rates into predicted outmigration rates and non-outmigration related outmigration rates. Table 3 presents estimates of $\alpha_{10}$ in each wave along with standard errors. We find the non-outmigration related attrition rates to be well estimated in all waves. The middle panel of Figure 2 plots these rates alongside the predicted outmigration rates, the later obtained by averaging predicted outmigration probabilities over all immigrants in each wave. We find that non-outmigration related attrition remained a more important source of sample attrition than outmigration over the horizon considered. The episode of decrease in sample attrition between 1987 and 1991 is predicted to be the result of a simultaneous decrease in both outmigration and non-outmigration related attrition rates. In particular, starting with a non-outmigration related attrition rate above 15% in 1987, three times greater than the corresponding level of outmigration related attrition, both sources of attrition diminished over the following waves, with outmigration rates falling to 2.5% immediately following the economic recovery of 1991. The episode associated with an increase in the sample attrition rates between 1991 and 1999 is predicted to be the result of an important increase in non-outmigration related attrition and a relatively more benign decrease in outmigration rates which, again, indicate that most of the observed fluctuations in sample attrition rates results from fluctuations in non-outmigration related attrition, while outmigration rates oscillated around the level of 6% per two years span.

It is interesting to report that the estimated values of $\alpha_{10}$ over our time horizon closely follow the sample attrition rates of the German sample, a sample with presumably little outmigration related attrition. The bottom panel of Figure 2 plots both lines. We find that apart from the higher non-outmigration related attrition rate in 1999, both attrition rates followed each other closely. Both rates are directly comparable if the true level of non-outmigration related attrition is of comparable magnitude in both populations. We do not have direct information on this similarity. However, because we excluded from our sample individuals who died during our observation window, the non-outmigration related sample attrition we observe can result from either untraceable individual mobility within the country or individual refusal to continue participating in the panel. Concerning the former possibility, 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 suggests that, if anything, survey institutes should not have greater difficulties in tracking mobile immigrants than mobile natives. Concerning refusals, Spiess and Pannenberg (2003) present evidence suggesting that the proportions of individuals refusing to participate in each wave once contacted is approximately the same in both the Germans and immigrant samples. Both sets of evidence point to similar non-outmigration related attrition rates in both populations.

From the results of section 2, semiparametric identification of the economic performance of outmigrants in the context of the present empirical model, which conditions $\alpha_{10}$ on the time dimension, requires that there exist immigrants with extremely low outmigration probabilities in each wave. Assuming correct model specification, we check for this by computing percentiles of the predicted outmigration probability distribution in each wave of the sample. The 25th percentile of the predicted outmigration probability distribution oscillated between 0.69% in 1985 and 0.81% in 1997, indicating the presence of a considerable amount of immigrants with an outmigration probability close to 0 in all our waves.

### 5.1.2 Determinants of outmigration

Table 3 presents estimates of the outmigration equation alongside the estimated non-outmigration related attrition rates. We find that immigrants whose wife lives with them in Germany have a significantly lower probability of outmigration, reflecting some preferences for family unity. Immigrants satisfied with their health are significantly less likely to outmigrate, a finding consistent with the sociological findings reported in Stark (1998). Intended length of stay captures the expectations of immigrants and offers direct information on their remigration intentions. We find that migrants who expect to remain longer in Germany are also less likely to outmigrate, indicating that our immigrants react to preestablished life-cycle plans, indicating elements of forward looking decision making. Deteriorations of the local labor market conditions, reflected in higher unemployment rates, have a positive and significant effect on the likelihood of leaving the country. The effect of cumulative savings returned to the home country is not significant, implying that immigrants who have saved and returned more money to their native country are not more likely to outmigrate. Dustmann and Kirchkamp (2002) find that Turkish return migrants have accumulated enough wealth in Germany to start up businesses in their home country upon their return. Because Turks are the biggest ethnic group in our sample, we would expect that increasing remittances increase the probability of outmigration if the money returned is intended to be eventually invested in a business. Our results suggest that migrants returned money to help relatives rather than for investment purposes. Finally, immigrant's feelings of integration in the German society are not correlated with outmigration.

### 5.1.3 Earnings and labor force participation equations

Table 4 presents parameter estimates of the earnings and work equations for the immigrant and German samples for all three specifications. Focusing first on the more general model which controls for both work and outmigration selectivity, we find that the returns to education of immigrants are roughly one third those of Germans, where an extra year of schooling raises earnings of Germans by 9.2% and those of immigrants by 2.9%. Labor market earnings have the usual concave relation to experience, with an extra year of labor market experience raises earnings of Germans by 0.6% compared to 0.32% for immigrants. As expected, immigrants with better speaking fluency have higher earnings.[8] Finally, higher unemployment rates are associated with lower earnings in the immigrant

[8]Dustmann and van Soest (2001) show that the self-reported speaking fluency indicator of the GSOEP is measured with noise, a feature which biased downwards the effect of speaking fluency on earnings. Due to the complexity of their correction, we have not attempted to include it in the present study.

population (at the 10% significance level) but do not affect labor market earnings of the native population. Given we include controls for time periods, identification of this effect relies on regional variations across provinces in Germany. The effect of unemployment on earnings thus reflects that at any point in time, earnings differ across provinces depending on the tightness of the local labor market.

When controlling for outmigration selectivity, we control for the fact that the sample of immigrants observed over time has above average conditional earnings relative to the population expectation. We then expect that the returns to some human capital factors will be lower in the overall immigrant population than in the population of permanent migrants. Changes in the returns to education when controlling or not for outmigration goes along those lines. We find that the returns to education of immigrants passes from 2.9% when outmigration is accounted for to 3.5% when we do not control for outmigration. This change is consistent with the hypothesis that permanent migrants have above average labor market earnings. The coefficient of years since migration progressively decreases as less selection is accounted for, passing from 0.079 to 0.073 when controlling for work selectivity to 0.069 without any selection controls, although these changes are not significant. Finally, the coefficient of the linear term of labor market experience increases while the coefficient of the quadratic term decreases when outmigration is not accounted for. Again, both these changes are not significant at conventional levels.

The robustness of parameter estimates to controls for work and outmigration selectivity has a direct implication for estimates of the economic assimilation rates computed on the basis of equation (7), which we evaluated at the sample average of the labor market experience for both the immigrant and native samples in 1985. The estimate of the assimilation rate is found to be -5.00% per year when outmigration is not accounted for, and raises to -4.78% when outmigration is accounted for, a statistically insignificant increase, which indicates that the lack of assimilation observed cannot be accounted for by selective immigrant departures. Contrary to the results of Edin, LaLonde, and Aslund (2000) for Sweden who found strong effects, our approach is conditional on observable characteristics.

The results for the labor force participation equation are in line with those of the earnings equation, both in terms of the sign of the effects and on the robustness of the parameters to outmigration selection. Education and labor market experience have positive effects on the probability of working. Higher unemployment rates have a negative effect on the work probability while immigrants and natives with better reported health satisfaction have a higher probability of working. Speaking fluency has a positive effect on work participation while the number of years since immigration has a negative and significant impact on work participation. Similar to earnings, we find that parameter estimates of the immigrant work propensity are quite robust to return migration selectivity.

#### 5.1.4 Covariance structure

Table 5 presents estimates of the covariance structure of all three specifications. Focusing on the most general model which controls for both work and outmigration selection, we find that transitory shocks between earnings and work, and shocks between work and outmigration, are all significantly negatively correlated, the former at -34.2% and the latter at -27.8%, while we do not find significant correlation between the transitory shocks of the earnings and outmigration processes. The negative correlation between the transitory shocks of the earnings and work equations is somewhat unexpected since it implies that conditional of observable and unobservable heterogeneity, those attracted to work at the same time have lower expected log earnings. As we show below, these transitory shocks explain only a small part of the overall unexplained variation in the three economic outcomes.

The correlation between the unobserved individual heterogeneity of work and earnings $\left(\rho^{\eta}_{1,2}\right)$ is found to be small but significant, indicating that individuals with higher propensities to working are more likely to have higher earnings. The correlation between individual time invariant heterogeneity of outmigration and earnings $\left(\rho^{\eta}_{1,3}\right)$ is -56% while that between outmigration and work $\left(\rho^{\eta}_{2,3}\right)$ is -49.8%, both significant at the 1% level. Both correlations suggest that individuals with a higher propensity to outmigrate are those with both a lower probability of finding work, and lower labor market earnings, which points to a clear pattern of negative outmigration selection. When comparing results with the bivariate model which does not correct for outmigration, we find that the estimated correlation between the time-invariant unobserved components in the earnings and work equations ($\rho^{\eta}_{1,2}$) remains stable, which indicates the robustness of the selection into work effect to non-random immigrant departures.

Relative to the transitory shocks, these unobserved individual effects account for 53.8% of the unexplained variation in labor market earnings, and respectively 73.9% and 74.5% of the unexplained variation of the labor force participation and outmigration propensity, a clear indication of their relative importance in determining all three outcomes and the inherent selection patterns.[9]

Results for Germans are similar to that of the immigrant sample, with a small but

[9]Both $Var(\varepsilon^2_{it})$ and $Var(\varepsilon^2_{it})$ are normalized to 1. Hence, the total unexplained variations in both the labor force participation and the outmigration equations are respectively $1+\sigma^2_{\eta}$ and $1+\sigma^3_{\eta}$. The shares out of the total variance are thus estimated to be 2.834/[1+2.834]=0.739 and 2.934/[1+2.934]=0.745.

positive and significant work selection effect $\left(\rho_{1,2}^{\eta}\right)$. Unobserved individual heterogeneity effects account for 61.5% of the unexplained variation in labor market earnings, and 74.5% of the the unexplained variation in labor force participation, figures which are similar to those of immigrants.

## 5.2 Simulations

Simulations are used for two purposes. First, they allow to check whether our model provides a good fit to the data. Secondly, they allow us to quantify the implications of earnings and work propensities on outmigration selectivity.

Our simulations were done in the following way. For each individual appearing in the sample in 1985, we take 1000 draws from the joint distribution of the time invariant components $\left(\eta_i^1, \eta_i^2, \eta_i^3\right)$. Then, in each time period, we draw for each immigrant appearing in that period 1000 draws from the joint distribution of transitory stochastic components $\left(\varepsilon_{it}^1, \varepsilon_{it}^2, \varepsilon_{it}^3\right)$. The draws from the time invariant stochastic components are then matched to the draws of the transitory stochastic components and used to predict whether the immigrant will work and whether he will outmigrate in the next period. We compute the predicted log earnings for each immigrant predicted to work in a given wave. Simulations are then averaged over all draws and individuals. Simulations for the German sample follow a similar path. Simulation results are presented in Table 6. The fit for the German sample is very good, with both real and simulated paths closely following each other over the entire sample period. Simulated log earnings paths of immigrants are good up till 1991, after which, the model tends to over predict the monthly log earnings. Part of these discrepancies can be attributed to the progressively small immigrant sample sizes in the latter years, a fact reflected in the increasing dispersion of the simulated log earnings estimates over time (not shown here).

The empirical results of the previous section indicated that outmigrants were selected from the bottom of the earnings and work propensity distributions of the immigrant population. To gain some insights into the economic performance gap between immigrants who remained in Germany and those who left, we took the simulations which were used to compute results for immigrants in Table 6 and separated them into a group of predicted outmigrants and a group of predicted stayers. The top panel of Figure 6 reports simulations of log earnings while the bottom panel reports the simulated work propensities. In 1985, the log earnings of outmigrants where 11.1% lower than those of the immigrant stayers. This gap widened to 14.1% in 1991 before dropping back to a gap of 11.9% in 1997. The gap in work propensities between immigrant stayers and outmigrants also confirms the strong negative outmigration selectivity. Outmigrants are predicted to have a work propensity 25% lower than that of immigrant stayers in 1985. In 1995, at the end of the economic downturn, this gap climbed to nearly 44%.

Overall, these simulations clearly indicate that the economic performance of outmigrants in the wave preceding their departure was dramatically worse than that of stayers, both in terms of earnings and probabilities of working. These results differ from those of Constant and Massey (2002) who do not report evidence that outmigrants leaving Germany during the same time period are self-selected in any particular direction. The main difference between both papers is that their econometric model excludes selection based on individual unobservable characteristics. As we argued in the introduction, we have good theoretical reasons to believe that such unobservable factors play an important role in shaping immigrant performance and their resulting durations of stay in the host country. Our simulations have confirmed this importance and suggest that selection patterns may be sensitive to whether unobserved individual characteristics are accounted for.

# 6 Conclusions

This paper has presented a general framework to analyze the determinants of outmigration and to identify and estimate the economic parameters characterizing the economic performance of outmigrants which does not require empirical researchers to observe outmigration decisions, which fully exploits the advantages of panel data sets by allowing individuals to differ with respect to unobservable differences such as their intrinsic ability to reap labor market benefits, and which has the potential to be applied in countries with an ongoing panel of immigrants. Conditions for semiparametric identification of the conditional expected outcomes have been presented. The main condition requires an exclusion restriction sufficient to induce low probabilities of immigrant departures.

We applied our framework to estimate a three equation panel data model which simultaneously determines labor market earnings, the labor force participation decision, and the outmigration decision. Estimates of our model predict an annual outmigration rate of 3%. Our simulation results clearly indicated the importance of accounting for unobserved heterogeneity in the context of outmigration in Germany. Contrary to existing evidence, we found clear patterns of negative outmigration selection attributed to individual differences in unobserved characteristics. Moreover, unobserved heterogeneity was found to explain the greater part of the unexplained variation in earnings, work, and outmigration outcomes, a finding which warrants their inclusion in the model. Simulations revealed that outmigrants have between 11% and 14% lower expected labor market log earnings, and between 25% and 44% lower probabilities of working over the 1985-1999 period when compared to immigrants who remain in Germany. These results clearly indicate that immigration policies aimed at improving the economic performance of immigrants were not sufficient to bridge the gap between immigrants and natives. If Germany's optimal immigration policy requires a mixture of both skilled and unskilled labor, then the negative selection of departing immigrants found in this paper is a source of concern. Our results indicated that policies which affect expected planed migration durations, barriers to family unity, and age of immigrants at entry, are likely to have a significant impact of immigrant departures, and may serve as useful tools in adapting the immigrant pool to the needs of the German labor market.

Extending the present analysis to other countries would not only shed light on the robustness of the method, but also improve and extend international comparisons of outmigration behavior within a unified framework. The identification strategy proposed also allows to estimate many more economic models than the one presented in this paper. A noteworthy extension is to use the present framework to estimate economic structural dynamic life-cycle model of outmigration decision making, directly aligning the theory with the empirical data. As mentioned in the introduction, the approach presented here can also be used to study migration movements other than those of immigrants. Burda, Hardle, Muller, and Werwatz (1998) for example study migration of native Germans from the East to West-Germany following reunification using data on intentions to migrate rather than actual migration movements, the later which were difficult to observe in their panel data set. The framework proposed here suggests that an extension to analyze such migrations is promising.

## Proof of Lemma 1

Under Assumption A1, the conditional expected outcome of immigrants who remain in the panel is given by

$$\begin{aligned}
\text{(8)} \qquad \boldsymbol{E}\{y|r^o=0,\boldsymbol{m}\} &= \boldsymbol{E}\{y|r^u=1,\boldsymbol{m}\}\cdot\Pr(r^u=1|r^o=0,\boldsymbol{m}) \\
&\quad +\boldsymbol{E}\{y|r^u=0,\boldsymbol{m}\}\cdot\Pr(r^u=0|r^o=0,\boldsymbol{m}) \\
\text{(9)} \qquad &= \boldsymbol{E}\{y|r^u=0,\boldsymbol{m}\}
\end{aligned}$$

where the last equality follows from the fact that an immigrant cannot be observed to have left the country given he is observed to be in the panel ($\Pr(r^u=1|r^o=0,\boldsymbol{m})=0$). Substituting (9) in (1) and solving for $\boldsymbol{E}\{y|r^u=1,\boldsymbol{m}\}$ we obtain

$$\begin{aligned}
\boldsymbol{E}\{y|r^u=1,\boldsymbol{m}\} &= \boldsymbol{E}\{y|r^o=1,\boldsymbol{m}\}\cdot W_1(\boldsymbol{m})^{-1} \\
\text{(10)} \qquad &\quad -\boldsymbol{E}\{y|r^o=0,\boldsymbol{m}\}\cdot W_0(\boldsymbol{m})\cdot W_1(\boldsymbol{m})^{-1}
\end{aligned}$$

which represents a weighted average of two conditional expectations which are nonparametrically identified from the data. The weights are given by

$$\begin{aligned}
W_0(\boldsymbol{m}) &= \Pr(r^u=0|r^o=1,\boldsymbol{m}) \\
&= \alpha_{10}(\boldsymbol{m})\frac{\Pr(r^u=0|\boldsymbol{m})}{\Pr(r^o=1|\boldsymbol{m})} \\
W_1(\boldsymbol{m}) &= \Pr(r^u=1|r^o=1,\boldsymbol{m}) \\
&= \underbrace{\Pr(r^o=1|r^u=1,\boldsymbol{m})}_{=1}\frac{\Pr(r^u=1|\boldsymbol{m})}{\Pr(r^o=1|\boldsymbol{m})} \\
&= \frac{\Pr(r^u=1|\boldsymbol{m})}{\Pr(r^o=1|\boldsymbol{m})}
\end{aligned}$$

where $\alpha_{10}(\boldsymbol{m}) \equiv \Pr(r^o=1|r^u=0,\boldsymbol{m})$. The attrition probability $\Pr(r^o=1|\boldsymbol{m})$ is identified from the sample attrition in the data.

What remains to be identified is $\Pr(r^u|\boldsymbol{m})$ and $\alpha_{10}(\boldsymbol{m})$. Imposing the following single index structure $\Pr(r^u|\boldsymbol{m})=F(s\gamma+\boldsymbol{w}'\boldsymbol{\delta})$, identification of the sign of $\gamma$ and of $\boldsymbol{\delta}$ follows Assumption A2 and Lemma 1 of Lewbel (2000), while identification of $F(\cdot)$ and $\alpha_{10}(\boldsymbol{w})$ follow from assumption A2 and Lemma 2 of Lewbel (2000). Hence, $\Pr(r^u|\boldsymbol{m})$ and $\alpha_{10}(\boldsymbol{m})$ are identified and so is $\boldsymbol{E}\{y|r^u=1,\boldsymbol{m}\}$.

| | 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 | 8.28 | 242 | 33.1 | 16.8 |
| 1999 | 834 | 41.9 | 9.25 | 195 | 26.7 | 19.4 |
| Mean 1985-1999 | | | 11.6 | | | 17.2 |

Table 1: Panel attrition for West-German and Immigrant samples 1985-1999.

| | Immigrants | Germans | Description |
|---|---|---|---|
| Age | 39.78 | 38.33 | in years |
| Experience | 301.77 | 257.11 | in months |
| Education | 9.34 | 11.51 | in years |
| Health satisfaction | 7.21 | 7.26 | 0 = unsatisfied, 10 = totally satisfied |
| Wife in Germany | 0.73 | | 1 if yes, 0 otherwise |
| Integration feeling | 3.94 | | Do you feel German ? 1 = Totally, 5 = Not at all |
| German speaking fluency | 2.65 | | 1 = Excellent, 5 = Bad |
| Intended length of stay | 2.18 | | 1 = Within 1 year, 2 = After a few years, 3 = Never |
| Age at immigration | 24.03 | | in years |
| Years since immigration | 15.75 | | in years |
| Immigration year | 1969 | | as is. |
| Number of Observations | 732 | 1987 | |

Table 2: Description of the data and statistics for the first wave

| | | | |
|---|---|---|---|
| $\alpha_{10}$ (1987) | 0.151 | Constant | -0.034 |
| | (0.036) | | (0.489) |
| $\alpha_{10}$ (1989) | 0.121 | Health satisfaction | -0.084 |
| | (0.037) | | (0.028) |
| $\alpha_{10}$ (1991) | 0.060 | Wife in Germany | -0.681 |
| | (0.026) | | (0.183) |
| $\alpha_{10}$ (1993) | 0.112 | Expected length of stay | -0.589 |
| | (0.025) | | (0.119) |
| $\alpha_{10}$ (1995) | 0.072 | Integration feeling | 0.030 |
| | (0.028) | | (0.067) |
| $\alpha_{10}$ (1997) | 0.121 | Unemployment rate | 0.066 |
| | (0.037) | | (0.029) |
| $\alpha_{10}$ (1999) | 0.205 | Age at immigration / $10^2$ | 1.608 |
| | (0.032) | | (0.711) |
| | | Cumulative remittances / $10^3$ | -0.003 |
| | | | (0.014) |

Table 3: Estimation results for the attrition and outmigration processes. Asymptotic standard errors in parentheses. Wave dummies were included in the outmigration propensity but are not reported in the table.

| | Immigrants | | | | | West-Germans | | |
|---|---|---|---|---|---|---|---|---|
| Equation | Earnings | | | Work | | Earnings | | Work |
| Work | No | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Return migration | No | No | Yes | No | Yes | | - | |
| Constant | 7.121 | 7.0198 | 7.086 | -0.596 | -0.444 | 5.971 | 6.030 | -2.652 |
| | (0.066) | (0.055) | (0.052) | (0.489) | (0.529) | (0.051) | (0.038) | (0.238) |
| Education / 10 | 0.257 | 0.346 | 0.304 | 1.007 | 0.961 | 1.002 | 0.915 | 1.489 |
| | (0.045) | (0.029) | (0.028) | (0.326) | (0.352) | (0.031) | (0.016) | (0.130) |
| Experience / $10^3$ | 3.112 | 3.150 | 3.318 | 21.934 | 23.261 | 5.999 | 6.087 | 31.613 |
| | (0.201) | (0.174) | (0.174) | (1.484) | (1.598) | (0.147) | (0.157) | (0.966) |
| Experience squared / $10^4$ | -0.439 | -0.431 | -0.468 | -3.439 | -3.741 | -0.786 | -0.799 | -5.509 |
| | (0.029) | (0.028) | (0.029) | (0.217) | (0.247) | (0.024) | (0.027) | (0.158) |
| Years since immigration /10 | 0.069 | 0.073 | 0.069 | -0.438 | -0.364 | | | |
| | (0.015) | (0.012) | (0.012) | (0.091) | (0.100) | | | |
| German speaking fluency | -0.017 | -0.015 | -0.020 | -0.256 | -0.261 | | | |
| | (0.006) | (0.007) | (0.007) | (0.063) | (0.066) | | | |
| Unemployment rate | -0.005 | -0.007 | -0.009 | -0.054 | -0.079 | -0.0041 | -0.0004 | -0.068 |
| | (0.004) | (0.003) | (0.003) | (0.022) | (0.027) | (0.0029) | (0.002) | (0.015) |
| Health satisfaction | | | | 0.129 | 0.127 | | | 0.069 |
| | | | | (0.016) | (0.018) | | | (0.011) |

Table 4: Estimation results for income and work equations. Asymptotic standard errors in parentheses. Wave dummies were included for all waves in both equations but are not reported in the table.

| | **Immigrants** | | | **West-Germans** |
|---|---|---|---|---|
| Work | No | Yes | Yes | |
| Outmigration | No | No | Yes | |
| $\rho^{\varepsilon}_{1,2}$ | | -0.416 | -0.331 | -0.153 |
| | | (0.103) | (0.129) | (0.069) |
| $\rho^{\varepsilon}_{1,3}$ | | | -0.094 | |
| | | | (0.099) | |
| $\rho^{\varepsilon}_{2,3}$ | | | -0.278 | |
| | | | (0.151) | |
| $\rho^{\eta}_{1,2}$ | | 0.044 | 0.046 | 0.057 |
| | | (0.009) | (0.010) | (0.007) |
| $\rho^{\eta}_{1,3}$ | | | -0.564 | |
| | | | (0.153) | |
| $\rho^{\eta}_{2,3}$ | | | -0.499 | |
| | | | (0.181) | |
| $\sigma^2_{\eta^1}$ | 0.068 | 0.061 | 0.043 | 0.118 |
| | (0.006) | (0.003) | (0.002) | (0.003) |
| $\sigma^2_{\eta^2}$ | | 2.739 | 2.834 | 2.405 |
| | | (0.313) | (0.355) | (0.164) |
| $\sigma^2_{\eta^3}$ | | | 2.934 | |
| | | | (0.371) | |
| $\sigma^2_{w}$ | 0.033 | 0.037 | 0.035 | 0.074 |
| | (0.0005) | (0.0008) | (0.0007) | (0.0005) |
| Log-likelihood | -7137.81 | -333.54 | -699.11 | -1372.04 |

Table 5: Covariance structure of the time variant and time invariant components. Asymptotic standard errors in parentheses.

| | Immigrants | | | | Germans | | | |
|---|---|---|---|---|---|---|---|---|
| | Log earnings | | % Working | | Log earnings | | %Working | |
| | R | S | R | S | R | S | R | S |
| 1985 | 7.85 | 7.85 | 0.84 | 0.84 | 7.98 | 7.98 | 0.81 | 0.81 |
| 1987 | 7.93 | 7.94 | 0.85 | 0.86 | 8.10 | 8.09 | 0.83 | 0.83 |
| 1989 | 8.06 | 8.09 | 0.85 | 0.84 | 8.22 | 8.22 | 0.85 | 0.85 |
| 1991 | 8.16 | 8.20 | 0.82 | 0.82 | 8.31 | 8.31 | 0.86 | 0.86 |
| 1993 | 8.23 | 8.29 | 0.78 | 0.77 | 8.46 | 8.44 | 0.85 | 0.84 |
| 1995 | 8.29 | 8.38 | 0.73 | 0.71 | 8.50 | 8.49 | 0.85 | 0.84 |
| 1997 | 8.30 | 8.37 | 0.70 | 0.70 | 8.58 | 8.57 | 0.81 | 0.80 |

Table 6: Real (R) and simulated (S) log earnings of workers and work propensities for Germans and immigrants.

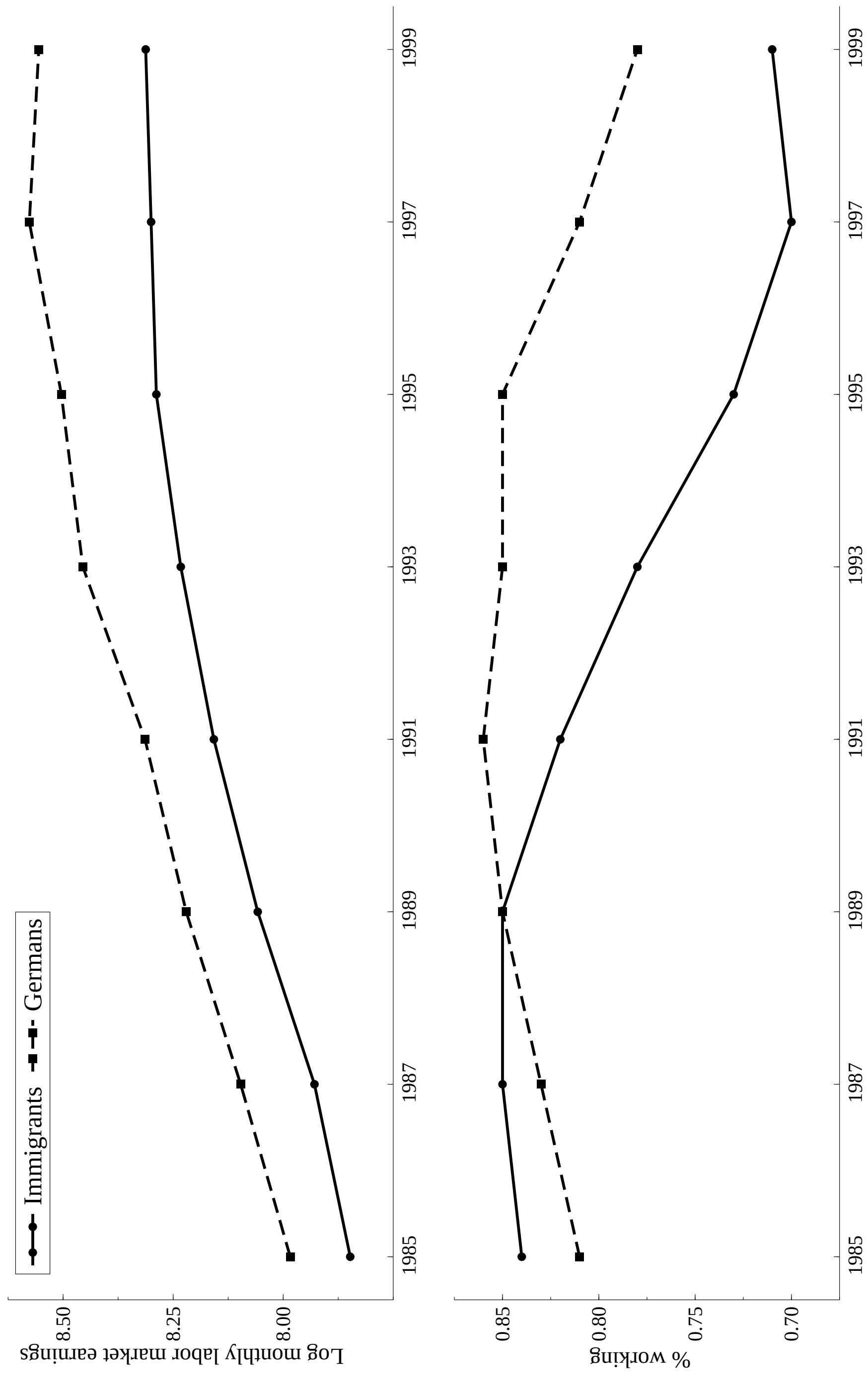


Figure 1: Log monthly earnings and work propensities - Germans and immigrants

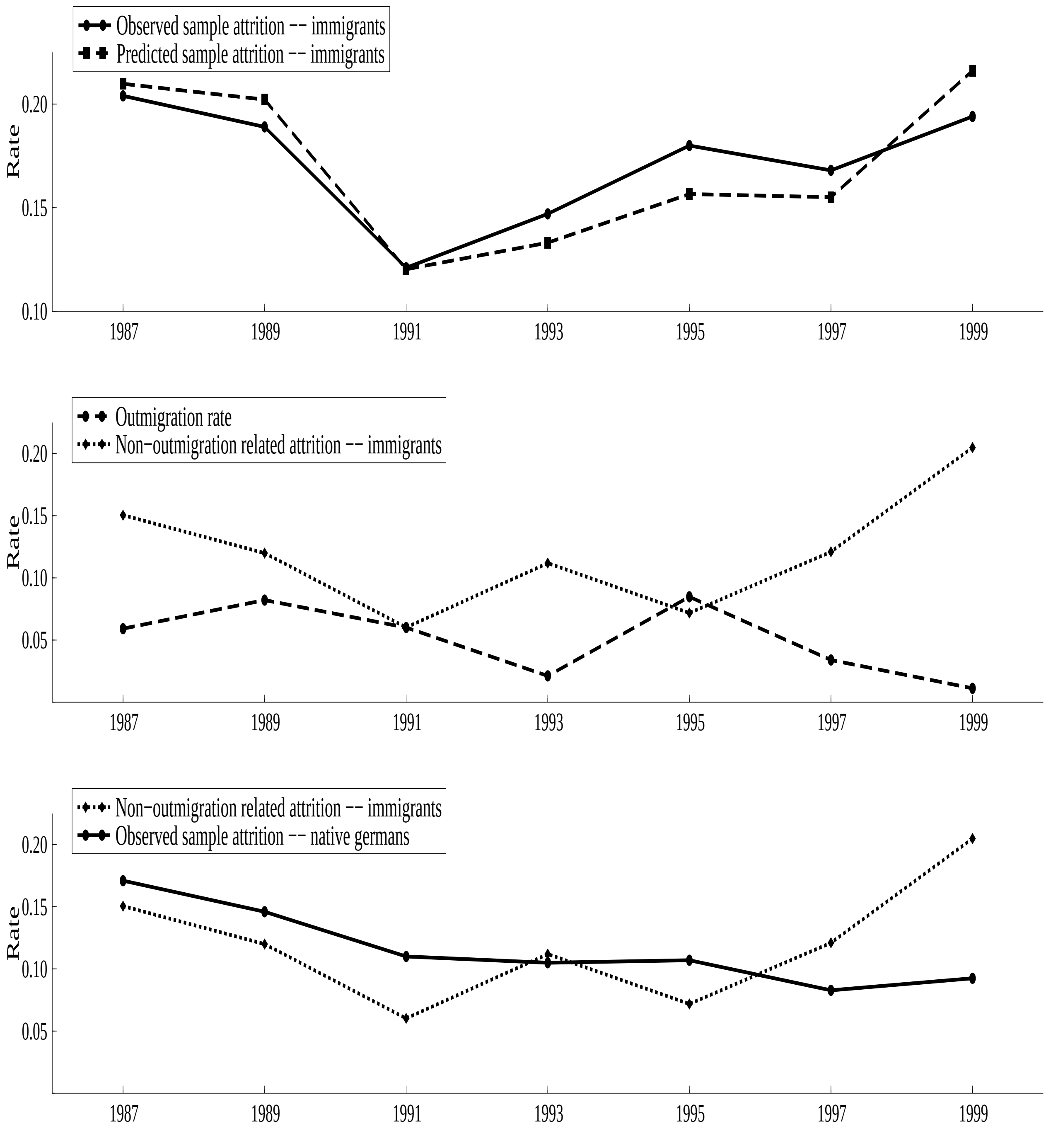


Figure 2: Top graph: true (full-circles) and predicted (dashed-squares) sample attrition rates for the immigrant sample. Middle graph: Predicted outmigration (dashed-circles) and non-outmigration related (dotted-diamonds) attrition rates. Bottom graph: Predicted non-outmigration related attrition rate for immigrants (dotted-diamonds) and observed sample attrition rate for native Germans (full-circles).

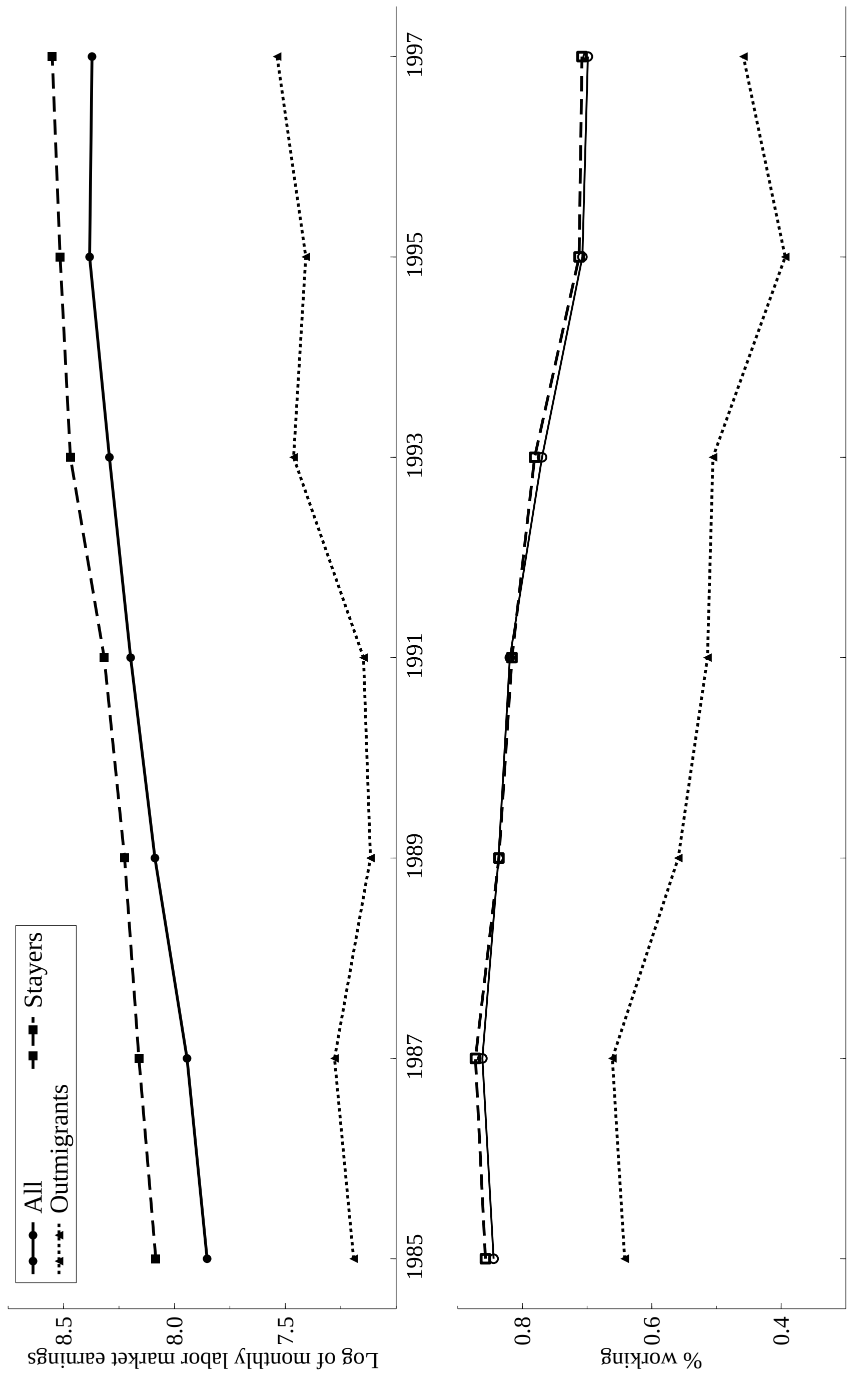


Figure 3: Top panel: simulated log earnings for immigrants over the 1985-1997 period. All, Stayers and Outmigrants refer to simulations averaged respectively over all immigrants, predicted stayers only and predicted out-migrants only. Simulations in each period are obtained by taking for each $i$ 1000 draws from the distribution of $\varepsilon_{it}^1, \varepsilon_{it}^2, \varepsilon_{it}^3$ and $\eta_i^1, \eta_i^2, \eta_i^3$ and averaging over all draws the predicted earnings of those predicted to work. Bottom panel: Simulated proportion of immigrants working in the 1985-1997 period. Simulations are performed as in the top panel.

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