Günter Lang

Empirical evidence of the assimilation hypothesis for Eastern European immigrants

International Journal of Management and Economics 11, 118-135

2001

Günter Lang
University of Augeburg

EMPIRICAL EVIDENCE OF THE ASSIMILATION HYPOTHESIS FOR EASTERN EUROPEAN IMMIGRANTS

Introduction

Free movement of goods, services, capital and labor are the core elements of the European Union. When discussing about the Eastern enlargement of the European Union, the last-mentioned of these four dimensions of freedom is of special interest: All civilians of the new member countries will be able to move easily across the borders. Driven by wage differentials and more generous social security systems, many observers are concerned that a great number of Eastern Europeans will migrate towards Western Europe. *Baldwin (1994)* is assuming that, roughly, between 5% and 10%, of the population in the new member countries could leave their homeland. Estimations from a more sophisticated study confirm this result: As *Franzmeyer and Brücker (1997)* show, every 10% wage difference motivates 0.08% of the workforce to move. Aggregating these figures over ten years and assuming current income levels, we can infer that 5% of the Eastern European population would leave their home countries. In a recent paper, *Sinn et al. (2001)* estimate that at least 4% of the current population could migrate to the destination country Germany. Following their results, between 150 000 and 200 000 persons per year can be expected from Poland alone.

For Germany, this would be the third wave of immigrants from Eastern Europe. The first wave was a result of the second world war: Germans mainly from Poland and the Czech Republic were forced to move westwards. The second wave was a consequence of better relationships between East and West, followed by the transformation process in Eastern Europe. As a result, more than 2 million persons from Eastern Europe (mainly Russia, Poland and Romania) arrived in Germany between 1980 and 1995, when that flow slowly started to cease. Because of their ethnic extraction and in contrast to guest workers or refugees, these people have legitimate claim for permanent residence in Germany. Most of these East European immigrants moved to the western part of Germany, where additional 1.5 million East Germans arrived.

Because of the essential meaning of labor markets for the macroeconomic stability of any country, the theoretical and empirical analysis of this field has a long

tradition. Labor contributes two thirds to the gross domestic product of highly developed countries, and even small changes have significant impacts on inflation, growth, fiscal policy, savings and capital markets in general. Large-scale immigration, as observed in Germany during the last two decades, can surely be considered as a significant change in labor market characteristics.

The focus of this paper is one of the most important and most traditional topics of migration research: The labor market performance of immigrants. Specifically, earnings of Eastern European immigrants in Germany – mainly from the second wave – are explained by a number of factors. The results may give useful hints whether a resurgence of immigration from Eastern Europe, motivated by an enlargement of the EU, has positive or negative economic impacts on the destination countries. As a critical assumption, one has to assume that future migrants have similar abilities to adopt to Western labor market conditions as their predecessors.

Basic theory, which is tested for East European immigrants, is the assimilation hypothesis proposed by *Chiswick (1978)*. Following *Chiswick*, foreign borns have lower wages than *comparable* natives immediately after immigration, but catch up in subsequent periods. From a political point of view the importance of this question is evident: If the assimilation hypothesis is true and immigrant workers are not totally replacing natives in the labor market, their high productivity dynamic should substantially contribute to enhanced growth in the host country. Durable low wages are more difficult to interpret, however: On the one side, low earnings could be the result of discrimination against inhabitants, which raises important distributional questions, but does not have a negative impact on macroeconomic growth. On the other hand, this outcome could indicate a permanent productivity gap relative to natives, implying a long-term burden for the public welfare system and the fiscal situation.

Existing empirical work on the assimilation issue has concentrated on the US (for an overview see *Borjas, 1994, Chiswick, 1994*). For Germany, there exist some work for guest workers (e.g. *Licht and Steiner, 1994, Dustmannn, 1993, 1996, Pischke, 1993*), whereas the large immigrant flows from Eastern Europe are hardly analyzed (for some recent contributions see *Bauer and Zimmermann, 1995, Schulz and Seiring, 1994*). The reason for this deficit are insufficiencies in the database, which could be overcome with the latest supplement of the Socio-Economic Panel (see *Schupp and Wagner, 1995,* for a description).

To enhance the quality of the earnings estimates, not a classical "average" function, but a frontier technique is used. The estimation of frontier income functions is based on models which were originally introduced for production technologies (*Farell, 1957*). In that framework, firms are allowed to produce inefficiently. This means that with a given set of inputs not the maximum possible output is produced, but a lower quantity – with varying degrees of inefficiencies between firms

(*Fried et al., 1993*, give a survey about estimation methods). Imperfect markets allow for the permanent existence of such deviations from the frontier function. Transferred to the labor market, individual-specific information deficiencies, immobility or discrimination could prevent workers from realizing maximum possible earnings. Analogous to a production frontier, the earnings frontier gives the highest potential income associated with varying amounts of human capital inputs.

The estimation of production or cost frontiers has become increasingly popular during the last years, especially for the analysis of financial institutions (for a survey see *Berger and Humphrey, 1997*). Within the field of labor economics, this approach has been used in some US studies (*Herzog et al., 1985, Hofler and Polachek, 1985, Robinson and Wunnava, 1989, Hunt-McCool and Warren, 1993*). For the immigration problem there exists a study of *Daneshvary et al. (1992)*, who define assimilation as a decrease in the difference between actual and potential earnings and test this hypothesis for the US immigration market. The most important conceptual difference between this study and that of *Daneshvary* can be found in the definition of assimilation: the latter defines assimilation as the decrease in the difference between actual and potential earnings with time of residence in the receiving country. In this paper separate earnings functions for residents as well as for immigrants are estimated. This allows for differences in the parameters of the potential earnings functions as well as for gaps between actual and frontier earnings.

The following section contains the stochastic specification of the employed earnings frontiers and the estimation methods. In section III the dataset is described. Furthermore, separate frontier earnings estimates for East European immigrants and inhabitants are presented. From these estimates, conclusions on the assimilation hypothesis can be drawn. Section IV analyzes deviations from the frontier in more detail, especially by comparing income efficiency from inhabitants and foreigners. The relationship between individual degrees of earnings efficiency and some hypothetical sources like marital status or firm size are also presented. Finally, section V sums up.

Specification

Basic assumption is the existence of a semilogarithmic human capital production function of the extended *Mincer (1974)*-type

$$\ln E_i = \alpha + \beta' X_i + \varepsilon_i \; i = 1,\ldots,n \; , (1)$$

where E_i denotes earnings of individual i, X is a vector of socio-economic characteristics, a and b are fixed but unknown parameter (vectors), and e is the error term. Equation (1) assumes that wages are determined by the endowment with human capital X, which is proxied by a number of factors: Age, schooling,

training, work experience and times of unemployment. The better the endowment with human capital, the higher the productivity and therefore the market wage.

The earnings equation (1) is estimated separately for immigrants and for native workers. To test the assimilation hypothesis proposed by *Chiswick (1978)*, earnings of immigrants are allowed to be additionally influenced by the term "years since migration" (*ysm*). The assimilation theory is supported if immigrants earn less than *comparable* natives immediately after migration, but are able to narrow this gap during the following years. Translated to the econometric framework, the coefficient of the "years since migration"-variable has to be significant positive. Economically, such an earnings pattern is the result of migration-induced reductions in the worth of human capital, which is not fully transferable between different countries. After the migration process, country specific human capital will be continuously accumulated due to factors like training on the job or increasing language skills. After a certain time and because of a (hopefully) high motivation, immigrants may even overtake earnings levels of inhabitants. Therefore one has to compare the wage function of inhabitants with that of comparable immigrants at different levels of "years since migration".

This paper focuses on the specification of the error term *e*. The idea is to estimate for inhabitants as well as for foreigners, a "frontier earnings function", which gives the maximum earnings one can receive with his socio-economic characteristics. For this purpose, frontier estimation techniques, which can be divided into Data Envelopment Analysis (DEA) and econometric approaches, are used. Because of the parametric structure of the earnings function (1), the econometric frontier approach is appropriate for the estimation process. Econometric techniques can again be subdivided into deterministic and stochastic procedures, the latter being used in this study because of its higher flexibility and the diminished outliers problem (for an overview see *Greene, 1993*).

The main characteristics of the stochastic frontier approach is the error term which consists from two parts: $\varepsilon_i = v_i - u_i$. The standard random variable u_i is represented by $u_i \sim N(0, \sigma_v^2)$, whereas u_i reflects labor market inefficiency of individual *i*. This second part u_i is restricted to be non-negative, because otherwise one would be allowed to earn systematically higher wages than defined by the upper boundary. Characterized within the econometric framework, the deterministic part of the earnings function $\alpha + \beta' X_i$ defines an envelope associated with specific amounts of human capital. Since individuals can earn less because of information deficiencies, immobility and so on ($u_i > 0$), the composite error term e_i has a nonzero mean which reflects the systematic deviation of actual wage from the hypothetical norm.

To estimate parameters of the underlying function, the stochastic distribution of the inefficiency term u_i has to be specified. Two of the most popular assumptions are the half normal distribution and the exponential distribution of u_i, introduced by *Aigner et al. (1977)*.[1] To test the stability of results, both alternatives are used in this paper. The log-likelihood function for the half-normal distribution is

$$\ln L(\alpha,\beta,\sigma^2,\lambda)=-\sum_{i=1}^{N}\left[\ln\sigma+\frac{1}{2}\ln\frac{\pi}{2}+\frac{1}{2}\frac{\varepsilon_i^2}{\sigma^2}-\ln\Phi\left(\frac{-\varepsilon_i\sqrt{\lambda}}{\sigma}\right)\right], \quad (2)$$

where $\Phi(\cdot)$ is the standard normal distribution function, $\sigma^2=\sigma_u^2+\sigma_v^2$, $\lambda=\sigma_u^2/\sigma_v^2$, and $\varepsilon_i=\ln E_i-\alpha-\beta' X_i$.

For an exponentially distributed inefficiency term, the log-likelihood is defined as

$$\ln L(\alpha,\beta,\sigma_v^2,\theta)=\sum_{i=1}^{N}\left[\ln\theta+\frac{1}{2}\theta^2\sigma_v^2+\theta\varepsilon_i+\ln\Phi\left(\frac{-\varepsilon_i}{\sigma_v}-\theta\sigma_v\right)\right], \quad (3)$$

with θ characterizing the underlying density function of u, i.e. $d(u)=\theta\exp[-\theta u], u\geq 0$

The likelihood functions (2) and (3) are estimated separately for foreigners and inhabitants, allowing different parameters and inefficiency distributions.

Estimation of (2) and (3) produces the compounded residual e_i which consists from pure randomness (u_i) and inefficiency (u_i). The inefficiency component u_i can't be directly observed. *Jondrow et al. (1982)* provide a solution to this problem, deriving an explicit formula for the half-normal cas

$$E(u_i|\varepsilon_i)=\left(\frac{\phi[\varepsilon_i\sqrt{\lambda}/\sigma]}{\Phi[-\varepsilon_i\sqrt{\lambda}/\sigma]}-\frac{\varepsilon_i\sqrt{\lambda}}{\sigma}\right)\sqrt{\frac{\sigma_u^2\sigma_v^2}{\sigma_u^2+\sigma_v^2}}, \quad (4)$$

with $\phi(\cdot)$ representing the density of the standard normal distribution, and $\Phi(\cdot)$ is the standard normal distribution function. All information (σ_u, σ_v, σ, λ, ε_i) necessary for the estimation of $E(u_i)$ is available from the likelihood-function (2).

Similarly, for the exponential case, u_i can be evaluated as

$$E(u_i|\varepsilon_i)=(-\varepsilon_i-\sigma_v^2\theta)+\left(\frac{\sigma_v\phi[(\varepsilon_i+\theta\sigma_v^2)/\sigma_v]}{\Phi[(-\varepsilon_i-\theta\sigma_v^2)/\sigma_v]}\right). \quad (5)$$

From (4) and (5), the level of income inefficiency u_i can be determined for each individual. However, more interesting than the absolute value of u_i is the efficiency ratio EFF_i which gives the percentage of maximum income actually realized by

worker *i*. Because of the semilogarithmic form of the earnings equation (1), EFF_i can be derived as

$$EFF_i = \frac{\exp(\alpha + \beta' X_i - u_i)}{\exp(\alpha + \beta' X_i)} = \exp(-u_i). \qquad (6)$$

EFF_i is restricted to the interval]0,1], with the upper boundary representing a worker who transforms his human capital endowment perfectly into market income. A value of less than one – e.g. 0.90 – indicates that the underlying employee actually earns 90% of this potential income.

The knowledge of individual EFF_i-values raises the question for the sources which drive the heterogeneity in earnings efficiency. Therefore in a second step we estimate a simple regression, explaining EFF_i by some individual and market specific factors:[2]

$$EFF_i = \delta_0 + \delta_1 * MARRIAGE + \delta_2 * CHILD + \delta_3 * SMALL + \delta_4 * MEDIUM + \varepsilon_i^1 \qquad (7)$$

MARRIAGE gives the marital status, CHILD the number of children living in the household of individual i. Being married and educating children are assumed to reduce regional mobility, which in turn reduces job opportunities and increases the willingness to accept wages below the frontier income. The influence of these variables is therefore expected to be negative. Dummy variables SMALL and MEDIUM take the value one if the firm, where worker i is employed, has respectively less than 20, and between 20 and 2000 employees. Large firms with more than 2000 employees are the reference scenario. If unions are more influential in large firms, δ_3 and δ_4 should have a negative sign. ε_i^1 represents a regular error term. Again, (7) was estimated separately for inhabitants and immigrants.

Earnings Estimates and Assimilation

This paper strongly profited from the latest supplement to the German "socio-economic panel" (GSOEP), where a random sample of immigrants was interviewed. The bulk of this immigration sample consists from East Europeans and East Germans (only if they moved before re-unification). Most of them migrated to Western Germany since 1984. As in contrast to guest workers, these persons can be considered as permanent immigrants without a return motivation. There are at least three arguments for this assumption:

- Economic, social and political conditions in many East European countries are not attractive for the German minority. This is especially true for Russia, which is the most important source of East European immigrants.

• For East Germans, a return motive may appear if economic conditions catch up with West Germany. The assimilation process should not be influenced, however, because East- or West- specific labor market conditions will disappear by this time in the unified Germany.

• The majority of the East European immigrants from the second wave are ethnic Germans. This ensures the right for a German passport and permanent stay without any further residence permit.

To test the assimilation hypothesis, the immigrant sample was compared to a sample of West-German natives. To reduce distortions from self-selection, extreme outliers or measurement errors, the research population was confined to a subsample of full-time employed males between 18 and 65 years of age. Furthermore, all self-employed or persons with missing information were excluded. In Table 1 variables and their content are described, clearly showing a considerable higher income of inhabitants in comparison to immigrants.

Table 1. Description of the dataset

Variable	Definition	Inhabitants			Immigrants		
		Mean	Minimum	Maximum	Mean	Minimum	Maximum
EARNINGS	gross DM-income from wages/salaries divided by hours of work	28.9	4.2	92.9	20.9	6.3	55.6
AGE	age of person in years	41.5	18	62	39.4	23	63
SCHOOL	years of schooling	10.7	9	13	9.9	5	13
TRAINING	equals 1 if employee received occupational training or — university degree; 0 otherwise	0.94	0	1	0.85	0	1
EXPERIENCE	actual full-time work experience in years (without time of apprenticeships)	20.0	0	47	16.7	0	45
JOBLESS	time of unemployment in years	0.56	0	17	0.59	0	6
IMMIGRATION	years since immigration to West-Germany	-	-	-	4.85	2	10
MARRIED	equals 1 if married; 0 otherwise	0.82	0	1	0.93	0	1
CHILD	number of children living in household	0.80	0	5	0.45	0	3
SMALL	equals 1 if firm has less than 20 employees, 0 otherwise	0.16	0	1	0.27	0	1
MEDIUM	equals 1 if firm has more than 20 and less than 2000 employees, 0 otherwise	0.47	0	1	0.58	0	1
	Number of observations	1099			182		

Notice: Male full-time employees only; all data for 1994.
Source: German SOEP; own calculations.

To analyze this earnings structure in more detail, income functions are separately estimated for two research populations (likelihood functions (2) and (3)). The wage function (1) is specified as

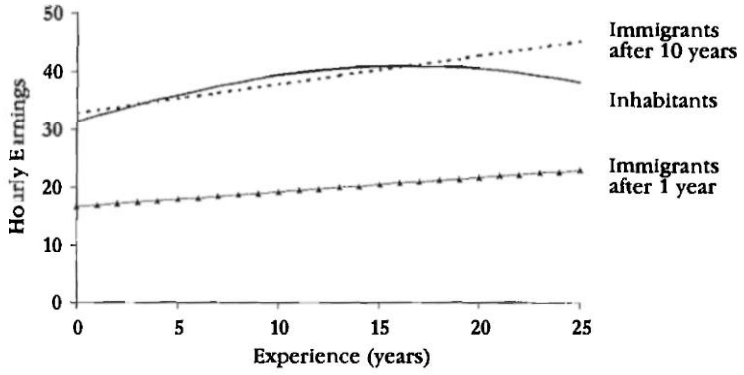
$$\begin{aligned} \ln E_i = {} & \alpha + \beta_1 * AGE + \beta_2 * SCHOOL + \beta_3 * TRAINING \\ & + \beta_4 * EXPERIENCE + \beta_5 * EXPERIENCE^2 + \beta_6 * JOBLESS \\ & + \beta_7 * IMMIGRATION + \varepsilon_i \end{aligned} \qquad (8)$$

with $\beta_7 = 0$ for inhabitants.[3] This functional form allows for concavity in the experience variable. No regressors like firm size, marital status and the like were added, because these factors aren't considered as components of the human capital stock. However, as equation (7) shows, these variables are assumed to determine the wedge between potential and actual earnings.

The results of the Maximum-Likelihood estimation and – for comparison – of the standard OLS-method are presented in Table A-1 in the Appendix. The iteration process turned out to be stable and converging. Most of the estimated parameters are statistically significant; exceptions are the training-variable for natives and the squared experience term as well as the jobless parameter for immigrants. Likelihood-ratio tests clearly reject the hypothesis that only random error exists (l = 0 for the half-normal assumption; q = 0 for the exponential case). The advantage of the frontier approach is evident since the stochastic frontier approach reduces the residual variance σ_v^2 by about 50% for immigrants and 60–70% for natives, respectively.

As the results indicate, the differences between the half-normal and the exponential distribution are small and confirm the robustness of the stochastic frontier. However, the picture changes somewhat if we turn to a comparison of the OLS-models and the earnings frontiers. Although all parameters take the same sign for both estimation methods (within the group of natives and immigrants, respectively), remarkable differences between parameter values appear. One additional year of schooling, for example, increases immigrant wages by 1.7% in the OLS case, but by more than 2.8% with the half-normal frontier estimation. Similarly, return on training decreases from 25% (OLS) to 16% with an exponential distributed inefficiency term.

Figure 1. Frontier Earnings Functions for Inhabitants and Foreigners



Notice: Simulation based on human capital stock of a representative inhabitant (41.5 years old, 10.7 years of schooling, 0.94 received training, 0.55 years of unemployment).

Because of the focus of this paper on assimilation, differences between inhabitants and immigrants are of greater interest. As the parameter estimates show, returns on schooling are higher for inhabitants (6.7% versus 2.8%), whereas training has a more sizeable impact on the wage frontier of migrants (less than 6% versus more than 16%). The *AGE* variable changes its sign from significantly positive for West-Germans to significantly negative for East Europeans. Within the human-capital context, the negative sign is more in line with expectations, because older people are more likely to be ill and have less physical strength. The wage-increasing effect of getting older – accumulating job experience – is explicitly considered by the experience variable. Finally, the wage of natives depends more heavily on individual skills than for immigrants. This can be seen from the constant term, which takes a lower value for natives in spite of their higher income.

What is most important, however, the results strongly support the assimilation hypothesis in the sense of *Chiswick (1978)*. This implication can be illustrated by Figure 1, where frontier earnings of a representative native employee is plotted against frontier earnings of immigrants. Equipped with an identical human capital stock as the native colleague, immediately after arrival an immigrant has a potential income of about 60% relative to the inhabitant. The earnings profile turns out to be much steeper in the subsequent years, however: Ten years after arrival, differences between natives and former East Europeans disappear. Former East Europeans perfectly assimilate within a relatively short time period, at least in terms of income. Whether immigrants would even overtake nationals after this period is unclear, because the sample covers only individuals who crossed the border after 1984. An extrapolation beyond this time horizon would therefore be speculative.

Earnings Efficiency

Given the parameter estimates in Table A-1, the underlying distribution of earnings inefficiency can be determined. For example, the density function of u in the half-normal case[4] can be expressed as

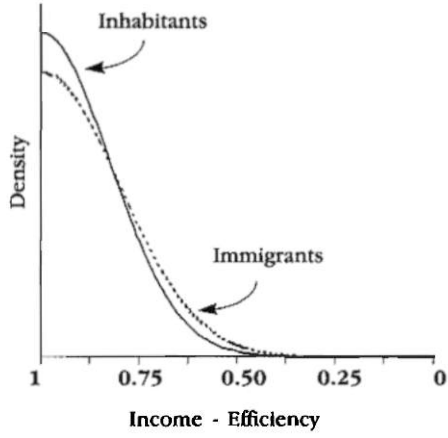
$$d(u) = \begin{cases} \frac{\sqrt{2}}{\sqrt{\pi}\sigma_u} \exp\left[-0.5\left(\frac{u}{\sigma_u}\right)^2\right] & \text{if } u \geq 0 \\ 0 & \text{otherwise} \end{cases} \qquad (9)$$

As can be seen from Figure 2, where the half-normal case is illustrated, the estimated differences between natives and foreigners are small[5]. Given the distribution in (9), the mean value of u is $\sigma_u(2/\pi)^{0.5}$, which produces 0.280 for inhabitants and 0.319 for immigrants. Transformed to efficiency values EFF_i, the results are 75.6% versus 72.7%. This implies that immigrants are somewhat less efficient in transforming human capital to market income, but the discrepancy turns out to be of interest.

Aside from these mean figures, individual estimates of e_i and u_i can also be determined for all natives and immigrants (equations (4) respectively (5)). Table A-2 in the appendix provides the distribution of the expected efficiency values, confirming the above mentioned results. A slightly more heterogeneous appearance of immigrants notwithstanding, the distances between estimated and potential income are very similar for both groups. Average $XEFF$ values are close to the forecast from the distribution function (9). The ranking coefficient between the exponential and the half-normal model is at 0.99, supporting the reliability of the results. Actually, the major difference is the trivial more pessimistic assessment of the half-normal model.

In a second step, the relationship between wage inefficiency and its potential sources is estimated (equation (7)). Table 2 shows the regression results for both groups and the half-normal as well as the exponential distribution. As can be seen, being employed at small firms with less than 20 employees significantly increases the wedge between potential and realized earnings. In that case, the EFF_i value is estimated to decrease by about 8% (natives) respectively 9%-11% (immigrants). This general picture is in line with other studies[6] and may be due to a smaller influence of unions, for example. Interestingly, the wedge between medium sized (20-2000 employees) and large firms (>2000 employees) is only 2% and significant only for the native group.

Figure 2. Estimated Distribution of Income Efficiency for Half-Normal Assumption



Notice: Income efficiency calculated as $\exp(-u)$.

Some questions with regard to the marital status and the number of children remain open: being married should have a negative effect on mobility and therefore reduce income efficiency, but this expectation doesn't find empirical support. Actually, native married males can even reduce their distance to the frontier by about 3%-5%. The parameter for immigrants is insignificant, but positive, also. The presence of children in one's household also should decrease mobility and drive a wedge between potential and realized income, but this assumption is empirically supported only by the immigrant population.

Table 2. Explanation of Earnings Efficiency

	Inhabitants		Immigrants	
	Half-Normal	Exponential	Half-Normal	Exponential
CONST	0.759	0.803	0.768	0.838
	(88.52)	(94.51)	(18.42)	(22.34)
MARRIED	0.032	0.049	0.044	0.032
	(3.78)	(5.91)	(1.22)	(0.99)
CHILD	0.005	0.004	-0.051	-0.046
	(1.68)	(1.20)	(-4.29)	(-4.26)
SMALL	-0.077	-0.076	-0.105	-0.092
	(-8.20)	(-8.20)	(-3.50)	(-3.39)
MEDIUM	-0.019	-0.016	-0.022	-0.019
	(-2.82)	(-2.34)	(-0.82)	(-0.80)
R^2	0.089	0.112	0.175	0.168

Notice: Dependent variable is EFF_i. t-ratios in parentheses.

Finally, note that equation (7) can explain only a small part of the earnings efficiency differences. The R_c-value takes values of about 10% for West-Germans, 15% for East Germans, respectively, which leaves a room for further speculation about the reasons for diverging levels of income efficiency.

Conclusions

This paper follows recent research in the economic literature, assessing the labor market performance of Eastern European immigrants in Germany. On the basis of a stochastic earnings frontier, income profiles of these migrants are compared to those of inhabitants. The estimation of earnings frontiers quantifies the maximal income which can be earned given an exogenous level of human capital. Furthermore, individual differences between potential and actual wages are estimated, and in a second step related to some hypothetical factors of influence.

One of the most important results of this study is the empirical support for the assimilation process. The observed immigrants show a significantly steeper earnings profile than natives. Starting with considerably lower wages immediately after arrival, only ten years later immigrants adjust to natives. Notice, however, that there are substantial differences in the parameters of the potential earnings function: For example, return on schooling is greater for inhabitants, whereas apprenticeships or university degrees turned out to be more positive for migrants.

The observed evidence in favor of the assimilation hypothesis is in sharp contrast to the group of guest workers (Turks, Yugoslavs, Italians, ...). For these persons, who typically live in Germany for 25 or more years, no assimilation process could be observed (*Licht and Steiner, 1994, Pischke, 1993*).

With regard to the wedge between potential and actual income, the stochastic frontier estimations are in line with other studies analyzing labor markets (see e.g. *Daneshvary et al., 1992, Hunt-McCool, 1993*). On average, about 75%–80% of the potential income can be realized as market earnings. The difference between natives and East Europeans amounts to 2%, which seems insignificant. This last result is even more surprising than the rapid assimilation process, because newly arrived job searchers should have less information about the host countries labor market than natives.

As for the explaining factors of this wedge between potential and actual wage, to be employed at a small firm is clearly negative for workers. The market power of small firms seems sufficient to pay their employees below the value of their human capital endowment and therefore below their productivity. Somewhat surprising is the efficiency-increasing impact of the marital status, where married employees are found to be closer to their earnings frontier than non-married. The opposite sign was expected because of a reduced mobility. Children living in one's household lowers income efficiency only for immigrants. In general, only a small part of earnings inefficiency can be explained, leaving room for further analysis.

Summing up, the historically good labor market performance of immigrants from Eastern Europe is a positive sign for the future. Opening the borders in result of EU enlargement could substantially contribute to higher macroeconomic growth rates and help stabilizing the welfare system. Further support for this positive conclusion can be found in trade theory: Because of the comparative advantage in industries demanding high-skilled workers, the Western labor market will tend to pull in workers with a high endowment in human capital. Simultaneously, capital for labor-intense firms will be flowing to the East (*Straubhaar, 1998*, 156 f.). This mechanism can fasten up the enlargement process of the EU: The willingness to support full membership of Eastern European countries is surely larger, if instead of a great number of low skilled workers relatively few white-collar specialists will cross the borders.

Notes

[1] As an alternative, the more flexible Gamma-distribution proposed by *Greene (1990)* could be considered, but increased complexity of the estimation procedure has prevented its wide-spread use.

[2] Alternatively one could specify a model, where the level of inefficiency and some potential determinants of this inefficiency are entering the estimation process jointly *(Reifschneider and Stevenson, 1991)*.

[3] To control for differences between East Germans and Eastern Europeans, additional estimations were run including a Dummy for East Germans. Neither for the earnings function (8) nor for the efficiency equation (7) any significant influence could be found. Furthermore, the parameter values turned out to be very stable against this modification.

[4] For the exponential assumption, the distribution is $\theta \exp[-\theta u]$, $u > 0$.

[5] A very similar picture can be drawn for the exponential case.

[6] For example, *Althammer and Wenzler (1996)* and *Bauer and Zimmermann (1995)* also show a positive influence of firm size on earnings. Notice, however, that both studies use firm size as explaining variable within the earnings equation context, whereas in this paper firm size is explaining the difference between potential and realized earnings. Only direct human capital measures are entering the earnings equation (8).

References

Aigner, D., Lovell, C., Schmidt, P. (1977), Formulation and Estimation of Stochastic Frontier Production Models, Journal of Econometrics 6, pp. 21–37.

Althammer, J., Wenzler, S. (1996), Intrafamiliale Zeitallokation, Haushaltsproduktion und Frauenerwerbstätigkeit. Ein mikroökonometrisches Modell zur empirischen Bestimmung des wirtschaftlichen Werts der Hausarbeit, in: Jahrbücher für Nationalökonomie und Statistik 215, pp. 398–418.

Baldwin, R. (1994), Towards an Integrated Europe. London: CEPR.

Bauer, T., Zimmermann, K.F. (1995), Arbeitslosigkeit und Löhne von Aus- und Übersiedlern, in: *Steiner, V., Bellmann, L. (eds.),* Mikroökonomik des Arbeitsmarktes, Beiträge zur Arbeitsmarkt- und Berufsforschung 192, Nürnberg.

Berger, A.N., Humphrey, D.B. (1997), Efficiency of Financial Institutions: International Survey and Directions for Future Research, European Journal Operational Research, forthcoming.

Borjas, G.J. (1985), Assimilation, Changes in Cohort Quality, and the Earnings of Immigrants, Journal of Labor Economics 4, pp. 463–489.

Borjas, G.J. (1994), The Economics of Immigration, Journal of Economic Literature 32, pp. 1667–1717.

Chiswick, B.R. (1978), Americanization and the Earnings of foreign-born Men, Journal of Political Economy 86, pp. 897–921.

Chiswick, B.R. (1994), The Performance of Immigrants in the United States Labor Market, in: *Giersch, H. (ed.),* Economic Aspects of International Migration, pp. 95–114, Berlin: Springer.

Daneshvary, N., Herzog, H.W. jr., Hofler, R.A., Schlottmann, A.M. (1992), Job Search and Immigrant Assimilation: An Earnings Frontier Approach, Review of Economics and Statistics 74, pp. 482–492.

Dustmann,C. (1993), Earnings Adjustment of Temporary Migrants, Journal of Population Economics 7, pp. 153–168.

Dustmann, C. (1996), The Social Assimilation of Immigrants, Journal of Population Economics 9, pp. 37–54.

Farrell, M.J. (1957), The Measurement of Productive Efficiency, Journal of the Royal Statistical Society, A120, pp. 253–281.

Franzmeyer, F., Brücker, H. (1997), Europäische Union: Osterweiterung und Arbeitskräftemigration, Wochenbericht des DIW 64 (Nr. 5), S. 89–96.

Fried, H.O., Lovell, C.A.K., Schmidt, S.S. (1993), The Measurement of Productive Efficiency: Techniques and Applications, Oxford: Oxford University Press.

Greene, W.H. (1990), A Gamma-Distributed Stochastic Frontier Model, Journal of Econometrics 46, pp. 141–163.

Greene, W.H. (1993), The Econometric Approach to Efficiency Analysis, in: *Fried, H.O. et al. (eds.),* The Measurement of Productive Efficiency: Techniques and Applications, pp. 68–119, Oxford: Oxford University Press.

Herzog, H.W. jr., Hofler, R.A., Schlottmann, A.M. (1985), Life on the Frontier: Migrant Information, Earnings and Past Mobility, Review of Economics and Statistics 67, pp. 373–382.

Hofler, R.A., Polachek, S. (1985), A New Approach for Measuring Wage Ignorance in the Labor Market, Journal of Economics and Business 37, pp. 267–276.

Hunt-McCool, J.C., Warren, R.S. jr. (1993), Earnings Frontiers and Labor Market Efficiency, in: *Fried, H.O. (ed.),* The Measurement of Productive Efficiency: Techniques and Applications, Oxford: Oxford University Press, pp. 197–209.

Jondrow, J., Lovell, C.A.K., Materov, I.S., Schmidt, P. (1982), On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model, Journal of Econometrics 19, pp. 233–238.

Licht, G., Steiner, V. (1994), Assimilation, Labour Market Experience, and Earnings Profiles of Temporary and Permanent Immigration Workers in Germany, International Review of Applied Economics 8, pp. 130–156.

Mincer, J. (1974), Schooling, Experience and Earnings, New York: Columbia University Press.

Pischke, J.-S. (1993), Assimilation and the Earnings of Guestworkers in Germany, mimeo Massachusetts Institute of Technology.

Reifschneider, D., Stevenson, R. (1991), Systematic Departures from the Frontier: A Framework for Analysis of Farm Inefficiency, International Economic Review 32, pp. 715–723.

Robinson, M.D., Wunnava, P.V. (1989), Measuring Direct Discrimination in Labor Markets Using a Frontier Approach: Evidence from CPS Female Earnings Data, Southern Economic Journal 56, pp. 212–218.

Schulz,, E., Seiring, K. (1994), Integration deutscher Zuwanderer in den westdeutschen Arbeitsmarkt, DIW Wochenbericht 35, pp. 609–617.

Schupp, J., Wagner, G. (1995), Die Zuwanderer-Stichprobe des Sozio-ökonomischen Panels (SOEP), DIW Vierteljahreshefte zur Wirtschaftsforschung 64, pp. 16–25.

Sinn, H.-W., Flaig, G., Werding, M., et al. (2001), EU-Erweiterung und Arbeitskräftemigration, München: ifo Beiträge zur Wirtschaftsforschung 2.

Straubhaar, T. (1998), Osterweiterung der Europäischen Union und Migration aus Ost- nach Westeuropa, Schriften des Vereins für Socialpolitik 255, pp. 145–161.

Appendix

Table A-1. Estimation Results

	Inhabitants			Immigrants		
	OLS	ML – Half Normal	ML – Exponential	OLS	ML – Half Normal	ML – Exponential
CONST	1.379	1.708	1.697	2.453	2.734	2.680
	(16.52)	(20.74)	(21.56)	(12.08)	(15.28)	(15.35)
AGE	0.025	0.025	0.024	-0.010	-0.011	-0.011
	(8.82)	(8.48)	(8.17)	(-1.85)	(-2.16)	(-2.18)
SCHOOL	0.062	0.065	0.065	0.017	0.028	0.025
	(9.21)	(9.71)	(10.15)	(1.17)	(2.12)	(1.97)
TRAINING	0.050	0.048	0.055	0.225	0.174	0.155
	(1.28)	(1.29)	(1.53)	(3.52)	(3.18)	(2.74)
EXPERIENCE	0.039	0.032	0.028	0.016	0.015	0.016
	(9.31)	(7.49)	(6.58)	(2.07)	(2.18)	(2.40)
$EXPERIENCE^2 * 10$	-0.113	-0.098	-0.088	-0.013	-0.009	-0.012
	(-16.45)	(-14.20)	(-12.90)	(-0.68)	(-0.56)	(-0.73)
JOBLESS	-0.041	-0.040	-0.039	-0.006	-0.006	-0.004
	(-6.45)	(-6.64)	(-6.64)	(0.28)	(-0.31)	(-0.19)
IMMIGRATION	-	-	-	0.073	0.075	0.073
				(4.59)	(5.64)	(5.46)
R^2	0.449			0.221		
σ_v^2	0.089	0.044	0.046	0.084	0.023	0.033
		(9.46)	(12.87)		(2.84)	(4.21)
λ		2.799			6.936	
		(4.72)			(1.91)	
θ			4.940			4.484
			(15.140)			(6.70)
Observations	1099	1099	1099	182	182	182

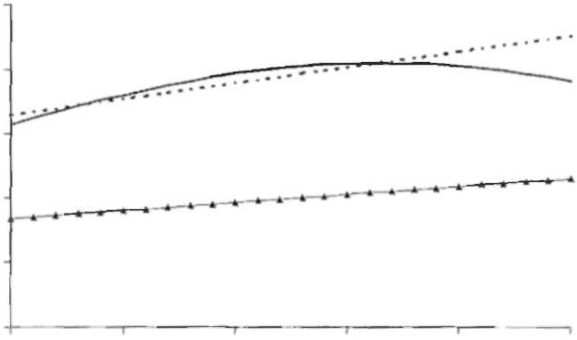
Notice: Dependent variable is ln of hourly (gross) earnings. t-ratios in parentheses.

Table A-2. Distribution of Earnings Efficiency

	Inhabitants		Immigrants	
	Half-Normal	Exponential	Half-Normal	Exponential
< 0.50	3.0%	2.7%	6.6%	4.4%
0.50 - 0.60	4.3%	2.1%	8.8%	2.8%
0.60 - 0.70	13.1%	4.5%	14.3%	8.2%
0.70 – 0.80	36.5%	15.6%	26.9%	14.8%
0.80 – 0.90	37.9%	54.9%	33.5%	47.8%
0.90 – 1	5.3%	20.2%	9.9%	22.0%
Average Efficiency	0.768	0.826	0.744	0.812

Notice: Earnings Efficiency has been estimated as $EFF_i = \exp(-u_i)$ (see also formula (6) in the text).

Figure 1: Frontier Earnings Functions for Inhabitants and Foreigners



Simulation based on human capital stock of a representative inhabitant (41.5 years old, 10.7 years of schooling, 0.94 received training, 0.55 years of unemployment).

Because of the focus of this paper on assimilation, differences between inhabitants and immigrants are of greater interest. As the parameter estimates show, returns on schooling are higher for inhabitants (6.7% versus 2.8%), whereas training has a more sizeable impact on the wage frontier of migrants (less than 6% versus more than 16%). The *AGE* variable changes its sign from significantly positive for West-Germans to significantly negative for East Europeans. Within the human-capital context, the negative sign is more in line with expectations, because older people are more likely to be ill and have less physical strength. The wage-increasing effect of getting older – accumulating job experience – is explicitly considered by the experience variable. Finally, the wage of natives depends more heavily on individual skills than for immigrants. This can be seen from the constant term, which takes a lower value for natives in spite of their higher income.

What is most important, however, the results strongly support the assimilation hypothesis in the sense of *Chiswick (1978)*. This implication can be illustrated by Figure 1, where frontier earnings of a representative native employee is plotted against frontier earnings of immigrants. Equipped with an identical human capital stock as the native colleague, immediately after arrival an immigrant has a potential income of about 60% relative to the inhabitant. The earnings profile turns out to be much steeper in the subsequent years, however: Ten years after arrival, differences between natives and former East Europeans disappear. Former East

Europeans perfectly assimilate within a relatively short time period, at least in terms of income. Whether immigrants would even overtake nationals after this period is unclear, because the sample covers only individuals who crossed the border after 1984. An extrapolation beyond this time horizon would therefore be speculative.

Earnings Efficiency

Given the parameter estimates in *Table A-1*, the underlying distribution of earnings inefficiency can be determined. For example, the density function of u in the half-normal case[4] can be expressed as

$$d(u) = \begin{cases} \frac{\sqrt{2}}{\sqrt{\pi}\sigma_u} \exp\left[-0.5\left(\frac{u}{\sigma_u}\right)^2\right] & \text{if } u \geq 0 \\ 0 & \text{otherwise} \end{cases} . \quad (9)$$

As can be seen from Figure 2, where the half-normal case is illustrated, the estimated differences between natives and foreigners are small[5]. Given the distribution in (9), the mean value of u is $\sigma_u(2/\pi)^{0.5}$, which produces 0.280 for inhabitants and 0.319 for immigrants. Transformed to efficiency values EFF_i, the results are 75.6% versus 72.7%. This implies that immigrants are somewhat less efficient in transforming human capital to market income, but the discrepancy turns out to be of minor interest.

Aside from these mean figures, individual estimates of e_i and u_i can also be determined for all natives and immigrants (equations (4) respectively (5)). Table A-2 in the appendix provides the distribution of the expected efficiency values, confirming the above mentioned results. A slightly more heterogeneous appearance of immigrants notwithstanding, the distances between estimated and potential income are very similar for both groups. Average XEFF values are close to the forecast from the distribution function (9). The ranking coefficient between the exponential and the half-normal model is at 0.99, supporting the reliability of the results. Actually, the major difference is the trivial more pessimistic assessment of the half-normal model.