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Sarah Okoampah[1]

Estimating Earnings Assimilation of Immigrants to Germany – Evidence from a Double Cohort Model

Abstract

Following the seminal work of Chiswick (1978), many studies have examined the extent to which earnings of immigrants vary over the settlement process. While these studies usually find that the initial earnings gap between native and immigrant workers in traditional immigration countries disappears as the duration of residence in the host country increases, empirical evidence mostly suggests that immigrants to Germany experience persistent earnings disadvantages and, if at all, only a moderate earnings assimilation process for some immigrant groups. However, due to variations in the economic performance of different immigration cohorts, estimates derived from cross-sectional models may be biased (Borjas, 1985). Against this background, this paper employs a double cohort model to revisit the existing evidence on earnings assimilation processes of immigrants to Germany. In line with this literature, no evidence for a robust assimilation process for immigrants is found, even after accounting for potential cohort effects.

JEL Classification: F22, F15, J31

Keywords: Earnings assimilation; cohort effects; international migration

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1 *Sarah Okoampah, RGS Econ and UDE.* *– I thank Mathias Sinning, participants of the Spring Meeting of Young Economists 2011 in Groningen, the Annual Congress of the Verein für Socialpolitik 2011 in Frankfurt and the European Association of Labour Economists 2011 in Paphos for valuable comments and suggestions. Financial support by the Ruhr Graduate School in Economics is gratefully acknowledged.* *– All correspondence to: Sarah Okoampah, University of Duisburg-Essen, Chair of Health Economics, Weststadttürme, Berliner Platz 6-8, 45127 Essen, Germany, e-mail: sarah.okoampah@uni-due.de*

1 Introduction

Given the increasing number of immigrants worldwide, the social and economic integration of immigrants into the societies of their host countries is of particular importance. The economic literature on the integration of immigrants focuses especially on exploring the convergence of immigrant earnings to the earnings of (comparable) natives. Following the seminal work of Chiswick (1978), a broad literature measures the economic performance of immigrants by estimating cross-section earnings regressions. In general, these studies interpret the coefficient of the variable "years since migration" as earnings assimilation pattern, starting from an initial earnings differential between immigrants and natives.

In this context, cohort effects and selection processes are of special interest in the empirical discussion. Borjas (1985) argues, that cross-section estimates might be biased, when basic differences between immigration cohorts exist or the composition of immigration cohorts has changed over time (e.g. due to systematic return migration). In this case, the parameter estimate of the variable "years since migration" does not solely measure the assimilation effect, but might also reflect differences in trajectory paths between immigration cohorts. If, for example, earlier immigration cohorts follow a flatter assimilation path than more recent cohorts, the assimilation effect might be underestimated in a cross-section regression. Myers and Lee (1996) and Myers et al. (1998) state, that the same argument holds when trajectory paths vary by birth cohort, since these differences are carried by the age or labor market experience variable, respectively, which is normally included as a regressor as well. The coefficient of this variable, which is meant to measure the trajectory path of the reference group, is then potentially distorted. In spite of this fundamental critique, existing studies on earnings assimilation nearly exclusively focus on the estimation of cross-section models,[1] while cohort effects are rarely taken into account.

In the decades after World War II, Germany experienced an intensive immigration history. In the 1960s and 1970s the government recruited a large number of guestworkers mainly from Southern Europe. Although these workers were expected to return to their home countries after some years, many of them decided for a permanent residence in Germany. After the oil crisis started in 1973, migration inflows were due to family reunions, the immigration of "Aussiedler" (ethnic Germans residing in East European countries), refugees and asylum-seekers. In 1992, Germany experienced a historical peak with 1.5 million new immigrants (Bauer et al., 2005). Since the mid 1990s the foreign population equals about 9% of the total population (Federal Statistical Office, 2010). Given this impressive immigration history, Germany provides an eminent case study for analyses of the economic and social integration of immi-

[1] For a literature overview, see Bauer et al. (2005).

grants.

While for other traditional immigration countries like the U.S., Canada and Australia a clear earnings assimilation process is empirically confirmed by cross-sectional studies, empirical evidence mostly suggests that immigrants to Germany experience persistent earnings disadvantages and, if at all, only a moderate earnings assimilation process for some immigrant groups. Given the rather pessimistic picture drawn by the existing empirical evidence for Germany and the fundamental critique in the literature regarding cross-section regressions, the question arises, whether the existing literature underestimates the economic performance of immigrants to Germany.

The current paper reexamines the question of earnings assimilation of immigrants to Germany under exploration of the relevance of cohort effects for the validity of cross-sectional estimates. The empirical analysis is based on data from the German Socio-Economic Panel (SOEP) for the time period 1990 to 2012 and is restricted to men residing in West Germany or Berlin. Both a traditional cross-section design and a double cohort model, which controls for potential distortions due to cohort effects, are estimated in order to allow for direct comparisons of the model predictions regarding the economic performance of immigrants over the settlement process. The estimation results of the cross-section regressions confirm the frequent finding of no assimilation process for immigrants to Germany. Likewise, cohort model estimates from several specifications deliver either insignificant or, for some immigrant groups, even slightly negative duration effects. Hence, no evidence for an earnings assimilation process for immigrants to Germany is found, even after accounting for potential cohort effects.

The paper contributes to the empirical migration literature by providing a first application of a double cohort model to earnings assimilation processes. This model circumvents the identification problem of age, cohort and period effects in a more convincing way than traditional cross-section models. Further, empirical evidence is provided, which confirms the frequent finding of no universal assimilation process for immigrants to Germany, even after accounting for potential cohort effects.

The paper proceeds as follows. Referring to the respective literature, Section 2 briefly surveys the age-period-cohort identification problem, different models of assimilation as well as the existing empirical evidence for Germany. Section 3 describes the utilized data and the descriptive statistics. In Section 4 the empirical strategy is outlined. Section 5 reports and discusses the empirical results, and Section 6 concludes.

2 Literature

2.1 The Classic Age-Period-Cohort Identification Problem

The problem of separating age, period and cohort effects is well discussed in the literature on cohort analysis (e.g. Heckman and Robb, 1985; Mason and Fienberg, 1985). Applying the problem to the context of earnings determinants, all three temporal dimensions might have separate effects on earnings. First, earnings are determined by age, since they typically grow positively at decreasing rates over individuals' life cycles. Second, earnings levels depend on period-specific economic conditions like the business cycle. Third, trajectory paths might be birth cohort-specific, that is, the speed of earnings growth might vary by cohort structure, size or cohort-specific economic optimism. All three variables can therefore be considered as eligible for inclusion as covariates in earnings regressions. An identification problem arises, however, due to perfect multicollinearity:

$$P \;=\; BC \;+\; A\,,$$

where P denotes period, BC denotes birth year, and A denotes age.

When focusing on immigrants, two additional temporal earnings determinants become obvious. Typically, immigrants earn significantly lower wages immediately after their immigration than comparable natives. This may be explained by imperfectly transferable human capital between countries (Chiswick, 1978; Friedberg, 2000). Basilio et al. (2014) empirically confirm the hypothesis of imperfect transferability of human capital between countries for the case of Germany. If immigrants gain host country-specific human capital over time (like language skills and information on labor market conditions), an additional earnings growth process is implemented by the event of immigration, which is not related to age but to the duration of stay in the host country (Myers and Lee, 1996). Again, trajectory paths might vary between immigration cohorts because of different cohort sizes and structures, or because the composition of immigration cohorts has changed over time (e.g. due to systematic return migration, Borjas, 1985). In this context, an identification problem arises from the following relation:

$$P \;=\; MC \;+\; D\,,$$

where P again denotes period, MC denotes year of immigration, and D denotes the duration of stay in the host country.

As a consequence of the perfect multicollinearity, effect identification for all temporal variables by including them simultaneously as regressors in a cross-section regression is impossible. The omission of variables, however, leads to biased effect estimates. As Bell and Jones (2013) show, there is no solution to

the age-period-cohort identification problem which does not rely on any kind of assumptions. The following section discusses different strategies taken in the earnings assimilation literature and their implicit assumptions.

2.2 Relating Models of Earnings Assimilation

Studies on the economic and social integration of immigrants constitute an important strand of the economic literature. In this context, empirical studies on earnings assimilation processes focus on comparisons between natives and immigrants regarding their speed of earnings growth. Theoretically, due to imperfect transferability of human capital between countries, immigrants have lower opportunity cost of investments in (host country-specific) education than comparable natives (Regets and Duleep, 1999). Therefore, immigrants are expected to have higher earnings growth rates than natives, such that their initial earnings disadvantage is expected to narrow over time. The question of interest in empirical analyses of earnings assimilation processes is whether such an adaptation process indeed takes place. Based on the assumption that natives and immigrants follow the same aging trajectory path over time, existing empirical studies deduce an earnings assimilation process, when the earnings growth path related to duration of stay (which is followed by immigrants but not by natives) is estimated to exhibit positive growth rates (e.g. Chiswick, 1978; Borjas, 1985).

In his seminal paper on the earnings assimilation of immigrants to the U.S. Chiswick (1978) undertakes the first empirical attempt to measure the effect of duration of stay on earnings. He estimates a cross-section earnings regression including, besides other socioeconomic characteristics, labor market experience (as calculated from age) and years since migration as independent variables. Considering natives as reference group, he interprets the coefficient of years since migration as earnings assimilation path. The coefficients of experience and years since migration reflect earnings differences between individuals with different age and duration of stay, respectively. But as pointed out above, earnings differences between individuals at a specific point in time might be due to both age differences and birth cohort differences. Hence, the coefficient of labor market experience captures both aging effects and birth cohort effects. Likewise, the coefficient of years since migration reflects duration effects and immigration cohort effects. Hence, while Chiswick's approach assumes natives and immigrants to follow the same aging trajectory path, another strong implicit assumption behind it is the absence of any cohort-specific earnings differences.

In Borjas' (1985) famous reply study he criticizes the potential bias in a cross-section comparison of immigrants from different immigration cohorts. Exploiting data for natives and immigrants from two periods, he decomposes the cross-section effect of years since migration into two parts, the first measuring earnings differences of immigrants from the same immigration cohort

over time, the second measuring differences of immigrants from different cohorts but with identical durations of stay. Borjas interprets the first part, denoted as earnings growth within a cohort, as earnings assimilation effect, while the second part, denoted as earnings growth between cohorts, is interpreted to capture immigration cohort-specific differences. Borjas' method controls for immigration cohorts but not for birth cohort-specific earnings differences, since, as Chiswick, he includes labor market experience (as measured from age) as a cross-sectional variable into his regression. While Borjas recognizes the necessity of controlling for immigration cohort differences, his approach makes the implicit assumption of a non-existence of birth cohort-specific earnings differences. If birth cohort-specific earnings differences are present, the estimated aging trajectory path of natives, who serve as reference group, might be biased (Myers and Lee, 1998).

Hence, both of the described approaches rely on strong assumptions that may be unrealistic. A superior strategy to estimate the duration effect of interest would be one that makes more reasonable assumptions and recognizes the presence of both birth and immigration cohort-specific earnings differences. Myers and Lee (1996) and Myers et al. (1998) provide such a strategy which controls for age, duration, period, birth cohort and immigration cohort simultaneously. As Borjas, they exploit data from several periods.

The implicit assumptions made by this model are the following: Period effects apply to all individuals equally. Members of the same birth cohort have the same birth cohort effect and follow the same aging path. Natives and immigrants from the same birth cohort have identical birth cohort and aging effects. Members of the same immigration cohort have the same immigration cohort effect and follow the same duration path. Finally, the model allows for wage effects that are specific to immigration cohorts nested within birth cohorts.

Applying these assumptions, the model identifies changes over time applying to all individuals equally as period effects. To account for potential cohort differences, aging and duration effects are allowed to vary by birth and immigration cohort, respectively. Aging effects are identified as changes over time applying to natives from a specific birth cohort, and duration effects are estimated for each immigration cohort as the difference in changes between natives and immigrants from the same birth cohort. Technically, the method isolates dynamic effects from constant cohort effects by regressing on both cohort dummy variables and interaction terms between cohort and period.[2]

[2] Myers and Lee (1996) apply the model to residential overcrowding, while Myers et al. (1998) explore homeownership attainment.

2.3 Empirical Evidence for Germany

Although the presence of the age-period-cohort identification problem in cross-section regressions has long been recognized, a wide range of studies on earnings assimilation patterns adopts the estimation strategy of Chiswick (1978). While for other traditional immigration countries like the U.S., Canada or Australia an earnings assimilation process is empirically confirmed by cross-sectional regressions, studies for immigrants to Germany, which are based on data mainly from the SOEP, deliver ambiguous results (Bauer et al., 2005).

Only few studies find evidence confirming an assimilation process. Based on the first wave of the SOEP, Schmidt (1993) estimates an initial earnings disadvantage for guestworkers of 12% relative to comparable Germans. On average 17 years after immigration guestworkers reach income equality with Germans. Constant (1998) finds an initial earnings disadvantage for female guestworkers, using the first 10 waves of the SOEP. After 10 years they overtake the earnings of comparable German women. Basing their study on the first 14 SOEP waves, Constant (2005) conclude that immigrants reach income equality with Germans after 23 years.

In contrast to these results, Pischke (1992) measures, based on the first six waves of the SOEP, an initial earnings differential between 20% and 25%, which does not significantly decline over time. He finds evidence for an assimilation process only for immigrants from guestworker countries, who immigrated after 1976. Dustmann (1993) estimates different specifications of a cross-section regression on the basis of the first wave of the SOEP and finds a persistent earnings disadvantage of 13% to 19% for guestworkers relative to comparable Germans. After control for potential distortions due to systematic selection into the labor market and the return migration decision, Licht and Steiner (1994) also find, based on the first six waves of the SOEP, a large initial earnings disadvantage for immigrants, which is not narrowing over time. However, for immigrants with relatively short durations of stay they find similar earnings levels and higher earnings growth rates as for Germans. Schmidt (1997) as well finds a persistent earnings disadvantage of 20% for guestworkers compared to Germans. He concludes, that this earnings differential is caused by long-run differences in education. Based on the first 10 waves of the SOEP, Constant (1998) finds a significant and persistent earnings disadvantage for male guestworkers compared to Germans. However, she also finds an initial but short-lived earnings advantage for immigrants. Fertig and Schurer (2007) investigate assimilation patterns for different immigrant groups regarding earnings as well as unemployment probability. They find evidence for an earnings assimilation process only for ethnic Germans and the youngest immigrant group immigrated between 1969 and 2002. The results of Zibrowius (2012) suggest that although immigrants in Germany experience wage growth, their earnings profiles are mostly flatter than those of Germans and a persistent earnings differential remains. Taking a slightly different perspective, Gathmann and Keller (2014)

detect wage returns to citizenship for female immigrants to Germany, while there are no returns for men and traditional guestworkers.

Summarized, the majority of studies arrives at rather pessimistic conclusions, mostly predicting persistent earnings disadvantages for immigrants, while an earnings assimilation process can be confirmed, if at all, only for specific immigrant groups. Given these pessimistic results, the question arises whether unconsidered cohort effects might have caused an underestimation of the economic performance of immigrants to Germany in existing cross-sectional studies of earnings assimilation patterns.

3 Data and Descriptive Statistics

3.1 Data

The empirical analysis is based on data from the German Socio-Economic Panel (SOEP). The SOEP is a representative longitudinal study for Germany collecting information on native and foreign households. All household members above 15 years of age are questioned individually in face-to-face interviews. In addition, household-related questionnaires are answered by household heads (Kroh, 2011; Haisken-DeNew and Frick, 2005). The yearly repeated survey started in 1984 with about 6,000 interviewed households and samples about 12,000 households per year since 2000 (Goebel et al., 2008).

The empirical analysis of this paper is based on data from the waves 1990 to 2012. To focus on a population with a high share of full-time employed, the sample is restricted to male individuals aged from 18 to 65 years who are employed and no apprentices. Immigrants are defined as foreign-born individuals who immigrated to Germany since 1948. Since the population share of immigrants is relatively small in East Germany (Federal Statistical Office, 2010), only individuals residing in West Germany or East or West Berlin are included. Foreign-born ethnic Germans who received German citizenship after immigration are excluded from the sample because it is unclear whether they should be assigned as natives or as immigrants.

3.2 Descriptive Statistics

Table 1 reports average labor earnings by birth and immigration cohort.[3] As expected, the mean wages of immigrants are lower than that of natives in most categories, implying earnings disadvantages for immigrants compared to natives. The overall earnings increase from 1990-96 to 2004-12 is higher

[3] Inconsistencies between the means result from the weighting of the observations with weights provided by the SOEP. (For example, the absolute increase from 1990-96 to 2004-12 is larger for natives from all birth cohorts separately than it is for the whole group of natives.)

for immigrants than for natives, suggesting that an assimilation process over the considered time period may potentially take place. However, dividing the sample into birth cohorts confirms this picture only for individuals born before 1955. Within the two younger birth cohorts, immigrants experience a lower wage growth than natives. A comparison by immigration cohort reveals that wages tend to be higher and to increase stronger the earlier is the period of immigration.

Comparing immigration cohorts by birth cohort shows that the wage increase for immigrants before 1974 is mainly driven by the strong increase for the youngest birth cohort born after 1965 of 3.69€. These individuals have immigrated during childhood, meaning that their human capital was mostly attained within Germany, which might explain their comparably high economic success. However, also immigrants from this birth cohort who immigrated later in their life cycles experienced a wage growth of more than 2€. Considering the oldest birth cohort born before 1955, there is a strong heterogeneity in wage growth. In particular, within this birth cohort, immigrants between 1974 and 1989 experience an increase of over 6€, while the wages of immigrants after 1989 decrease by more than 6€. However, the observation numbers for these groups are relatively low. In summary, the reported variation in earnings levels and in changes over time by birth and immigration cohort indicate that earnings levels and earnings growth paths might differ remarkably between birth and immigration cohorts, underlining the necessity to control for both in the empirical analysis.

4 Empirical Strategy

In order to explore the relevance of cohort effects for the validity of cross-sectional earnings assimilation estimates, the empirical analysis focuses on a comparison of the results of a cross-section regression model after Chiswick (1978) and a double cohort regression model after Myers and Lee (1996) and Myers et al. (1998), respectively. Only the latter model allows an estimation of assimilation effects undistorted by cohort effects. The current paper provides a first application of this estimation strategy to earnings assimilation processes.

To appropriately apply the double cohort regression model, observations from several points in time are needed, which cover a sufficiently long time span for an earnings assimilation process to potentially take place. The present analysis exploits all years from 1990 to 2012. To account for the possibility that assimilation patterns differ by country of origin, the regressions are run separately for immigrants from OECD countries, which are relatively highly industrialized, and other countries of origin. Moreover, to exclude the possibility that substantial variation by educational level between immigration cohorts may distort the results (most immigrants before 1974 were relatively low educated guestworkers), the regressions are also run separately for indi-

Table 1: Real Labor Earnings by Birth and Immigration Cohort

	All				*Born before 1955*				*Born 1955-1965*				*Born after 1965*			
	1990-96	1997-04	2004-12	Δ	1990-96	1997-04	2004-12	Δ	1990-96	1997-04	2004-12	Δ	1990-96	1997-04	2004-12	Δ
Natives	17.03	18.07	17.56	0.53	18.52	19.90	19.95	1.43	16.28	18.65	18.55	2.27	13.30	15.33	16.06	2.77
	(7.29)	(7.50)	(7.78)		(7.86)	(7.71)	(8.79)		(5.64)	(7.16)	(7.42)		(6.99)	(6.89)	(7.35)	
	[12556]	[21077]	[21122]		[5937]	[6479]	[4084]		[4362]	[7594]	[7423]		[2257]	[7004]	[9615]	
Immigrants	15.15	15.68	16.01	0.86	15.64	16.93	18.01	2.37	15.16	15.79	16.31	1.15	12.37	13.80	14.62	2.25
	(4.95)	(5.79)	(7.70)		(5.14)	(6.67)	(10.40)		(4.59)	(5.42)	(7.07)		(3.50)	(4.12)	(6.13)	
	[4957]	[4438]	[2402]		[2892]	[1588]	[501]		[1343]	[1498]	[902]		[722]	[1352]	[999]	
Immigrants before 1974	15.67	17.27	17.87	2.20	15.52	17.08	17.23	1.71	16.95	18.58	18.59	1.64	13.24	14.37	16.93	3.69
	(4.87)	(6.04)	(8.42)		(4.89)	(5.83)	(7.68)		(4.76)	(6.65)	(9.40)		(2.98)	(4.42)	(5.11)	
	[3388]	[1826]	[656]		[2571]	[1131]	[273]		[592]	[477]	[269]		[225]	[218]	[114]	
Immigrants 1974-1989	14.37	15.17	16.30	1.93	15.80	16.93	21.91	6.11	14.31	15.33	15.86	1.55	12.30	14.03	14.68	2.38
	(4.27)	(5.12)	(7.76)		(4.84)	(7.24)	(14.23)		(3.75)	(4.51)	(5.32)		(3.50)	(3.97)	(5.05)	
	[1366]	[1714]	[1085]		[280]	[290]	[143]		[689]	[745]	[450]		[397]	[679]	[492]	
Immigrants after 1989	13.68	13.99	13.95	0.27	18.67	16.19	12.63	-6.04	12.61	13.25	13.75	1.14	11.76	13.39	14.29	2.53
	(7.37)	(5.76)	(6.36)		(11.35)	(9.16)	(4.36)		(5.61)	(3.78)	(4.99)		(3.80)	(4.21)	(7.15)	
	[203]	[898]	[661]		[41]	[167]	[85]		[62]	[276]	[183]		[100]	[455]	[393]	

Means of real hourly gross earnings in €. Standard deviations in parentheses. Number of observations in brackets. Weights provided by the SOEP are used. Δ: absolute change from 1990-96 to 2004-12.

viduals with less than 11 years of education and individuals with at least 11 years of education, such that only the latter group includes individuals who received at least an upper secondary degree or technical school degree.

4.1 Cross-Section Regression Model

Chiswick (1978) extended the Human Capital Earnings Function (Mincer, 1974) to application on datasets containing immigrants. The following variant of this extended specification is estimated:

$$\begin{aligned} ln\,Y &= \alpha_0 + \sum_i \alpha_{1i}\, P_i + \alpha_2\, exp + \alpha_3\, exp^2 \\ &\quad + mig\Big[\alpha_4 + \alpha_5\, ysm + \alpha_6\, ysm^2\Big] + \alpha_7\, educ + \varepsilon\,, \end{aligned} \tag{1}$$

where Y is gross hourly earnings in nominal terms, P_i are year dummy variables, which equal one for observations from the particular year i, exp is years of labor market experience in full-time employment and ysm is years since migration. mig is a dummy variable, which equals one if an individual immigrated to Germany since 1948, zero otherwise. $educ$ is education in years and ε is a random error with expectation value zero.

Following Chiswicks interpretation, which derives from the human capital theory, $\hat{\alpha_4}$ measures the initial earnings differential between natives and immigrants after immigration, which is under the assumption of imperfectly transferable human capital between countries expected to be negative. The coefficients of labor market experience are interpreted to capture the concave aging trajectory path of natives, who serve as reference group. The coefficients of years since migration should capture all deviations of immigrants from the natives' trajectory path and are therefore interpreted to measure the earnings assimilation process. However, as pointed out above, both the coefficients of years since migration and experience might also carry cohort differences, such that they might not reflect the pure effects of duration of stay and aging, respectively.

4.2 Double Cohort Regression Model

Adopting the estimation strategy of Myers and Lee (1996) and Myers et al. (1998), the following regression equation is estimated:

$$\begin{aligned} ln\,Y \;=\; & \beta_0 + \sum_i \beta_{1i}\,P_i + \sum_{j=2,3}\Big[\beta_{2j}\,BC_j + \beta_{3j}\,(BC_j \cdot T)\Big] \\ & + mig\,\Bigg\{\sum_{k=1,2,3}\Big[\beta_{4k}MC_k + \beta_{5k}\,(MC_k \cdot T)\Big] \\ & + \sum_{j=2,3}\sum_{k=1,2,3}\Big[\beta_{6jk}\,(BC_j \cdot MC_k) + \beta_{7jk}\,(BC_j \cdot MC_k \cdot T)\Big]\Bigg\} \\ & + \beta_8\,educ + \varepsilon, \end{aligned} \tag{2}$$

where Y is again gross hourly earnings in nominal terms and P_i are year dummy variables, which equal one for observations from the particular year i, zero otherwise. BC_j are dummy variables for different birth cohorts, which equal one for observations of individuals born during the corresponding time period, zero otherwise (BC_1: born before 1955 [serves as reference group]; BC_2: born between 1955 and 1965; BC_3: born after 1965). The birth cohorts have been chosen such that the medium-aged birth cohort roughly comprises the baby boomers. MC_k are dummy variables for different immigration cohorts, which equal one for observations of immigrants during the particular time period, zero otherwise (MC_1: immigrant before 1974; MC_2: immigrant between 1974 and 1989; MC_3: immigrant after 1989; natives serve as reference group). The earliest birth cohort includes the guestworkers, who were recruited by the German government until the beginning of the oil crises in 1974. The most recent immigration cohort comprises immigrants who entered the country after the German reunification in 1989. T gives the observation year with 1990 set to zero. *mig* is a dummy variable, which equals one if an individual immigrated to Germany since 1948, zero otherwise. *educ* is education in years, the terms in parentheses are interaction terms and ε is an error term with expectation value zero.

The coefficients of P_i measure year-specific effects, which occur to all observations equally (e.g. because of changes in macroeconomic conditions). The coefficients of BC_j measure the initial average earnings level of the particular birth cohort compared to BC_1. This differential partly results from the different initial age levels of the birth cohorts, but also captures, for example, differences in the cohort structure between BC_j and BC_1. The interaction terms between birth cohort and period $(BC_j \cdot T)$ represent the cohort-specific linear time trends in earnings, such that $\hat{\beta}_{3j}$ can be interpreted as the aging effect of birth cohort BC_j compared to BC_1. The coefficients of MC_k quantify the initial earnings differential between the particular immigration cohort and natives, which is not explained by birth cohort-specific earnings differences.

Besides earnings differences due to different initial durations of stay, these coefficients also capture immigration cohort-specific differences. The coefficients $\hat{\beta}_{5k}$ measure the average earnings change of the particular immigration cohort compared to natives, net of birth cohort-specific changes, such that these coefficients provide estimates for the duration effects of interest. The interaction term between birth and immigration cohort ($BC_j \cdot MC_k$) controls for the case that specific birth cohorts within immigration cohorts have effects on earnings, which appear neither for the whole birth cohort nor the whole immigration cohort (age-at-arrival effect). The highest interaction term, finally, ($BC_j \cdot MC_k \cdot T$) represents dynamic effects specific to birth cohorts nested within immigration cohorts and therefore captures duration effects, which do not appear for a whole immigration cohort, but only for a specific birth cohort within an immigration cohort. In contrast to the assimilation effects derived from a cross-section regression model like Equation (1), the estimated duration effects derived from Equation (2) are not potentially distorted by birth or immigration cohort effects.

5 Empirical Results

Table 2 reports cross-sectional estimates of Equation (1) for both natives and immigrants from OECD countries as well as natives and immigrants from other countries. The coefficients of labor market experience have the expected signs in both regressions, indicating that the individuals follow a concave aging trajectory path over time.

For immigrants from OECD countries the coefficient of the immigrant dummy variable exhibits a negative and significant sign, suggesting an initial earnings disadvantage for these immigrants compared to Germans of about 10%. For immigrants from countries not participating in the OECD, this differential amounts to even 25%. Immigrants from non-OECD countries may have a larger initial earnings disadvantage because human capital may be more easily transferable within the OECD than across OECD borders. At the same time, the coefficients of years since migration are either insignificant or, for immigrants from non-OECD countries, significant only at the 10% level. This result suggests that the dynamic growth path of immigrants does not significantly deviate from the native trajectory path. Hence, the estimated initial earnings disadvantage may be persistent over time, so that there is no evidence for an earnings assimilation process. This confirms the results of most existing cross-sectional studies for Germany.

Table 3 reports cross-sectional estimates separately for individuals with low and high education levels. As before, the coefficients of the immigrant dummy are significantly negative in all regressions. A higher education level as well as originating from a country other than an OECD country seem to

Table 2: Cross-Sectional Earnings Regressions

	OECD		Other	
	Coef.	SE	Coef.	SE
Labor market experience	0.029***	0.001	0.030***	0.001
Labor market experience$^2/10^2$	-0.046***	0.002	-0.048***	0.002
Immigrant	-0.101***	0.034	-0.248***	0.032
Years since immigration	0.004	0.003	0.008*	0.004
Years since immigration$^2/10^2$	-0.005	0.006	-0.006	0.008
Education	0.070***	0.001	0.070***	0.001
Full-time employed	0.119***	0.021	0.120***	0.022
Married	0.081***	0.007	0.080***	0.007
Constant	1.131***	0.042	1.093***	0.042
R^2	0.37		0.38	
Observations	64340		60186	

OLS. Year, county and industry fixed effects are included in all regressions. Robust standard errors (SE) are clustered at the household level. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3: Cross-Sectional Earnings Regressions, Effect Heterogeneity

	Less than 11 years of education				At least 11 years of education			
	OECD		Other		OECD		Other	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Labor market experience	0.021***	0.001	0.022***	0.001	0.034***	0.001	0.034***	0.001
Labor market experience$^2/10^2$	-0.032***	0.003	-0.034***	0.003	-0.052***	0.003	-0.054***	0.003
Immigrant	-0.103**	0.041	-0.171***	0.044	-0.121**	0.052	-0.313***	0.038
Years since immigration	0.006*	0.004	0.008*	0.005	-0.003	0.005	0.006	0.004
Years since immigration$^2/10^2$	-0.010	0.008	-0.014	0.011	0.013	0.011	0.004	0.009
Education	0.042***	0.005	0.045***	0.006	0.070***	0.002	0.069***	0.002
Full-time employed	0.212***	0.044	0.225***	0.045	0.077***	0.025	0.078***	0.025
Married	0.077***	0.009	0.082***	0.010	0.086***	0.009	0.082***	0.009
Constant	1.358***	0.072	1.308***	0.081	1.128***	0.065	1.094***	0.061
R^2	0.21		0.22		0.38		0.38	
Observations	25749		22211		38591		37975	

OLS. Year, county and industry fixed effects are included in all regressions. Robust standard errors (SE) are clustered at the household level. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

increase the initial earnings disadvantage compared to German natives. Again, the estimated coefficients of years since migration are either insignificant or significant at the 10% level only. Hence, the results by education confirm the results reported in Table 2.

Table 4 shows results from cohort regressions of Equation (2) by country of origin. Both regressions predict an earnings disadvantage of about 12.4% for the medium-aged birth cohort and of about 22.4% for the youngest birth cohort both compared to the oldest birth cohort, reflecting that earnings are increasing in age. The estimated aging effects suggest that over time the earnings of the medium-aged birth cohort grow at a significantly higher rate than the earnings of the oldest birth cohort.

The average earnings differential between natives and immigrants from OECD countries is insignificant for the immigration cohort after 1989, while it is negative and significant for immigrants between 1974 and 1989 and immigrants before 1974. However, positive age-at-arrival effects of different size are measured for these immigration cohorts, mostly offsetting the negative overall effects. Hence, there may not be an earnings disadvantage for immigrants from OECD countries after all. Also, the duration effects are insignificant for all immigration cohorts and may be even negative for some nested cohorts.

For immigrants from countries other than OECD countries there is a significantly negative earnings differential between natives and all three immigration cohorts. In particular, immigrants before 1974 earn 5.5% less, immigrants between 1974 and 1989 earn 13.5% less and immigrants after 1989 earn even 24.1% less than comparable Germans. While for the earliest immigration cohort, the positive age-at-arrival effects may offset the overall earnings disadvantage, this is not the case for immigrants between 1974 and 1989 and immigrants after 1989. As the duration effects suggest, a narrowing of these differentials does not take place at all. On the contrary, there is a negative effect for the most recently immigrated group that is significant at 5%, suggesting that the earnings disadvantage may be even growing. However, within this immigration cohort the duration effect of nested cohorts is significantly positive for individuals born after 1965, offsetting the widening of the overall disadvantage for younger immigrants. Overall, a convergence of immigrant wages to the wages of natives is not predicted.

Table 5 reports cohort regressions of Equation (2) by country of origin and educational group. Focusing on the estimated birth cohort effects, the medium-aged birth cohort and especially the youngest birth cohort have on average significantly lower earnings than the oldest birth cohort, again reflecting that wages are increasing in age. The differentials are more pronounced for higher education levels, suggesting a higher wage inequality in this group. While the corresponding aging effects are positive in the regressions for higher education levels, indicating wage growth over time, they are insignificant for lower educated individuals born between 1955 and 1965 and even negative for those born after 1965 in the lower education group, suggesting an average

Table 4: Double Cohort Earnings Regressions

	OECD		Other	
	Coef.	SE	Coef.	SE
Birth cohort				
Born before 1955 (reference group)				
Born 1955-1965 (BC_2)	-0.124***	0.013	-0.125***	0.013
Born after 1965 (BC_3)	-0.225***	0.015	-0.224***	0.015
Aging effect				
Born before 1955 (reference group)				
Born 1955-1965 ($BC_2 \cdot T$)	0.004***	0.001	0.004***	0.001
Born after 1965 ($BC_3 \cdot T$)	-0.001	0.001	-0.001	0.001
Immigration cohort				
Natives (reference group)				
Immigrant before 1974 (MC_1)	-0.044***	0.017	-0.055**	0.021
Immigrant 1974-1989 (MC_2)	-0.180***	0.044	-0.135**	0.062
Immigrant after 1989 (MC_3)	-0.157	0.227	-0.241***	0.090
Duration effect				
Natives (reference group)				
Immigrant before 1974 ($MC_1 \cdot T$)	-0.001	0.003	-0.006*	0.003
Immigrant 1974-1989 ($MC_2 \cdot T$)	0.007	0.006	-0.001	0.006
Immigrant after 1989 ($MC_3 \cdot T$)	-0.003	0.015	-0.015**	0.007
Age-at-arrival effect				
Born before 1955; natives (reference groups)				
Immigrants before 1974:				
Born 1955-1965 ($BC_2 \cdot MC_1$)	0.129***	0.027	0.124*	0.064
Born after 1965 ($BC_3 \cdot MC_1$)	0.124***	0.039	0.127***	0.042
Immigrants 1974-1989:				
Born 1955-1965 ($BC_2 \cdot MC_2$)	0.129**	0.051	0.002	0.083
Born after 1965 ($BC_3 \cdot MC_2$)	0.234***	0.051	0.090	0.082
Immigrants after 1989:				
Born 1955-1965 ($BC_2 \cdot MC_3$)	-0.036	0.237	-0.088	0.104
Born after 1965 ($BC_3 \cdot MC_3$)	0.068	0.235	0.046	0.101
Duration effect of nested cohorts				
Born before 1955; natives (reference groups)				
Immigrants before 1974:				
Born 1955-1965 ($BC_2 \cdot MC_1 \cdot T$)	-0.006*	0.004	-0.004	0.007
Born after 1965 ($BC_3 \cdot MC_1 \cdot T$)	-0.003	0.004	0.003	0.006
Immigrants 1974-1989:				
Born 1955-1965 ($BC_2 \cdot MC_2 \cdot T$)	-0.013**	0.006	-0.005	0.007
Born after 1965 ($BC_3 \cdot MC_2 \cdot T$)	-0.011*	0.006	0.001	0.007
Immigrants after 1989:				
Born 1955-1965 ($BC_2 \cdot MC_3 \cdot T$)	0.006	0.016	0.012	0.008
Born after 1965 ($BC_3 \cdot MC_3 \cdot T$)	0.007	0.016	0.023***	0.008
Control variables				
Education in years	0.062***	0.001	0.063***	0.001
Full-time employed	0.210***	0.021	0.209***	0.021
Married	0.137***	0.007	0.138***	0.007
Constant	1.451***	0.042	1.425***	0.042
R^2	0.34		0.35	
Observations	64340		60186	

OLS. Year, county and industry fixed effects are included in all regressions. Robust standard errors (SE) are clustered at the household level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

earnings decline of 0.4% per year.

Table 5: Double Cohort Earnings Regressions, Effect Heterogeneity

	Less than 11 years of education				At least 11 years of education			
	OECD		Other		OECD		Other	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Birth cohort								
Born before 1955 (reference group								
Born 1955-1965 (BC_2)	-0.051***	0.017	-0.046***	0.017	-0.193***	0.018	-0.196***	0.018
Born after 1965 (BC_3)	-0.134***	0.020	-0.121***	0.021	-0.341***	0.021	-0.347***	0.021
Aging effect								
Born before 1955 (reference group)								
Born 1955-1965 ($BC_2 \cdot T$)	0.001	0.002	0.001	0.002	0.007***	0.001	0.007***	0.001
Born after 1965 ($BC_3 \cdot T$)	-0.004**	0.002	-0.004***	0.002	0.004***	0.001	0.004***	0.002
Immigration cohort								
Natives (reference group)								
Immigrant before 1974 (MC_1)	0.017	0.022	0.011	0.031	-0.263***	0.031	-0.168***	0.031
Immigrant 1974-1989 (MC_2)	-0.092**	0.044	-0.065	0.125	-0.289***	0.068	-0.206***	0.067
Immigrant after 1989 (MC_3)	-0.434***	0.147	-0.075	0.150	-0.100	0.320	-0.409***	0.082
Duration effect								
Natives (reference group)								
Immigrant before 1974 ($MC_1 \cdot T$)	-0.005*	0.003	-0.009***	0.003	0.019***	0.005	0.004	0.006
Immigrant 1974-1989 ($MC_2 \cdot T$)	-0.003	0.005	-0.004	0.009	0.015*	0.008	0.001	0.006
Immigrant after 1989 ($MC_3 \cdot T$)	0.016	0.015	-0.018	0.012	-0.005	0.023	-0.009	0.007
Age-at-arrival effect								
Born before 1955; natives (reference groups)								
Immigrants before 1974:								
Born 1955-1965 ($BC_2 \cdot MC_1$)	0.025	0.032	0.001	0.078	0.318***	0.053	0.288***	0.071
Born after 1965 ($BC_3 \cdot MC_1$)	0.003	0.045	-0.009	0.047	0.280***	0.065	0.235**	0.101
Immigrants 1974-1989:								
Born 1955-1965 ($BC_2 \cdot MC_2$)	0.046	0.052	0.040	0.137	0.125	0.077	0.002	0.096
Born after 1965 ($BC_3 \cdot MC_2$)	0.083*	0.049	-0.125	0.147	0.256**	0.103	0.244**	0.100
Immigrants after 1989:								
Born 1955-1965 ($BC_2 \cdot MC_3$)	0.240	0.169	-0.255	0.168	-0.082	0.334	0.058	0.107
Born after 1965 ($BC_3 \cdot MC_3$)	0.286*	0.164	-0.126	0.156	0.063	0.337	0.177	0.111
Duration effect of nested cohorts								
Born before 1955; natives (reference groups)								
Immigrants before 1974:								
Born 1955-1965 ($BC_2 \cdot MC_1 \cdot T$)	0.005	0.004	-0.001	0.008	-0.030***	0.006	-0.009	0.009
Born after 1965 ($BC_3 \cdot MC_1 \cdot T$)	0.008	0.005	0.009	0.008	-0.020***	0.008	-0.005	0.009
Immigrants 1974-1989:								
Born 1955-1965 ($BC_2 \cdot MC_2 \cdot T$)	-0.000	0.005	-0.005	0.012	-0.016*	0.009	-0.005	0.008
Born after 1965 ($BC_3 \cdot MC_2 \cdot T$)	0.006	0.005	0.017	0.012	-0.020*	0.011	-0.008	0.009
Immigrants after 1989:								
Born 1955-1965 ($BC_2 \cdot MC_3 \cdot T$)	-0.008	0.016	0.019	0.014	0.002	0.025	0.005	0.009
Born after 1965 ($BC_3 \cdot MC_3 \cdot T$)	-0.005	0.016	0.032**	0.013	-0.001	0.025	0.013	0.008
Control variables								
Education in years	0.043***	0.005	0.051***	0.006	0.058***	0.002	0.058***	0.002
Full-time employed	0.256***	0.044	0.262***	0.046	0.192***	0.023	0.190***	0.024
Married	0.121***	0.010	0.130***	0.010	0.147***	0.009	0.145***	0.009
Constant	1.525***	0.075	1.439***	0.085	1.578***	0.065	1.549***	0.061
R^2	0.19		0.20		0.34		0.35	
Observations	25749		22211		38591		37975	

OLS. Year, county and industry fixed effects are included in all regressions. Robust standard errors (SE) are clustered at the household level. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Focusing on immigration cohort effects for immigrants from OECD countries with a lower education level, there is a negative wage differential between

natives and immigrants between 1974 and 1989 as well as immigrants after 1989. In particular, the former are estimated to earn 9.2% less, while the latter are measured to earn even 43.3% less than comparable natives. The corresponding duration effects and the duration effects of nested cohorts, which are either insignificant or even slightly negative, do not indicate a narrowing of these differentials over time.

For lower educated immigrants from countries not participating in the OECD, no significant differentials compared to natives are measured. Additionally, all age-at-arrival effects are insignificant. Hence, although the wages of immigrants before 1974 decline significantly over time and those of immigrants after 1989 from the youngest birth cohort rise, there are no overall earnings disadvantages compared to natives.

Considering higher educated individuals, there are significant overall earnings differentials for all immigration cohorts except for immigrants after 1989 from OECD countries. However, the positive age-at-arrival effects for immigrants before 1974 and younger immigrants between 1974 and 1989 potentially offset the differentials for these groups. As for lower educated individuals, the overall duration effects in combination with the duration effects of nested cohorts do not point at any earnings assimilation process taking place. The positive duration effect for immigrants before 1974 may be compensated by the negative duration effects of nested cohorts for this immigration cohort. The remaining duration effects are mostly insignificant.

In summary, there are considerable earnings differences between immigrants from OECD countries and immigrants with other countries of origin, while the differences to Germans seem negligible for some immigrant groups from OECD countries. Dividing the samples in lower and higher educated individuals still reveals no convergence in earnings. Neither the cross-sectional estimates nor the cohort model predictions yield evidence for a robust earnings assimilation process.[4] This confirms the pessimistic findings of most existing studies on earnings assimilation processes of immigrants to Germany. Hence, although the double cohort estimates suggest remarkable cohort differences, these seem in general not to qualitatively distort predictions derived from earlier cross-section studies on earnings assimilation processes for the case of Germany.

6 Conclusion

This paper estimates earnings assimilation effects for immigrants to Germany under exploration of the relevance of cohort effects for the validity of cross-

[4] To check for the robustness of the results, all regressions were also estimated including interaction terms between the immigrant dummy and all control variables, except for the variables of the basic model in Equation (2) but education. This as well did not yield significant duration effects.

sectional estimates. In the empirical analysis, which is based on data for male immigrants to Germany, a traditional cross-section regression model is estimated, which does not control for birth or immigration cohort effects and therefore yields potentially biased results. Consistent with the majority of existing empirical studies, this model predicts a huge initial earnings disadvantage for immigrants from countries not participating in the OECD compared to Germans, which remains persistent over time.

In order to measure earnings assimilation effects under consideration of potential birth or immigration cohort effects, a double cohort model, which circumvents the identification problem of age, cohort and period effects in a more convincing way than traditional cross-section models do, is estimated by both country of origin and educational level. The paper provides the first application of a double cohort model to earnings assimilation processes. The estimation results suggest that birth cohorts nested within immigration cohorts affect earnings remarkably differently. However, in spite of controlling for these differences, no evidence for a universal earnings assimilation process can be found. This confirms the frequent finding of no appreciable earnings assimilation process for immigrants to Germany. Hence, the results of this paper do not indicate a qualitative distortion of cross-sectional estimates of earnings assimilation processes for the case of Germany. In contrast, the result of no significant earnings assimilation process appears to be robust for the case of Germany.

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