

Findeisen, Sebastian; Dauth, Wolfgang; Lee, Tim

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Human Capital Accumulation over the Life-Cycle: Evidence from Germany's Reunification

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Human Capital Accumulation over the Life-Cycle: Evidence from Germany's Reunification*

Wolfgang Dauth

University of Würzburg and IAB

Sebastian Findeisen

University of Mannheim and CEPR

Sang Yoon (Tim) Lee

University of Mannheim and TSE

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Abstract

We study and compare the importance of human capital acquired at different stages of the life-cycle. We exploit Germany's unique reunification episode and the sudden restructuring of East Germany's labor market institutions and education system. We show graphical evidence that earnings, employment and wages for each East German birth cohort—scaled by the same outcomes for West German cohorts—change linearly with age at reunification. These linear exposure effects display structural breaks, i.e., changes in slope, around the ages 18 and 30 at reunification for both genders, and age 35 for females: there are significant gender differences. Exposure effects are by far the strongest for males between ages 20 and 30, where relative earnings decline at a rate of 2% per year for older cohorts. Around 40% of this effect is explained by higher college graduation rates for younger cohorts, while the remaining 60% underscores the importance and long lasting impact of early career effects. For females, earnings differences are almost completely explained by employment. We document reverse exposure effects for East German women between age 5 and 30 at reunification: employment and labor force participation rates increase linearly with each additional year spent in the socialist East. This trend is reversed after age 30, with older cohort's earnings and employment declining with each additional year spent in the East.

Very preliminary draft with first results.

*Contact: wolfgang.dauth@uni-wuerzburg.de, findeisen@uni-mannheim.de, sylee.tim@uni-mannheim.de.
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1 Introduction

Earnings and wages are crucial indicators of an individual's economic well-being. Accordingly, there is a large body of literature devoted to understanding their determinants: some of the most prominent candidates being formal schooling (Mincer, 1974; Card, 1999; Katz and Murphy, 1992; Goldin and Katz, 2007), work experience (Katz and Autor, 1999; Kambourov and Manovskii, 2009; Lemieux, 2010) and family background (Solon, 1992; Black et al., 2005; Chetty et al., 2014).

One of the main challenges for research is separately identifying these elements and many others, due to potential selection on factors unobserved to the econometrician but correlated with earnings outcomes. Many existing studies use quasi-experimental variation to identify local treatment effects, for example, the returns to an additional year of schooling or college enrollment (Angrist and Krueger, 1991; Zimmerman, 2014; Fuchs-Schündeln and Masella, 2016). Another approach is to posit a structural model and identify the deep parameters of human capital stock/formation, but at the cost of somewhat stronger assumptions (Keane and Wolpin, 1997; Heckman and Honoré, 1990; Carneiro et al., 2011).

In this paper, we will present new quasi-experimental evidence using the German reunification episode to shed light on the roles of education, schooling and on-the-job-training (work experience), on individual earnings. The approach will allow us to disentangle those factors and identify effects for a broad range of years of schooling and experience, sharing some of the advantages of the structural approaches, but arguably under less restrictive assumptions on the data.

Germany was formally reunified in 1990 following forty years of political and economic separation, which provides the unique historical setting of integrating more than 16 million East Germans with vastly different education and experience background into the West German system, at about 63 million at the time of reunification. We exploit the exogenous variation in the exposure to the East German regime of each Eastern German cohort born between 1935 and 1985. Consequently, the effects we identify in our cross-cohort design are interpreted as the effect of obtaining more years of schooling or work experience in the market oriented Western system, rather than under a socialist regime. We use detailed administrative data on the work histories of approximately 15 million workers which allows

us to provide evidence in other dimensions as well, such as migration, occupational choices, and selection into firms.

Our first results already show some clear patterns. The data very strongly suggests that for males there are three regimes, corresponding to the effects of secondary schooling, early career years and advanced career years. In our preliminary analysis we find that for individuals who were between 5 and 18 years old when the Wall came down, the effect of being from a later cohort, i.e. being one year younger at reunification, is very small. In contrast, there is a very strong gradient for those who were between the ages of 20 and 29: Being one year younger at reunification increases earnings relative to individuals brought up in the West from the same cohort by 2%.

Put differently, for men born in the East around 1960 the earnings gap to their Western counterparts is 45%. In contrast, it is only 25% for Easterners born around 1970. At age 30, however, this strong exposure effect disappears. Between ages 30 and 50, so for male individuals already in the middle of their careers when the Iron Curtain collapsed, the gradient is almost flat with a slight U-shape.

Strikingly, the data shows very different patterns for females. For females who were in primary or secondary school during reunification, we find that each year of exposure to socialist education actually increases earnings. Further investigation shows that this is driven by the higher labor participation rates of older cohorts. Note that this effect of schooling on future labor supply is present despite the fact that these cohorts had not yet entered the labor market in 1989, so the effect must purely come from different experiences in secondary school. That is, each year of secondary schooling may have shaped different attitudes towards work among the affected women. For women between 20 and 30 at reunification, there is a small negative slope in line with results for men. Last but not least, women aged 30 or more at reunification show only very weak exposure effects. Again, all the patterns in Eastern women's relative earnings are mirrored in their relative employment rates (labor supply).

Related Literature. Our exposure design is related to [Chetty and Hendren \(2015\)](#) who estimate neighborhood exposure effects for children across U.S. commuting zones and counties. Their identification comes from variation in children's age at the time of a household's move. Our approach is complementary by exploiting that each Eastern birth cohort experienced a

different number of years of exposure to the socialist regime. Similarly as [Chetty and Hendren \(2015\)](#), we normalize each East German cohort's outcome by the respective outcomes of Western Germans of the same cohort. Moreover, the historical episode of reunification allows us to investigate the effects of exposure at even later stages of the life-cycle. Intuitively, the Western cohort outcomes of serve a natural goalpost, allowing us (at least partially) to control for macroeconomic conditions that vary with time. We find strong evidence for linearity of exposure effects beyond childhood, complementing the patterns from [Chetty and Hendren \(2015\)](#).

Our paper is also related to papers investigating persisting labor market differences between East and West Germans ([Fuchs-Schündeln et al. \(2010\)](#) [Fuchs-Schündeln and Izem \(2012\)](#)). [Fuchs-Schündeln and Masella \(2016\)](#) use within cohort variation, exploiting a birth cutoff, differentially exposing individuals from mid-1970 Eastern birth cohorts to the number of years of socialist education. They find the strongest effects at the college attendance margin. Our cross-cohort exposure design adds to this literature by studying the effects of human capital at different stages of the life-cycle beyond schooling; our preliminary analysis suggests that such effects can be large. In addition, we will be able to leverage detailed data from the social security records of around 15 million people.

2 Data

Our first set of results for this paper comes from the Sample of Integrated Labour Market Biographies (SIAB) from the German Institute for Employment Research (IAB). This data stems from all German social security notifications, and a random two percent sample has been drawn from all persons who have either been employed, or officially registered as job-seekers. This individual-level spell data set is highly accurate even on a daily basis, due to its original purpose of calculating retirement pensions. With this data, we can follow single workers over time, and keep track of all on-the-job earnings changes as well as employer changes within and across industries, regions, and plants. Unfortunately, the data lacks information on family background, from which we suspect much of the remaining unexplained variation will be coming from.

Table 1: Summary Statistics for Men in 2000

	East		West		Uncertain	
	mean	sd	mean	sd	mean	sd
age	39.0	12.5	39.5	12.4	40.0	10.1
part time	0.102	0.303	0.093	0.290	0.162	0.369
apprentice	0.077	0.266	0.056	0.229	0.016	0.124
low skilled	0.153	0.360	0.167	0.373	0.254	0.436
med skilled	0.718	0.450	0.726	0.446	0.474	0.499
high skilled	0.130	0.336	0.106	0.308	0.271	0.445
daily wage	77.52	88.86	126.75	141.83	115.78	135.56
yearly earnings	25419	31863	43059	50757	38339	47657
lives in East	0.822	0.383	0.014	0.119	0.070	0.255
	53760		208667		31086	

2.1 Basic Statistics

Table 1 shows basic summary statistics for males in the year 2000, separately for Eastern/Western-born, and “Uncertain,” those whom we are unable to assign their birth place with some degree of certainty (due to the lack of personal/family background information). In the next section, we describe our strategies for circumventing this problem. Except for wages and earnings, the means of formal skill levels, age and part-time shares are remarkably similar between the Eastern and Western men. For the Uncertain category, it stands out that they are more educated than both Eastern and Western men.

Table 2 reveals some important differences between Eastern and Western women. First, the part-time share is much lower for women from the former socialist East. This is a well-known stylized fact and is typically attributed to the active role the government played in the socialist regime to promote gender equality in the labor market and other areas of life (Campa and Serafinelli (2015)). The table also shows that the East has almost twice as high a share of women with tertiary education than the West. Unlike the Uncertain men, the Uncertain women have lower earnings than both Eastern and Western women.

In stark contrast to men, the earnings of Eastern women have already caught up to their western counterparts in 2000. As our analysis will show, this is not driven by a single factor but by more stable labor force attachment, more full time work, and education. However, we

Table 2: Summary Statistics for Women in 2000

	East		West		Uncertain	
	mean	sd	mean	sd	mean	sd
age	39.5	11.9	38.0	12.1	45.6	11.1
part time	0.317	0.465	0.416	0.493	0.595	0.491
apprentice	0.059	0.235	0.057	0.232	0.011	0.104
low skilled	0.153	0.360	0.215	0.411	0.436	0.496
med skilled	0.728	0.445	0.730	0.444	0.456	0.498
high skilled	0.119	0.324	0.055	0.229	0.107	0.310
daily wage	60.18	52.10	62.50	58.02	46.63	58.07
yearly earnings	20071	18985	20802	20826	15246	20078
lives in East	0.829	0.376	0.012	0.110	0.014	0.118
	53326		174143		41741	

will also observe evidence for new a divergence setting in, as the youngest Eastern women in our sample has worse labor market outcomes than some of the older cohorts.

2.2 Identifying East and West Germans

One challenge of using German administrative data is that for some individuals, we cannot exactly identify whether s/he is from the East or the West. The administrative dataset only contains work-related data, plus schooling level and birth information, and no other explicit personal information prior to being added to the social security system. But since East Germany was added into the dataset only in 1992, and mass migration from East to West commenced only after the fall of the Berlin Wall in 1989, we classify all individuals who are in the sample on and before 1989 as West Germans. This assumes that Eastern migrants prior to this period are more affected by Western than Eastern factors, which we consider a reasonable approximation: Most migration prior to reunification occurred in the 1950s to early 1960s within a decade of separation (Hunt, 2006); Furthermore, the size is negligible compared to our total sample.

For the period after 1989, we first assume that an individual's first location of work corresponds to their origin; that is, if an individual's first place of work is in the East, s/he is classified as East German, similarly for the West. This is not without its problems, since following 1989 all individuals, both East and West, were free to migrate across the former border. Hence, this would misclassify all individuals taking their first job in the other region, where they did not grow up. However, this would only bias our estimates if the number of

individuals whose first job is in the region where they did not grow up varies systematically by cohort. Migration flows did not change much over time since 1992 (Hunt, 2006), suggesting that this was not the case. That is, after 1992, we do not expect asymmetric migration patterns at labor market entry across cohorts to affect our results in a meaningful way.

Clearly, there were some West Germans who migrated to the East, but we expect this to be a relatively small fraction of people for the period after 1992. Nevertheless, in the future we will use additional data from other sources at the aggregate and individual level to increase the precision of our classifications. At the aggregate level, the Statistical Office of Germany has data on migration flows across states for all years, which we can exploit. At the individual level, the GSOEP can provide us with the characteristics of migrants across different cohorts, which we can exploit in a factor analysis.

The main challenge then is the assignment of those individuals who show up for the first time in the labor market data in the West in the three big immigration years of 1990, 1991 and 1992. In those years, over one million Eastern Germans exploited the newly opened border to settle in the West (Hunt, 2006). An analysis of the new individuals added in each wave of the data (which corresponds to individuals' first jobs) reveals that in the period 1990-1992, there was a spike in the number of workers aged 25+ whose first place of work is in the West, which is in line with migration flow evidence from other data sets. Figure 1 shows that new entrants with Germany nationality of age 25 and older more or less doubled in the years 1990-1992, compared to the years before 1990 and after 1992 (albeit slightly less in 1992).

To control for individuals aged 25+ who were newly added to the data in 1990-1992, we employ four strategies:

1. Drop all such observations.
2. Denote the fraction of Eastern Germans among these individuals as x_t , which is unobserved. By varying x_t from 0 to 1, we can get a lower- and upper-bound of the error coming from misclassification, in any of our estimates that compute East-West differences. The x_t can be obtained from alternative data sources, or using our data. In the latter case, we can also let the weight vary by age: if N_a is the average number of workers of age a who first appear in the data in the years 1980-1988, and $n_{a,t}$ the number of workers of age a who first appear in the data at time $t \in \{1990, 1991, 1992\}$ and located in West Germany, $x_{a,t} = (n_{a,t} - N_a)/n_{a,t}$.

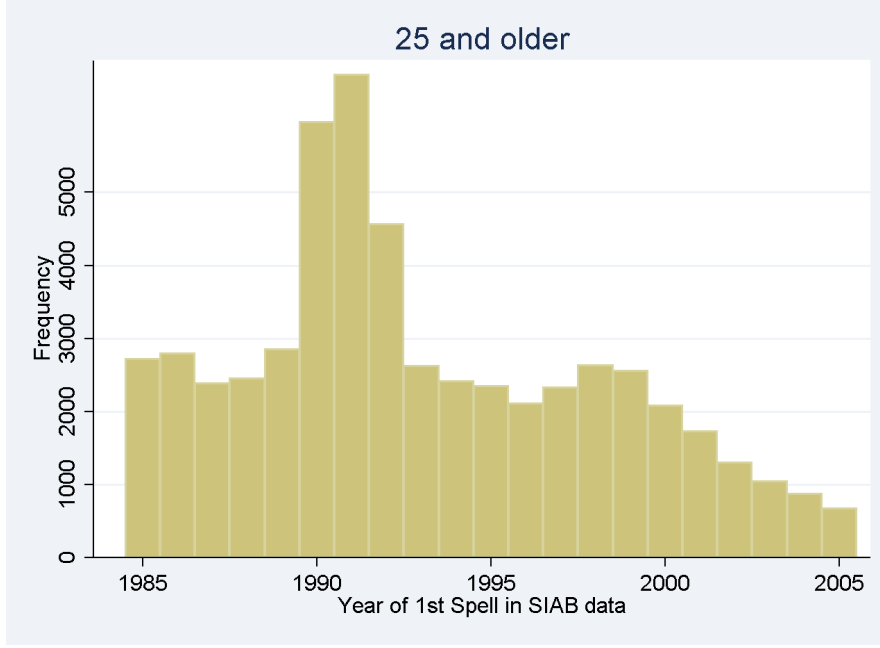


Figure 1: Number of entrants with German nationality into the SIAB who have their first spell in Western Germany in a given year, 25 years and older.

3. When estimating the effect of age, cohort, schooling and work experience on an outcome (we focus on wages, earnings and employment), we can employ a modified method of [Lin and Ng \(2012\)](#) to control for the fact that group membership is unknown for only some members of the sample (their statistical model assumes that group membership is unknown for the entire sample). The advantage of this approach is that we need not be able to perfectly assign all individuals, but are still able to obtain consistent estimates.
4. Lastly, we can use a factor model that takes common, Eastern, and Western factors as explanatory variables. Let X_t be the vector of all individual outcomes at time t . Let $\Theta \equiv [\theta_{Ct}; \theta_{Et}; \theta_{Wt}]$ denote the vector of unobserved common, Eastern and Western factors. Letting Λ denote the matrix of factor loadings, the model is

$$X_t = \Lambda\Theta_t + U_t$$

where U_t is the vector of individual residuals at time t . The principal component/factor analysis can be conducted using the covariance matrix of X_t , while restricting the factor loadings to be zero or non-zero for those observations we know come from the West or East. Then by testing whether the factor loading λ_i for an individual i whose

origin is unknown, we can assign her/him to West or East. For those that we cannot assign using these procedure, we can test again using another outcome variable X_t^2 ; alternatively, we can take many variables of interest and average the factor loadings for the assignment, or borrow estimates from other sources (such as the GSOEP).

As a first pass, we focus on the first and second approaches; the third approach is in progress.

3 Results

Our first results graphically and non-parametrically illustrate the differences in East-West German outcome gaps across cohorts. The main outcome of interest is the average annual earnings of an eastern cohort, normalized by the average earnings of the same western cohort. This measure serves as a natural tool from which we can check convergence in earnings across individuals from different sides of the former border. We calculate for each eastern cohort:

$$\bar{Y}_c^R = \sum_a \left(\sum_{i=1}^{N_c^E} \frac{Y_{ica}^E}{\bar{Y}_{ca}^W} \right),$$

where Y_{ica}^E is an outcome of individual i from the East (E) from cohort c at age a . Note that because the metric is for a given birth cohort c , we could have used time instead of age as indicator interchangeably. \bar{Y}_{ca}^W is the average outcome for cohort c at age a for people brought up in Western Germany. Note that our metric \bar{Y}_c^R , by construction, directly takes out aggregate time effects and cohort effects which are the same for eastern and western educated individuals.

3.1 Males

The first outcome of interest is labor earnings and Figure 2 plots \bar{Y}_c^R for males by cohort c . The first natural cutoff for the age at reunification is 18, around the age most students finish secondary schooling in both Eastern and Western Germany. We chose another cutoff at age 30, to differentiate early career exposure effects from later ones.

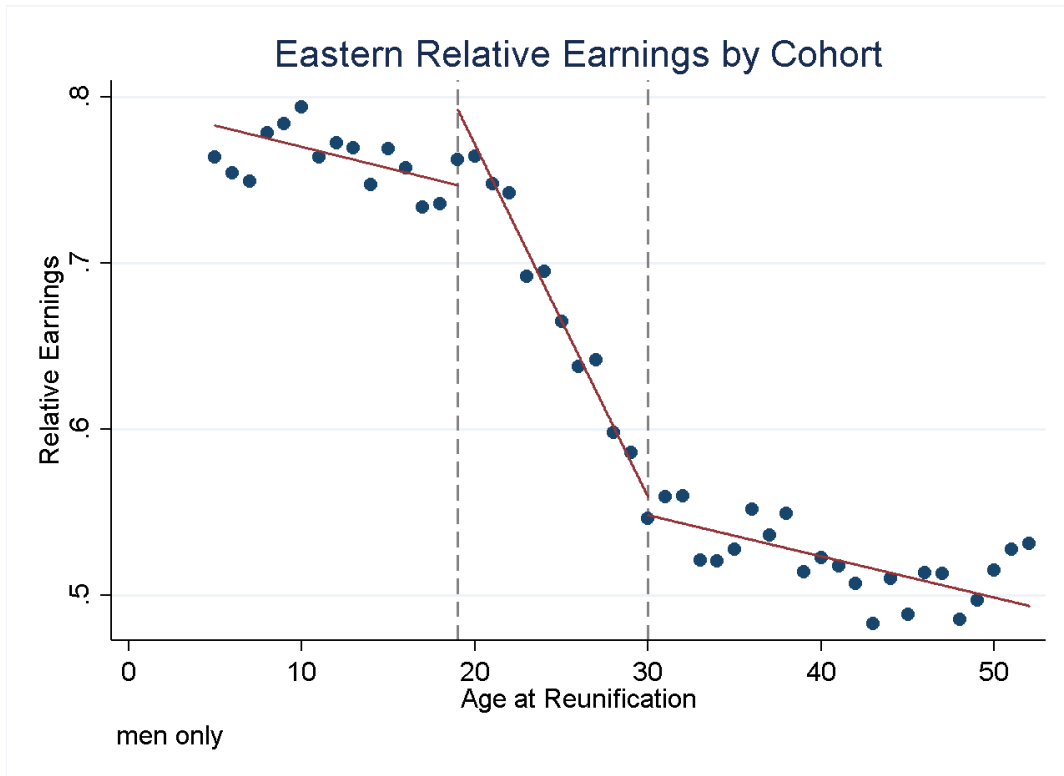


Figure 2: Relative earnings of eastern born men relative to western born by birth cohort. Assignment is according to rule one, so new labor market entrants in West in years 90-92 are left out.

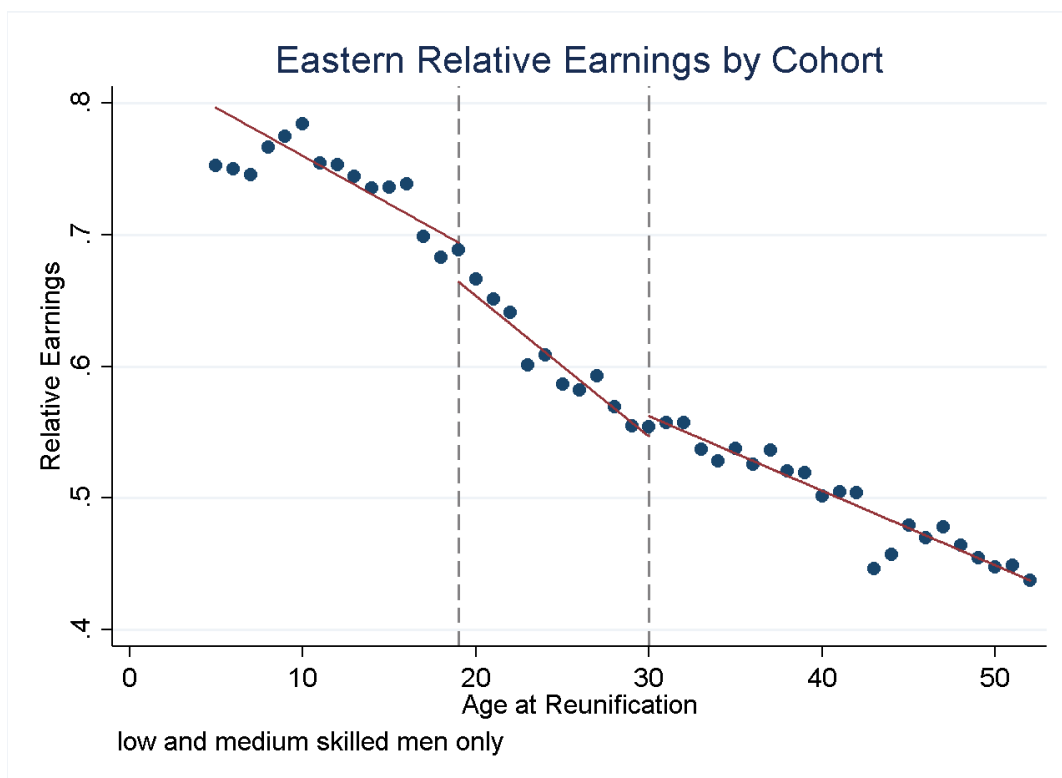


Figure 3: Relative earnings of eastern born men without a college degree relative to western born without a college degree by birth cohort. Assignment is according to rule one, so new labor market entrants in West in years 90-92 are left out.

The picture clearly shows break points in the slope of \bar{Y}_c^R . While a gradient exists, exposure effects are relatively flat for high-school students. In fact, the effects are almost the same as those who were above age 30 at reunification, indicating that the exposure effect may have little to do with schooling. In contrast, there is a very steep gradient starting around age 20: each younger birth cohort has earnings 2% closer to their western counterparts.

This pattern strongly suggests that the mid 20s seem to be the important part of the life-cycle determining convergence. One plausible reason may be that younger individuals were more likely to decide to get a college degree under the new Western system. For first evidence on this channel, Figure 3 shows the exposure effects for individuals without a university degree, so people whose final education level apprenticeship training, high-school, or less. The size of exposure effects within this cohort groups between 18 and 30 is about 60% the size than with the whole sample. This, indeed, suggests that younger Eastern-born individuals were more likely to respond at the college margin than older individuals, which contributed to helping them close the gap with their western counterparts.

If we were to view college as an outcome, this means that younger cohorts in the age group 18-30 at the time of reunification were more likely to get a college degree. Since all these individuals would have already completed secondary school by the time of reunification, this points to other factors than formal schooling that may have attributed to this, in contrast to [Fuchs-Schündeln and Masella \(2016\)](#).

3.2 Females

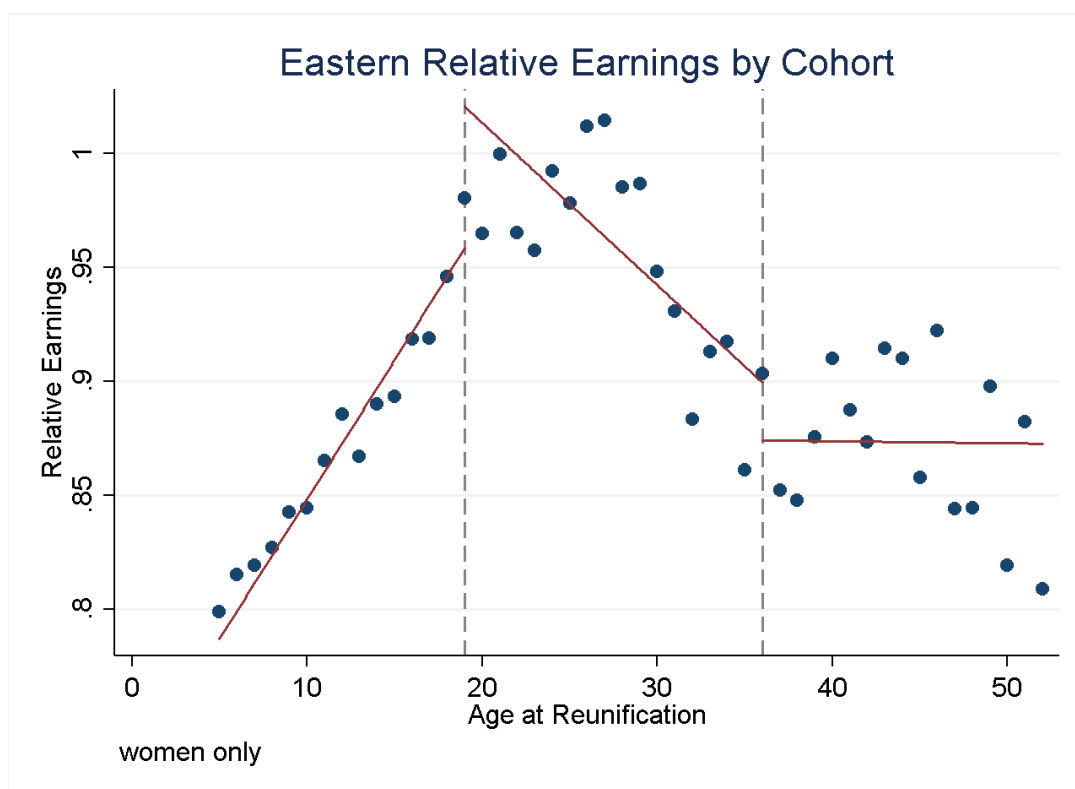


Figure 4: Relative earnings of eastern born women relative to western born by birth cohort. Assignment is according to rule one, so new labor market entrants in West in years 90-92 are left out.

Figure 4 plots relative earnings for females by cohort. Strikingly, for young individuals up to age 18 reunification, the sign of the exposure effects is reversed. This means older eastern born women look more like their western counterparts in terms of earnings. Existing studies suggest that two opposing forces may be working against each other to generate this pattern. On the one hand, older cohorts (statistically) have more stable and higher labor force attachment, as in the socialist East female labor force participation was much higher. So younger cohorts could have lower employment rates. On the other hand, we would expect

some moderate wage catch-up by cohort, as the evidence for males suggests. In future work, we will precisely decompose this channels.

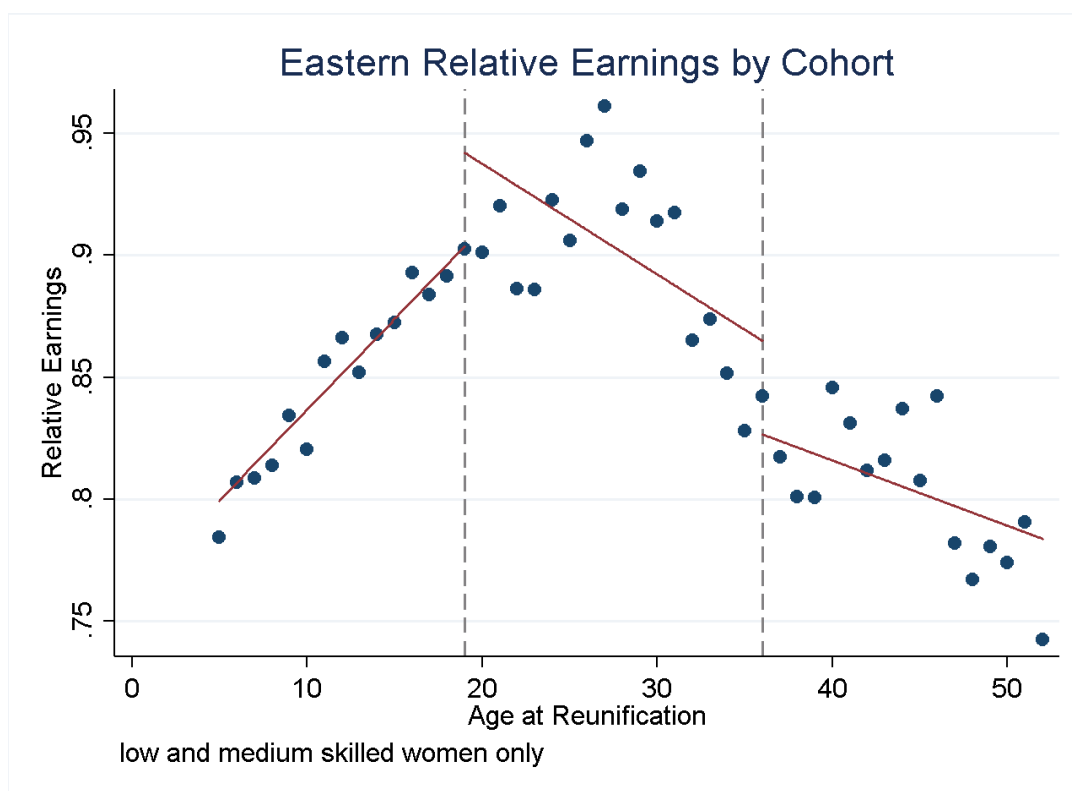


Figure 5: Relative earnings of eastern born women without a college degree relative to western born by birth cohort. Assignment is according to rule one, so new labor market entrants in West in years 90-92 are left out.

In contrast to males, comparison of Figures 5 and 4 indicates that the college enrollment margin for females is less important for cohorts aged 18-30 at reunification. The two plots closely mirror each other, in contrast to men.

The next two figures show that Eastern women's relative earning differences are indeed driven by relative employment differences. Older Eastern women work more than their Western counterparts, but this trend declines linearly for the cohorts below 18 at reunification. That is, younger Eastern women work relatively less than the older cohorts.

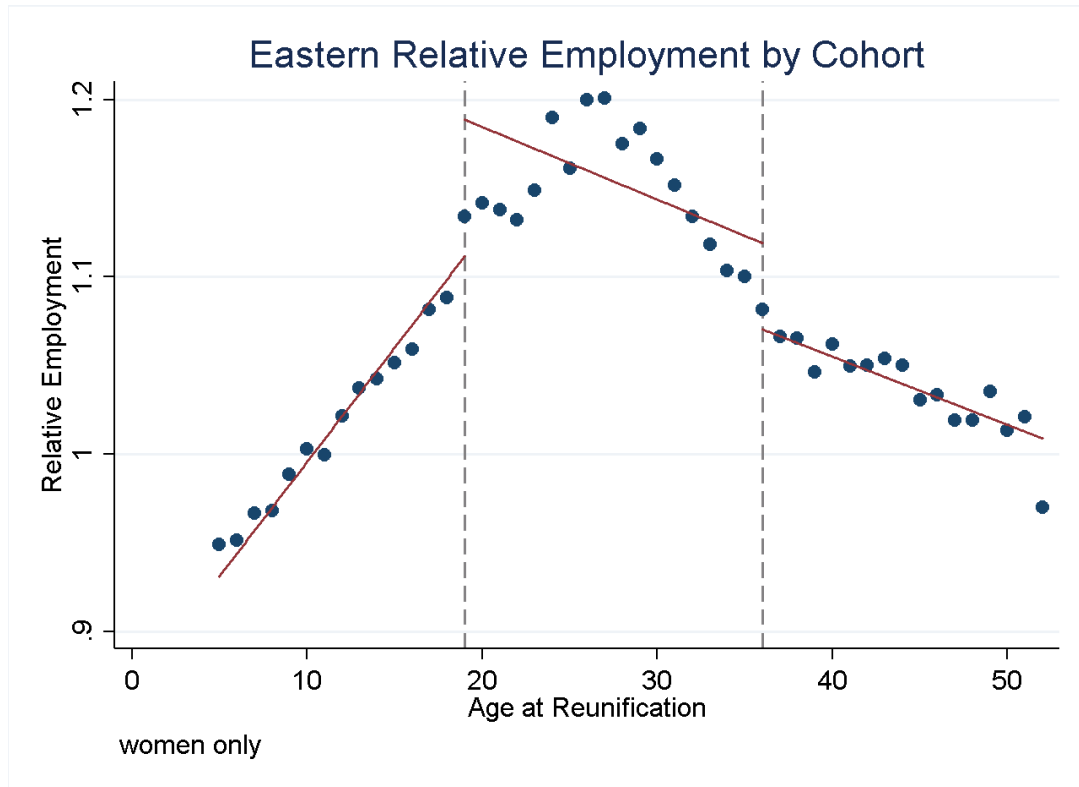


Figure 6: Relative employment of eastern born women relative to western born by birth cohort. Assignment is according to rule one, so new labor market entrants in West in years 90-92 are left out.

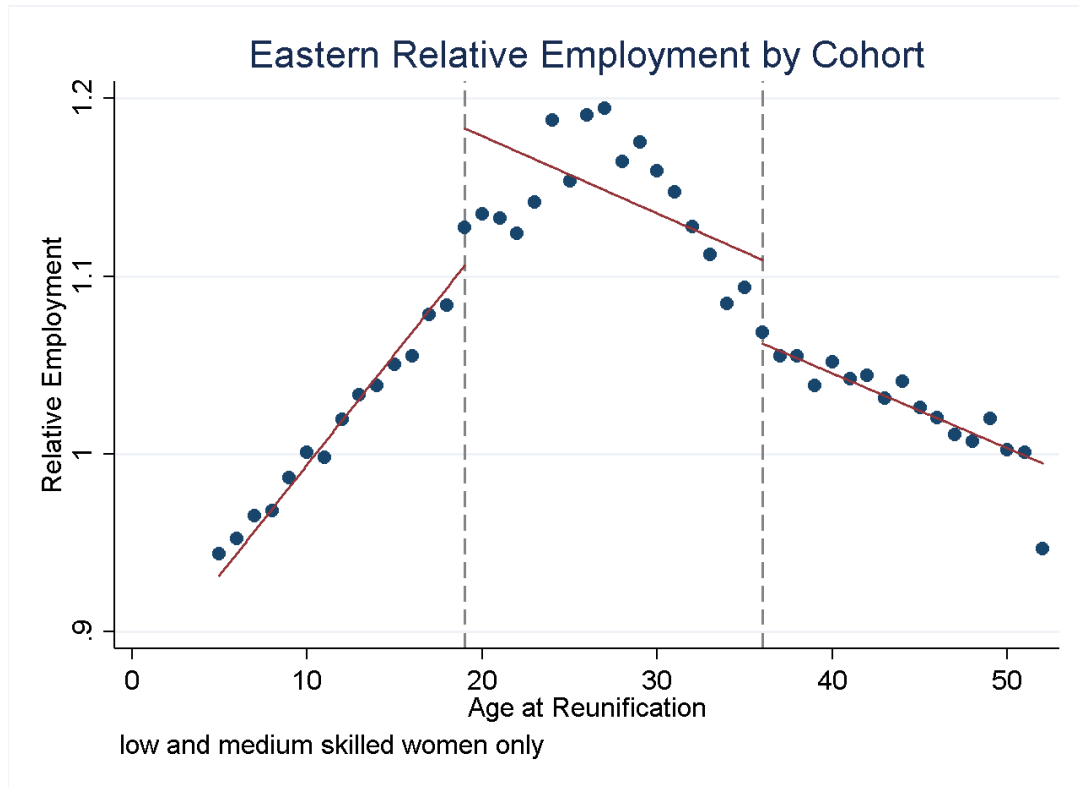


Figure 7: Relative employment of eastern born women without a college degree relative to western born by birth cohort. Assignment is according to rule one, so new labor market entrants in West in years 90-92 are left out.

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Appendix

Table 3: Characteristics of men when first observed in W. Germany

	1985-88		1990		1991		1992		1993-1995	
count	9948		12709		13182		10170		6745	
age	22.87	8.68	26.71	9.824	27.66	10.422	26.90	10.74	25.076	10.03
part time	0.035	0.185	0.032	0.176	0.030	0.171	0.036	0.186	0.050	0.218
apprentice	0.615	0.487	0.346	0.476	0.324	0.468	0.409	0.492	0.541	0.498
low skilled	0.741	0.438	0.538	0.499	0.521	0.500	0.571	0.495	0.692	0.462
med skilled	0.163	0.370	0.378	0.485	0.395	0.489	0.332	0.471	0.197	0.398
high skilled	0.096	0.294	0.084	0.278	0.084	0.278	0.097	0.296	0.111	0.314
daily wage	41.61	57.77	60.86	66.28	63.41	62.05	59.20	64.97	49.67	60.54
yearly earnings	12248	18978	17034	22715	17926	20555	17287	20740	14629	19955

Table 4: Characteristics of women when first observed in W. Germany

	1985-88		1990		1991		1992		1993-1995	
count	10967		11949		11602		10251		7102	
age	25.09	10.46	28.86	11.91	29.53	11.80	29.00	12.02	27.13	11.30
part time	0.151	0.359	0.211	0.408	0.209	0.407	0.199	0.399	0.185	0.388
apprentice	0.535	0.499	0.374	0.484	0.340	0.474	0.392	0.488	0.496	0.500
low skilled	0.717	0.450	0.614	0.487	0.577	0.494	0.595	0.491	0.660	0.474
med skilled	0.237	0.425	0.341	0.474	0.369	0.483	0.346	0.476	0.275	0.447
high skilled	0.046	0.209	0.046	0.209	0.054	0.225	0.060	0.237	0.065	0.246
daily wage	30.20	28.05	37.43	25.77	41.28	29.30	40.83	31.97	36.60	26.68
yearly earnings	8881	9101	10657	8423	11899	9888	12010	10838	10817	8564