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Union Membership and Age:
The inverted U-shape hypothesis under test

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Union Membership and Age: The inverted U-shape hypothesis under test

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Abstract

In this note we cast some doubt on the claim put forward by David Blanchflower (2007) that the probability of being unionized follows an inverted U-shaped pattern in age with a maximum in the mid- to late 40s. By using a special test for an inverted U-shaped pattern that has not been applied to the age-membership nexus before, and by constructing exact confidence intervals for the maximum value, we demonstrate that at least for West Germany Blanchflower's hypothesis does not hold. Our findings suggest that more definitive evidence is needed before the existence of international unionization-age patterns can be taken for granted.

JEL classification: J51

Keywords: unionization, age, inverted U-shape, Germany

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1. Motivation

In a recent contribution David Blanchflower documents "an empirical regularity not hitherto identified, namely the probability of being unionized follows an inverted U-shaped pattern in age, maximizing in the mid- to late 40s in 34 of the 38 countries [studied]" (Blanchflower 2007: 1). Germany is a case in point according to the figures reported in his Table 7, with an age maximum in unionization at 43 in both West and East Germany. To test for this inverted U-shaped pattern and to compute the estimated maximum, Blanchflower estimates probit functions with a union membership dummy as the endogenous variable, while the exogenous variables include age and age squared plus a set of control variables (such as gender, education, and year dummies if appropriate). He argues that a statistically significant positive coefficient of age and a statistically significant negative coefficient of age squared indicate an inverted U-shaped pattern, and reports the maximum of this pattern obtained from solving this quadratic equation (Blanchflower 2007: 15).

While this procedure is standard in many fields of economics and social sciences, it is not fully appropriate. Lind and Mehlum (2007) recently showed that statistically significant regression coefficients of a variable and its squared term that have opposite signs, plus a computed extreme value based on these estimated coefficients that lies inside the data range, are only necessary but not sufficient to proof the existence of a U-shaped (or inverted U-shaped) relationship.[1] They point out that standard testing methodology is no longer suitable for the U shape test of the *composite* null hypothesis that the relationship is decreasing at the left hand side of the interval *and/or* is increasing at the right hand side (resp. the opposite in case of

[1] Lind and Mehlum (2007: 2) argue "that this criteria is too weak. The problem arises when the true relationship is convex but monotone. A quadratic approximation will then erroneously yield an extreme point and hence a U shape."

an inverted U shape). In other words, even if the estimated coefficients of age and age squared in a union membership function are positive and negative, respectively, and statistically significantly different from zero at a conventional error level, and if the computed maximum of the probability of being a union member based on these estimates is neither smaller nor larger than the age of the youngest or oldest person in the sample, this is not sufficient to claim that there is an inverted U-shaped pattern of union membership in age. Lind and Mehlum (2007) adopt a general framework developed by Sasabuchi (1980) to test for the presence of a U-shaped or inverted U-shaped pattern, and they propose the Fieller method to compute the confidence interval for the estimated extreme value.

In this note we compute Sasabuchi tests and Fieller confidence intervals to test the hypothesis of an inverted U-shaped pattern of union membership in age with a maximum in the mid- to late 40s put forward by Blanchflower (2007) using data for West Germany. Section 2 describes the data and outlines our empirical strategy. Section 3 reports the results of our econometric investigation. Section 4 concludes.

2. Data and empirical strategy

In this note, the relationship between unionization and age is investigated using data that are taken from various waves of the ALLBUS, the German general social survey. This survey has been conducted every second year since 1980. Note that the ALLBUS data sets are not part of a panel study; for each wave an independent random sample is drawn covering people aged 18 years or more (for additional information on the ALLBUS, see Terwey 2000). We look at individuals who were 18 to 64 years old and who were working full time or part time, either as blue-collar workers, white-collar workers (except top managers) or civil servants (*Beamte*). Foreigners are excluded here because they were not covered in the years before

1991 and because they form a small and rather heterogeneous proportion of the samples. We focus on West Germany because of the special modalities of quasi-automatic union recruitment in East Germany before and after unification and because this enables us to cover a longer period of observation. We conduct separate analyses for male and female employees to take into account the different work histories of men and women and the lower labour force attachment of women which both can be expected to affect union membership differently.

Data are taken from the ALLBUS surveys conducted in every other year between 1980 (the starting year of this series of surveys) and 2006 (the most recent year for which data were available). Since information on one important variable, the political orientation of the individuals, is missing in 1984, this wave could not be included. The data were pooled over all surveys in a decade, leading to three data sets covering 1980 to 1988, 1990 to 1998, and 2000 to 2006.

Table 1 reports descriptive statistics on the share of union members and non-members, and on the average age of both groups, for West German men and women for the 1980s, 1990s, and 2000s. It can be seen that union density is higher for men than for women, but this gender gap in unionization narrows over time because the substantial fall in union density is much more pronounced for men. The average age of both union members and non-members increases between the 1980s and 2000s, and union members tend to be slightly older than non-members.

[Table 1 near here]

To investigate the role of age as a determinant of union membership, we estimate membership functions separately for men and women using the probit method and pooled data for the 1980s, the 1990s, and the 2000s. The endogenous

variable is a dummy variable that is one if a person is a union member, and zero otherwise. To test for the presence of an inverted U-shaped pattern of union membership in age, four different (nested) empirical models are estimated. Model 1 includes only age and age squared (plus a constant). Model 2 augments model 1 by adding a set of dummy variables indicating whether or not a person is a member of one of the following cohorts of employees who were born within periods of ten years: 1916-1925, 1926-1935, 1936-1945, 1946-1955, 1956-1965, 1966-1975, 1976-1985. Model 3 further adds a set of dummy variables for the ALLBUS surveys the data are taken from. Model 4 augments model 3 by including the following control variables: dummy variables for completed apprenticeship or master craftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, as well as the value of an index measuring the political orientation of individuals (from 1 = extreme left to 10 = extreme right).[2]

We test the Blanchflower (2007) hypothesis of an inverted U-shaped pattern of union membership in age with a maximum at the mid- to late 40s in three stages: First, we apply the standard significance tests to the estimated coefficients of the variables age and age squared (both separately and jointly). Second, we conduct a Sasabuchi (1980) test of an inverted U-shape in age (which is also known as an intersection-union test): This tests the composite null hypothesis that the relationship is increasing at low values of the age interval and/or is decreasing at high values. Third, for the estimated extreme point we compute the Fieller confidence interval (for the ratio of the two normally distributed estimates for the age and age squared variables) and check whether this confidence interval is contained within the data

[2] See Schnabel and Wagner (2005, 2008) for a discussion of these control variables.

range. We also look whether the estimated maximum lies in the age range found by Blanchflower (i.e. the mid- to late 40s).[3]

3. Empirical results

The results of our empirical investigation are reported in Tables 2.1 – 2.3 for men and in Tables 3.1 – 3.3 for women. Given our focus on testing the inverted U-shape hypothesis, we just report the estimated coefficients of the age and age squared variables, but not the coefficients of the cohort dummy variables, the survey dummy variables, and the control variables measured at the individual level.[4]

Our results for men clearly reject the hypothesis of an inverted U-shaped pattern of union membership in age with a maximum at the mid- to late 40s. While age (age squared) has a positive (negative) sign in all 12 empirical models, the estimated coefficients are statistically significant (separately and jointly) at an error level of five percent or less only in model 1 for all three decades plus in model 4 for the pooled data from 1990 to 1998. The Sasabuchi test rejects the hypothesis of an inverted U-shape at the five percent level for all models with the sole exception of model 4 in the 1990s. Even in this model, however, a closer look casts doubt on the second part of the hypothesis under test, i.e. that the maximum is at the mid- to late 40s. The Fieller confidence interval is rather broad, spanning an age period from the late 20s to the mid-50s. The bottom line thus is that we find no stable evidence on a

[3] For details regarding the statistical theory underlying these methods, see Lind and Mehlum (2007). All computations use Stata 10.0 and the ado-file `utest` provided by Lind and Mehlum. To facilitate replication and extensions all do-files are available from the second author.

[4] Detailed results for the individual-level control variables in membership functions estimated with data for 1980 and 2006 can be found in Schnabel and Wagner (2008).

Blanchflower-type relationship between unionization and age among West German men.

[Tables 2.1 – 2.3 near here]

The results for West German women are even less in line with the hypothesis put forward by Blanchflower. The estimated coefficients of the age and age squared variables are statistically significantly different from zero (individually and jointly) at an error level of five percent or better for model 1 in the 1990s and 2000s only. Only the latter model also passes the Sasabuchi test with a prob-value of 0.039. While the point estimates of the maximum of the inverted U are in both cases in line with Blanchflower's hypothesis (taking values of 47.6 and 45.7 years), the Fieller confidence intervals demonstrate that these estimates for the maxima are too imprecise to rectify the conclusion that the maximum falls into the range of the mid- to late 40s.

[Tables 3.1 – 3.3 near here]

4. Concluding remarks

The results presented in this note cast some doubt on the claim put forward by David Blanchflower (2007) that the probability of being unionized follows an inverted U-shaped pattern in age with a maximum in the mid-to late 40s. We demonstrate that at least for West Germany this is not the case – contrary to the findings for Germany presented by Blanchflower (2007). Since our findings are based on a different data set than Blanchflower's, distinguish between men and women, and apply a new statistical method for appropriately testing U-shaped patterns that has not been used

to investigate the relationship between union membership and age before, we would agree that the jury is still out on this issue. Using the data sets and empirical models which Blanchflower's study is based upon and replicating the estimations with the test procedures used here might be a promising way to gain more definitive evidence on the existence of international patterns of unionization and age.

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Table 1: Descriptive statistics on union membership and age in West Germany, 1980 – 2006

Sample	1980 – 1988		1990 – 1998		2000 – 2006	
	Share (percent)	Age (mean) (years)	Share (percent)	Age (mean) (years)	Share (percent)	Age (mean) (years)
Men						
Union members	38.0	40.7	34.2	40.8	26.6	42.9
Non-members	62.0	39.1	65.8	39.1	73.4	40.4
Women						
Union members	19.0	36.6	18.9	39.8	16.5	42.0
Non-members	81.0	36.7	81.1	37.9	83.5	40.5

Note: Computed from various waves of the ALLBUS survey; see text for details.

Table 2-1: Test of an inversely U-shaped relationship between the probability of union membership and age for West German men, Part I: 1980 – 1988

		Model 1	Model 2	Model 3	Model 4
Age (years)	ß	0.04076	0.03092	0.02578	0.02205
	p	0.008	0.248	0.347	0.480
Age squared	ß	-0.00040	-0.00032	-0.00030	-0.00027
	p	0.032	0.323	0.348	0.459
Test of joint significance of age variables. prob-value		0.0001	0.431	0.635	0.760
Sasabuchi-test of inverse U-shape in age. prob-value		0.114	0.276	0.232	0.264
Estimated extreme point (years)		50.5	48.8	42.8	40.3
(bounds of 95% Fieller interval)		44.3 ; 154.7	-inf. ; +inf.	-inf. ; +inf.	-inf. ; +inf.
Test of joint significance of cohort dummy variables. prob-value		[-]	0.004	0.0025	0.054
Test of joint significance of survey dummy variables. prob-value		[-]	[-]	0.145	0.338
Test of joint significance of control variables. prob-value		[-]	[-]	[-]	0.000
LR-Test of entire regression. prob-value		0.0001	0.0000	0.0000	0.0000
Number of observations		2943	2943	2943	2234

Notes: ß is the estimated regression coefficient from a probit model, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. Cohort dummy variables are included for birth years 1926-1935, 1936-1945, 1946-1955, 1956-1965, and 1966-1975, using 1916-1925 as the reference category. Survey dummy variables are included for the ALLBUS surveys 1982, 1986, and 1988, using 1980 as the reference category. The control variables include dummy variables for completed apprenticeship or master raftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, and the value of an index measuring the political orientation (from 1 = extreme left to 10 = extreme right). Data from the ALLBUS survey for 1984 were excluded due to missing information on the political orientation. [-] indicates that the group of variables is not included in the model.

Table 2-2: Test of an inversely U-shaped relationship between the probability of union membership and age for West German men, Part II: 1990 – 1998

		Model 1	Model 2	Model 3	Model 4
Age (years)	ß	0.04833	0.03262	0.03906	0.08597
	p	0.004	0.241	0.170	0.009
Age squared	ß	-0.00049	-0.00050	-0.00045	-0.00107
	p	0.015	0.140	0.185	0.008
Test of joint significance of age variables. prob-value		0.000	0.176	0.388	0.028
Sasabuchi-test of inverse U-shape in age. prob-value		0.067	0.183	0.164	0.011
Estimated extreme point (years)		49.3	32.8	43.8	40.2
(bounds of 95% Fieller interval)		44.2 ; 86.5	-inf. ; +inf.	-inf. ; +inf.	27.5 ; 55.2
Test of joint significance of cohort dummy variables. prob-value		[-]	0.133	0.965	0.670
Test of joint significance of survey dummy variables. prob-value		[-]	[-]	0.114	0.241
Test of joint significance of control variables. prob-value		[-]	[-]	[-]	0.0000
LR-Test of entire regression. prob-value		0.0000	0.0002	0.0002	0.0000
Number of observations		2907	2907	2907	2320

Notes: ß is the estimated regression coefficient from a probit model, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. Cohort dummy variables are included for birth years 1926-1935, 1936-1945, 1946-1955, 1956-1965, and 1966-1975, using 1916-1925 as the reference category. Survey dummy variables are included for the ALLBUS surveys 1992, 1994, 1996, and 1998, using 1990 as the reference category. The control variables include dummy variables for completed apprenticeship or master-craftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, and the value of an index measuring the political orientation (from 1 = extreme left to 10 = extreme right). [-] indicates that the group of variables is not included in the model.

Table 2-3: Test of an inversely U-shaped relationship between the probability of union membership and age for West German men, Part III: 2000 – 2006

		Model 1	Model 2	Model 3	Model 4
Age (years)	ß	0.06930	0.00042	0.00996	0.01514
	P	0.003	0.993	0.831	0.779
Age squared	ß	-0.00067	-0.00012	-0.00008	-0.00010
	P	0.016	0.819	0.875	0.872
Test of joint significance of age variables. prob-value		0.000	0.580	0.962	0.786
Sasabuchi-test of inverse U-shape in age. prob-value		0.104	1.000	0.487	1.000
Estimated extreme point (years)		52.0	1.7	58.7	75.6
(bounds of 95% Fieller interval)		46.1 ; 98.2	-inf. ; +inf.	-inf. ; +inf.	-inf. ; +inf.
Test of joint significance of cohort dummy variables. prob-value		[-]	0.0015	0.008	0.411
Test of joint significance of survey dummy variables. prob-value		[-]	[-]	0.243	0.397
Test of joint significance of control variables. prob-value		[-]	[-]	[-]	0.000
LR-Test of entire regression. prob-value		0.0000	0.0000	0.0000	0.0000
Number of observations		1708	1708	1708	1410

Notes: ß is the estimated regression coefficient from a probit model, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. Cohort dummy variables are included for birth years 1946-1955, 1956-1965, 1966-1975, and 1976-1985, using 1936-1945 as the reference category. Survey dummy variables are included for the ALLBUS surveys 2002 and 2004, using 2000 as the reference category. The control variables include dummy variables for completed apprenticeship or master-craftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, and the value of an index measuring the political orientation (from 1 = extreme left to 10 = extreme right). [-] indicates that the group of variables is not included in the model.

Table 3-1: Test of an inversely U-shaped relationship between the probability of union membership and age for West German women, Part I: 1980 – 1988

		Model 1	Model 2	Model 3	Model 4
Age (years)	ß	-0.015	-0.0126	-0.0095	-0.0172
	p	0.478	0.737	0.807	0.709
Age squared	ß	0.00019	-0.00009	-0.00011	0.0002
	p	0.490	0.848	0.819	0.714
Test of joint significance of age variables, prob-value		0.7745	0.1126	0.3816	0.9316
Sasabuchi-test of inverse U-shape in age, prob-value		0.262	1.000	1.000	0.389
Estimated extreme point (years) (bounds of 95% Fieller interval)		40.0 [-inf .; +inf.]	-68.5 [-inf. ; 35.2]	-43.2 [-inf. ; +inf.]	41.2 [-inf. ; +inf.]
Test of joint significance of cohort dummy variables, prob-value		[-]	0.1300	0.3751	0.4519
Test of joint significance of survey dummy variables, prob-value		[-]	[-]	0.8258	0.6926
Test of joint significance of control variables, prob-value		[-]	[-]	[-]	0.0000
LR-Test of entire regression, prob-value		0.7745	0.2492	0.4466	0.0000
Number of observations		1767	1767	1767	1323

Notes: ß is the estimated regression coefficient from a probit model, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. Cohort dummy variables are included for birth years 1926-1935, 1936-1945, 1946-1955, 1956-1965, and 1966-1975, using 1916-1925 as the reference category. Survey dummy variables are included for the ALLBUS surveys 1982, 1986, and 1988, using 1980 as the reference category. The control variables include dummy variables for completed apprenticeship or master raftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, and the value of an index measuring the political orientation (from 1 = extreme left to 10 = extreme right). Data from the ALLBUS survey for 1984 were excluded due to missing information on the political orientation. [-] indicates that the group of variables is not included in the model.

Table 3-2: Test of an inversely U-shaped relationship between the probability of union membership and age for West German women, Part II: 1990 – 1998

		Model 1	Model 2	Model 3	Model 4	
Age (years)	ß	0.0544	0.0494	0.0595	0.0649	
	p	0.020	0.215	0.134	0.180	
Age squared	ß	-0.0006	-0.00062	-0.00062	-0.00071	
	p	0.049	0.197	0.198	0.236	
Test of joint significance of age Variables, prob-value		0.0028	0.4340	0.2947	0.3885	
Sasabuchi-test of inverse u-shape in age, prob-value		0.0947	0.123	0.233	0.218	
Estimated extreme point (years) (bounds of 95% Fieller interval)		47.6 [41.9 ; 1564.1]	39.6 [-inf. ; +inf.]	48.4 [-inf. ; +inf.]	45.4 [-inf. ; +inf.]	
Test of joint significance of cohort dummy variables,prob-value		[-]	0.2988	0.3681	0.7734	0.4528
Test of joint significance of survey dummy variables,prob-value		[-]	[-]	0.2326	0.1833	[-]
Test of joint significance of control Variables,prob-value		[-]	[-]	[-]	0.0000	0.0000
LR-Test of entire regression, prob-value		0.0028	0.0106	0.0107	0.0000	0.0000
Number of observations		1950	1950	1950	492	1492

Notes: ß is the estimated regression coefficient from a probit model, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. Cohort dummy variables are included for birth years 1926-1935, 1936-1945, 1946-1955, 1956-1965, and 1966-1975, using 1916-1925 as the reference category. Survey dummy variables are included for the ALLBUS surveys 1992, 1994, 1996, and 1998, using 1990 as the reference category. The control variables include dummy variables for completed apprenticeship or master-craftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, and the value of an index measuring the political orientation (from 1 = extreme left to 10 = extreme right). [-] indicates that the group of variables is not included in the model.

Table 3-3: Test of an inversely U-shaped relationship between the probability of union membership and age for West German women, Part III: 2000 – 2006

		Model 1	Model 2	Model 3	Model 4
Age (years)	ß	0.0738	0.0224	0.0407	0.0920
	p	0.013	0.692	0.488	0.186
Age squared	ß	-0.00081	-0.00043	-0.000383	-0.00088
	P	0.024	0.523	0.577	0.288
Test of joint significance of age Variables, prob-value		0.0179	0.4489	0.7183	0.2970
Sasabuchi-test of inverse U-shape in age, prob-value		0.039	0.417	0.405	0.312
Estimated extreme point (years)		45.7	26.1	53.1	52.0
(bounds of 95% Fieller interval)		[40.7 ; 78.0]	[-inf. ; +inf.]	[-inf. ; +inf.]	[-inf. ; +inf.]
Test of joint significance of cohort dummy variables, prob-value		[-]	0.0424	0.1143	0.1392
Test of joint significance of survey dummy variables, prob-value		[-]	[-]	0.0199	0.0802
Test of joint significance of control variables, prob-value		[-]	[-]	[-]	0.0000
LR-Test of entire regression, prob-value		0.0179	0.0044	0.0008	0.0000
Number of observations		1309	1309	1309	1058

Notes: ß is the estimated regression coefficient from a probit model, p is the prob-value (based on robust standard errors). For an explanation of the Sasabuchi-test and the Fieller interval see text. Cohort dummy variables are included for birth years 1946-1955, 1956-1965, 1966-1975, and 1976-1985, using 1936-1945 as the reference category. Survey dummy variables are included for the ALLBUS surveys 2002 and 2004, using 2000 as the reference category. The control variables include dummy variables for completed apprenticeship or master-craftsman, polytech or university degree, blue-collar worker, civil servant, public sector employee, and father being a blue collar worker, and the value of an index measuring the political orientation (from 1 = extreme left to 10 = extreme right). [-] indicates that the group of variables is not included in the model.

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