The Impact of Continuous Training on a Firm's Innovations

Stefan Bauernschuster, Friedrich Schiller University, Jena
Oliver Falck, ifo Institute, Munich
Stephan Heblich, Max Planck Institute for Economics, Jena

Max Planck Institute of Economics, Jena
MAX-PLANCK-GESELLSCHAFT
Friedrich Schiller University Jena
seit1558

- **Gary Becker (1964): Human Capital**
  - Training as an investment decision in perfect labour markets
    - Result: Firms do not finance general training

- **Daron Acemoglu, Jörn-Steffen Pischke (1999): Beyond Becker**
  - Reality: Firms do finance general training
    - Training in imperfect labour markets
  - Asymmetric information and compressed wage structures

- Focus on the appropriability of future rents

Incumbent firms have to
„use innovation as the main battle weapon
with which they protect themselves from competitors
and with which they seek to beat those competitors out“
(Baumol 2002)

Innovation has to become a *routinized* process (constant innovation)

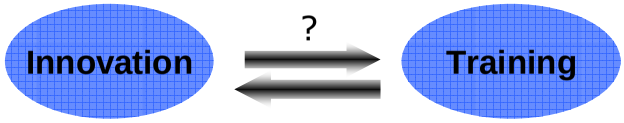
- Existing knowledge stock as a basis for further improvement and extensions (tacit knowledge: know-how and know-who)
- (New) knowledge about the latest technologies

GSBC EIC The Impact of Continuous Training on a Firm's Innovations

- " … And what has this got to do with training?"
  - Danger of closed networks (Granovetter 1973)
  - Training as a way to prevent inflexibility and decrepit structures, although the employee network might be relatively closed

- A firm's routinized innovations are influenced by…
  - Moderate *labour turnover*
  - *Training* of the incumbent employees

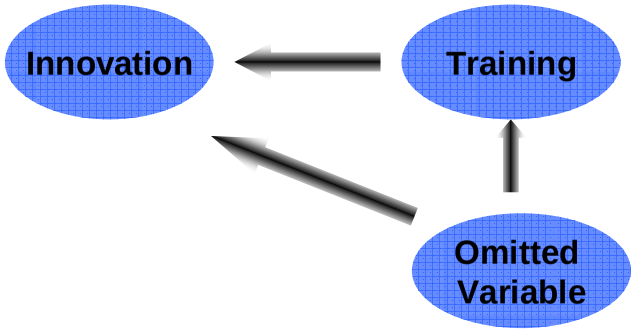
- Endogeneity concerns I
  - Reverse causality



- Lagged training variable
- Focus on the continuity of training
- Lagged innovation variable

GSBC EIC The Impact of Continuous Training on a Firm's Innovations

- Endogeneity concerns II
  - Omitted variables



- Various control variables
- Lagged innovation variable

- Method

1. Simple multivariate regressions

   - Probit models and simple linear model (Angrist 2001)
   - INNO: I (1 | continuous training, lagged INNO, firm level and industry level characteristics, e)

2. Instrumental variable regressions

   - Training instrumented by union contract and works council
   - Union contracts
     - include sections on training and qualification
     - Have no direct impact on innovations
   - German Works Council Constitution Act (§§96-98)
     - Works councils are legally entitled to foster training activities
     - Have no direct impact on innovations

GSBC EIC The Impact of Continuous Training on a Firm's Innovations

- Data

Establishment panel of the German Institute for Employment Research *(IAB Betriebspanel)*

- Various general information on establishments 1997-2001
- 2001: innovations (1999-2001)
  - No innovation
  - Enhancement of one's own products/services
  - Imitation of existing products/services
  - Completely new products/services
- 1997, 1999, 2000: training
  - Training is not financed by the employer
  - Training is financed by the employer

The Impact of Continuous Training on a Firm's Innovations

- Descriptive Statistics

Continuous training	Innovation 1999-2001		
	No	Yes	Total
No	1,315	500	1,815
	72.45	*27.55*	*100.00*
Yes	552	792	1,344
	41.07	*58.93*	*100.00*
Total	1,867	1,292	3,159
	59.10	*40.90*	*100.00*

GSBC EIC

The Impact of Continuous Training on a Firm's Innovations

Independent Variable	Probit regression INNOVATION 1999-2001		Linear Regression INNOVATION 1999-2001	
Constant	-2.007075 ***		-.1083071 *	
Continuous training 1997,1999,2000	.2451723 ***		.0781075 ***	
Log average number of employees 1997-2000	.1609916 **		.048103 **	
Average fraction of skilled employees 1997-2000	-.3059251		-.0699467	
Average fraction of unskilled employees 1997-2000	-.1657358		-.041018	
Average fraction of part-time employees 1997-2000	-.5040503 ***		-.1411576 ***	
Labour turnover 1997-2000	.2879323		.0653807	
Investment in ICT 1997-2000	.3401941 ***		.0881465 ***	
Investment in production technology 1997-2000	.2340427 ***		.0593351 ***	
Organisational changes in 1998	.3309213 ***		.093636 ***	
R&D department in 1998	.6885898 ***		.2172463 ***	
Technical condition of the machines in 1997	.0447866		.0124921	
Union contract 1997-2000	-.0030044		-.0056543	
Works council 1998-2000	-.1241666		-.0336488	
Some innovation in 1998	.6937816 ***		.2324211 ***	
Founding year	.1414595 **		.0433346 **	
Log Average fraction of employees on population 1997-2001	-.0674979		-.0217236	
West Germany	.1227076 *		.0375005	
Industry dummies	Yes		Yes	
	Number of observations	*2,911*	*Number of observations*	*2.921*
	Wald chi2	*838.21*	*F(39,2881)*	*65.15*
	Prob > chi2	*0.0000*	*Prob > F*	*0.0000*
	McFadden R2	*0.2769*	*R-squared*	*0.3353*
	Count R2	*0.771*		
	Adjusted Count R2	*0.435*		

GSBC EIC

The Impact of Continuous Training on a Firm's Innovations

Independent Variable	Probit regression CONTINUOUS TRAINING		Linear regression CONTINUOUS TRAINING	
Constant	-2.995997 ***		-.2076526 ***	
Log average number of employees 1997-2000	.7487761 ***		.1856118 ***	
Average fraction of skilled employees 1997-2000	.4932552 **		.0681674	
Average fraction of unskilled employees 1997-2000	-.4564573 **		-.1468892 ***	
Average fraction of part-time employees 1997-2000	-.1408319		-.0323097	
Labour turnover 1997-2000	-1.04204 **		-.2747758 ***	
Investment in ICT 1997-2000	.242201 ***		.0470883 ***	
Investment in production technology 1997-2000	.2299202 ***		.0545757 ***	
Organisational changes in 1998	.2184312 ***		.0549766 ***	
R&D department in 1998	.3087096 ***		.0870828 ***	
Technical condition of the machines in 1997	.2566838 ***		.0540344 ***	
Union contract 1997-2000	.2219137 ***		.054426 ***	
Works council 1998-2000	.5587528 ***		.2275608 ***	
Some innovation in 1998	.109266 *		.0286444 *	
Founding year	-.0001418		-.0014307	
Log Average fraction of employees on population 1997-2001	-.0305769		-.0050054	
West Germany	.0633637		.0133407	
Industry dummies	Yes		Yes	
	Number of observations	*2,946*	*Number of observations*	*2.946*
	Wald chi2	*1083.56*	*F(39,2881)*	*139.09*
	Prob > chi2	*0.0000*	*Prob > F*	*0.0000*
	McFadden R2	*0.3873*	*R-squared*	*0.4334*
	Count R2	*0.803*	*Root MSE*	*.37441*
	Adjusted Count R2	*0.534*		

GSBC EIC

The Impact of Continuous Training on a Firm's Innovations

Independent Variable	Seemingly unrelated bivariate probit estimation CONTINUOUS TRAINING	INNOVATION 1999-2001	Instrumental variable regression INNOVATION 1999-2001	
Constant	-2.943752 ***	-2.160794 ***	-.1384451 **	
Continuous training 1997,1999,2000		-.6696602	-.0649435	
Log average number of employees 1997-2000	.745593 ***	.3412823	.0748943 **	
Average fraction of skilled employees 1997-2000	.5045903 **	-.1902845	-.0592514	
Average fraction of unskilled employees 1997-2000	-.4251538	-.2954689	-.0613519	
Average fraction of part-time employees 1997-2000	-.1430111	-.5014293 ***	-.1457636 ***	
Labour turnover 1997-2000	-.9732814 **	-.012486	.0255136	
Investment in ICT 1997-2000	.2396861 ***	.3678988 ***	.0948521 ***	
Investment in production technology 1997-2000	.2176261 **	.2749621 ***	.0669665 ***	
Organisational changes in 1998	.2353901 ***	.3659975 ***	.1019366 ***	
R&D department in 1998	.2947368 ***	.7174994 ***	.229625 ***	
Technical condition of the machines in 1997	.2618671 ***	.1006507	.0202351	
Union contract 1997-2000	.1996612 **	.0570874		
Works council 1998-2000	.5654541 ***	.0840514		
Some innovation in 1998	.0925953	.6672616 ***	.2360781 ***	
Founding year	-.0008548	.1327518 *	.0434389 **	
Log Average fraction of employees on population 1997-2001	-.0027894	-.0656253	-.0222589	
West Germany	.0766747	.1314749 **	.0401491	
Industry dummies	Yes	Yes	Yes	
	Number of observations	*2,921*	*Number of observations*	*2.921*
	Wald chi2(77)	*3,039.72*	*F(39,2881)*	*66.39*
	Prob > chi2	*0.0000*	*Prob > F*	*0.0000*
	Likelihood Ratio test of rho = 0		*R-squared*	*0.3235*
	chi2(1)	*.918502*	*Root MSE*	*.40694*
	Prob > chi2	*0.3379*		

Independent Variable	Probit regression REAL INNOVATION vs. PRODUCT ENHANCEMENT/IMITATION 1999-2001		Linear regression REAL INNOVATION vs. PRODUCT ENHANCEMENT/IMITATION 1999-2001	
Constant	-7.044758 ***		-.0705656	
Continuous training 1997,1999,2000	-.031542		-.0063295	
Log average number of employees 1997-2000	.098223		.0226688	
Average fraction of skilled employees 1997-2000	.187516		.0428748	
Average fraction of unskilled employees 1997-2000	.0424639		.0022511	
Average fraction of part-time employees 1997-2000	-.091363		-.0060608	
Labour turnover 1997-2000	1.200811		.2905585	
Investment in ICT 1997-2000	-.0757918		-.0167778	
Investment in production technology 1997-2000	.3312543 *		.0641921 *	
Organisational changes in 1998	-.0121613		-.0052238	
R&D department in 1998	.2591119 **		.0696695 **	
Technical condition of the machines in 1997	-.0096771		-.001671	
Union contract 1997-2000	.1168214		.0303019	
Works council 1998-2000	-.0963043		-.0219831	
Real innovation in 1998	.4630527 ***		.1412073 ***	
Founding year	.0139797		.0050596	
Log Average fraction of employees on population 1997-2001	.1320533		.0354316	
West Germany	-.1674628		-.0438296	
Industry dummies	Yes		Yes	
	Number of observations	*1.174*	*Number of observations*	*1.189*
	McFadden R2	*0.0761*	*F(39, 1149)*	*4.98*
	Count R2	*0.815*	*Prob > F*	*0.0000*
	Adjusted Count R2	*0.023*	*R-squared*	*0.0738*

GSBC EIC The Impact of Continuous Training on a Firm's Innovations

Thank you very much

for your attention!