Firm productivity and wages: evidence from Finnish twin data

The 11th CAED COST Conference
Nuremberg 26.-28.4.2012
Anni Nevalainen (JSBE, FDPE)

Outline

- Introduction
- Empirical modeling
  - OLS
  - FE
  - WT and WT-FD
- Data
- Descriptive statistics
- Estimation results
- Conclusions

Do high productivity firms pay higher wages?

- Descriptive evidence: average wages increase when firm productivity increases
- Labor productivity affects wages more than TFP
- High productivity firms may pay higher wages, but effects are heterogeneous between workers and not only due to selection
- Heterogeneity between genders
- The effect of one standard deviation increase in firm productivity on wages
  - Men: labor productivity 1.6% to 3.3%, TFP 1.0% to 2.1%
  - Women: labor productivity -2.5% to 2.3%, TFP -0.7% to 1.5%

Introduction (1/3)

- **The role of firms in the wage setting one of the key questions in economics**
  - Are firms price-takers or do they have an active role?
  - Rent sharing literature usually finds a positive connection between firm profitability and wages
    - e.g. Blanchflower et al. (1996), Van Reenen (1996), Hildreth & Oswald (1997), Bronars & Famulari (2001), Arai (2003)
  - Labor markets are not frictionless
  - Competitive models, efficiency wage models, bargaining models

- **Why productivity instead of profitability?**
  - Less research
  - Productivity is persistent (Foster et al. 2008), whereas profits may fluctuate more over time
  - If firm productivity affects wages, it can create a more persistent wage gap between employees

Introduction (2/3)

- **Firms and employees are widely heterogeneous**
  - Firms: management quality, atmosphere…
  - Employees: ability, attitudes, preferences…
  - Remain largely unobserved, but affect the outcomes – pure selection?
  - Traditional solutions: fixed effects (e.g. Abowd et al. 1999, Arai 2003), instrumental variables (e.g. Van Reenen 1996, Margolis & Salvanes 2001), IQ test scores (e.g. Bound, Griliches & Hall 1986, Blackburn & Neumark 1992)

Introduction (3/3)

- **This study:**
- **Unobserved individual heterogeneity tackled with twin data**
  - Use information on identical twins
  - Identical twins share the same genes and the same innate ability
  - Identification based on cross sectional variation within pair of identical twins (Ashenfelter & Kruger 1994)
- **Unobserved firm heterogeneity complicates the choice of estimation method**
  - Several approaches
  - Assumptions concerning estimation sample and structure of the error term in a key role

Empirical estimation (1/2)

- **OLS**

$$w_{j,k,t} = \beta_0 + \beta_1 \varphi_{p(j,k,t),t} + \beta_2 X_{j,k,t} + \beta_3 Z_{p(j,k,t),t} + \theta_k + \phi_{p(j,k,t)} + \varepsilon_{j,k,t}$$

  - j = twin order, j = {1,2}
  - k = twin pair, k = {1,…,K}
  - t = time, t = {1990,…,2004}
  - $p(j,k,t)$ = firm indicator function (Abowd et al. 1999)
  - w = logarithmic wage
  - θ = innate ability (shared by an identical twin pair)
  - ϕ = unobserved firm/plant heterogeneity
  - ε = i.i.d. error term
  - φ = firm/plant productivity measure
  - X = individual controls
  - Z = firm/plant controls

- **(Individual) FE**

$$\tilde{w}_{j,k,t} = \beta_1 \tilde{\varphi}_{p(j,k,t)} + \beta_2 \tilde{X}_{j,k,t} + \beta_3 \tilde{Z}_{p(j,k,t)} + \tilde{\phi}_{p(j,k,t)} + \tilde{\varepsilon}_{j,k,t}$$

$$,where\ \widetilde{\log w_{j,k,t}} = \log w_{j,k,t} - \overline{\log w}, \tilde{\varphi}_{p(j,k,t)} = \varphi_{p(j,k,t)} - \bar{\varphi}\ and\ \tilde{\phi}_{p(j,k,t)} = \phi_{p(j,k,t)} - \bar{\phi}.$$

Empirical estimation (2/2)

- **WT**

$$\Delta w_{k,t} = \beta_1 \Delta \varphi_{p(2,k,t),p(1,k,t),t} + \beta_2 \Delta X_{k,t} + \beta_3 \Delta Z_{p(2,k,t),p(1,k,t),t} + \Delta \phi_{p(2,k,t),p(1,k,t)} + \Delta \varepsilon_{k,t}$$

$,if\ p(2,k,t) \neq p(1,k,t)\ for\ some\ k.$

- **WT-FD**

$$(\Delta w_{k,t} - \Delta w_{k,t-1}) = \beta_1 \left(\Delta \varphi_{p(2,k,t),\psi(1,k,t),t} - \Delta \varphi_{p(2,k,t-1),p(1,k,t-1),t-1}\right) + \beta_2 \left(\Delta X_{k,t} - \Delta X_{k,t-1}\right) + \beta_3 \left(\Delta Z_{p(2,k,t),p(1,k,t),t} - \Delta Z_{p(2,k,t-1),p(1,k,t-1),t-1}\right) + (\Delta \varepsilon_{k,t} - \Delta \varepsilon_{k,t-1})$$

$,if\ p(2,k,t) \neq p(1,k,t), p(2,k,t) = p(2,k,t-1) and\ p(1,k,t) = p(1,k,t-1).$

Data

- **Finnish Twin Cohort Study (1975, 1981 and 1990 surveys)**
- **Finnish Longitudinal Employer-Employee Data (FLEED)**
  - ln(wage) = ln(salary income + income from entrepreneurial activities)
- **Additional variables**
  - Relative firm productivity = ln(productivity of firm *p* in year *t*/average productivity of 2-digit industry in year *t*)
  - Employee characteristics (average wages, ages, education…)
  - Firm characteristics (R&D, global-dummy…)
- **Unbalanced panel of nearly 12 000 identical (1/3) and fraternal (2/3) twin pairs between 1990-2004**
- **This study includes only twins working in private sector**

- **Data on total population** – TBA!

Descriptive statistics (1/3)

Table 1. Wages and productivity distribution

Panel A. Full twin sample

		Relative firm LP				Relative firm TFP			
		1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
Both	**ln(wage)**								
	Average	10.02	10.10	10.18	10.31	10.07	10.11	10.17	10.27
	Std. dev.	0.460	0.418	0.422	0.445	0.463	0.426	0.421	0.460
	t-tests (H_0)	q2 = q1	q3 = q2	q4 = q3		q2 = q1	q3 = q2	q4 = q3	
	p-values	**< 0.001**	**< 0.001**	**< 0.001**		**< 0.001**	**< 0.001**	**< 0.001**	
		Relative firm LP				**Relative firm TFP**			
		1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
Men	**ln(wage)**								
	Average	10.18	10.24	10.32	10.45	10.22	10.25	10.31	10.41
	Std. dev.	0.440	0.383	0.401	0.414	0.440	0.407	0.391	0.428
	t-tests (H_0)	q2 = q1	q3 = q2	q4 = q3		q2 = q1	q3 = q2	q4 = q3	
	p-values	**< 0.001**	**< 0.001**	**< 0.001**		**< 0.001**	**< 0.001**	**< 0.001**	
		Relative firm LP				**Relative firm TFP**			
		1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
Women	**ln(wage)**								
	Average	9.83	9.87	9.95	10.06	9.86	9.89	9.94	10.02
	Std. dev.	0.416	0.374	0.345	0.396	0.404	0.362	0.369	0.410
	t-tests (H_0)	q2 = q1	q3 = q2	q4 = q3		q2 = q1	q3 = q2	q4 = q3	
	p-values	**< 0.001**	**< 0.001**	**< 0.001**		**< 0.001**	**< 0.001**	**< 0.001**	

Notes: Both = men and women included, ln(wage) = ln(salary income + income from entrepreneurial activities). LP = labor productivity, TFP = total factor productivity. Relative firm productivity = ln(productivity of firm *p* in period *t* /average productivity of 2-digit industry in year *t*). At 5% level statistically significant p-values of t-tests are bolded.

Descriptive statistics (2/3)

Panel B. Identical (MZ) twins

		Relative firm LP				Relative firm TFP			
		1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
Both	**ln(wage)**								
	Average	10.01	10.09	10.17	10.33	10.05	10.10	10.16	10.29
	Std. dev.	0.473	0.429	0.421	0.457	0.472	0.408	0.426	0.496
	t-tests (H_0)	q2 = q1	q3 = q2	q4 = q3		q2 = q1	q3 = q2	q4 = q3	
	p-values	**< 0.001**	**< 0.001**	**< 0.001**		**< 0.001**	**< 0.001**	**< 0.001**	
		Relative firm LP				**Relative firm TFP**			
		1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
Men	**ln(wage)**								
	Average	10.19	10.23	10.34	10.50	10.21	10.26	10.33	10.46
	Std. dev.	0.462	0.407	0.394	0.434	0.467	0.371	0.392	0.485
	t-tests (H_0)	q2 = q1	q3 = q2	q4 = q3		q2 = q1	q3 = q2	q4 = q3	
	p-values	**0.001**	**< 0.001**	**< 0.001**		**< 0.001**	**< 0.001**	**< 0.001**	
		Relative firm LP				**Relative firm TFP**			
		1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile
Women	**ln(wage)**								
	Average	9.83	9.87	9.93	10.04	9.86	9.87	9.90	10.03
	Std. dev.	0.422	0.369	0.336	0.352	0.416	0.335	0.350	0.391
	t-tests (H_0)	q2 = q1	q3 = q2	q4 = q3		q2 = q1	q3 = q2	q4 = q3	
	p-values	**0.044**	**< 0.001**	**< 0.001**		0.610	**0.019**	**< 0.001**	

Notes: See panel A.

Descriptive statistics (3/3)

Table 2. Twin pairs working in different firms

	All			DZ			MZ		
	Both	Men	Women	Both	Men	Women	Both	Men	Women
Percentage share (%)	73.8	72.2	76.3	80.0	79.0	81.6	63.4	60.8	67.6
No. of observations	12323	7300	5023	8353	5000	3353	3970	2300	1670

Notes: All = full twin sample, DZ = fraternal twins, MZ = identical twins, Both = men and women included.

Estimation results (1/3)

Table 3. OLS and FE results for the effects of productivity on wages

Panel A. Relative firm labor productivity

	Men								Women							
Method:	OLS	OLS	OLS	OLS	FE	FE	FE	FE	OLS	OLS	OLS	OLS	FE	FE	FE	FE
Sample:	All	All	MZ	MZ	All	All	MZ	MZ	All	All	MZ	MZ	All	All	MZ	MZ
Relative firm LP	0.06***	0.04***	0.06***	0.04***	0.04***	0.04***	0.04***	0.03***	0.03***	0.02***	0.03**	0.03***	0.02***	0.01*	0.02***	0.01**
	(0.012)	(0.008)	(0.017)	(0.013)	(0.008)	(0.006)	(0.013)	(0.010)	(0.007)	(0.008)	(0.011)	(0.007)	(0.006)	(0.006)	(0.006)	(0.005)
Region, industry and year controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm controls	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
# observations	20500	20500	6785	6785	20500	20500	6785	6785	13435	13435	4773	4773	13435	13435	4773	4773

Notes: Equations refer to equations (2) and (3). Standard errors are clustered at individual level. All = full twin sample, MZ = identical twins. Significance levels: *** = 1%, ** = 5%, * = 10%. All regressions contain individual and firm controls. Individual controls: age, age2, age3, age4, years of schooling, house owner -dummy, married -dummy, no of children under 7 years, no of children 7-18 years old. Firm controls: average wage of employees, average age of employees, average seniority of employees, share of female employees, no of employees, R&D-dummy, global-dummy. Relative firm productivity = ln(productivity of firm *p* in year *t* /average productivity of 2-digit industry in year *t*). LP = labor productivity, TFP = total factor productivity.

Panel B. Relative firm TFP

	Men								Women							
Method:	OLS	OLS	OLS	OLS	FE	FE	FE	FE	OLS	OLS	OLS	OLS	FE	FE	FE	FE
Sample:	All	All	MZ	MZ	All	All	MZ	MZ	All	All	MZ	MZ	All	All	MZ	MZ
Relative firm TFP	0.03***	0.03***	0.03**	0.04***	0.02***	0.03***	0.02***	0.03***	0.02**	0.01*	0.02**	0.02**	0.02***	0.02***	0.02***	0.01*
	(0.011)	(0.007)	(0.017)	(0.014)	(0.006)	(0.006)	(0.009)	(0.010)	(0.007)	(0.007)	(0.011)	(0.007)	(0.005)	(0.006)	(0.008)	(0.006)
Region, industry and year controls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm controls	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
# observations	20453	20453	6765	6765	20453	20453	6765	6765	13353	13353	4747	4747	13353	13353	4747	4747

Notes: See panel A.

Estimation results (2/3)

Table 4. WT and WT-FD estimates for the effects of productivity on wages

Panel A. Relative firm labor productivity

	Men			Women		
Method:	WT	WT	WT-FD	WT	WT	WT-FD
Relative firm LP	0.03	0.02	0.04*	-0.01	-0.03	0.00
	(0.024)	(0.025)	(0.023)	(0.017)	(0.023)	(0.020)
Region, industry and time controls	yes	yes	yes	yes	yes	yes
Firm controls	no	yes	no	no	yes	no
# observations	1994	1994	457	1005	1005	220

Notes: Estimation equations refer to equations (4) and (5). Standard errors are clustered by twin pair. Significance levels: *** = 1%, ** = 5%, * = 10%. All regressions contain individual and firm controls. Relative firm productivity = ln(productivity of firm *p* in year *t*/average productivity of 2-digit industry in year *t*). LP = labor productivity, TFP = total factor productivity. Regressions include only identical twins.

Panel B. Relative firm TFP

	Men			Women		
Method:	WT	WT	WT-FD	WT	WT	WT-FD
Relative firm TFP	0.03	0.02	0.05**	0.00	-0.01	-0.01
	(0.022)	(0.025)	(0.024)	(0.019)	(0.023)	(0.021)
Region, industry and time controls	yes	yes	yes	yes	yes	yes
Firm controls	no	yes	no	no	yes	no
# observations	1982	1982	452	996	996	218

Notes: See panel A.

Estimation results (3/3)

- **OLS produces the highest coefficient values when no control for innate ability or unobserved firm heterogeneity**
- **Labor productivity affects wages more than TFP**
- **Men's wages are more affected by firm productivity than women's**
  - One standard deviation increase in labor productivity increases men's wages by 1.6 to 3.3% and women's by -2.5 to 2.3%
  - One standard deviation increase in TFP increases men's wages by 1.0 to 2.1% and women's by -0.7 to 1.5%
- **Directions of biases caused by unobserved individual and firm heterogeneity**
- **Robustness**
  - 4-digit industries
  - Plant level
  - Total population – TBA!
  - Others – TBA!

Conclusions

- **Working in high productivity firm can result in higher earnings**
  - **Effects for men positive and (nearly always) statistically significant after ability and unobserved firm heterogeneity are controlled for**
  - **For women results less straight forward to interpret**
  - **Selection by ability does not fully explain connection between firm productivity and wages**
  - **Comparisons to results for firm profitability and wages**
  - **Elements according with rent sharing -models**

- **Heterogeneity between employees – especially between genders**
  - **Occupational selection by gender (Nekby 2003)**
  - **Differences in bargaining abilities?**
  - **Efficiency wages?**