The Heterogeneous Effects of Workplace Diversity on Wages and Productivity

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Motivation

Changing workforce (women, migrants, ageing), changing work environment (increasing competition, ICTs), legislative pression (quotas, affirmative action): workforce less and less homogenous.

Workforce diversity good for complementarities, bad for communication and coordination problems.

Research questions

- What is the right workforce mix to enhance productivity at firm level?
- And whom does it benefit? In a perfectly competitive model there should be no gap.
- Is the impact the same across all sectors?

Theoretical literature

Several ways to theoretically model diversity and productivity: *preferences*, *strategies* or *production function*.

AGE	+	Complementarities (Lazear, 1999); less career comparison and rivalry (Choi, 2007); knowledge transfer and mentoring.
	-	Prime age workers more productive and less turnover; communication problems (Lazear, 1999; Becker, 1957); lower peer pressure and more absenteeism (Ilmakunnas et al., 2010).
GENDER	+	Person-organization fit (Kristof, 1996). Quotas motivation for women (Bertrand et al. 2012) and more competition for men.
	-	Distaste and discrimination from threatened men (Haile, 2012; Akerlof and Kranton, 2000). Quotas lead to patronizing (Bertrand et al. 2012).
EDUCATION	+	Complementarities (Lazear, 1999) and spillovers (Hamilton et al. 2004).
	-	O'Ring theory (Kremer, 1993): assortative matching.

Heterogeneity across sectors

But effects may change across sectors (Göbel and Zwick, 2011). In more innovative ones:

- **Age**: higher complementarities between young and old: youth more knowledgeable in ICTs (Lazear, 1999); skill update, compensation for disabilities and physical decline (Cataldi et al. 2011);
- **Gender**: distaste stronger in traditional industries (carpenter in Akerlof and Kranton, 2000) and soft skills and more creative thinking and less physical stamina (Arun and Arun, 2002);
- **Education**: Complementarities even more relevant in innovative sectors: need of creative thinking, $\neq$ perspectives (Parrotta et al. 2010).

Empirical literature

Three main strands:

- **One company**: Hamilton et al. (2004), Kurtulus (2011), Leonard and Levine (2006), ...
- **LEED**: Ilmakunnas and Ilmakunnas (2011), Iranzo et al. (2008), Navon (2009), Parrotta et al. (2010), ...
- **Others**: Kahane et al. (2012), ...

↪ Strong methodological and/or data limitations (only 4 papers correct for endogeneity).
↪ Only Ilmakunnas and Ilmakunnas (2011) on wages, but at individual level.
↪ Little evidence on heterogeneity across firms.

Contribution

What does this paper add to this literature?

- Data and methods:
  - LEED 1999-2006 on the overall Belgian economy;
  - Correction for heterogeneity and endogeneity bias (GMM, but also LP);
- How are benefits or costs shared? Impact on wages at firm level and productivity-wage gap;
- Is the effect homogenous across sectors (e.g. does the technological environment matter?)

Estimation strategy

Firm production function:

$$Y_{i,t} = F(K_{i,t}, QL_{i,t})$$

or

$$log(Y_{i,t}) = log(A_{i,t}) + \alpha log(K_{i,t}) + \beta log(QL_{i,t})$$

Q, the quality of labour (or efficiency of the labour force), can be expressed as:

$$Q(c) = \left[\frac{1}{N} \sum_{i=1}^{N} c_i^{\gamma} \right]^{\frac{1}{\gamma}}$$

which, following Iranzo et al. (2011), can be developed as:

$$Q(c) = \overline{c} + \frac{1}{2}(\gamma - 1)\frac{\sigma^2}{\overline{c}}$$

Hence in our empirical specification we use the first and second moment of workers' characteristics.

Productivity

$$log(VA/h)_{i,t} = \alpha + \beta_1 A^{\sigma}_{i,t} + \beta_2 E^{\sigma}_{i,t} + \beta_3 G^{\sigma}_{i,t} + \beta_4 \overline{A}_{i,t} + \beta_5 \overline{E}_{i,t} + \lambda X_{i,t} + s_i + y_t + \epsilon_{i,t}$$

where

- A^{σ} age diversity, E^{σ} education diversity, G^{σ} gender diversity, $\overline{A}$ average age, $\overline{A}$ average years of education
- $X_{i,t}$: % non open-ended, % part-time, firm size, % workers with $>$10 years of tenure, % white collars, capital stock
- s_i: industry dummies
- y_t: time dummies

Extended Mincer equation at firm level with the same regressors:

Wage

$$log(W/h)_{i,t} = \alpha^* + \beta_1^* A_{i,t}^{\sigma} + \beta_2^* E_{i,t}^{\sigma} + \beta_3^* G_{i,t}^{\sigma} + \beta_4^* \overline{A}_{i,t} + \beta_5^* \overline{E}_{i,t} + \lambda^* X_{i,t} + s_i + y_t + \epsilon_{i,t}^*$$

Productivity-wage gap (van Ours and Stoeldraijer, 2011):

Gap

$$log(VA - W)_{i,t} = \alpha^{\diamond} + \beta_1^{\diamond} A_{i,t}^{\sigma} + \beta_2^{\diamond} E_{i,t}^{\sigma} + \beta_3^{\diamond} G_{i,t}^{\sigma} + \beta_4^{\diamond} \overline{A}_{i,t} + \beta_5^{\diamond} \overline{E}_{i,t} + \lambda^{\diamond} X_{i,t} + s_i + y_t + \epsilon_{i,t}^{\diamond}$$

Econometric method

Productivity, wage and gap:

- **OLS**, but bias due to unobservables (heterogeneity and simultaneity bias).
- **GMM**: Arellano-Bond static system GMM where variables in the differenced equation are instrumented by their lagged levels and variables in the level equation are instrumented by their lagged differences.

+ for **productivity**:

- **Levinsohn-Petrin** (2003): unobservable productivity shock approximated by a nonparametric estimation method that uses intermediate inputs as instrument (development of Olley-Pakes, 1996).

Data

LEED for Belgium: SES + SBS

- All firms operating in Belgium that employ at least 10 workers and with economic activities within sections C to K;
- In SES firm characteristics (e.g. sector of activity, number of workers, level of collective wage bargaining) and on the individuals (e.g. age, education, tenure, gross earnings, paid hours, sex, occupation) + Financial info from SBS.

Two filters:

- Only private sector;
- Firms with >10 obs.;

Final sample

2,431 firms yielding 7,463 firm-year-observations during 8-year period (1999-2006). ▸ Descriptive statistics

Diversity indexes

Two diversity indicators for age, education and gender:

- *Standard deviation* (measure of dispersion)
- *Dissimilarity index* (relational demography):

$$diss_i = \sqrt{\frac{1}{N}\sum_{k=1}^{N}(x_i - x_k)^2} = \sqrt{(x_i - \overline{x})^2 + Var(x)}$$

and as a robustness check for gender:

- *Gender diversity index*: % women $\cdot$ % men

Table: GMM and LP approach estimates, 1999-2006

	GMM			LP
	(1)	(2)	(3)	(4)
Dependent variables	VA	W	Gap	VA
Age std. Dev	-0.022***	-0.010***	-0.013*	-0.007
	(0.008)	(0.004)	(0.007)	(0.005)
Education std. Dev	0.009	0.017**	-0.008	0.032***
	(0.015)	(0.007)	(0.013)	(0.010)
Gender std. Dev	-0.260**	-0.140**	-0.120	-0.113*
	(0.102)	(0.055)	(0.094)	(0.058)
Age average	0.011***	0.009***	0.002	0.010***
	(0.003)	(0.001)	(0.003)	(0.002)
Education average	0.077***	0.046***	0.032***	0.075***
	(0.007)	(0.003)	(0.006)	(0.007)
Workers' & firm char.	X	X	X	X
Industry and time f.e.	X	X	X	X
Observations	7463	7463	7463	7461
Number of firms	2431	2431	2431	2431
P-value Hansen test	0.765	0.152	0.487	
P-value AR(2)	0.123	0.370	0.560	

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Regressions include worker and firm characteristics (% non open-ended, % part-time, firm size, % workers with >10 years of tenure, % white collars, capital stock), industry (8 dummies) and time dummies (7). In GMM first and second lags of explanatory variables are used as instruments.

Table: GMM and LP approach estimates, 1999-2006

	GMM			LP
	(1)	(2)	(3)	(4)
Dependent variables	VA	W	Gap	VA
Age dissimilarity	-0.016***	-0.007***	-0.009*	-0.005*
	(0.006)	(0.003)	(0.005)	(0.003)
Education dissimilarity	0.007	0.012**	-0.005	0.024***
	(0.011)	(0.005)	(0.010)	(0.006)
Gender dissimilarity	-0.176**	-0.097**	-0.079	-0.075**
	(0.076)	(0.041)	(0.069)	(0.033)
Age average	0.011***	0.009***	0.002	0.010***
	(0.003)	(0.001)	(0.003)	(0.003)
Education average	0.077***	0.046***	0.032***	0.075***
	(0.007)	(0.003)	(0.006)	(0.007)
Workers' & firm char.	X	X	X	X
Industry and time f.e.	X	X	X	X
Observations	7463	7463	7463	7461
Number of firms	2431	2431	2431	2431
P-value Hansen test	0.767	0.172	0.480	
P-value AR(2)	0.124	0.356	0.561	

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Regressions include worker and firm characteristics (% non open-ended, % part-time, firm size, % workers with >10 years of tenure, % white collars, capital stock), industry (8 dummies) and time dummies (7). In GMM first and second lags of explanatory variables are used as instruments.

Heterogeneity across sectors

Check HT/KIS vs. non-HT/KIS.

$$
\begin{aligned}
log(VA/h)_{i,t} = {} & \alpha + \beta_1 A^{\sigma}_{i,t} + \beta_2 E^{\sigma}_{i,t} + \beta_3 G^{\sigma}_{i,t} + \beta_4 \overline{A}_{i,t} + \beta_5 \overline{E}_{i,t} \\
& + \beta_6 A^{\sigma}_{i,t} \cdot HT/KIS + \beta_7 E^{\sigma}_{i,t} \cdot HT/KIS + \beta_8 G^{\sigma}_{i,t} \cdot HT/KIS \\
& + \beta_9 \overline{A}_{i,t} \cdot HT/KIS + \beta_{10} \overline{E}_{i,t} \cdot HT/KIS \\
& + \lambda X_{i,t} + s_i + y_t + \epsilon_{i,t}
\end{aligned}
$$

and the same for wages and productivity-wage gap.

HT/KIS: Eurostat grouping of industries, according to their technological intensity (R&D spending/value added) at NACE 2- or 3-digit level ▸ Full list.

Table: GMM and LP approach estimates, 1999-2006

	GMM			LP
	(1)	(2)	(3)	(4)
Dependent variables	VA	W	Gap	VA
Age std. dev	-0.022**	-0.011**	-0.011	-0.001
	(0.010)	(0.005)	(0.009)	(0.005)
Education std. dev	0.011	0.001	0.010	0.025***
	(0.022)	(0.010)	(0.021)	(0.009)
Gender std. dev	-0.327**	-0.172**	-0.155	-0.194***
	(0.136)	(0.068)	(0.123)	(0.069)
Age std. dev*HT/KIS	0.011	0.006	0.005	-0.014
	(0.026)	(0.012)	(0.024)	(0.009)
Education std. Dev*HT/KIS	-0.007	0.039*	-0.047	0.033
	(0.056)	(0.022)	(0.049)	(0.024)
Gender std. Dev*HT/KIS	0.716*	0.174	0.542	0.343**
	(0.398)	(0.139)	(0.361)	(0.147)
Age average	-0.005	0.003	-0.008	0.008***
	(0.016)	(0.008)	(0.014)	(0.003)
Education average	0.055	0.002	0.053	0.063***
	(0.043)	(0.020)	(0.040)	(0.005)

Age average*HT/KIS	0.035*	-0.001	0.036**	0.006
	(0.021)	(0.010)	(0.018)	(0.004)
Education average*HT/KIS	0.066	0.064**	0.002	0.037***
	(0.064)	(0.029)	(0.053)	(0.010)
HT/KIS	-2.552***	-0.934**	-1.618*	-0.691***
	(0.981)	(0.453)	(0.868)	(0.213)
Observations	7463	7463	7463	7461
Number of firms	2431	2431	2431	2431
R-squared				
P-value Hansen test	0.177	0.0551	0.334	
P-value AR(2)	0.117	0.458	0.499	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Regressions include worker and firm characteristics (% non open-ended, % part-time, firm size, % workers with >10 years of tenure, % white collars, capital stock), industry (8 dummies) and time dummies (7). In GMM first and second lags of explanatory variables are used as instruments.

Table: GMM and LP approach estimates, 1999-2006

	GMM			LP
	(1)	(2)	(3)	(4)
Dependent variables	VA	W	Gap	VA
Age dissimilarity	-0.017**	-0.007**	-0.009	-0.001
	(0.007)	(0.003)	(0.007)	(0.003)
Education dissimilarity	0.006	0.001	0.005	0.019***
	(0.016)	(0.007)	(0.015)	(0.007)
Gender dissimilarity	-0.230**	-0.119**	-0.112	-0.142***
	(0.100)	(0.050)	(0.089)	(0.039)
Age dissimilarity*HT/KIS	0.011	0.004	0.007	-0.010
	(0.019)	(0.009)	(0.017)	(0.007)
Education dissimilarity*HT/KIS	-0.001	0.026	-0.028	0.023
	(0.040)	(0.016)	(0.034)	(0.017)
Gender dissimilarity*HT/KIS	0.527*	0.121	0.406	0.261***
	(0.283)	(0.102)	(0.255)	(0.091)
Age average	-0.003	0.003	-0.006	0.008***
	(0.016)	(0.008)	(0.014)	(0.003)
Education average	0.048	0.002	0.046	0.064***
	(0.042)	(0.019)	(0.039)	(0.007)

Age average*HT/KIS	0.034	-0.000	0.034*	0.006
	(0.021)	(0.010)	(0.018)	(0.004)
Education average*HT/KIS	0.073	0.062**	0.011	0.037***
	(0.064)	(0.029)	(0.052)	(0.013)
HT/KIS	-2.635***	-0.896**	-1.739**	-0.689***
	(0.972)	(0.452)	(0.860)	(0.212)
Observations	7463	7463	7463	7461
Number of firms	2431	2431	2431	2431
R-squared				
P-value Hansen test	0.192	0.0647	0.306	
P-value AR(2)	0.116	0.442	0.502	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Regressions include worker and firm characteristics (% non open-ended, % part-time, firm size, % workers with >10 years of tenure, % white collars, capital stock), industry (8 dummies) and time dummies (7). In GMM first and second lags of explanatory variables are used as instruments.

Robustness checks

- Baseline results confirmed by Wooldridge (2009).
- Gender diversity index.
- Non linearities? Second-order polynomial and interaction with dummy for $>50^{th}$ percentile or $>66^{th}$ percentile.
- Interaction between diversity dimensions? No sign. effect.
- Other taxonomies for technological level: ICT and KIA
- Just services vs. manufacturing? No.
- Size of the firm? Cut-offs at 75, 100, 125, 150 employees and no sign.

Conclusions

Demographic diversity (age and gender) has a negative effect on productivity and wages with no significant gap in traditional industries, while in HT/KIS industries diversity is a positive factor. Education diversity has a positive effect on productivity.

Potentially important implications for firms and HR managers:

- Increasing pressure to diversify the workforce (quotas, AA, CSR, marketing...)
- ...but diversity has not always a positive impact...
- ...and the effects are not homogenous and vary across sectors!

Thank you!

Table: Descriptive statistics (1999-2006)

	All		HT/KIS		Non-HT/KIS	
Variable	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Hourly wage (2006 euros)	17.14	5.39	18.38	5.68	16.64	5.18
Value-added per hour (2006 euros)	61.06	458.61	64.49	239.1	59.71	520.2
Capital	244,287	2,117,000	489,790	3,946,000	147,644	292,979
Investment	18,543	254,447	40,205	476,648	10,019	24,221
Firm size	268.3	281.99	299.9	326.8	255.9	261.2
Average workers age	38.42	4.19	37.45	4.35	38.8	4.07
Age std. dev. intra firms	9.33	1.82	9.01	2.01	9.45	1.73
Age dissimilarity index intra firms	12.61	2.52	12.16	2.77	12.79	2.39
Women	0.27	0.24	0.33	0.25	0.24	0.23
Gender std. Dev.	0.35	0.15	0.38	0.14	0.34	0.16
Gender dissimilarity index	0.46	0.22	0.51	0.2	0.45	0.22
Year of education	11.44	1.76	12.32	1.79	11.09	1.62
Education std. dev. intra firms	1.9	0.84	1.79	0.77	1.94	0.86
Edu. dissimilarity index intra firms	2.54	1.15	2.4	1.05	2.6	1.18
White collar	0.45	0.34	0.62	0.36	0.39	0.31
Part-time ($\leq$30h/week)	0.02	0.07	0.02	0.06	0.02	0.07
Non standard employment contract	0.04	0.1	0.05	0.12	0.04	0.09
Worker tenure:						
$\leq$ 1 year	0.2	0.16	0.23	0.18	0.19	0.16
2-4 years	0.21	0.15	0.24	0.17	0.2	0.14
5-9 years	0.2	0.14	0.21	0.16	0.19	0.14
$\geq$ 10 years	0.39	0.24	0.33	0.25	0.42	0.24

Table: Descriptive statistics (1999-2006)

Variable	All Mean	All Std. Dev.	HT/KIS Mean	HT/KIS Std. Dev.	Non-HT/KIS Mean	Non-HT/KIS Std. Dev.
Sector (%)						
Mining and quarrying (C)	0.01	0.09	0	0	0.01	0.11
Manufacturing (D)	0.57	0.49	0.53	0.5	0.59	0.49
Electricity, gas and water supply (E)	0	0.06	0	0	0.01	0.07
Construction (F)	0.1	0.29	0	0	0.13	0.34
Wholesale and retail trade (G)	0.12	0.33	0	0	0.17	0.37
Hotels and restaurant (H)	0.02	0.13	0	0	0.02	0.16
Transport, storage and comm. (I)	0.06	0.24	0.05	0.21	0.07	0.25
Financial intermediation (J)	0.01	0.11	0.05	0.21	0	0
Real estate, renting and business (K)	0.11	0.31	0.38	0.49	0	0.01
Number of observations	7463		2108		5355	
Number of firms	2431		679		1778	

Notes: Count of HT/KIS and non-HT/KIS firms exceeds the number of all firms due to firms that changed category during the observation period. Monetary values in 2006 euros.

Return

Eurostat taxonomy HT/KIS intensive industries

HT/KIS firms are found in the following sectors: Aerospace (NACE 353); Computers, office machinery (NACE 30); Electronics-communications (NACE 32); Pharmaceuticals (NACE 244); Scientific instruments (NACE 33); Motor vehicles (NACE 34); Electrical machinery (NACE 31); Chemicals (NACE 24); Other transport equipment (NACE 352+354+355); Non-electrical machinery (NACE 29); Water transport (NACE 61); Air transport (NACE 62); Post and telecommunications (NACE 64); Financial intermediation, except insurance and pension funding (NACE 65); Insurance and pension funding, except compulsory social security (NACE 66); Activities auxiliary to financial intermediation (NACE 67); Real estate activities (NACE 70); Renting of machinery and equipment without operator and of personal and household goods (NACE 71); Computer and related activities (NACE 72); Research and development (NACE 73); Other business activities (NACE 74); Education (NACE 80); Health and social work (NACE 85); Recreational, cultural and sporting activities (NACE 92).

Non-HT/KIS firms are found in the following sectors: Rubber and plastic products (NACE 25); Shipbuilding (NACE 351); Other manufacturing (NACE 362 through 366); Non-ferrous metals (NACE 274+2753/54); Non-metallic mineral products (NACE 26); Fabricated metal products (NACE 28); Petroleum refining (NACE 23); Ferrous metals (NACE 271 through 273+2751/52); Paper printing (NACE 21+22); Textile and clothing (NACE 17 through 19); Food, beverages, and tobacco (NACE 15+16); Wood and furniture 20+361); Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel (NACE 50); Wholesale trade and commission trade, except of motor vehicles and motorcycles (NACE 51); Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (NACE 52); Hotels and restaurants (NACE 55); Land transport; transport via pipelines (NACE 60); Supporting and auxiliary transport activities; activities of travel agencies (NACE63); Public administration and defense; compulsory social security (NACE 75); Sewage and refuse disposal, sanitation and similar activities (NACE 90); Activities of membership organization n.e.c. (NACE 91); Other service activities (NACE 93); Private households with employed persons (NACE 95); Extra-territorial organizations and bodies (NACE 99).

◂ Return