Size and persistence matters

Wage and employment insurance at the micro level

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Motivation

- firms offer substantial insurance against wage fluctuations to incumbent workers
  - aggregate productivity shocks (Bils, 1985; Devereux, 2001; Haefke et al., 2013)
  - idiosyncratic firm-level productivity shocks (Bronars and Famullari, 2001; Guiso et al., 2005; Card et al., 2018)
- how much wage insurance workers can enjoy depends on
  - persistence of the shock (Guiso et al., 2005)
  - direction of the shock (Dickens et al., 2007)
- this paper:
  1. analyze interaction between persistence and size of idiosyncratic shocks in shaping wage insurance
  2. extend the analysis to layoffs → employment insurance

Persistence matters

- seminal study by Guiso, Pistaferri, Schivardi (JPE, 2005)
  - use time-series based methods
  - estimate wage elasticities with respect to permanent and transitory shocks to idiosyncratic firm productivity
  - full insurance against transitory shocks, but not against permanent shocks (elasticity 0.0686)
- replicated for other countries with similar conclusions (Cardoso and Portela, 2009; Gürtzgen, 2014; Kátay, 2016)
- identification: (log)wage depends linearly on (log)productivity
  - $\Rightarrow$ wage response to positive and negative shocks is assumed to be symmetric
  - $\Rightarrow$ nonlinear relations cannot be estimated

Sign/direction matters

- International Wage Flexibility Project (Dickens et al., JEP, 2007)
  - use histogram-based approach (Dickens and Goette, 2006)
  - compare observed distribution of wage changes to a hypothetical symmetric distribution
  - the more right-skewed to observed distribution, the more pronounced is downwards wage rigidity
- downwards wage rigidity is universal property of employment relations in Europe and in the US
- approach uses only wage data
  - $\Rightarrow$ no explicit relation between wage changes and firm-specific shocks
  - $\Rightarrow$ no estimates of wage elasticity

This paper

- study the interaction between shock persistence and shock size
  - is downwards wage rigidity more pronounced for transitory than for permanent shocks?
  - does the (absolute) size of a shock matter as well?
  - is there heterogeneity w.r.t. firm and worker characteristics?
- organization
  1. outline estimation strategy
  2. productivity regression
  3. wage regressions
  4. layoff regressions

Estimation strategy (simplified)

1. use time-series properties to differentiate temporary and permanent shocks (Guiso et al. 2005)
   - fit productivity regression at the firm level
   - obtain autocorrelation matrix of the residuals $\Delta\hat{\varepsilon}$
   - infer stochastic process that generates these shocks, e.g.

$$\varepsilon_{jt} = \zeta_{jt} + \tilde{v}_{jt}, \quad \zeta_{jt} = \zeta_{jt-1} + \tilde{u}_{jt}, \quad \tilde{u}_{jt}, \tilde{v}_{jt} \text{ W.N.}$$

   - implies $\Delta\varepsilon = \tilde{u} + \Delta\tilde{v}$
2. run a Kalman filter to form predictions of $\tilde{u}$ and $\Delta\tilde{v}$ from $\Delta\hat{\varepsilon}$
3. use these predictions in (first differenced) wage regression

$$\Delta \ln w_{ijt} = \Delta X'_{ijt}\delta + f(\tilde{u}_{jt}) + g(\Delta\tilde{v}_t) + \Delta\psi_{ijt}$$

Data and sample selection

- linked employer-employee data of the IAB (LIAB), longitudinal version 1993–2010
  - employer data: representative annual IAB establishment survey
  - employee data: social insurance records
  - unit of observation is an establishment
- use information from 1993–2008
- privately-owned establishments in the private, non-financial sector with at least 5 employees
- male full time employees aged 25 to 59
- individuals with censored wages (16%) excluded from wage regressions but included in layoff regressions
- wage reg.: 2531 establishments, 216709 individuals sample statistics

Productivity regression

- productivity of establishment j in year t is

$$\ln\left(\frac{Y_{jt}}{L_{jt}}\right) = \rho \ln\left(\frac{Y_{jt-1}}{L_{jt-1}}\right) + \alpha \ln\left(\frac{K_{jt}}{L_{jt}}\right) + Z'_{jt}\gamma + \varphi_j + \varepsilon_{jt}$$

  - Y_{jt} annual sales in year t
  - L_{jt} total employment at June 30 of year t
  - K_{jt} capital stock constructed from investment data
  - Z_{jt} year dummies, linear time trend interacted with industry and region dummies
  - φ_j unobserved establishment-specific fixed effect
- estimated in first differences using GMM regression table
  - Diff-in-Hansen: capital-labor ratio can be treated as exogenous
  - constant returns to scale cannot be rejected adding log-employment

Residual autocorrelation

- autocorrelation matrix of the GMM residuals:

order (k)	$\mathbb{E}[\Delta\hat{\varepsilon}_{jt}\Delta\hat{\varepsilon}_{jt-k}]$	std. err.
0	0.0795^{***}	0.0038
1	-0.0344^{***}	0.0024
2	0.0018	0.0012
3	-0.0009	0.0011

standard errors bootstrapped with clustering at the establishment level, significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- consistent with the error process

$$\varepsilon_{jt} = \zeta_{jt} + \tilde{v}_{jt}, \quad \zeta_{jt} = \zeta_{jt-1} + \tilde{u}_{jt}, \quad \tilde{u}_{jt}, \tilde{v}_{jt} \text{ W.N.}$$

- estimates $\hat{\sigma}^2_{\tilde{v}} = 0.0344$ and $\hat{\sigma}^2_{\tilde{u}} = 0.0088$ significant at 1% level

Kalman smoothing

- first differencing yields stationary state-space model

$$\Delta\varepsilon_{jt} = \Delta\tilde{v}_{jt} + \tilde{u}_{jt} = \begin{pmatrix} 1 & -1 \end{pmatrix} z_{jt} + \tilde{u}_{jt},$$

$$z_{jt} = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix} z_{jt-1} + \begin{pmatrix} \tilde{v}_{jt} \\ 0 \end{pmatrix}$$

  where $z_{jt} := (\tilde{v}_{jt}, \tilde{v}_{jt-1})'$
- if $\mathbb{E}\tilde{u}_{jt}^2$ and $\mathbb{E}\tilde{v}_{jt}^2$ are known, Kalman smoothing yields the best linear prediction of $\{\tilde{u}_{jt}, z_{jt}\}_{t=1}^{T_j}$ given $\{\Delta\hat{\varepsilon}_{jt}\}_{t=1}^{T_j}$ (Hamilton, 1994)
- shock variances must be estimated

$$\mathbb{E}\tilde{u}_{jt}^2 = \sigma_{\tilde{u}j}^2 = \exp(D_j'\lambda_{\tilde{u}}), \quad \mathbb{E}\tilde{v}_{jt}^2 = \sigma_{\tilde{v}j}^2 = \exp(D_j'\lambda_{\tilde{v}})$$

  - baseline: D_j contains dummies for firm size (4 categories)

Linear wage response

- Guiso et al. (2005) model individual wages as

$$\ln w_{ijt} = X'_{ijt}\delta + \alpha P_{jt} + \beta T_{jt} + \phi_{ij} + \psi_{ijt}$$

  - w_{ijt} annual avg. wage that establishment j pays worker i in year t
  - X_{ijt} includes Z_{jt}, cubic polynomials in age and tenure, dummies for industrial relations, education, white collar employment
  - P_{jt} permanent productivity component (essentially ζ_{jt})
  - T_{jt} transitory productivity component (essentially $\tilde{v}_{jt}$)
  - ϕ_{ij} unobserved match-specific fixed effect
- P_{jt} and T_{jt} stem from decomposition $\ln\left(\frac{Y_{jt}}{L_{jt}}\right) = D_{jt} + P_{jt} + T_{jt}$
- problem: P_{jt} and T_{jt} are unobserved

Linear wage response (2)

- first differencing:

$$\Delta \ln w_{ijt} = \Delta X'_{ijt}\delta + \alpha \Delta P_{jt} + \beta \Delta T_{jt} + \Delta \psi_{ijt} \qquad (*)$$

where $\Delta P_{jt} = \frac{\tilde{u}_{jt}}{1-\rho}$, $\Delta T_{jt} = (1-\rho L)^{-1}[\Delta \tilde{v}_{jt} - \frac{\rho}{1-\rho}\Delta \tilde{u}_{jt}]$

- use predictions of $\tilde{u}_{jt}$ and $\Delta \tilde{v}_{jt}$ to predict ΔP_{jt} and ΔT_{jt}
- substitute these into $(*)$ and estimate by OLS
- bootstrap standard errors since predictions are used as regressors (clustering at the establishment level)

Wage elasticities

	ML variance estimate		MM variance estimate	
	coef.	std. err.	coef.	std. err.
α	0.0625^{***}	0.0143	0.0617^{***}	0.0145
β	0.0189^{*}	0.0102	0.0192^{*}	0.0105

bootstrapped standard errors clustered at the establishment level, coefficient significance levels: $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

estimated variances

- robustness: different variance patterns
- heterogeneity: by industry by establishment size by industrial relations

Nonlinear wage response

- generalize wage regression model

$$\Delta \ln w_{ijt} = \Delta X'_{ijt}\delta + f(\Delta P_{jt}) + g(\Delta T_{jt}) + \Delta\psi_{ijt}$$

- f and g may be parametric or non-parametric functions
  - to find appropriate parametric forms, first estimate semiparametrically, assuming that f and g are locally linear
  - then piecewise linear functions with appropriate break points
- replace ΔP_{jt} and ΔT_{jt} with the predictions of the Kalman filter

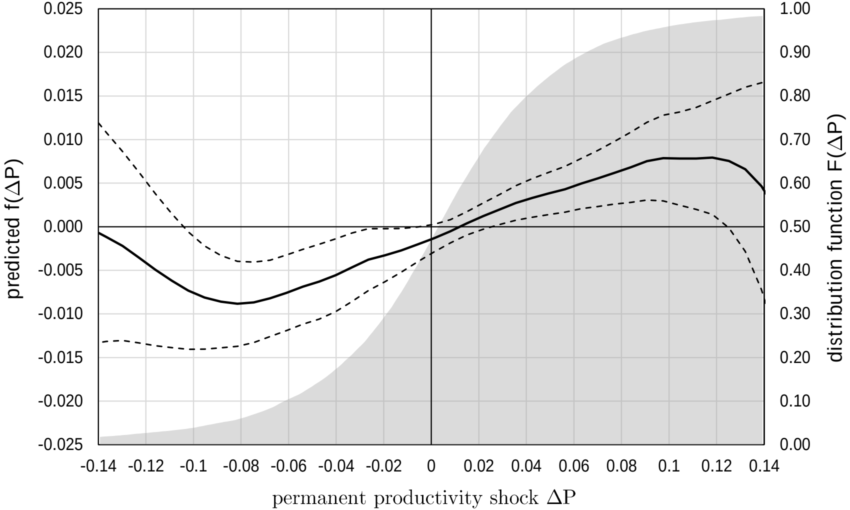
Local wage elasticities

- assume that f and g are piecewise linear on disjoint intervals I_k
- q_r refers to the rth percentile of the respective shock distribution

	permanent shock, ΔP_{jt}		transitory shock, ΔT_{jt}	
interval I_k	coefficient	std. err.	coefficient	std. err.
$\mathbb{R}$	0.0625^{***}	0.0143	0.0189^{*}	0.0102
$(-\infty, 0)$	-0.0056	0.0269	0.0462^{***}	0.0172
$[0, +\infty)$	0.1121^{***}	0.0268	-0.0067	0.0096
$[q_{10}, q_{50})$	0.1082^{**}	0.0524	0.0821^{**}	0.0325
$[q_{50}, q_{90})$	0.1149^{**}	0.0498	0.0043	0.0220

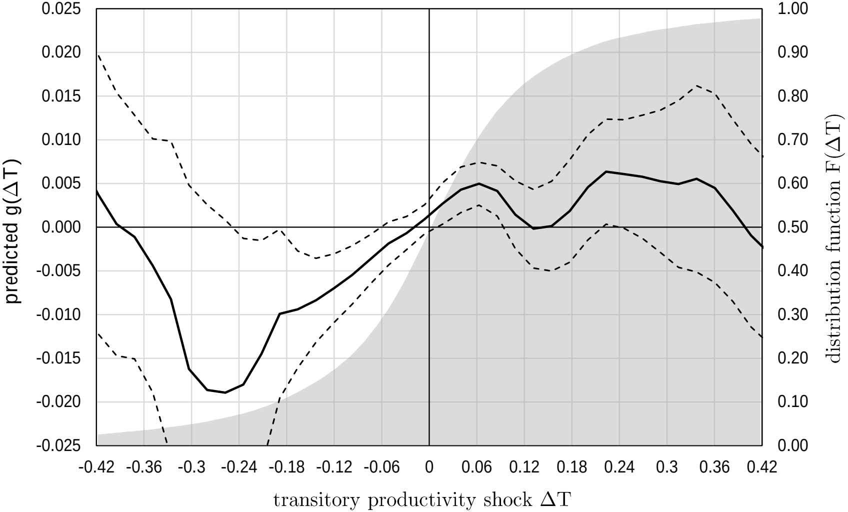
bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Wage response to a permanent shock



left axis: local linear kernel regression, 95% confidence band based on bootstrapped standard errors clustered at the establishment level; right axis: empirical cdf (shaded)

Wage response to a transitory shock



left axis: local linear kernel regression, 95% confidence band based on bootstrapped standard errors clustered at the establishment level; right axis: empirical cdf (shaded)

Local wage elasticities by worker type

	permanent shock, ΔP_{jt}		transitory shock, ΔT_{jt}	
interaction $\times$ interval I_k	coefficient	std. err.	coefficient	std. err.
blue-collar $\times$ $\mathbb{R}$	0.0613^{***}	0.0173	0.0244^{*}	0.0134
white-collar $\times$ $\mathbb{R}$	0.0651^{***}	0.0186	-0.0015	0.0088
blue-collar $\times$ (q_{10}, q_{50})	0.0920	0.0611	0.1117^{***}	0.0429
blue-collar $\times$ $[q_{50}, q_{90})$	0.1088^{**}	0.0555	-0.0059	0.0285
white-collar $\times$ (q_{10}, q_{50})	0.0453	0.0555	0.0136	0.0196
white-collar $\times$ $[q_{50}, q_{90})$	0.1819^{***}	0.0526	0.0054	0.0234

employees in the manufacturing sector only; q_r refers to the rth percentile of the respective distribution; bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Summary: wage elasticities

- permanent shocks:
  - downwards real wage rigidity only observed for very bad shocks
  - wage elasticity of 0.10–0.12 in the middle of the distribution
- transitory shocks:
  - negative shocks lower wages, positive shocks captured by firm $\Rightarrow$ upward rigidity
- heterogeneity with respect to worker type:
  - downwards flexibility of wages limited to blue-collar employment
  - wages of white-collar workers are downwards rigid
  - in line with previous empirical evidence, e.g. Campbell (1997), Du Caju et al. (2007)
  - might be due to motivational considerations (shirking, job search)

Layoff regressions

- layoff = transition from employment to non-employment s.t.
  1. non-employment spell lasts for at least 60 days
  2. the next employment spell is not with the same employer
- $lay_{ijt} = 1$ if worker i is laid off by establishment j in year t
- mean annual layoff probability is 6.87%
- linear probability model in first differences

$$\Delta lay_{ijt} = \Delta X'_{ijt}\delta + f(\Delta P_{jt}) + g(\Delta T_{jt}) + \Delta\psi_{ijt}$$

Semi-elasticity of the layoff rate

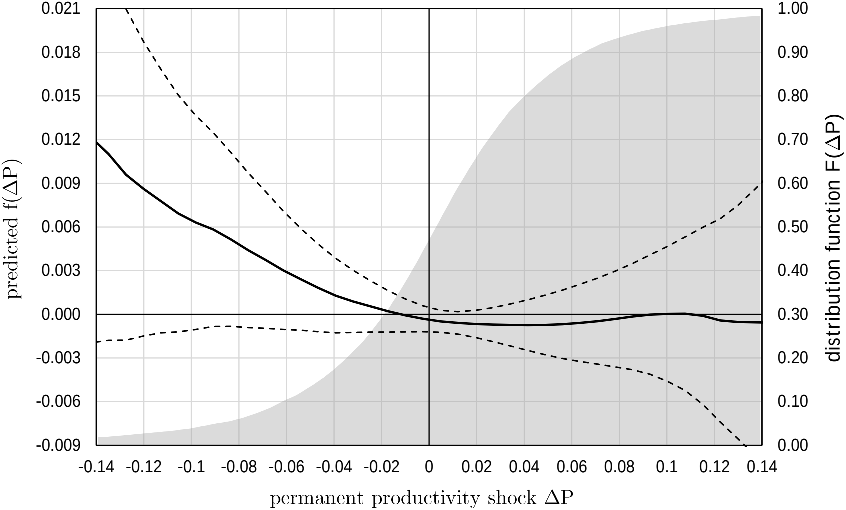
interval I_k	permanent shock, ΔP_{jt} coefficient	std. err.	transitory shock, ΔT_{jt} coefficient	std. err.
$\mathbb{R}$	-0.0262	0.0215	0.0018	0.0094
$(-\infty, 0)$	-0.0953^{**}	0.0463	0.0044	0.0232
$[0, +\infty)$	0.0257	0.0291	-0.0001	0.0175

bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

elasticity w.r.t. negative permanent shock:

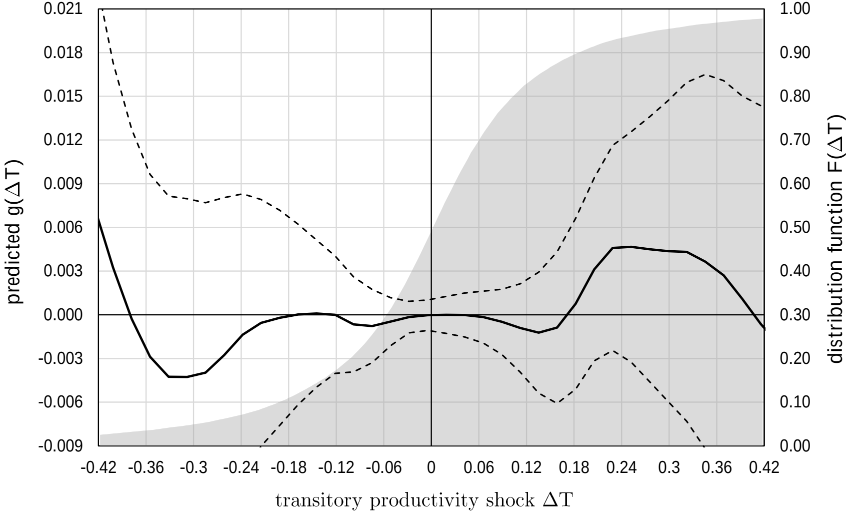
$$\frac{\partial lay_{ijt}}{\partial P_{ijt}} \frac{1}{\overline{lay}_{ijt}} = -\frac{0.0953}{0.0687} = -1.39$$

Layoff response to a permanent shock



left axis: local linear kernel regression, 95% confidence band based on bootstrapped standard errors clustered at the establishment level; right axis: empirical cdf (shaded)

Layoff response to a transitory shock



left axis: local linear kernel regression, 95% confidence band based on bootstrapped standard errors clustered at the establishment level; right axis: empirical cdf (shaded)

Semi-elasticity of the layoff rate by worker type

	permanent shock, ΔP_{jt}		transitory shock, ΔT_{jt}	
interaction $\times$ interval I_k	coefficient	std. err.	coefficient	std. err.
blue-collar $\times$ $\mathbb{R}$	-0.0251	0.0203	-0.0026	0.0103
white-collar $\times$ $\mathbb{R}$	0.0215	0.0231	-0.0007	0.0090
blue-collar $\times$ $(-\infty, 0)$	-0.0996^{***}	0.0381	0.0137	0.0250
blue-collar $\times$ $[0, +\infty)$	0.0259	0.0314	-0.0179	0.0165
white-collar $\times$ $(-\infty, 0)$	-0.0052	0.0547	0.0178	0.0262
white-collar $\times$ $[0, +\infty)$	0.0435	0.0415	-0.0217	0.0181

employees in the manufacturing sector only; q_r refers to the rth percentile of the respective distribution; bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Summary: layoff elasticities

- layoff probability only reacts to negative permanent shocks
- no reaction to negative transitory shocks (suggests that Kalman filter does a reasonably good job)
- heterogeneity by worker type:
  - increase in layoffs limited to blue-collar employment
  - white-collar employment perfectly insured against negative shocks
  - might be due to higher replacement costs

Conclusion

- how do productivity shocks at the firm level affect individual wages and employment?
- focus on interaction between shock persistence and shock size
- on average little evidence for downwards wage rigidity
  - permanent shocks have largely symmetric effect on wages
  - transitory shocks lead to *upwards* wage rigidity
- substantial heterogeneity at the worker level
  - wage cuts and employment loss after negative shocks concentrated on blue-collar workers
  - white-collar workers enjoy full insurance against negative shocks
  - hints at agency and turnover considerations

Appendix

Sample statistics

	productivity reg. (establishment lvl)		wage regressions (worker level)		layoff regressions (worker level)	
	mean	s.d.	mean	s.d.	mean	s.d.
sales per worker*	1.811	6.892	2.670	4.165	2.733	5.099
employment	181.3	772.1	2758.7	5477.5	3288.1	5477.5
capital-labor ratio*	0.947	5.913	1.409	2.172	1.426	2.182
1–9 employees	0.216		0.006		0.005	
10–99 employees	0.406		0.052		0.050	
100–199 employees	0.222		0.132		0.127	
200+ employees	0.156		0.810		0.818	
manufacturing	0.477		0.840		0.831	
construction	0.143		0.049		0.047	
sales	0.160		0.041		0.039	
services	0.220		0.070		0.083	
wage			107.23	27.28	116.29	39.09
tenure			12.234	7.393	11.578	7.823
age			41.459	8.702	41.817	8.762
white-collar			0.180		0.311	
establishments	2697		2531		2620	
individuals			216709		300667	

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* measured in 100000 €

Productivity regression

	coefficient	std. err.
$\ln\left(\frac{Y_{jt-1}}{L_{jt-1}}\right)$	0.2101^{***}	0.0376
$\ln\left(\frac{K_{jt}}{L_{jt}}\right)$	0.3173^{***}	0.0285
	χ^2-statistic	p-value
year dummies	95.72^{***}	0.000
industry dummies	39.83^{***}	0.000
regional dummies	10.54	0.837
	statistic	p-value
AR(2) test	1.32	0.186
AR(3) test	−0.83	0.407
AR(4) test	1.11	0.267
Hansen J test	39.23	0.415
establishments (observations)	2697 (17407)	

two-step difference GMM, corrected standard errors clustered at the establishment level, significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Productivity regression – robustness

	(a) static FE model		(b) dynamic FE model	
	coefficient	std. err.	coefficient	std. err.
$\ln\left(\frac{Y_{jt-1}}{L_{jt-1}}\right)$	——	——	0.2503^{***}	0.0378
$\ln\left(\frac{K_{jt}}{L_{jt}}\right)$	0.3205^{***}	0.0289	0.3021^{***}	0.0233
$\ln L_{jt}$	0.0234	0.0380	-0.0206	0.0318
	statistic	p-value	statistic	p-value
AR(2) test	-2.77	0.006	1.81	0.070
AR(3) test	-1.55	0.120	-0.69	0.493
AR(4) test	0.72	0.471	1.10	0.270
Hansen J test	44.70	0.211	80.66	0.252

two-step diff. GMM accounting for endogeneity of $\Delta \ln L_{jt}$, corrected standard errors clustered at the establishment level, significance levels: $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

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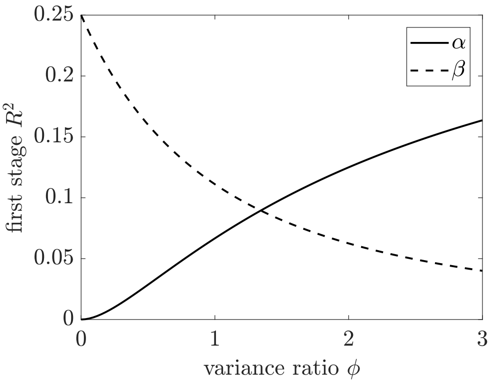
Weak instruments

first stage R^2 as a function of $\phi = \sigma^2_{\tilde{u}}/\sigma^2_{\tilde{v}}$



- unweighted: $\phi = 0.79,\ R^2_\alpha = 0.051,\ R^2_\beta = 0.129$
- weighted: $\phi = 0.29,\ R^2_\alpha = 0.013,\ R^2_\beta = 0.191$

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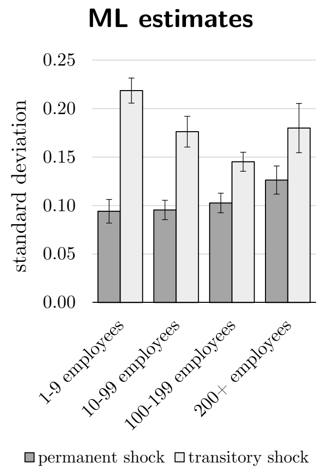
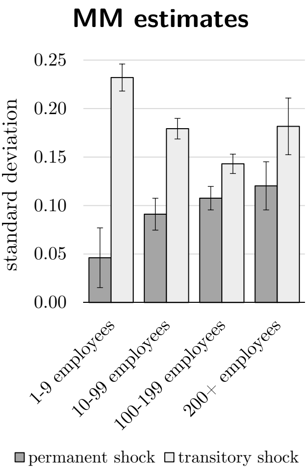
Estimated standard deviations $\hat{\sigma}_{\tilde{u}j}$ and $\hat{\sigma}_{\tilde{v}j}$





error bars indicate bootstrapped standard errors clustered at the establishment level

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Wage elasticities – robustness

different ML variance estimates

	homoscedastic		heteroscedastic: establish. size + industry	
	coefficient	std. err.	coefficient	std. err.
α	0.0701^{***}	0.0162	0.0626^{***}	0.0170
β	0.0201^{**}	0.0091	0.0192^{*}	0.0101

bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Wage elasticities – heterogeneity by industry

	permanent shock, ΔP_{jt}		transitory shock, ΔT_{jt}	
	coefficient	std. err.	coefficient	std. err.
manufacturing	0.0615^{***}	0.0162	0.0204^{*}	0.0121
construction	0.0950^{***}	0.0313	0.0113	0.0136
sales	0.0599^{**}	0.0236	0.0015	0.0116
services	0.0228	0.0344	0.0259	0.0246
total	0.0625^{***}	0.0143	0.0189^{*}	0.0102

bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Wage elasticities – heterogeneity by establishment size

	permanent shock, ΔP_{jt}		transitory shock, ΔT_{jt}	
size category	coefficient	std. err.	coefficient	std. err.
1–9 employees	0.0545	0.0404	0.0069	0.0091
10–99 employees	0.0681^{***}	0.0166	0.0148^{***}	0.0051
100–199 employees	0.0593^{***}	0.0141	0.0110^{***}	0.0078
200+ employees	0.0588^{***}	0.0166	0.0231	0.0130
total	0.0625^{***}	0.0143	0.0189^{*}	0.0102

bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Wage elasticities – heterogeneity by industrial relations

	permanent shock, ΔP_{jt}		transitory shock, ΔT_{jt}	
	coefficient	std. err.	coefficient	std. err.
ΔX_{jt}	0.0708^{*}	0.0396	0.0179^{**}	0.0091
ΔX_{jt} × CBA industry	-0.0142	0.0371	0.0035	0.0184
ΔX_{jt} × CBA firm	-0.0936	0.0821	0.0073	0.0243
ΔX_{jt} × WC	0.0104	0.0371	-0.0004	0.0200

establishments in the manufacturing sector only; bootstrapped standard clustered at the establishment level, significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Wage elasticities – heterogeneity by worker type

interact. × interval	permanent shock, ΔP_{jt} coefficient	permanent shock, ΔP_{jt} std. err.	transitory shock, ΔT_{jt} coefficient	transitory shock, ΔT_{jt} std. err.
Blue × $\mathbb{R}$	0.0613^{***}	0.0173	0.0244^{*}	0.0134
White × $\mathbb{R}$	0.0651^{***}	0.0186	-0.0015	0.0088
Blue × $(-\infty, 0)$	-0.0185	0.0339	0.0631^{***}	0.0239
Blue × $[0, +\infty)$	0.1131^{***}	0.0334	-0.0149	0.0117
White × $(-\infty, 0)$	0.0027	0.0262	0.0115	0.0133
White × $[0, +\infty)$	0.1150^{***}	0.0259	-0.0141	0.0123

manufacturing sector only; bootstrapped standard errors clustered at the establishment level, coefficient significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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