Size and persistence matter

Wage and employment insurance at the micro level

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Motivation

- firms offer substantial insurance against wage fluctuations to job stayers
- especially with respect to idiosyncratic firm-level shocks (Bronars and Famullari, 2001; Guiso et al., 2005; Card et al., 2018)
- degree of wage insurance depends on
  - persistence of the shock: transitory vs. permanent
  - size/direction of the shock: positive vs. negative
- this paper:
  1. analyze **interaction** between persistence and size of idiosyncratic shocks in shaping wage insurance at the firm level
  2. extend the analysis to layoffs

Relation to the literature

1. wage insurance and shock persistence
   - Guiso, Pistaferri, Schivardi (2005); Cardoso, Portela (2009); Gürtzgen (2014), Kátay (2016)
   - almost full insurance against transitory shocks, but not against permanent shocks (elasticity 0.05–0.10)
   - time-series methods + IV regressions
   - cannot estimate nonlinear effects of productivity on wages

Relation to the literature

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   - time-series methods + IV regressions
   - cannot estimate nonlinear effects of productivity on wages
2. downwards wage rigidity at the individual level
   - Dickens et al. (2007); Du Caju, Fuss, Wintr (2007); Babecký et al. (2010); Messina et al. (2010); Du Caju et al. (2015)
   - downwards wage rigidity is typical feature of labor markets
   - histogram-based approach using individual wage changes
   - cannot link wage changes to firm-specific shocks

Data

- German linked employer-employee data (LIAB), version 1993-2010
  - employer data: representative annual establishment survey
  - employee data: social insurance records
- sample restrictions
  - exclude Great Recession (2009 and 2010)
  - privately-owned firms in the private, non-financial sector with at least 5 employees
  - male full-time employees aged 25 to 59
  - exclude workers with top-coded wages (16%) from wage regressions
  - wage reg.: 2531 establishments, 216709 individuals sample statistics

Estimation strategy

1a productivity regression at the firm level isolates idiosyncratic productivity shocks $\Delta\varepsilon_{jt}$

1b identify stochastic process generating the shocks (Guiso et al., 2005)

$$\varepsilon_{jt} = \zeta_{jt} + v_{jt}, \quad \zeta_{jt} = \zeta_{jt-1} + u_{jt}, \quad u_{jt}, v_{jt} \sim \mathrm{WN}$$

2 use Kalman smoother to decompose residuals ε_{jt} into permanent component ζ_{jt} and transitory component v_{jt}

3 add these predictions as additional explanatory variables in wage/layoff regressions at the worker level

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 trends 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

Error process

- autocorrelation matrix of the GMM residuals $\Rightarrow \Delta\varepsilon_{jt} \sim \mathrm{MA}(1)$ table
- consistent with the error process

$$\varepsilon_{jt} = \zeta_{jt} + v_{jt}, \quad \zeta_{jt} = \zeta_{jt-1} + u_{jt}, \quad u_{jt}, v_{jt} \sim \mathrm{W.N.}$$

- can be transformed into a stationary state-space model for $\Delta\varepsilon_{jt}$
- idea: decompose total productivity shock

$$\underbrace{\Delta\varepsilon_{jt}}_{total} = \Delta\zeta_{jt} + \Delta v_{jt} = \underbrace{u_{jt}}_{perm.} + \underbrace{\Delta v_{jt}}_{trans.}$$

by Kalman smoothing at the establishment level

Decomposing transitory and permanent shocks

- if firm-specific variances $\mathbb{E}u_{jt}^2$ and $\mathbb{E}v_{jt}^2$ are known, Kalman smoothing yields the best linear prediction of $\{u_{jt}, \Delta v_{jt}\}_{t=1}^{T_j}$ given $\{\Delta\varepsilon_{jt}\}_{t=1}^{T_j}$
- assume heteroscadasticity of the form

$$\mathbb{E}u_{jt}^2 = \sigma_{uj}^2 = \exp(D_j'\lambda_u), \quad \mathbb{E}v_{jt}^2 = \sigma_{vj}^2 = \exp(D_j'\lambda_v)$$

- baseline:
  - D_j contains dummies for firm size (4 categories)
  - λ_u and λ_v are estimated by Gaussian ML
- variance estimates: estimated variances

Wage regressions

- model individual wage changes as

$$\Delta \ln w_{ijt} = \Delta X'_{ijt}\delta + f(u_{jt}) + g(\Delta v_{jt}) + \eta_{ijt}$$

  - 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
  - u_{jt} permanent productivity shock (unobserved)
  - Δv_{jt} transitory productivity shock (unobserved)

- practical estimation:
  - replace u_{jt} and Δv_{jt} with predicted values and estimate by OLS
  - functional forms f and g can be specified or estimated themselves
  - standard errors are clustered at the establishment level and bootstrapped to take the uncertainty of all estimation stages into account

Wage elasticities

- results for piecewise linear f and g: more results for linear specification

	shock size	permanent shock coefficient	permanent shock std. err.	transitory shock coefficient	transitory shock std. err.
1	all	0.0625^{***}	0.0143	0.0189^{*}	0.0102
2	negative	-0.0056	0.0269	0.0462^{***}	0.0172
	positive	0.1121^{***}	0.0268	-0.0067	0.0096
3	2nd–5th decile	0.1082^{**}	0.0524	0.0821^{**}	0.0325
	6th–9th decile	0.1149^{**}	0.0498	0.0043	0.0220

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

- nonparametric estimation of f and g: local linear regression
- main observations:
  - permanent: only very bad shocks lead to downwards wage rigidity
  - transitory: negative shocks lower wages, positive shocks captured by firm

Layoff regressions

- definition of a layoff follows Boockmann, Steffes (2010)
  - reported separation with non-employment spell of 60+ days if next employment spell is not with the same employer
  - mean annual layoff probability is 6.87%
- estimate linear probability model in first differences

$$\Delta lay_{ijt} = \Delta X'_{ijt}\delta + f(u_{jt}) + g(\Delta v_{jt}) + \eta_{ijt}$$

  - $lay_{ijt} = 1$ if worker i is laid off by establishment j in year t
  - X_{ijt} identical to wage regression

Semi-elasticity of the layoff probability

- results for piecewise linear f and g:

	shock size	permanent shock coefficient	permanent shock std. err.	transitory shock coefficient	transitory shock std. err.
1	all	-0.0276	0.0213	0.0021	0.0095
2	negative	-0.0986^{**}	0.0462	0.0048	0.0237
	positive	0.0257	0.0291	-0.0001	0.0175

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

- nonparametric estimation of f and g: local linear regression
- main observations:
  - transitory shocks do not have any effect
  - negative permanent shocks increase individual layoff probability
  - suggests that Kalman smoother does reasonably good job

Heterogeneity: blue-collar vs. white-collar workers

- downward wage flexibility is limited to blue-collar workers; white-collar wages are downward rigid regression table
- layoff response limited to blue-collar workers regression table

⇒ white-collar workers seem perfectly insured against negative shocks

- possible explanations:
  - agency considerations (monitoring costs, risk of shirking)
  - turnover considerations (replacement/recruitment/training costs)
  - degree of complementarity in the production process

Conclusion

- how do idiosyncratic shocks to firm productivity 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
- layoff probability responds only to negative permanent shocks
- substantial heterogeneity at the worker level
  - wage cuts and employment loss concentrated on blue-collar workers
  - white-collar workers enjoy full insurance against negative shocks
  - hints at considerations about agency, turnover, or complementarity

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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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: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

- implies $\Delta\varepsilon_{jt} \sim \mathrm{MA}(1) \Rightarrow$ error process in levels:

$$\varepsilon_{jt} = \zeta_{jt} + v_{jt}, \quad \zeta_{jt} = \zeta_{jt-1} + u_{jt}, \quad u_{jt}, v_{jt} \text{ W.N.}$$

- estimates $\hat{\sigma}_v^2 = 0.0344$ and $\hat{\sigma}_u^2 = 0.0088$ significant at 1% level

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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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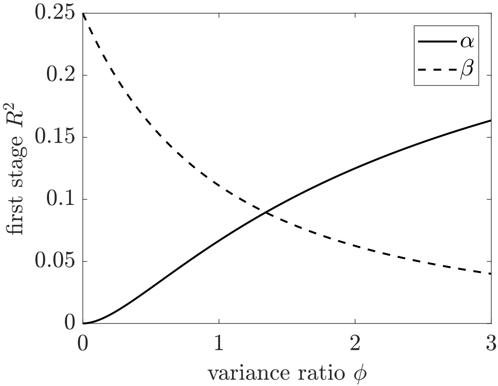
Weak instruments

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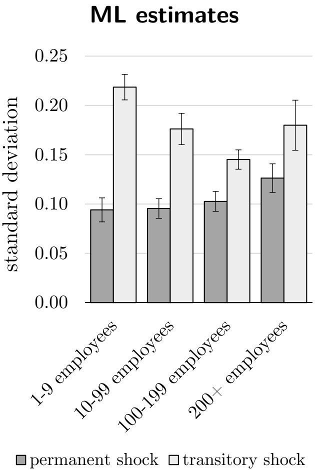
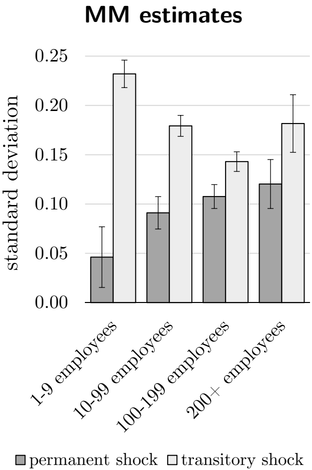
Estimated standard deviations $\hat{\sigma}_{\tilde{u}j}$ and $\hat{\sigma}_{\tilde{v}j}$





error bars indicate bootstrapped standard errors clustered at the establishment level

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Linear wage response

	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: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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

back to nonlinear effects

Linear wage response – 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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Linear wage response – 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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Linear wage response – 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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Linear wage response – 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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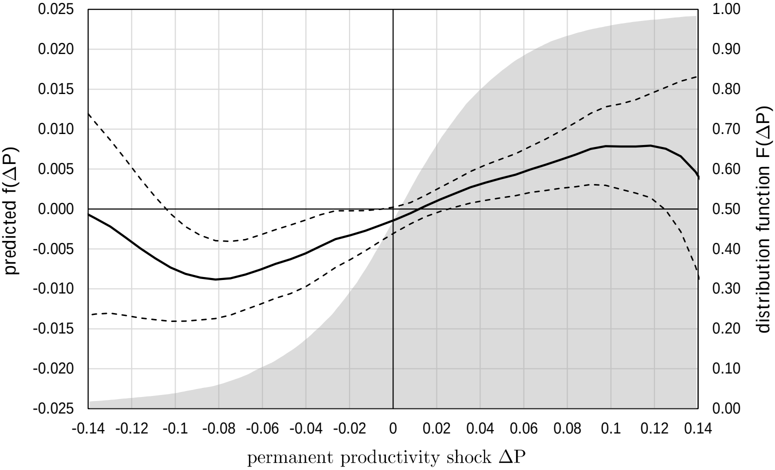
Nonparametric wage response to a permanent shock



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

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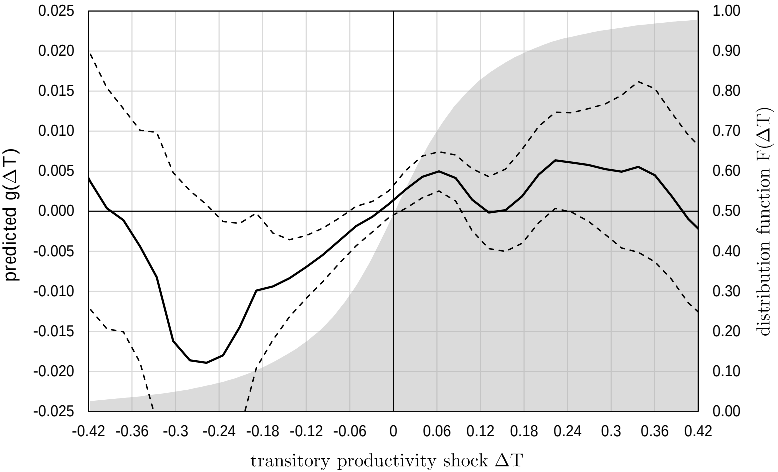
Nonparametric wage response to a transitory shock



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

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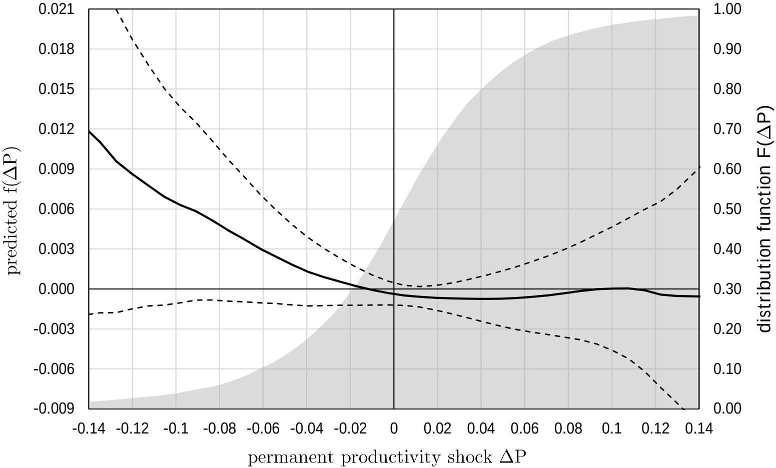
Nonparametric layoff response to a permanent shock



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

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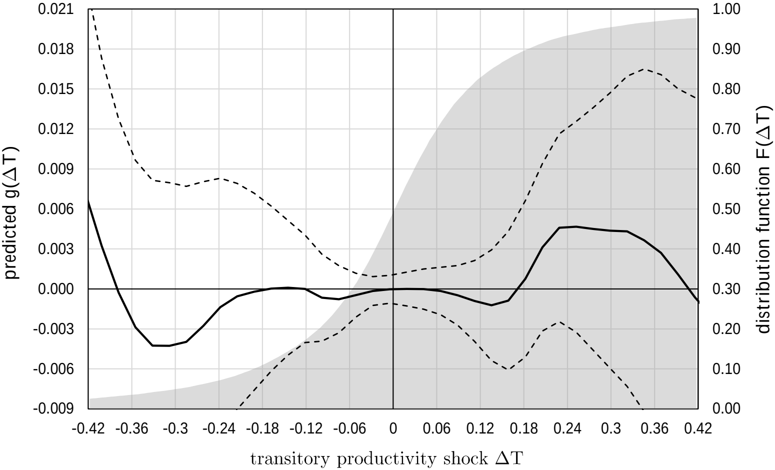
Nonparametric layoff response to a transitory shock



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

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Wage elasticities by worker type

	interaction × shock size	permanent shock coefficient	permanent shock std. err.	transitory shock coefficient	transitory shock std. err.
1	blue-collar × all	0.0613***	0.0173	0.0244*	0.0134
	white-collar × all	0.0651***	0.0186	−0.0015	0.0088
2	blue-collar × negative	−0.0228	0.0339	0.0634***	0.0239
	blue-collar × positive	0.1198***	0.0334	−0.0129	0.0117
	white-collar × negative	−0.0007	0.0262	0.0117	0.0133
	white-collar × positive	0.1224***	0.0259	−0.0139	0.0123
3	blue-collar × 2^{nd}–5^{th} decile	0.0920	0.0611	0.1117***	0.0429
	blue-collar × 6^{th}–9^{th} decile	0.1088**	0.0555	−0.0059	0.0285
	white-collar × 2^{nd}–5^{th} decile	0.0453	0.0555	0.0136	0.0196
	white-collar × 6^{th}–9^{th} decile	0.1819***	0.0526	0.0054	0.0234

employees in the 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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Semi-elasticity of the layoff probability by worker type

	interaction × shock size	permanent shock coefficient	permanent shock std. err.	transitory shock coefficient	transitory shock std. err.
1	blue-collar × all	-0.0266	0.0229	-0.0029	0.0118
	white-collar × all	0.0210	0.0229	-0.0003	0.0115
2	blue-collar × negative	-0.1015^{*}	0.0528	0.0135	0.0278
	blue-collar × positive	0.0246	0.0321	-0.0184	0.0204
	white-collar × negative	-0.0087	0.0549	0.0205	0.0299
	white-collar × positive	0.0452	0.0377	-0.0237	0.0208

employees in the 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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