COVID and Productivity in Europe: A Responsiveness Perspective

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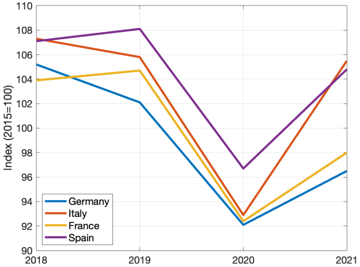
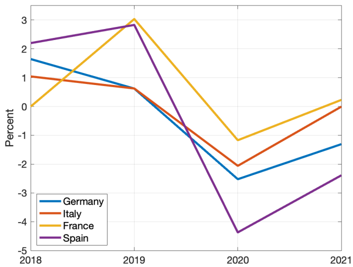
Covid-19: A large common shock with asymmetric impact



(a) Industrial Production



(b) Employment growth (Manufacturing)

Figure: Annual Output and Employment during Covid-19

▸ Economic Policy Support Index

Research Question

Take the firm responsiveness perspective and ask:

1. Are there differences in firm responsiveness across Europe?
2. How do these differences shape the economy-wide response to the Covid-19 economic shock and related policy support?

Firm Responsiveness

Definition:

- Firms face idiosyncratic profitability shocks from a variety of sources (e.g., labor force productivity or demand)
- "Responsiveness" measures how reactive firms are to these shocks in terms of their decisions (e.g., investment and labor adjustment).

Our project:

- Focus on labor demand

This paper

First part — *only briefly today*

- Estimate a structural dyn. labor choice model for four EA countries
  - Estimation separately for each country
  - Responsiveness measures estimated in data and included as moments
- Use model to understand cross-country differences in firms responsiveness to idiosyncratic shocks

Second part

- Extend model to include aggregate Covid-19 shock
- Simulate effects of aggregate shock and related policies on:
  - Aggregate employment
  - Firm exit
  - Productivity
- Disentangle effect of shock and policy support

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Agenda

Related Literature

Related Literature

1. **Firm responsiveness and macroeconomic outcomes**
   Decker et al. (2016), Foster et al. (2016), Bartelsman et al. (2019)
   → Take cross-sectional perspective; Covid-19 as laboratory to study the role of cross-country differences in responsiveness for resilience to aggregate shocks.

2. **Covid-19 and Firm Dynamics**
   Albert et al. (2020), Harasztosi et al. (2022), Kozeniauskas et al. (2022)
   → Take responsiveness perspective; study interaction of responsiveness, aggregate shocks, and labor market stabilization policies in structural labor-demand framework.

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Data

Data

- Bureau van Dijk's **Orbis**
  - Private and public firms
  - Sample: Unbalanced panel of manufacturing firms, 2014-2018
  - 4 countries: France, Germany, Italy, Spain
- Eurostat's **Structural Business Statistics**
  - Employment-weighted exit rate: 1-digit manufacturing sector

▸ Summary Moments

Model

Key ingredients

- Partial equilibrium model of firms' dynamic labor demand with
  - Discrete time, annual frequency
  - Firms are subject to idiosyncratic profitability shocks
  - Time to build for labor
  - Convex and non-convex adjustment costs for labor
  - Endogenous entry and exit

Firm Problem: Optimization

- **Exit Decision:**

$$V(A,e) = max(V^c(A,e), 0)$$

  - A = profitability shock, AR(1)
  - e = current employment level

- **Conditional dynamic labor demand:** $\forall(A,e)$

$$V^c(A,e) = \max_{e'} R(A,e) - \omega(e) - C(e',e) - \Gamma + \beta E_{A'|A} V(A',e')$$

  - $R(\cdot)$ = revenue
  - $\omega(\cdot)$ = compensation
  - $C(\cdot)$ = adjustment costs
  - Γ = fixed operating costs

- **Entry Decision:**

$$E_{A|s} V(A,\underline{e}) \geq 0$$

  - $\underline{e}$ = lowest employment level
  - s = signal about prospective profitability; same process as A

Details

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Details

Estimation

Estimation

- **Simulated Method of Moments**: ▸ SMM Approach ▸ Moments
  - Min. distance betw. key moments from actual and simulated data
  - Include responsiveness coefficients as moments
- Estimation Results: **Model Fit** ▸ Model Fit
- Estimation Results: **Parameters** ▸ Parameters

Table: Fixed Adjustment Costs Incurred Relative to Revenue

Country	Fixed costs	
	Fixed hiring costs (F_m)	Fixed firing costs (F_p)
France	0.9%	5.1%
Germany	1.5%	11.3%
Italy	1.8%	6.9%
Spain	1.2%	6.8%

Notes — This table reports fixed costs (computed as F_m and F_p times average revenues) as fraction of average revenues of firms that actually hire or fire.

Quantitative Exercise

Quantitative Exercise: Covid-19 Shock and Policies

Set-up

- Extend model to include aggregate state ($\mathcal{S}$)
  - $\mathcal{S} \in \{normal, disaster\} \Rightarrow R(A, e, \mathcal{S}) = \lambda_{\mathcal{S}} A e^{\alpha}$
  - λ captures both demand and labor supply shock
  - Parameterization
    - ⋆ $\mathcal{S}$ follows 2-state Markov process: $Q(\mathcal{S}'|\mathcal{S}) = \begin{bmatrix} \tau_{nn} & \tau_{nd} \\ \tau_{dn} & \tau_{dd} \end{bmatrix}$
    - ⋆ Transition probabilities: $\tau_{nd} = 0.01$, $\tau_{dd} = \rho$
    - ⋆ λ set to match employment drop in 2020

- Types of policies
  - Short-time work scheme (STW)/Hours sharing
  - 'No-firing' clauses (Italy)

Revised Firm Problem

Quantitative Exercise: Covid-19 Shock and Policies

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▸ Revised Firm Problem

Quantitative Exercise: Covid-19 Shock and Policies

Calibration

Table: Covid Shock and Policies

	STW (%)	Hours sharing (%)	Employment drop			λ
			Data	Model	Fit	
Germany	15.8	28.1	-2.40	-2.41	2.04e-04	0.78
France	14.0	31.0	-0.79	-0.79	1.19e-06	0.91
Italy	49.0	13.2	-1.10	-1.05	2.5e-03	0.85
Spain	38.0	24.1	-5.71	-5.69	1.45e-04	0.77

- STW (%): Fraction of firms using STW
- Hours sharing: Average fraction of hours cut

Quantitative Exercise: Covid-19 Shock and Policies

Simulation

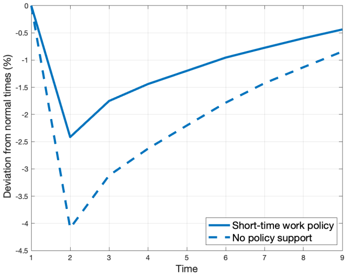
- Start economy in stationary distribution of productivity and employment in normal times
- Simulate two versions of economy for 10 time periods:
  1. *No Covid-19*: Economy evolves always in normal state
  2. *Covid-19*: Impose disaster state for one period in period 2
- Compare 1. and 2. to quantify the effect of shock and policies
- Baseline includes country-specific policy interventions
  - Policies linked to onset of shock
  - Targeted to support least productive fraction of firms
- Evaluate impact of policies by removing them

Model validation

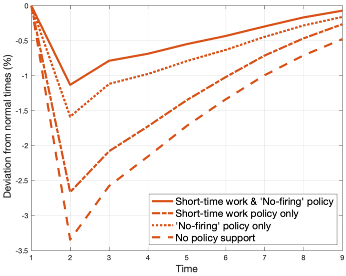
Covid-19 Shock and Policy Support

Covid-19: Shock and Policy Support

Employment Response



(a) Germany



(b) Italy

Figure: Employment Responses

- Policy support reduces employment losses by up to ∼47%

▸ Other countries

Covid-19: Shock and Policy Support

Exit margin

Table: Employment-weighted exit rates (Percent)

	Germany	Italy
Normal times	0.43	0.47
Shock with full policy support	1.75	1.72
Shock with only short-time work policy	1.75	1.63
Shock with only 'No-firing' policy	–	2.18
Shock without policy support	3.44	2.02

Note—This table summarizes the effect of the policy support on employment losses due to exit.

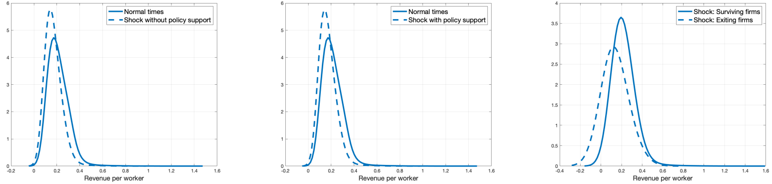
- Policy support reduces empl.-weighted exit rates by up to ∼65%
- 'No-firing' policy can increase employment losses due to exit

▸ Other countries

Productivity Implications

Covid-19: Productivity Implications

Aggregate Productivity and Cleansing Effect



(a) Covid-19 shock w/o policy support

(b) Covid-19 shock w/ policy support

(c) Survivors vs. Exiters

Figure: Productivity Implications of Covid-19 and policies

- Covid-19 shock adversely affects aggregate productivity
- Effect of shock on productivity not impacted much by policies
- "Cleansing effect" present but dominated in the aggregate

Adjustment Costs ▸ Details

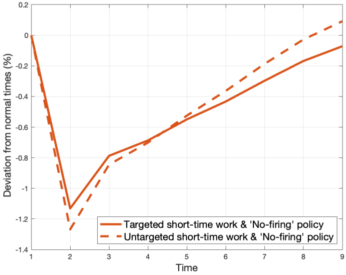
▸ Misallocation ▸ Other countries

The Importance of Targeted Policy Support

The Importance of Targeted Policy Support

Employment Response

(a) Germany



(b) Italy

- Untargeted: STW randomly allocated to same fraction of firms
- Targeting policy support reduces employment loss by up to ∼45%

▸ Other countries

The Importance of Targeted Policy Support

Aggregate Productivity and Misallocation

Table: Productivity measures

		Normal times	Shock	Shock + targeted pol. supp.	Shock + untargeted pol. supp
Germany	Agg. RPL	0.6019	0.5811	0.5803	0.5809
	Mstd	0.5421	0.5330	0.5333	0.5330
	c(A,ls)	0.5348	0.5329	0.5323	0.5332
Italy	Agg. RPL	0.6859	0.6586	0.6563	0.6565
	Mstd	0.5804	0.5667	0.5675	0.5673
	c(A,ls)	0.5791	0.5761	0.5730	0.5733

- Targeting policy support has limited effect on productivity due to large adjustment costs

▸ Other Countries

Role of Heterogeneous Beliefs

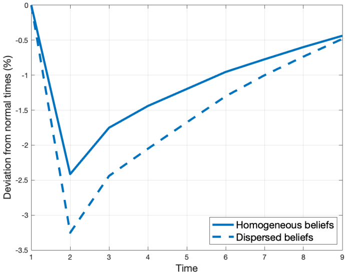
Role of Heterogeneous Beliefs

Set-up

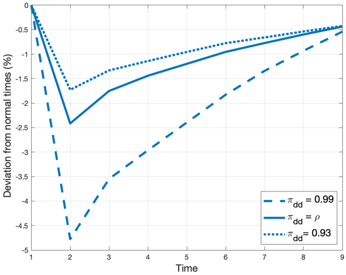
- Baseline: firms have identical beliefs, persistent shock
- Reality from survey: very dispersed beliefs
- Introduce dispersion: mean-preserving spread around baseline beliefs
  - optimists: $\rho = 0.93$
  - pessimists: $\rho = 0.99$
  - 50% of each type
- Study response to one period shock

Role of heterogeneous beliefs

Employment Response



(a) Germany: Employment



(b) Germany: Optimists vs. Pessimists

Figure: Homogeneous versus dispersed beliefs

- Belief dispersion matters for aggregate employment
- Firm decisions non-linear in expect. about duration of agg. state

Exit rates

Role of heterogeneous beliefs

Can uncertainty fuel misallocation?

Table: Productivity measures

		Normal times		Shock		Shock + policy support	
		Homogeneous	Dispersed	Homogeneous	Dispersed	Homogeneous	Dispersed
Germany	Agg. RPL	0.602	0.602	0.580	0.581	0.581	0.582
	Mstd	0.542	0.542	0.533	0.533	0.533	0.533
	c(A,ls)	0.535	0.536	0.532	0.533	0.533	0.533

Notes — The table shows the aggregate productivity implications of dispersion in beliefs in normal times, during the period of the shock absent any policy support, and during the period of the shock when policy support is activated. Homogeneous beliefs refers to the baseline economy. Dispersed beliefs refers to the economy described in section ??.

- No apparent misallocation from heterogeneous beliefs in this model

Conclusion

Conclusion

Motivation and Research Question

- Role of responsiveness for response to Covid-19 shock and policies
- Focus on cross-country diff. among four major EA countries

Results

- Estimated adjustment costs not that different across countries
- Policy Support mattered considerably:
  - Exit $\downarrow$ ($\sim$66%)
  - Employment loss $\downarrow$ ($\sim$47%)
  - Limited effects of policy on productivity (large adjustment costs)
- Targeting of support important
- Dispersion of beliefs matters:
  - More evidence
  - Policy implications

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Appendix

Policy Support During Covid-19

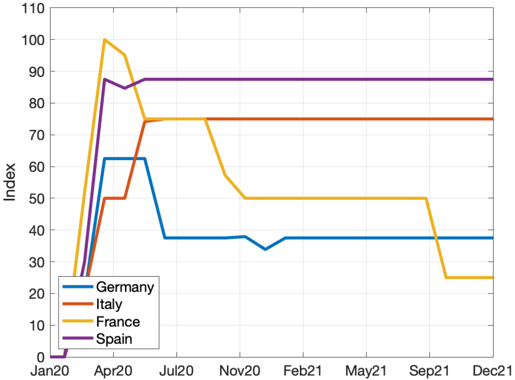

Figure: Economic Policy Support Index

Source: COVID-19 Government Response Tracker, Oxford University

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Summary Moments

Table: Data Moments

	μ_e	inaction	JC10+	JD10+	JC+5	JD+5	$\tilde{\alpha}$	$\tilde{\rho}$	$\tilde{\sigma}$	β_1^{int}	β_2^{int}	β_1^{ext}	β_2^{ext}	Exit Rate
		Job Growth					Revenue Function			Responsiveness Regressions				
France	17	0.329	0.132	0.047	0.255	0.125	1.040	0.920	0.301	0.343	0.255	-0.005	0.191	0.698
Germany	35	0.331	0.081	0.032	0.232	0.069	1.012	0.926	0.299	0.168	0.053	0.021	0.190	0.210
Italy	9	0.350	0.175	0.084	0.293	0.154	1.042	0.870	0.365	0.242	0.022	0.002	1.090	0.882
Spain	6	0.277	0.237	0.071	0.416	0.132	1.091	0.885	0.352	0.300	0.054	0.019	0.174	1.442

Notes — All moments are calculated from ORBIS data using an unbalanced panel of firms between 2014-2018. The exit rate is employment weighted and refers to the average of the "Employment share of enterprise deaths" from Eurostat's Business Dynamism Statistics (BDS) over the period 2014-2018. The exit rate is reported as a percentage. The estimation of the parameters pertaining to the revenue function is described in section **??**.

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Firm Problem: Environment

- **Revenue function**: $R(A, e) = Ae^{\alpha}$
  - e = employment, α = labor coefficient, A = AR(1) profitability shock

- **Compensation function**: $\omega(e) = w_0 \times e$
  - w_0 = wage rate

- **Adjustment costs**:

$$C\left(e', e\right) = \underbrace{\frac{\nu}{2}\left(\frac{e'-e}{e}\right)^2 e}_{\text{quadratic costs}} + \underbrace{F_p \mathbb{I}_{(e'-e>0)}}_{\text{fixed hiring costs}} + \underbrace{F_m \mathbb{I}_{(e'-e<0)}}_{\text{fixed firing costs}}$$

- **Fixed operating costs** Γ to generate firm exit

Back

SMM Approach

- Solve optimization problem country-by-country:

$$J = min_{(\Theta)} \left(M^s(\Theta) - M^d\right)' W \left((M^s(\Theta) - M^d)\right)$$

- Weighting matrix: $W = I$
- No aggregate shock; parameter values s.t. $\exists$ stat. dist. $\Lambda(A, e)$
- Moments (except exit rate) from balanced panel of surviving firms
- Exit rate from one period of steady state equilibrium

Back

Moments

Revenue Function and TFP(R) innovations

TFPR $\log Revenue_{i,t} = \alpha \log Employment_{i,t} + \sum_{t=2014}^{2018} \mathbb{D}_t + \varepsilon_{i,t}$

AR(1) $\varepsilon_{i,t} = \rho \varepsilon_{i,t-1} + \eta_{i,t}, \quad \eta_{i,t} \sim \mathcal{N}(0, \sigma_\eta^2)$

Responsiveness

Extensive Margin $Pr(\mathbb{I}^{adj} = 1) = \alpha + \beta_1^{ext} \varepsilon_{i,t} + \beta_2^{ext} \varepsilon_{i,t}^2 + \gamma Employment_{i,t-1} + \nu_{i,t}$

Intensive Margin $g_{i,t}^{emp}|_{\mathbb{I}^{adj}=1} = \delta + \beta_1^{int} \eta_{i,t} + \beta_2^{int} \eta_{i,t}^2 + \gamma Employment_{i,t-1} + \zeta_{i,t}$

$$\mathbb{I}^{adj} = \begin{cases} 0 & \text{if } g_{i,t}^{emp} \in [-2.5\%, +2.5\%] \\ 1 & \text{otherwise} \end{cases} \quad ; \; g_{i,t}^{emp} = \frac{e_{i,t} - e_{i,t-1}}{.5 * (e_{i,t} + e_{i,t-1})}$$

Exit

Emp-weighted exit rate Avg. emp.-weighted exit rate in 1-digit manufacturing sector

$$\Rightarrow M^d = \left[\alpha \quad \rho \quad \sigma_\eta \quad \hat{\beta}_1^{int} \quad \hat{\beta}_2^{int} \quad \hat{\beta}_1^{ext}, \xi \right]$$

Estimation: Model Fit

Table: Moments

Country		Revenue Function			Responsiveness			Exit rate	Fit
		$\tilde{\alpha}$	$\tilde{\rho}$	$\tilde{\sigma}_\eta$	β_1^{int}	β_2^{int}	β_1^{ext}		
France	Data	1.040	0.920	0.301	0.343	0.255	-0.005	0.698	–
	Model	0.917	0.900	0.159	0.242	0.052	-0.005	0.381	1.168
Germany	Data	1.012	0.926	0.299	0.168	0.053	0.021	0.210	–
	Model	0.920	0.924	0.134	0.217	0.050	0.019	0.277	0.505
Italy	Data	1.042	0.870	0.365	0.242	0.022	0.002	0.882	–
	Model	0.943	0.896	0.144	0.291	0.023	0.002	0.344	0.793
Spain	Data	1.091	0.885	0.352	0.300	0.054	0.019	1.442	–
	Model	0.900	0.882	0.141	0.323	0.051	0.019	0.575	0.760

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Table: Parameters

Country	Parameters						
	ν	F_P	F_M	α	ρ	σ	Γ
France	4.713	0.118	0.020	0.518	0.965	0.586	0.222
Germany	5.136	0.148	0.020	0.518	0.962	0.470	0.216
Italy	5.008	0.105	0.027	0.512	0.968	0.551	0.233
Spain	4.373	0.133	0.024	0.517	0.966	0.525	0.296

Notes — The parameters here are: ν = quadratic adjustment cost, (F_P, F_M) = fixed hiring and firing costs as a fraction of average revenue, (α, ρ, σ) = curvature of revenue functions, serial correlation of profitability shocks and the standard deviation of the innovation to profitability shocks. Γ denotes the fixed operating costs.

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Identification

Table: Elasticities of Moments with respect to Parameters

Parameter	Moments						
	$\tilde{\alpha}$	$\tilde{\rho}$	$\tilde{\sigma}_\eta$	β_1^{int}	β_2^{int}	β_1^{ext}	*Exit rate*
ν	-0.384	0.058	0.134	-1.881	8.913	8.849	-3.434
f_p	-0.049	0.041	0.029	1.190	-28.688	10.817	-1.734
f_m	-0.039	0.093	0.014	-1.482	11.301	-28.159	-0.904
α	-1.066	-0.061	0.158	-0.202	7.394	26.031	8.560
ρ	-4.956	0.868	-12.054	1.242	-72.454	144.541	27.259
σ	0.123	0.031	0.998	-1.615	14.794	1.665	0.019
ξ	-0.400	0.035	0.119	-0.614	18.588	-6.912	0.018

Covid-19: Revised Firm Optimization Problem

- Revised firm problem

$$V(A, e, \mathcal{S}) = max(V^c(A, e, \mathcal{S}), 0)$$

$$\begin{aligned} V^c(A, e, \mathcal{S}) \quad &= \max_{e'} \; R(A, (1-\tau(\mathcal{S}))e, \mathcal{S}) - \omega(e)(1-\tau(\mathcal{S})) \\ &\quad -C(e', e) - \Gamma + \beta E_{A', \mathcal{S}' | A, \mathcal{S}} V(A', e', \mathcal{S}') \end{aligned}$$

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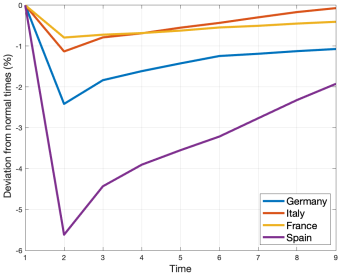
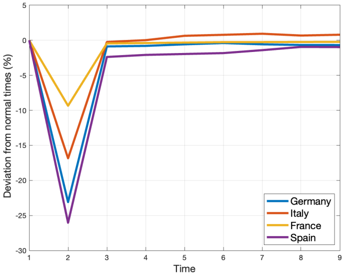
Model validation

Responses: Employment and Output



(a) Employment



(b) Output

Figure: Employment and Output Responses

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Model validation

Responses: Size-weighted exit

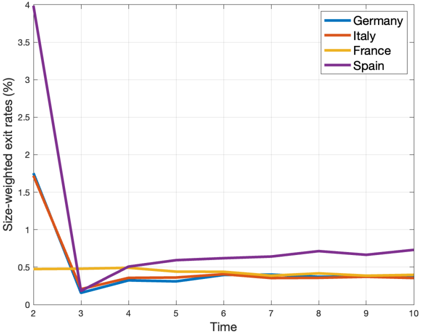

Figure: Exit Rates

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Output Response in Data

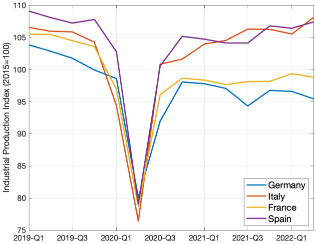

Figure: Output in data

Notes — The figure shows production output in the manufacturing sector in Germany, Italy, France, and Spain. Values are obtained from Eurostat's "Production in Industry Monthly" table, aggregated to quarterly values.

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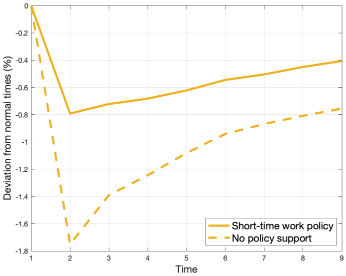
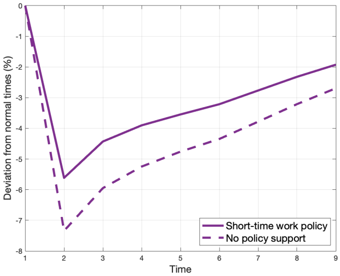
Covid-19 Policy Support

Employment Response



(a) France



(b) Spain

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Covid-19: Policy Support

Exit margin

Table: Employment-weighted exit rates (Percent)

	France	Spain
Normal times	0.45	0.83
Shock with full policy support	0.47	3.99
Shock with only short-time work policy	0.47	3.99
Shock with only 'No-firing' policy	–	–
Shock without policy support	1.34	4.72

Note—This table summarizes the effect of the policy support on employment losses due to exit.

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Covid-19: Productivity Implications

Aggregate Productivity and Misallocation

Table: Productivity measures

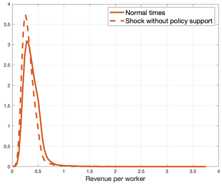
		Normal times	Shock	Shock + targeted policy support
Germany	Agg. RPL	0.6019	0.5811	0.5803
	Mstd	0.5421	0.5330	0.5333
	c(A,ls)	0.5348	0.5329	0.5323
Italy	Agg. RPL	0.6859	0.6586	0.6563
	Mstd	0.5804	0.5667	0.5675
	c(A,ls)	0.5791	0.5761	0.5730

- Adj. costs create misallocation (also in normal times)
- Adj. costs mute effect of shock and policies on (mis-)allocation

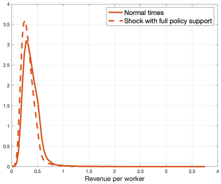
Back Other countries

Covid-19: Productivity Implications - Italy

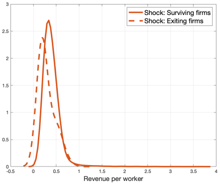
Aggregate Productivity and Cleansing Effect



(a) Covid-19 shock w/o policy support



(b) Covid-19 shock w/ policy support



(c) Survivors vs. Exiters

Figure: Productivity Implications of Covid-19 and policies

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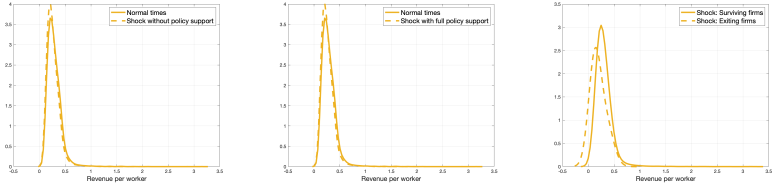
Covid-19: Productivity Implications - France

Aggregate Productivity and Cleansing Effect



(a) Covid-19 shock w/o policy support

(b) Covid-19 shock w/ policy support

(c) Survivors vs. Exiters

Figure: Productivity Implications of Covid-19 and policies

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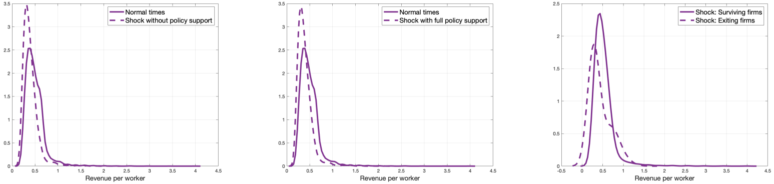
Covid-19: Productivity Implications - Spain

Aggregate Productivity and Cleansing Effect



(a) Covid-19 shock w/o policy support

(b) Covid-19 shock w/ policy support

(c) Survivors vs. Exiters

Figure: Productivity Implications of Covid-19 and policies

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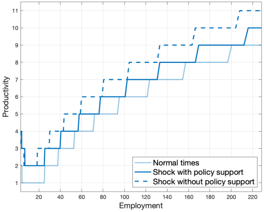
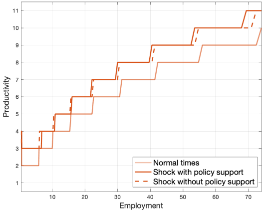
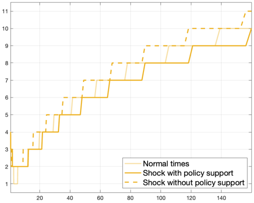
Productivity Thresholds



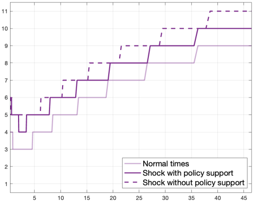
(a) Germany



(b) Italy

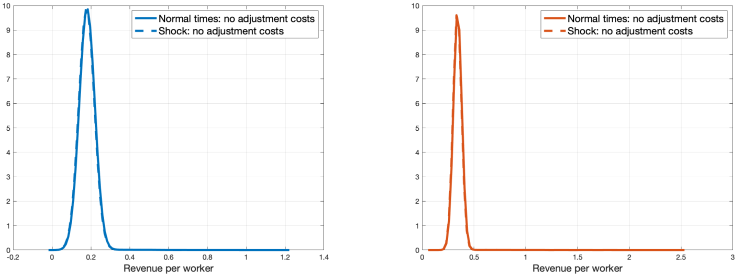


(c) France



(d) Spain

Adjustment Costs & Productivity Implications of Covid-19



(a) Germany (b) Italy

Figure: Surviving firms normal vs shock period with no adjustment costs

- ACs prevent firm from adjusting optimally ⇒ revenue per worker ↓
- Absent ACs, no effect on aggregate productivity

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Role of Adjustment Costs

Table: Productivity measures

		Shock with adjustment costs	Shock without adjustment costs
Germany	Aggregate RPL	0.5811	0.5904
	Mstd	0.5330	0.5144
	c(A,ls)	0.4960	0.5010
Italy	Aggregate RPL	0.6586	0.6722
	Mstd	0.5667	0.5247
	c(A,ls)	0.4970	0.5001

Covid-19: Productivity Implications

Aggregate Productivity and Misallocation

Table: Productivity measures

		Normal times	Shock	Shock + targeted policy support
France	Agg. RPL	0.6405	0.6291	0.6283
	Mstd	0.5684	0.5628	0.5633
	c(A,ls)	0.5909	0.5889	0.5884
Spain	Agg. RPL	0.7329	0.6843	0.6825
	Mstd	0.6065	0.5796	0.5800
	c(A,ls)	0.5595	0.5536	0.5522

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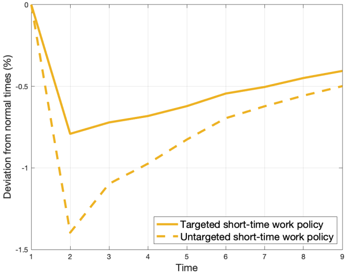
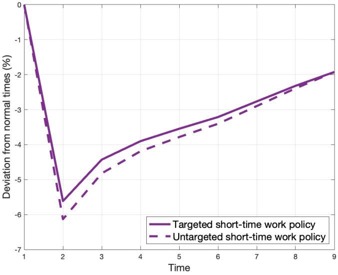
The Importance of Targeting Policy Support

Employment Response



(a) France



(b) Spain

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The Importance of Targeted Policies

Aggregate Productivity and Misallocation

Table: Productivity measures

		Normal times	Shock	Shock + targeted pol. supp.	Shock + untargeted pol. supp
France	Agg. RPL	0.6405	0.6291	0.6283	0.6289
	Mstd	0.5684	0.5628	0.5633	0.5627
	c(A,ls)	0.5909	0.5889	0.5884	0.5897
Spain	Agg. RPL	0.7329	0.6843	0.6825	0.6831
	Mstd	0.6065	0.5796	0.5800	0.5797
	c(A,ls)	0.5595	0.5536	0.5522	0.5536

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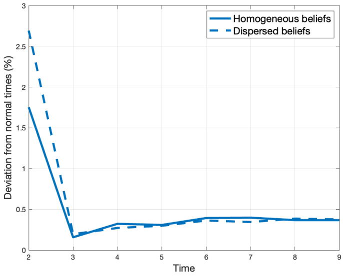
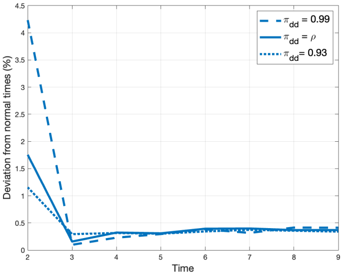


(a) Germany: Employment



(b) Germany: Size-weighted Exit Rate

Figure: Optimists versus Pessimists

- Optimists adjust employment less than pessimists
- Pessimists dominate exit margin

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