COVID and Productivity in Europe: A Responsiveness Perspective

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Motivation

- Covid-19 was large common shock with asymmetric impact across countries
  - 2020 Real GDP growth in big-4 EA countries: Mean: -7.95%; SD: 3.18%
- Governments across Europe intervened with different labor market policies
- Firms' responsiveness to idiosyncratic shocks matters for:
  - Aggregate dynamics
  - Design and effectiveness of firm-oriented stabilization policies

This Paper

1. **Q: Are there differences in firm responsiveness across Europe?**
   - Estimate a firm dynamics model with adjustment costs for big-4 EA countries
     - Estimation separately for each country
     - Responsiveness measures estimated in data and included as moments
   - Use model to understand cross-country diff. in responsiveness to idiosyncratic shocks

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   - Use model to understand cross-country diff. in responsiveness to idiosyncratic shocks

2. **Q: How do these differences shape the aggregate response to Covid-19?**
   - Extend model with aggregate Covid-19 shock and two types of labor market stab. policies
   - Simulate effects of aggregate shock and policies on:
     - Aggregate employment
     - Firm exit
     - Productivity
   - Disentangle effect of shock and policy support

Plan

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 = AR(1) profitability shock; e = current employment level

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

$$V^c(A, e) = \max_{e'} R(A, e) - \omega(e) - C(e', e) - T + \beta E_{A'|A} V(A', e')$$

  - $R(\cdot) = Ae^{\alpha}$; $\omega(\cdot)$ = compensation; $C(\cdot)$ = adjustment costs; T = fixed operating costs

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  - **Adjustment costs:**

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

Firm Problem: Optimization

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  - $R(\cdot) = Ae^{\alpha}$; $\omega(\cdot)$ = compensation; $C(\cdot)$ = adjustment costs; T = fixed operating costs

- **Entry Decision:**

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

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

Estimation

Parameters and Estimation Strategy

- **Parameters:**

Revenue Function			Adjustment Costs			Fixed Operating Costs
α	ρ	σ_η	ν	F_P	F_M	T

- **Simulated Method of Moments** (country-by-country):

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

  - Structurally estimate revenue function (indirect inference)
  - Include responsiveness coefficients as moments
  - Weighting matrix: $W = I$
  - No aggregate shock; parameter values s.t. $\exists$ stationary distribution over (A, e)

Moments

- **Revenue Function and TFP(R) innovations**:

TFPR $\log \textit{Revenue}_{i,t} = \alpha \log \textit{Employment}_{i,t} + \sum_{t=2014}^{2018} \mathbb{D}_t + \varepsilon_{i,t}$

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

Moments

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- **Responsiveness**:

  Ext. Margin $Pr(\mathbb{1}^{adj} = 1) = c + \beta_1^{ext} \eta_{i,t-1} + \beta_2^{ext} \eta_{i,t-1}^2 + \gamma Employment_{i,t-1} + \nu_{i,t}$

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

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

Moments

- **Revenue Function and TFP(R) innovations**:

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- **Responsiveness**:

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- **Exit margin**:

  Exit Avg. employment-weighted exit rate in 1-digit manufacturing sector

▸ Model Fit

Quantitative Exercise:
Covid-19 Shock and Policies

Quantitative Exercise: 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
  - $\mathcal{S}$ follows 2-state Markov process: $Q(\mathcal{S}'|\mathcal{S}) = \begin{bmatrix} \tau_{nn} & \tau_{nd} \\ \tau_{dn} & \tau_{dd} \end{bmatrix}$
- Types of policies
  - Short-time work scheme (STW)/Hours sharing
  - 'No-firing' clauses (Italy)

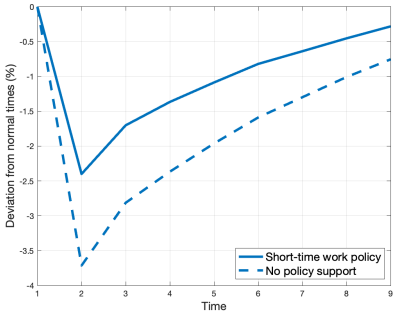
▸ Revised Firm Problem ▸ Parametrization

Quantitative Exercise: Simulation

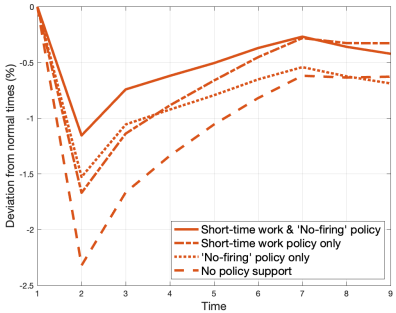
- Start economy in stationary dist. of productivity and employment in normal times
- Simulate two versions of economy for 10 time periods:
  1. *No Covid-19*: Economy evolves always in normal state
  2. *Covid-19*: Impose disaster state for one period in period 2
- Compare 1. and 2. to quantify the effect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

Covid-19 Shock and Policy Support

Covid-19 Shock and Policy Support: Employment Response



(a) Germany



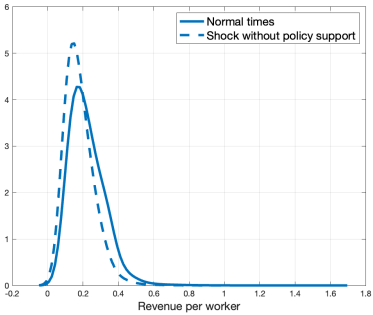
(b) Italy

Figure: Employment Responses

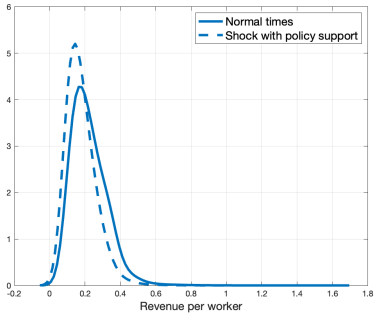
- Policy support reduces employment losses by up to $\sim$1.9 pp.

▸ Other countries ▸ Exit rates

Covid-19 Shock and Policy Support: Employment Response



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



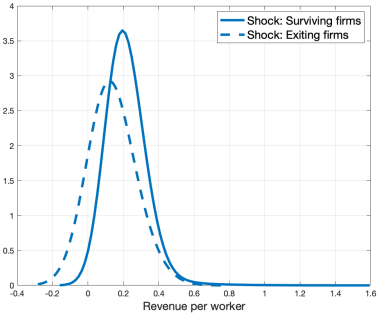
(b) C-19 shock w/ policy support

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

▸ Other countries

Productivity Implications: Mechanism

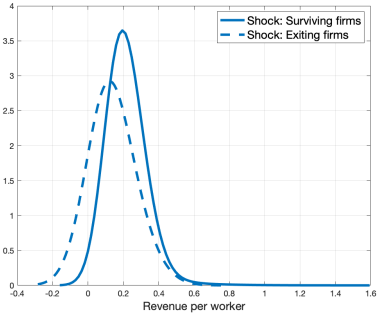


(a) Survivors vs. Exiters

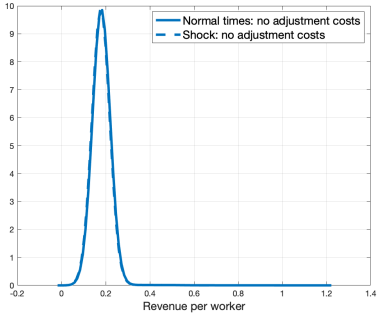
Figure: Productivity Implications: Role of Adjustment Costs

- "Cleansing effect" present...

Productivity Implications: Mechanism



(a) Survivors vs. Exiters



(b) Survivors: No Adjustment Costs

Figure: Productivity Implications: Role of Adjustment Costs

- "Cleansing effect" present...
- ... but dominated by adjustment costs

▸ Misallocation

Extensions

- The Importance of Targeted Policy Support ▸ Untargeted Support
- The Role of Heterogeneous Beliefs ▸ Beliefs

Conclusion

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

Results

- Estimated adjustment costs not that different across countries
- Policy Support mattered considerably:
  - Exit $\downarrow$ (up to $\sim$1.2 pp.)
  - Employment loss $\downarrow$ (up to $\sim$1.9 pp.)
  - Shock adversely affects aggregate productivity
  - Limited effects of policy on productivity
- Targeting of support important
- Dispersion of beliefs matters

Appendix

Summary Moments

Table: Data Moments

		Job Growth					Revenue Function			Responsiveness Regressions				
	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
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

Back

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** T to generate firm exit

Back

Model Fit

Table: Moments

		Revenue Function			Responsiveness			Exit	Fit
		$\tilde{\alpha}$	$\tilde{\rho}$	$\tilde{\sigma}_\eta$	β_1^{int}	β_2^{int}	β_1^{ext}	ξ	
France	Data	1.040	0.920	0.301	0.343	0.255	-0.005	0.698	
	Model	0.896	0.895	0.173	0.222	0.032	-0.005	0.476	1.189
Germany	Data	1.012	0.926	0.299	0.168	0.053	0.021	0.210	
	Model	0.808	0.928	0.144	0.209	0.047	0.019	0.386	1.089
Italy	Data	1.042	0.870	0.365	0.242	0.022	0.002	0.882	
	Model	0.815	0.902	0.182	0.258	0.022	0.002	0.563	0.437
Spain	Data	1.091	0.885	0.352	0.300	0.054	0.019	1.442	
	Model	0.828	0.880	0.149	0.302	0.056	0.019	0.875	0.546

▸ Back ▸ Parameters ▸ Adjustment costs ▸ Identification

Quantitative Exercise: Calibration/Parameterization

Table: Covid Shock and Policies

	Employment drop			λ
	Data	Model	Fit	
Germany	-2.40	-2.40	3.719e-06	0.79
France	-0.79	-0.79	2.123e-06	0.90
Italy	-1.10	-1.11	2.046e-04	0.87
Spain	-5.71	-5.73	7.431e-04	0.79

- **Covid-19 shock**:
  - λ calibrated to match manufacturing employment drop in 2020 (with policy support)
  - Transition matrix $Q(\mathcal{S}'|\mathcal{S})$: $\tau_{nd} = 0.01$, $\tau_{dd} = \rho$

Back

Quantitative Exercise: Calibration/Parameterization

Table: Covid Shock and Policies

	STW (%)	Hours sharing (%)	Employment drop			λ
			Data	Model	Fit	
Germany	15.8	28.1	-2.40	-2.40	3.719e-06	0.79
France	14.0	31.0	-0.79	-0.79	2.123e-06	0.90
Italy	57.2	13.0	-1.10	-1.11	2.046e-04	0.87
Spain	38.0	24.1	-5.71	-5.73	7.431e-04	0.79

- **Covid-19 shock**:
  - λ calibrated to match manufacturing employment drop in 2020 (with policy support)
  - Transition matrix $Q(\mathcal{S}'|\mathcal{S})$: $\tau_{nd} = 0.01$, $\tau_{dd} = \rho$
- **Policies**:
  - STW (%): Fraction of firms using STW; Hours sharing (%): Avg. fraction of hours cut
  - 'No firing' restriction: $F_m = \infty$

Back

Estimation: Parameters

Table: Parameters

Country	Parameters						
	ν	F_p	F_m	α	ρ	σ	T
France	4.794	0.122	0.019	0.518	0.959	0.594	0.238
	(0.175)	(0.004)	(0.002)	(0.003)	(0.005)	(0.020)	(0.013)”
Germany	5.250	0.220	0.019	0.519	0.961	0.506	0.216
	(0.206)	(0.005)	(0.002)	(0.024)	(0.002)	(0.009)	(0.010)
Italy	5.008	0.300	0.028	0.500	0.950	0.570	0.260
	(0.170)	(0.003)	(0.000)	(0.005)	(0.002)	(0.010)	(0.003)
Spain	4.391	0.159	0.024	0.542	0.965	0.559	0.335
	(0.105)	(0.004)	(0.000)	(0.011)	(0.001)	(0.008)	(0.002)

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. T denotes the fixed operating costs.

Back

Estimation: Adjustment Costs

Table: Fixed Adjustment Costs Incurred Relative to Revenue

Country	Fixed costs	
	Fixed hiring costs (F_p)	Fixed firing costs (F_m)
France	0.823%	5.248%
Germany	1.090%	12.360%
Italy	1.481%	15.982%
Spain	1.076%	7.166%

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.

Back

Estimation: Identification

Table: Elasticities of Moments with respect to Parameters

Parameter	Moments						
	$\tilde{\alpha}$	$\tilde{\rho}$	$\tilde{\sigma}_\eta$	β^{int}	β_2^{int}	β^{ext}	ξ
ν	0.376	-0.049	0.089	0.212	-39.575	-4.743	-0.332
F_m	0.428	-0.068	0.093	-1.133	-58.219	-15.492	-2.235
F_p	-0.086	0.013	-0.002	-0.261	-9.696	-2.618	0.215
α	-0.975	-0.229	-0.084	-4.679	-149.770	178.833	14.118
ρ	0.162	0.770	-11.705	5.769	-20.104	-161.353	0.900
σ	-0.999	-0.148	1.089	-4.834	-108.175	157.516	14.702
T	-1.494	-0.138	-0.116	-4.918	-124.912	201.343	15.030

Back

Revised Firm Optimization Problem

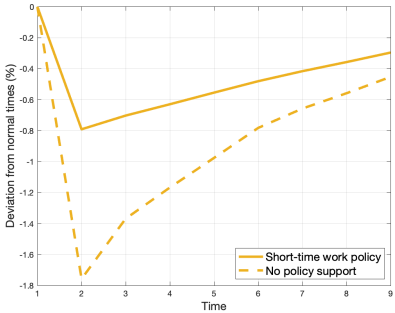
- Revised firm problem

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

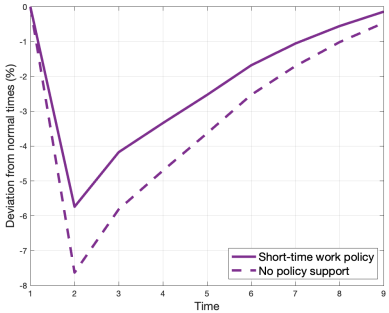
$$V^c(A, e, \mathcal{S}) = \max_{e'} R(A, (1 - \tau(\mathcal{S}))e, \mathcal{S}) - \omega(e)(1 - \tau(\mathcal{S}))$$
$$-C(e', e) - T + \beta E_{A', \mathcal{S}'|A, \mathcal{S}} V(A', e', \mathcal{S}')$$

Back

Covid-19 Shock and Policy Support: Employment Response



(a) France



(b) Spain

Back

Covid-19 Shock and Policy Support: Exit

Table: Employment-weighted exit rates (Percent)

	Germany	Italy
Normal times	0.386	0.563
Shock with full policy support	1.933	1.768
Shock with only short-time work policy	1.933	1.760
Shock with only 'No-firing' policy	–	2.154
Shock without policy support	3.235	2.073

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 $\sim$1.7 pp.
- 'No-firing' policy can increase employment losses due to exit

▸ Back ▸ Other countries

Covid-19 Shock and Policy Support: Exit

Table: Employment-weighted exit rates (Percent)

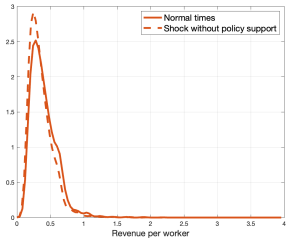
	France	Spain
Normal times	0.463	0.875
Shock with full policy support	0.538	4.662
Shock with only short-time work policy	0.538	4.662
Shock with only 'No-firing' policy	–	–
Shock without policy support	1.410	6.276

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

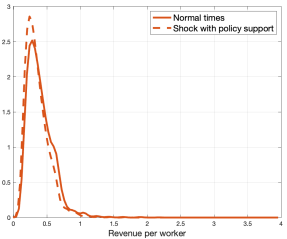
Back

Covid-19: Productivity Implications - Italy

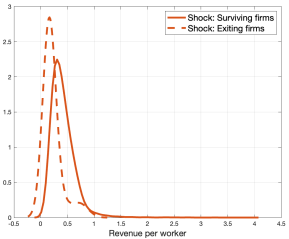
Aggregate Productivity and Cleansing Effect



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



(b) Covid-19 shock w/ policy support



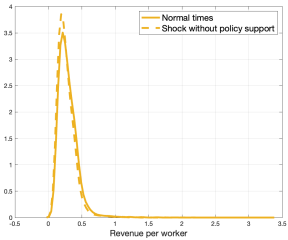
(c) Survivors vs. Exiters

Figure: Productivity Implications of Covid-19 and policies

Back

Covid-19: Productivity Implications - France

Aggregate Productivity and Cleansing Effect



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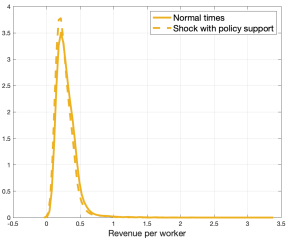
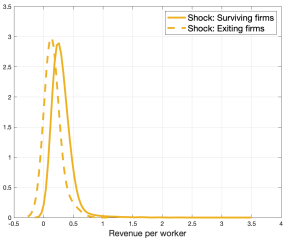


(b) Covid-19 shock w/ policy support



(c) Survivors vs. Exiters

Figure: Productivity Implications of Covid-19 and policies

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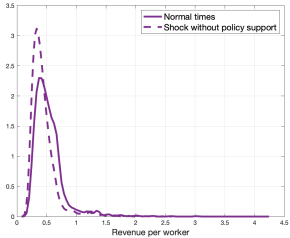
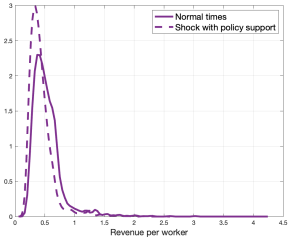
Covid-19: Productivity Implications - Spain

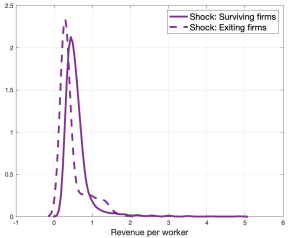
Aggregate Productivity and Cleansing Effect



(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

Back

Covid-19: Productivity Implications

Aggregate Productivity and Misallocation

Table: Productivity measures

		Normal times	Shock	Shock + targeted pol. supp.
Germany	APL	0.211	0.169	0.168
	Std	0.098	0.079	0.079
Italy	APL	0.384	0.339	0.336
	Std	0.201	0.179	0.179

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

Back | Other countries

Adjustment costs

Covid-19: Productivity Implications

Aggregate Productivity and Misallocation

Table: Productivity measures

		Normal times	Shock	Shock + targeted pol. supp.
France	APL	0.283	0.258	0.257
	Std	0.151	0.138	0.139
Spain	APL	0.491	0.400	0.395
	Std	0.263	0.214	0.215

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The Importance of Targeted Policy Support

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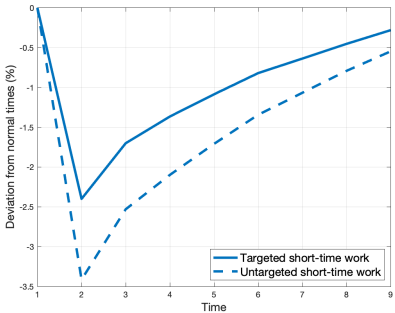
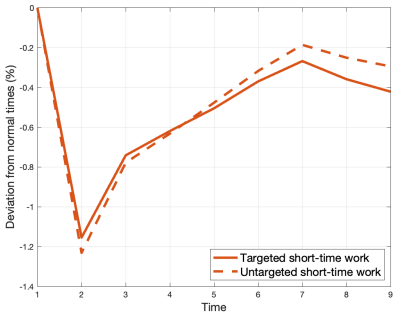
The Importance of Targeted Policy Support

Employment Response



(a) Germany



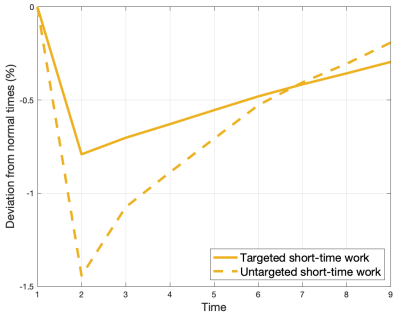
(b) Italy

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

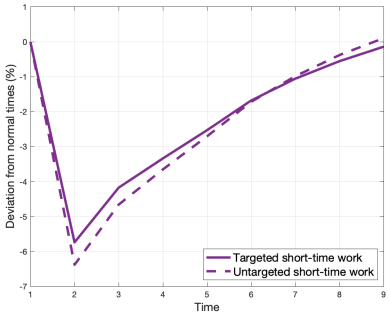
▸ Other countries

The Importance of Targeting Policy Support

Employment Response



(a) France



(b) Spain

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Role of Heterogeneous Beliefs

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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: ρ = 0.93
  - pessimists: ρ = 0.99
  - 50% of each type
- Study response to one period shock

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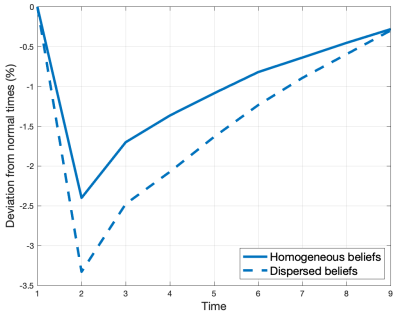
Role of heterogeneous beliefs

Employment Response



(a) Germany: Employment

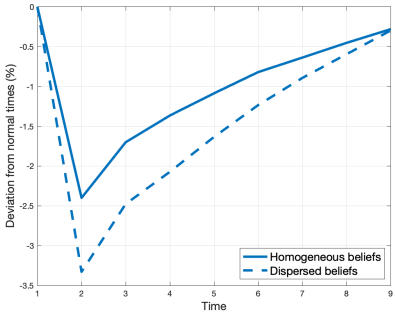
Figure: Homogeneous versus dispersed beliefs

- Belief dispersion matters for aggregate employment and exit rates

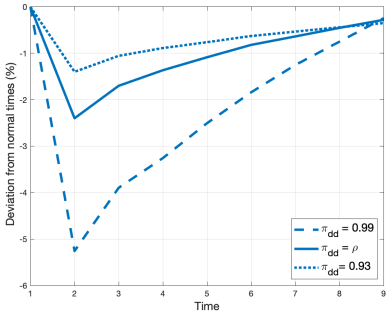
▸ Other countries ▸ Exit rates

Role of heterogeneous beliefs

Employment Response



(a) Germany: Employment



(b) Germany: Size-weighted exit rates

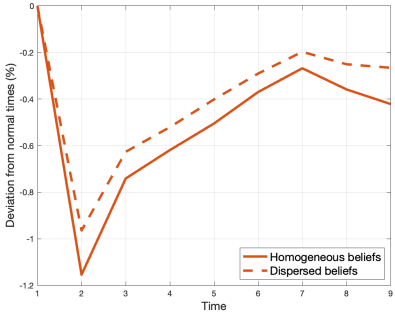
Figure: Homogeneous versus dispersed beliefs

- Belief dispersion matters for aggregate employment and exit rates

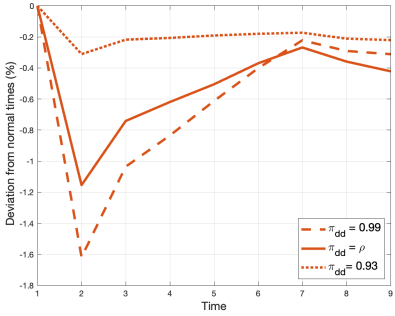
▸ Other countries ▸ Exit rates

Role of heterogeneous beliefs: Italy

Employment Response



(a) Italy: Dispersion



(b) Italy: Optimists vs. Pessimists

Figure: Homogeneous versus dispersed beliefs

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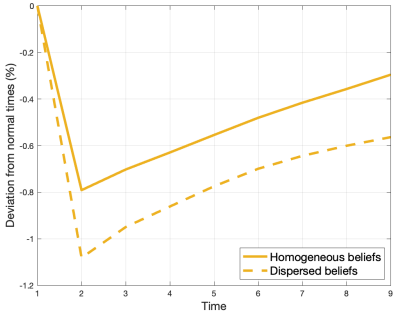
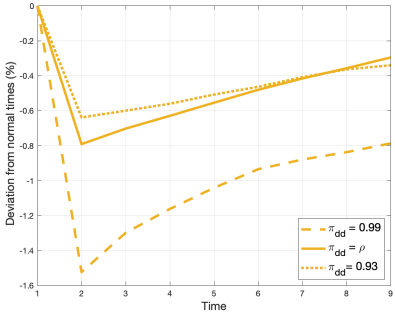
Role of heterogeneous beliefs: France

Employment Response



(a) France: Dispersion



(b) France: Optimists vs. Pessimists

Figure: Homogeneous versus dispersed beliefs

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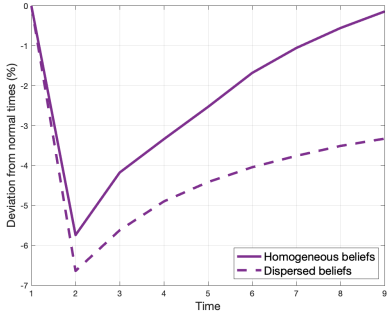
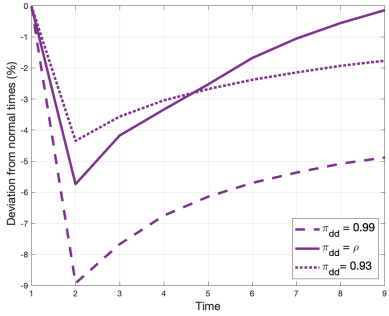
Role of heterogeneous beliefs: Spain

Employment Response



(a) Spain: Dispersion



(b) Spain: Optimists vs. Pessimists

Figure: Homogeneous versus dispersed beliefs

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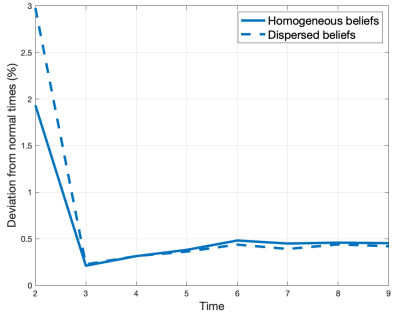
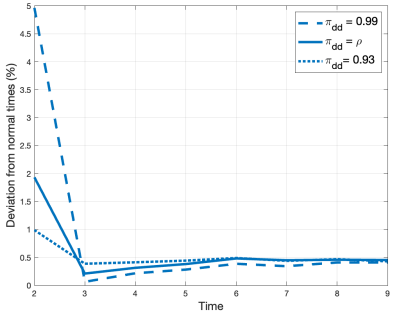
Role of heterogeneous beliefs: Germany

Size-weighted exit rates



(a) Exit: Dispersion



(b) Exit: Optimists vs. Pessimists

Figure: Optimists versus Pessimists

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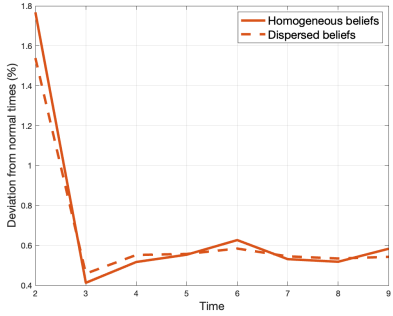
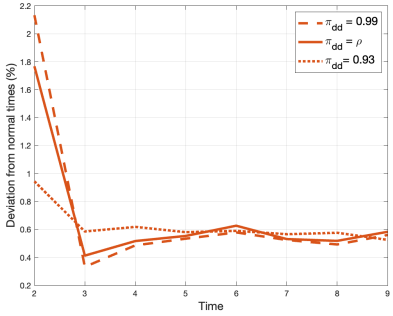
Role of heterogeneous beliefs: Italy

Size-weighted exit rates



(a) Exit: Dispersion



(b) Exit: Optimists vs. Pessimists

Figure: Optimists versus Pessimists

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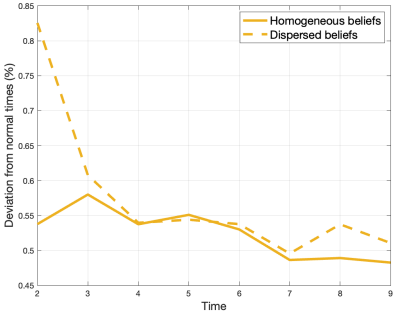
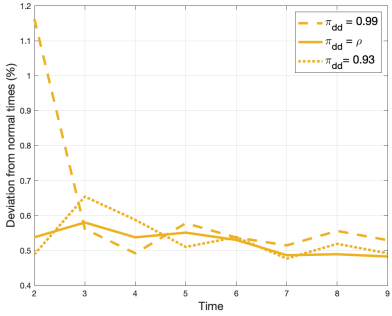
Role of heterogeneous beliefs: France

Size-weighted exit rates



(a) Exit: Dispersion



(b) Exit: Optimists vs. Pessimists

Figure: Optimists versus Pessimists

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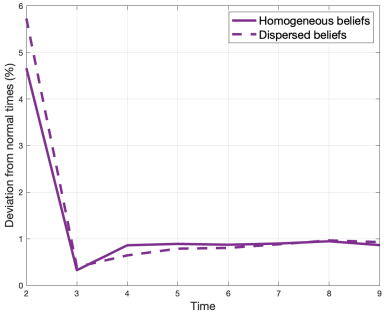
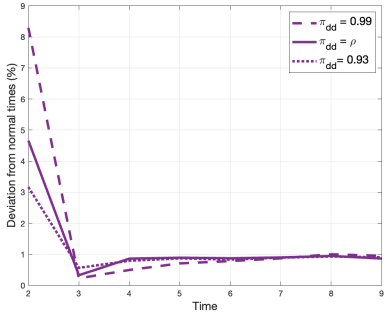
Role of heterogeneous beliefs: Spain

Size-weighted exit rates



(a) Exit: Dispersion



(b) Exit: Optimists vs. Pessimists

Figure: Optimists versus Pessimists

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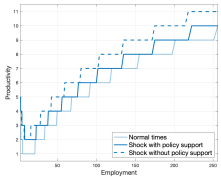
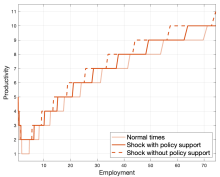
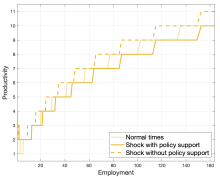
Productivity Thresholds



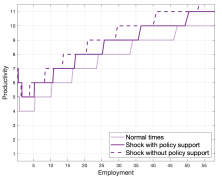
(a) Germany



(b) Italy



(c) France



(d) Spain

Role of Adjustment Costs

Table: Productivity measures

		Normal Times		Shock	
		AC	No AC	AC	No AC
Germany	APL	0.211	0.183	0.169	0.181
	Std	0.098	0.029	0.079	0.029
Italy	APL	0.384	0.341	0.339	0.337
	Std	0.201	0.079	0.179	0.079