Quantifying the Germany Shock:

Structural Labor-Market Reforms and Spillovers in a Currency Union

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Motivation

Germany's economic transformation after the introduction of the Euro

- High pre-EZ unemployment led to labor-market reforms (Hartz reforms and others)
  $\rightarrow$ followed by strong increase in labor-force participation
- Manufacturing boom around 2003
- From "sick man of the Euro" to "economic superstar" (Dustmann et al., 2014)

Research Question

What is the impact of unilateral structural reforms in a currency union?

- Quantitative trade theory: typically via changing wages
- But: wages are rigid and Euro pegs nominal exchange rates of EZ countries
- This paper: Supply shocks lead to contraction and unemployment in other EZ countries due to downward nominal wage rigidity (DNWR)

Adjustment of the "German competitiveness shock" as a laboratory to study spillovers

- Do unilateral reforms "externalize" unemployment to the rest of the currency union ("beggar-thy-neighbor" reforms)?
- Lessons for the implementation of economic reforms in the EZ

This Paper

1. Present reduced-form empirical evidence on the employment effects of German trade competition in the EZ
   - Akin to Autor et al. (2013) studying the China shock in the US
   - Taking into account the EZ specificities: common currency and European Single Market

2. Build a nominal quantitative GE model of international trade
   - Key: New-Keynesian wage frictions (DNWR) and upward-sloping labor supply as in Rodríguez-Clare et al. (2020)
     $\rightarrow$ create both, involuntary and voluntary unemployment
   - Accounts for (i) changes in workers' outside option, (ii) UI benefits, (iii) international saving

3. Calibrate the model
   - Characterize the impact of the reforms on the EZ
   - Quantify counterfactual policies to address the German supply shock: reforms without common currency, coordinated reforms, higher inflation, role of savings glut

Outline

- Background and stylized facts
- Empirical analysis
- Quantitative New-Keynesian trade model
- Calibration, results and counterfactual policies

Background

Creation of the Eurozone and structural reforms in the German labor market

Eurozone officially created on January 1, 1999:

- Locking in a hard currency peg
- After the European Exchange Rate Mechanism (1979-1999)
- Euro banknotes and currency physically introduced in 2002

Labor-market reforms and the *"German job miracle"* (Jacobi and Kluge, 2007):

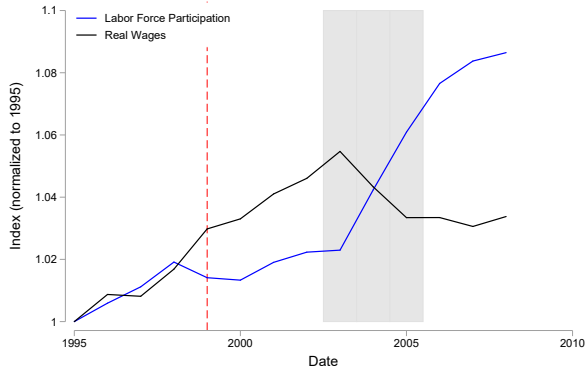
- From mid 1990s: strong increase in decentralized wage bargaining ▸ EZ Comparison
  → lowered wage rigidity (Dustmann et al., 2014; Card et al., 2013)
- 2001 pension reforms, 2003-2005 *"Hartz"* reforms, reform of disability insurance:
  - Reductions in outside options to market work

  → Increased incentives to participate in the labor market
  - Additionally: *Arbeitslosengeld I + II*: strong reduction in replacement rate

Stylized Facts

Increasing German labor-force participation

- Labor-force participation substantially increased during reform years
- Real wages declined, so likely not causing the increase in labor supply
- Reforms:
  stronger search incentives for (long-term) unemployed, increased retirement age, reform of disability insurance, "Ich AG"

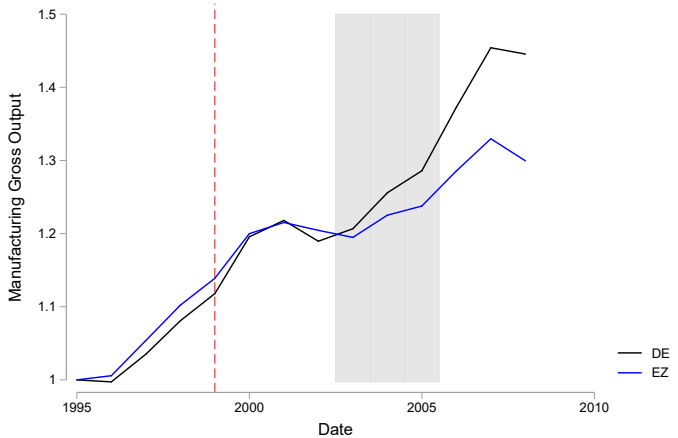


▸ Who increased labor supply?

Stylized Facts

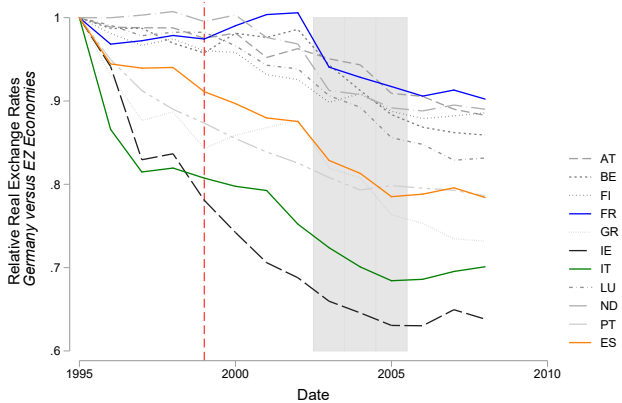
Manufacturing boom

Starting in 2003, real manufacturing output began to grow much faster in Germany than in the rest of the Eurozone.



Stylized Facts

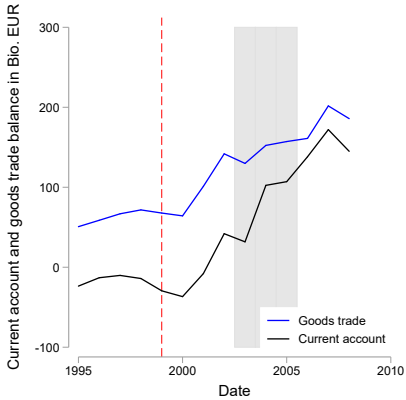
Real exchange rates in the Eurozone

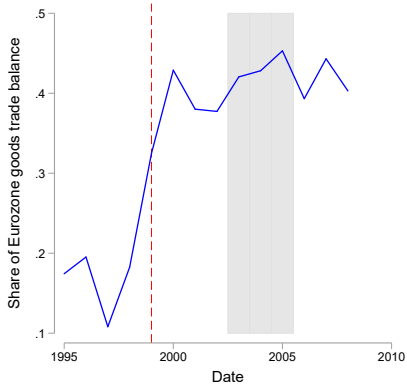


Notes: The Figure plots indices of real exchange rates for EZ economies relative to the German real exchange rate. Relative real exchange rates are defined as the German expenditure-based price level of GDP in purchasing power parities relative to the price level of respective EZ economy using data from the Penn World Tables 8.0.

Stylized Facts

German current account





Notes: The Figure plots the German current account and the goods trade balance in Bio. USD over time. The right plot depicts the fraction German goods trade surplus that accrues to trade within the Eurozone. Data are obtained from the World Bank World Development Indicators (WDI) and trade data from Eurostat Comext.

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Empirical Analysis

Employment effects of rising German trade competition

We run the following regression:

$$L_{cit} = \beta_1 EC^{EZ}_{cit} + \beta_2 EC^{EZ}_{cit} \times PostEuro_t + \delta_{ci} + \delta_t + \epsilon_{cit},$$

Our measure of German export competition that an individual EZ country c is exposed to is

$$EC^{EZ}_{cit} = \sum_{p \in EZ \setminus c} \phi^p_{ci} \frac{M^p_{DEit}}{Y^p_{i95} + M^p_{i95} - E^p_{i95}},$$

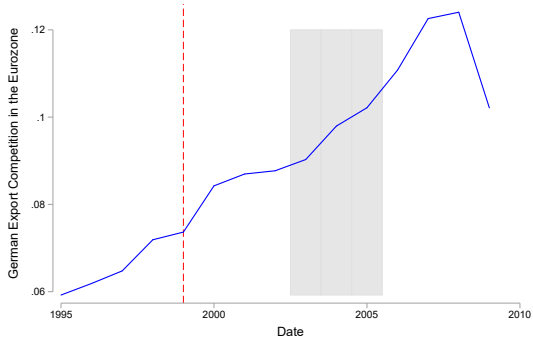
ϕ^p_{ci} market share of country c in market p sector i in 95.
Instrument German export competition in EZ using weighted exports of Germany to other OECD economies (SSIV):

$$EC^{OECD}_{cit} = \sum_{p,q} \phi^p_{ci} \psi^q_{DEi} \frac{M^q_{DEit}}{Y^p_{i95} + M^p_{i95} - E^p_{i95}}.$$

▸ Details on SSIV

Empirical Analysis

Rising German trade competition in the Eurozone



Notes: The Figure plots export market competition from Germany in other Eurozone economies. Export market competition is weighted across countries and sectors according to initial employment levels. Trade data are from Eurostat Comext and data on gross outputs from EU KLEMS.

Empirical Analysis

	(1)	(2)	(3)	(4)	(5)
	OLS			*2SLS*	
Panel A:	*Employment*				
German EZ EC	-1.134***	-0.778***	0.900**	-0.925**	0.389
	(0.347)	(0.288)	(0.453)	(0.369)	(0.487)
Chinese EZ EC		-1.435***			
		(0.353)			
German EZ EC × Post Euro			-1.193***		-0.682**
			(0.307)		(0.264)
F-statistic				237.0	76.04
Observations	2646	2646	2646	2646	2646
Country-Ind. Clusters	180	180	180	180	180
Country-Ind. F.E.	×	×	×	×	×
Year F.E.	×	×	×	×	×

Empirical Analysis

	(1)	(2)	(3)	(4)	(5)
	OLS			*2SLS*	
Panel B:	*Labor Costs*				
German EZ EC	0.285*	0.221	-0.0284	0.237	0.0199
	(0.156)	(0.137)	(0.126)	(0.166)	(0.130)
Chinese EZ EC		0.256**			
		(0.0992)			
German EZ EC × Post Euro			0.184		0.113
			(0.118)		(0.105)
F-statistic				237.0	76.03
Observations	2634	2634	2634	2634	2634
Country-Ind. Clusters	179	179	179	179	179
Country-Ind. F.E.	×	×	×	×	×
Year F.E.	×	×	×	×	×

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Model

Model overview (1/2)

Broad idea:

- Quantitative GE multi-country and multi-industry trade model
  - Armington trade, Roundabout production (IO linkages), trade imbalances
- Instead of a real model, this is a trade model expressed in nominal (EUR) terms
  - We borrow from Rodríguez-Clare et al. (2020):
    upward-sloping labor supply and DNWR as in Schmitt-Grohé and Uribe (2016)
  - Nominal wages take time to adjust downwards, creating temporary unemployment
- Key differences:
  - (i) Shock the utility of non-market participation
  - (ii) Tax-financed UI benefits ▸ Details
  - (iii) 2 types of agents: workers and investors:
    former supply labor, latter can save internationally

Model

Model overview (2/2)

Countries and industries:

- M countries within the EZ (**fixed nominal exchange rate**)
  $I - M$ countries outside the EZ (**floating nominal exchange rate**)
- S narrow sectors, map into B **broad sectors** (manufacturing, services, agriculture)
- 2 types of agents
  - **Workers**: Supply labor, fully mobile within broad sectors, imperfectly mobile across broad sectors, hand-to-mouth consumption, subject to DNWR
  - **Investors**: Supply capital, invest in international bond, are forward-looking

Preferences and demand:

- Cobb-Douglas preferences across sectors (expenditure shares α_{js})
- Armington within sectors: sectoral CES aggregates of varieties across countries (elasticity σ_s)

Production:

- Multi-sector model with IO structure and traded intermediate inputs (Armington) calibrated to detailed bilateral sectoral trade and gross-output data ▸ Details on production

Model

Fréchet-Roy model of workers' labor supply

Workers' labor-supply choice:

- Workers draw a z_b for each broad sector from nested Fréchet distribution
- Home production with flow utility $\mu_{it} \rightarrow$ Indirect utility is $\ln \mu_{it} + z_0$
- Participate in labor market for *expected* real wage ω_{ibt} if work in sector b $\rightarrow$ Indirect utility is $\ln \omega_{ibt} + z_b$
- l_{ibt}: labor supply in sector b

Labor-force participation rate:

$$\pi_{it} = \frac{\sum_b l_{ibt}}{\overline{L}_i} = \frac{\omega_{it}^{\kappa}}{{\mu_{it}}^{\kappa} + \omega_{it}^{\kappa}}, \text{ with } \omega_{it} = \left(\sum_b \omega_{ibt}^{\eta} \right)^{1/\eta}.$$

Model

Downward nominal wage rigidity (DNWR) à la Schmitt-Grohé and Uribe (2016)

Wage stickiness:

- Nominal wages in domestic currency cannot fall by more than $(1 - \tilde{\delta}_{ib}) \times 100\%$ per period
- Might lead to transitional involuntary unemployment

$$\mathcal{W}^{LCU}_{ibt} \geq \tilde{\delta}_{ib} \mathcal{W}^{LCU}_{ibt-1}, \text{ with } \tilde{\delta}_{ib} \geq 0.$$

- Let E_{it} be the nominal xrate (Euros/LCU): then $E_{ibt}\mathcal{W}^{LCU}_{ibt} = \mathcal{W}_{ibt}$
- DNWR in Euros:

$$\mathcal{W}_{ibt} \geq \frac{E_{it}}{E_{it-1}} \tilde{\delta}_{ib} \mathcal{W}_{ibt-1} := \delta_{ib} \mathcal{W}_{ibt-1}.$$

Nominal rigidity:

- Flexible ER $\rightarrow$ DNWR constraint never binding, $\delta_{ib} = 0$
- Within EZ $\rightarrow$ fixed ER $(E_{it}/E_{it-1} = 1)$, $0 < \delta_{ib} < 1$

▸ Role of inflation and complementary slackness

Model

Current account, trade balance and international saving

- Investors own capital stock, are born with initial debt D_{j0} (i.e. -NFA) and maximize utility:

$$U_j^k = \sum_{t=0}^{\infty} \varphi_{jt} \beta^t u_{jt}^k(C_{jt}^k), \quad u_{jt}^k = \log(C_{jt}^k)$$

- Have access to 1-period Euro bond and face budget constraint (in Euros)

$$P_{jt} C_{jt}^k + (1 + r_{t-1}) D_{jt-1} = \mathcal{R}_{jt} K_{jt} + D_{jt}$$

- CA equals ΔNFA:

$$CA_{jt} = -(D_{jt} - D_{jt-1})$$

- TB equals CA net of interest payment on debt, endogenizable w/ Euler equation

$$TB_{jt} = CA_{jt} + r_{t-1} D_{jt-1} = \mathcal{R}_{jt} K_{jt} - P_{jt} C_{jt}^k$$

Model

Equilibrium: dynamic hat algebra à la Dekle et al. (2007); Caliendo et al. (2019)

An equilibrium in changes is a sequence of endogenous variables in relative changes such that all equilibrium conditions are satisfied for a sequence of shocks ▸ Details

$$\left\{ \underbrace{\hat{\mu}_{it}, \hat{\delta}_{it}, \hat{\tau}_{it}}_{\text{labor-market variables}}, \hat{A}_{ist}, \hat{d}_{ijst}, \hat{\varphi}_{it} \right\}$$

- Conditions:
  (i) Product markets clear, *(ii)* Factor markets clear: labor income = labor expenditure and capital income = capital expenditure, *(iii)* Labor-supply decisions optimal, *(iv)* Investors' savings decisions optimal, *(v)* Wage rigidity considered, *(vi)*, Bond market clears, *(vii)* Nominal growth is anchored
- Iterate forward period-by-period (new level is old level $\times$ change)

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Calibration

Goal:

- Use calibrated version of the model to characterize the impact of the Germany shock
- Then, study policy counterfactuals

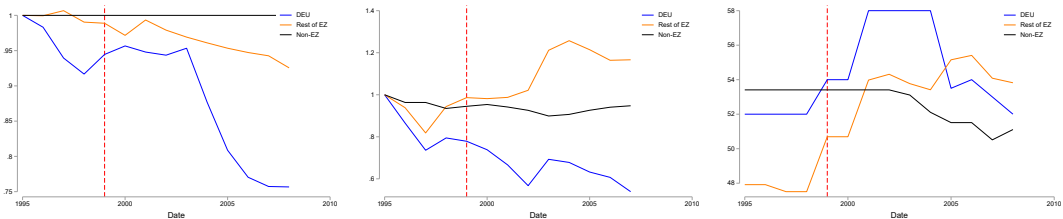
Shock identification:

- Labor-market variables $\hat{\mu}_{it}, \hat{\delta}_{it}, \hat{\tau}_{it}$:
  - $\hat{\mu}_{it}$ identified by wedges between LFP and real wages
  - $\hat{\delta}_{it}$ identified by nom. wage growth during phases with growing unemployment
  - $\hat{\tau}_{it}$ taken from data on avg. UI replacement rates
- Shocks to TFP and trade costs $\hat{A}_{ist}, \hat{d}_{ijst}$:
  - Recovered from structural model equations filled with data for equ. objects
  - As in Eaton et al. (2016) or Dix-Carneiro et al. (2023)
- Shocks to international savings preferences $\hat{\varphi}_{it}$:
  - Recovered from investors' Euler equation
  - Using data on the IMF money-market interest rate and trade imbalances.

▸ Details on Calibration ▸ Untargeted Moments

Calibration

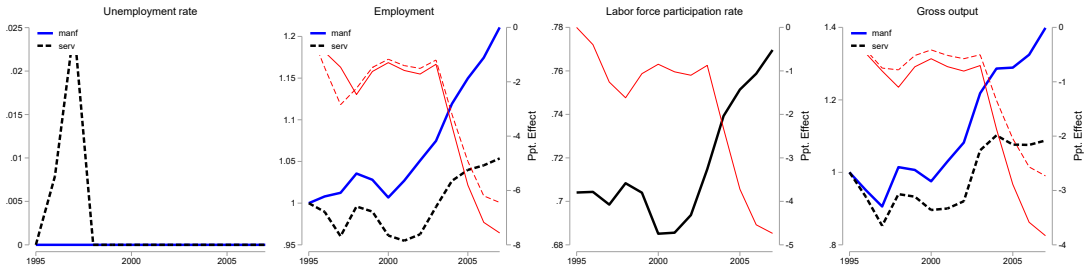
Non-market utility shocks, patience shocks and replacement rates



Notes: The Figure plots calibrated average cumulated shocks to the utility of non-market activities $\hat{\mu}_{ist}$ (left) and cumulated patience shocks $\hat{\varphi}_{it}$ (middle) and replacement rates in levels τ_{it} (right) for Germany, the rest of the EZ and non-EZ economies. Variables are weighted across countries i based on GDP in 1995.

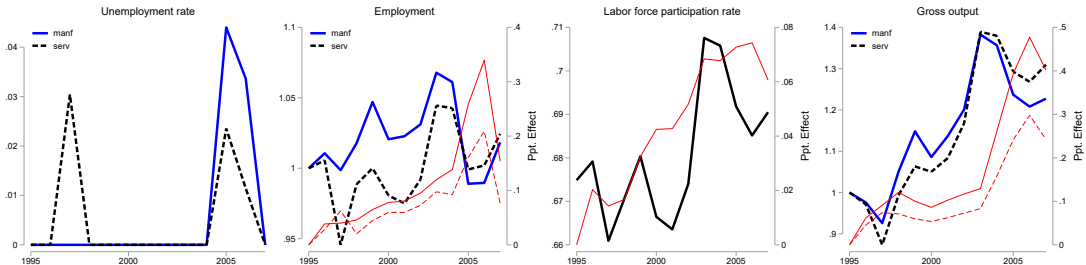
Calibration

Results: baseline scenario for Germany



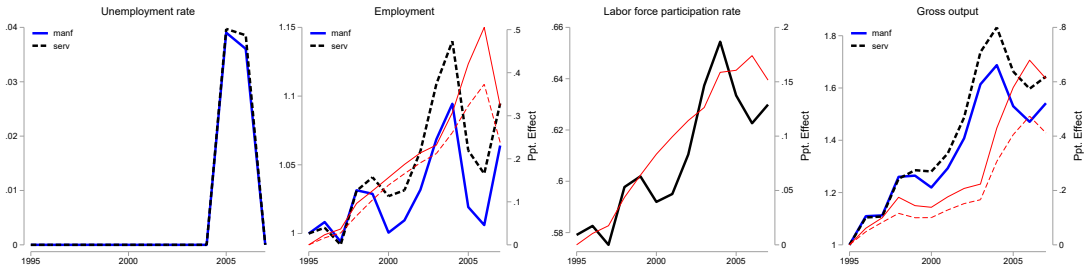
Calibration

Results: baseline scenario for France



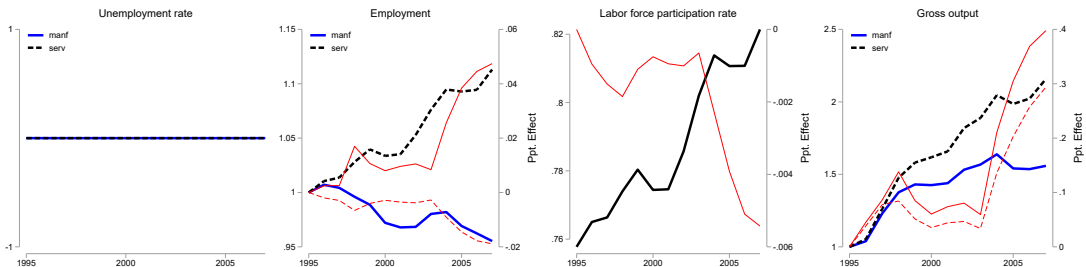
Calibration

Results: baseline scenario for Italy



Calibration

Results: baseline scenario for the UK



Counterfactual Policies

- Flexible exchange rates:
  - Assume flexible exchange rates within the EZ ($\delta_{it} = 0$)
  - Nominal wages flexibly adjust without the currency peg $\rightarrow$ no involuntary unemployment
  - Southern Europe experiences significantly higher employment growth
  - Most EZ members also benefit from higher growth in expected real wages ▸ Table

- Coordinated reforms in the EZ:
  - All EZ economies experience the same labor-market shocks ($\hat{\mu}_{it}, \hat{\delta}_{it}, \hat{\tau}_{it}$), taking the values from Germany
  - Lower unemployment and increases in LFP and employment across the EZ
  - But: expected real wages drop in most countries to absorb increased labor supply ▸ Table

- Monetary Policy:
  - Idea: countries can outgrow DNWR with higher inflation
  - Model-Implied Phillips curve: compute average unemployment levels for different levels of nominal anchoring (i.e. setting higher nominal growth rates) ▸ Figure

Counterfactual Policies

The role of the German savings glut

- Homogeneous Savings Preferences:
  - Homogeneous shocks to discount rate ($\hat{\varphi}_{it}$)
  - Set equal within the EZ, all countries receiving the EZ average (computed excluding Germany)
  - Less growth of German manufacturing employment, higher growth of service employment
  - German CA surplus vanishes
  - EZ periphery experiences more growth in manufacturing and less growth in services ▸ Table

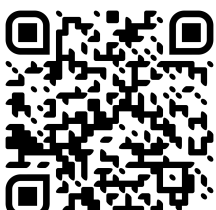
Conclusion

- We have studied the impact of the German manufacturing export boom on the EZ
- Due to the peg in the nominal exchange rate, nominal wages could not sufficiently adjust, causing reductions in employment and temporary increases in unemployment in the rest of the EZ

Policy Implications:

- Reforms that increase competitiveness unilaterally transfer unemployment to the rest of EZ (beggar-thy-neighbor policy)
- Coordination of structural reforms within a currency union useful
- Alternative: higher avg. inflation rate would have cushioned the impact of the Germany shock in the EZ

Paper URL



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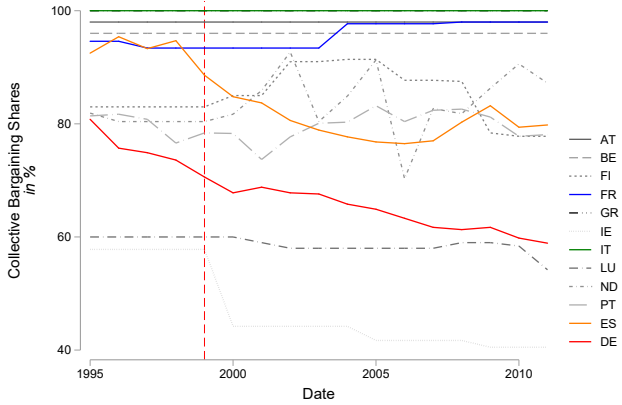
Backup Slides

Stylized Facts

Collective wage bargaining in the Eurozone



Notes: The Figure plots the share of workers with jobs covered by collective wage bargaining in percent for Eurozone economies using data from the OECD.

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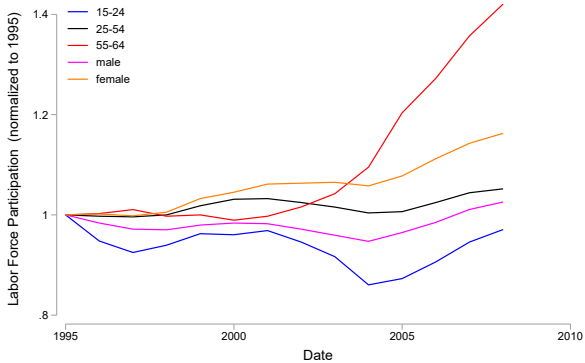
Stylized Facts

Labor-force participation by age and gender in Germany



Notes: The Figure plots indices of labor-force participation in Germany. Index values are relative to the base year 1995. Labor-force participation is based on Eurostat data for age cohorts 15-24, 25-54, 55-64 years and males and females (ages 15-64).

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Empirical Analysis

Properties the shift-share instrument

- Endogeneity problem:
  - Exports from Germany to EZ depend on EZ supply and demand conditions
  - These may have direct effects on EZ labor markets
- SSIV as an approximation of an idealized experiment:
  - Generates random variation in the growth of German exports across countries and industries
  - Instrument by observed changes in trade between Germany and OECD countries outside the EZ
- Borusyak et al. (2021) diagnostics:
  - Set of Shocks $\frac{M^q_{DEit}}{Y^p_{i95}+M^p_{i95}-E^p_{i95}}$
  - Complete Shares $\sum_{p,q} \phi^p_{ci} \psi^q_{DEi} = 1$
  - Distribution of shocks – computed with importance weights – not too granular: std. dev. 0.461, mean 0.136, interquartile range 0.101, 99th pct. 1.74
  - Inverse HHI of the shock-level shares (effective sample size): 5,576
  - Moderate clustering of shock residuals: ICC estimated share of the overall shock residual variance due to the random effect EZ partner by industry combinations is 0.26

Back

Empirical Analysis

Crowding-out of Eurozone exports

	(1)	(2)	(3)	(4)
	Individual EZ Econ.		Aggregate EZ	
Partner:	*OECD*	*Intra-EZ*	*OECD*	*Intra-EZ*
Panel A:	*Growth in Export Value*			
Export Growth DE	0.388***	0.402***	0.180***	0.177***
	(0.0322)	(0.0688)	(0.0147)	(0.0282)
× Post Euro	-0.198***	-0.218***	-0.127***	-0.126***
	(0.0374)	(0.0778)	(0.0161)	(0.0310)
Observations	879,864	283,862	121,319	37,877
Clusters	76,924	24,232	9,066	2,849
Exporter × Partner × Ind F.E.	×	×	×	×
Year F.E.	×	×	×	×

◂ Back

Model

Production

Multi-sector model with IO structure and traded intermediate inputs that can be calibrated to detailed bilateral sectoral trade and gross-output data

Production Function:

- Cobb-Douglas production with CRS using **labor** (ϕ_{jk}), **capital** (ψ_{jk}) and **materials** (Cobb-Douglas aggregate of sectoral inputs, with IO shares $\phi_{j,sk}$)

  $$\phi_{jk} + \psi_{jk} + \sum_s \phi_{j,sk} = 1$$

- TFP A_{jkt} varies across sectors, countries and over time
- Sectoral inputs are also CES Armington aggregates with same elasticity σ_s as final goods.

Product Markets:

- Competitive product markets
- Iceberg trade costs $d_{ijkt} > 1$ for good k to flow from i to j

Back

Model

DNWR: complementary slackness and nominal anchoring

Complementary Slackness:

- Either DNWR is **non-binding** $\rightarrow$ labor market clears
  or DNWR is **binding** $\rightarrow$ involuntary unemployment

$$(l_{ibt} - L_{ibt})\,(\mathcal{W}_{ibt} - \delta_{ib}\mathcal{W}_{ibt-1}) = 0.$$

Nominal Anchoring:

- High inflation allows nominal wages to rise without making the DNWR binding, since in this case $\frac{\mathcal{W}_{ibt}}{\mathcal{W}_{ibt-1}} > \delta_{ib}$ always satisfied
- A nominal anchor that sets inflation sufficiently low prevents this

Back

Model

UI benefits and expected real wages

Unemployment Insurance:

- UI benefits financed via a revenue-neutral income tax
- Broadly match key characteristics of *Arbeitslosengeld I*
  - Recipients within labor force, prop. to wages, financed via social-security contr.

$$\sum_b t_{it} \mathcal{W}_{ibt} L_{ibt} = \sum_b \tau_{it} \mathcal{W}_{ibt} (l_{ibt} - L_{ibt}),$$

Expected Real Wages:

- Expected real wage in broad sector b is

$$\omega_{ibt} = \frac{L_{ibt}}{l_{ibt}} \frac{(1 - t_{it}) \mathcal{W}_{ibt}}{P_{it}} + (1 - \frac{L_{ibt}}{l_{ibt}}) \frac{\tau_{it} \mathcal{W}_{ibt}}{P_{it}}.$$

Back

Model

Equilibrium in changes

Product-market clearing:

$$\hat{R}_{ist} R_{ist-1} = \sum_{j=1}^{I} \hat{\lambda}_{ijst} \lambda_{ijst-1} \times \left[\alpha_{js} \left(\sum_{b} \hat{\mathcal{W}}_{jbt} \hat{L}_{jbt} \mathcal{W}_{jbt-1} L_{jbt-1} + \hat{\mathcal{R}}_{jt} \hat{K}_{jt} \mathcal{R}_{jt-1} K_{jt-1} - \hat{TB}_{jt} TB_{jt-1} \right) + \sum_{k} \phi_{jsk} \hat{R}_{jkt} R_{jkt-1} \right] \quad \forall i, \forall s$$

Changes in trade shares and in prices:

$$\hat{\lambda}_{ijst} = \frac{\left(\hat{d}_{ijst} \hat{A}_{ist}^{-1} \hat{\mathcal{W}}_{i,b(s),t}^{\phi_{is}} \hat{\mathcal{R}}_{it}^{\psi_{is}} \prod_k \hat{P}_{ikt}^{\phi_{i,ks}} \right)^{1-\sigma_k}}{\sum_{r=1}^{I} \lambda_{rjst-1} \left(\hat{d}_{rjst} \hat{A}_{rst}^{-1} \hat{\mathcal{W}}_{r,b(s),t}^{\phi_{rs}} \hat{\mathcal{R}}_{rt}^{\psi_{rs}} \prod_k \hat{P}_{rkt}^{\phi_{r,ks}} \right)^{1-\sigma_k}} \quad \forall i, \forall s$$

$$\hat{P}_{ist} = \left[\sum_{j} \lambda_{jist-1} \left(\hat{d}_{ijst} \hat{A}_{jst}^{-1} \hat{\mathcal{W}}_{j,b(s),t}^{\phi_{js}} \hat{\mathcal{R}}_{jt}^{\psi_{js}} \prod_k \hat{P}_{jkt}^{\phi_{j,ks}} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \quad \forall i, \forall s$$

$$\hat{P}_{it} = \prod_{s} \hat{P}_{ist}^{\alpha_{is}} \quad \forall i$$

Factor-market clearing:

$$\hat{\mathcal{R}}_{it}\hat{K}_{it}\mathcal{R}_{it-1}K_{it-1} = \sum_{s\in S}\psi_{is}\hat{R}_{ist}R_{ist-1} \qquad \forall i$$

$$\hat{\mathcal{W}}_{ibt}\hat{L}_{ibt}\mathcal{W}_{ibt-1}L_{ibt-1} = \sum_{s\in b}\phi_{is}\hat{R}_{ist}R_{ist-1} \qquad \forall i, \forall b$$

Nominal wages and employment constraints:

$$\prod_{q=1}^{t}\hat{L}_{ibq} \leq \prod_{q=1}^{t}\hat{l}_{ibq}, \hat{\mathcal{W}}_{ibt} \geq \hat{\delta}_{it}\delta_{it-1}, \quad \forall i, \forall s$$

Changes in labor supply and expected real wages:

$$\hat{l}_{ibt} = \frac{\hat{\omega}_{it}^{\kappa}}{\hat{\mu}_{it}^{\kappa}(1-\pi_{it-1}) + \hat{\omega}_{it}^{\kappa}\pi_{it-1}}\frac{\hat{\omega}_{ibt}^{\eta}}{\hat{\omega}_{it}^{\eta}} \qquad \forall i, \forall b$$

$$\hat{\omega}_{ibt} = \frac{\left(1-\hat{t}_{it}t_{it-1}-\hat{\tau}_{it}\tau_{it-1}+\frac{\hat{l}_{ibt}l_{ibt-1}}{L_{ibt}L_{ibt-1}}\hat{\tau}_{it}\tau_{it-1}\right)}{\left(1-t_{it-1}-\tau_{it-1}+\frac{l_{ibt-1}}{L_{ibt-1}}\tau_{it-1}\right)}\frac{\hat{\mathcal{W}}_{ibt}\hat{L}_{ibt}}{\hat{P}_{it}\hat{l}_{ibt}} \qquad \forall i, \forall b$$

$$\hat{\omega}_{it} = \left[\sum_{b}\pi_{ibt-1}\hat{\omega}_{ibt}^{\eta}\right]^{1/\eta} \qquad \forall i$$

Unemployment benefits are revenue neutral:

$$\sum_b \hat{t}_{it}\, t_{it-1} \hat{\mathcal{W}}_{ibt} \mathcal{W}_{ibt-1} \hat{L}_{ibt} L_{ibt-1} = \sum_b \hat{\tau}_{it}\, \tau_{it-1} \hat{\mathcal{W}}_{ibt} \mathcal{W}_{ibt-1} \left(\hat{l}_{ibt}\, l_{ibt-1} - \hat{L}_{ibt} L_{ibt-1} \right) \quad \forall i$$

Savings decision of investors:

$$\begin{aligned}
\hat{P}_{it} \hat{C}^k_{it} &= \hat{\varphi}_{it} \beta (1 + r_{t-1}) && \forall i \\
\hat{TB}_{it}\, TB_{it-1} &= \hat{\mathcal{R}}_{it} \hat{K}_{it} \mathcal{R}_{it-1} K_{it-1} - \hat{P}_{it} \hat{C}^k_{it} P_{it-1} C^k_{it-1} && \forall i \\
\hat{CA}_{it}\, CA_{it-1} &= \hat{TB}_{it}\, TB_{it-1} - r_{t-1} D_{it-1} && \forall i \\
\sum_i \hat{CA}_{it}\, CA_{it-1} &= 0
\end{aligned}$$

World nominal GDP growth is set equal to γ:

$$\sum_i \left(\sum_b \hat{\mathcal{W}}_{ibt} \hat{L}_{ibt} \mathcal{W}_{ibt-1} L_{ibt-1} + \hat{\mathcal{R}}_i \hat{K}_{it} \mathcal{R}_{it-1} K_{it-1} \right) = \gamma \sum_i \left(\sum_b \mathcal{W}_{ibt-1} L_{ibt-1} + \mathcal{R}_{it-1} K_{it-1} \right)$$

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Calibration

Data:

- WIOT for sectoral trade and production data, EU KLEMS:
  31 countries + RoW
  3 broad sectors (agr, manuf, services), 12 narrow manufacturing sectors
- OECD and World Bank for labor-force participation and UI replacement rates
- PWT 8.0 for capital stocks, IMF for Euro nominal interest rate and NFA

Parameters:

Elasticity of substitution	σ	4
Labor supply parameter	κ	1
Sectoral mobility frictions	ν	1
Nominal anchor	γ	1.027
Discount factor	β	0.99

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Calibration

List of countries

AUT	ESP	IRL	POL
BEL	EST	ITA	PRT
BGR	FIN	JPN	ROU
CHN	FRA	LUX	SVK
CYP	GBR	LTU	SVN
CZE	GRC	LVA	SWE
DEU	HUN	MLT	USA
DNK	IND	NLD	RoW

Notes: List of countries included in the structural model. Countries in blue mark the EZ.

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Calibration

List of industries

1	Agriculture
2	Mining, petroleum and coal products
3	Food, Beverages, and Tobacco
4	Textiles and textile products
5	Wood and paper products
6	Chemicals and chemical products
7	Rubber and plastics
8	Other non-metallic mineral products
9	Basic metals and fabricated metal
10	Machinery
11	Computer and electronic products
12	Transport equipment
13	Furniture and misc. manufacturing
14	Services

Notes: List of sectors included in the structural model.

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Calibration

Estimation of nominal wage rigidities δ_{it}

- All countries that joined EZ in the first round + Greece are subject to DNWR
- Estimation of δ_{it} (Schmitt-Grohé and Uribe, 2016):
  Use complementary slackness condition to infer δ_{it},
  Whenever unemployment rate $\uparrow \rightarrow$ growth rate of nominal wages $= \delta_{it}$
- Consider nominal wage growth over all periods between 1999-2008 to pin down $\delta_{iPostEZ}$
- To guarantee convergence to a zero-unemployment steady state without shocks:
  Set the maximum of δ_{it} (Greece) to 1.0 and then normalize all values by that value (Germany has lowest rigidity)
- Before 1999: adjust δ_{it} for the width of the ERM exchange-rate band (2.25% per year):
  $\delta_{iPreEZ} = 0.975 \times \delta_{iPostEZ}$

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Calibration

Details on the calibration of shocks

TFP shocks and trade cost shocks $\hat{A}_{ist}$, $\hat{d}_{ijkt}$:

$$\hat{d}_{ijst} = \left(\frac{\hat{\lambda}_{ijst}}{\hat{\lambda}_{iist}} \right)^{\frac{1}{1-\sigma_s}} \frac{\hat{P}_{jt}}{\hat{P}_{it}},$$

$$\hat{A}_{ist} = \frac{1}{\hat{P}_{it}} \left(\hat{\lambda}_{iist} \right)^{\frac{1}{\sigma_s - 1}} \left(\hat{\mathcal{W}}_{i,b(s),t}^{\phi_{js}} \hat{\mathcal{R}}_{it}^{\psi_{js}} \prod_k \hat{P}_{ikt}^{\phi_{i,ks}} \right).$$

Shocks to workers' outside option $\hat{\mu}_{it}$:

$$\hat{\mu}_{it} = \left(\frac{\hat{\omega}_{it}^{\kappa}}{\hat{\pi}_{it}} - \hat{\omega}_{it}^{\kappa} \right)^{\frac{1}{\kappa}}$$

Patience shocks $\hat{\varphi}_{it}$:

- Euler equation: $\hat{P}_{it} \hat{C}_{it}^{k} = \hat{\varphi}_{it} \beta (1 + r_{t-1})$

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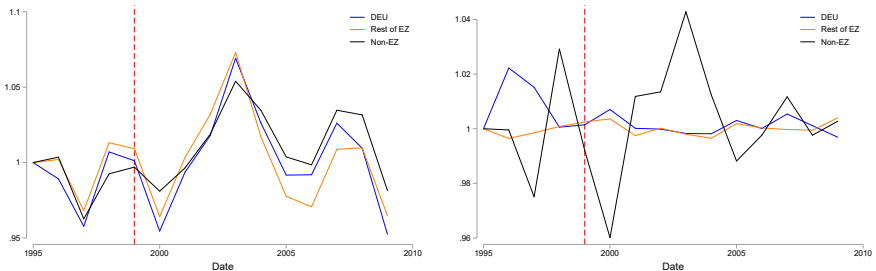
Calibration

TFP and trade-cost shocks

Figure: TFP shocks (left), Trade-cost shocks (right)



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Calibration

Model Fit and untargeted moments: baseline outcomes versus data

Variable	Regression Coefficient	Explained Variation
Labor-Force Participation		
no fixed effects	0.70	0.66%
country fixed effects	0.59	0.59%
Real Exchange Rates		
no fixed effects	0.85	0.87%
country fixed effects	0.88	0.87%
Current Account per GDP		
no fixed effects	0.69	0.79%
country fixed effects	0.89	0.46%
Cumulative Gross-Output Growth		
no fixed effects	1.10	0.69%
country fixed effects	1.20	0.63%
Cumulative Wage Growth		
no fixed effects	0.36	0.48%
country fixed effects	0.50	0.66%

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Counterfactual Policies

Flexible exchange rates

EZ country	*manf.* $\hat{L}_{ibt}$	*serv.* $\hat{L}_{ibt}$	$\hat{\omega}_{it}$	*unempl.*	$\widehat{CA}$
	Flexible Exchange Rates				
	ppt. difference to baseline				
AUT	0.00	0.00	0.00	0.00	0.00
BEL	0.00	0.00	0.01	-0.85	0.00
DEU	0.00	0.00	0.01	-0.07	0.00
ESP	1.25	0.88	0.43	-3.50	0.12
FIN	0.00	0.00	0.00	-0.03	0.00
FRA	0.00	0.00	0.00	-0.67	0.00
GRC	0.45	0.02	0.05	-1.12	0.01
IRL	4.21	2.49	1.43	-6.83	0.03
ITA	0.00	0.00	0.01	-1.34	0.00
LUX	0.00	0.00	0.03	-1.44	0.00
NLD	0.00	0.00	0.00	-0.03	0.00
PRT	0.01	0.01	0.02	-0.54	-0.01

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Counterfactual Policies

Coordinated reforms in the EZ

EZ country	*manf.* $\hat{L}_{ibt}$	*serv.* $\hat{L}_{ibt}$	$\hat{\omega}_{it}$	*unempl.*	$\widehat{CA}$
	Coordinated Reforms				
	ppt. difference to baseline				
AUT	0.36	0.37	-0.12	0.00	0.01
BEL	0.36	0.36	-0.13	-0.25	0.01
DEU	0.02	0.02	0.00	0.02	0.00
ESP	1.38	1.03	0.32	-2.49	0.12
FIN	0.75	0.73	-0.28	-0.01	0.03
FRA	0.75	0.71	-0.26	-0.04	0.05
GRC	1.46	0.98	-0.33	-0.78	0.16
IRL	1.94	1.93	0.34	-2.31	0.02
ITA	0.45	0.43	-0.16	0.21	0.02
LUX	0.12	0.10	-0.01	-0.70	0.00
NLD	0.18	0.17	-0.09	-0.03	0.00
PRT	0.51	0.48	-0.22	-0.22	0.03

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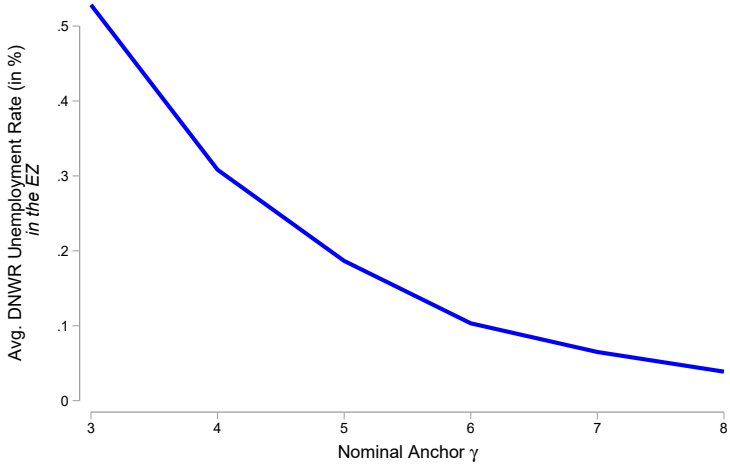
Counterfactual Policies

The role of monetary policy



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Counterfactual Policies

Homogeneous savings preferences

EZ country	*manf.* $\hat{L}_{ibt}$	*serv.* $\hat{L}_{ibt}$	$\hat{\omega}_{it}$	*unempl.*	$\widehat{CA}$
	Homogeneous Savings Preferences				
	ppt. difference to baseline				
AUT	-0.23	0.09	0.08	0.00	-0.49
BEL	-0.08	0.04	0.05	-0.15	-0.24
DEU	-0.54	0.25	0.17	0.03	-0.87
ESP	0.18	-0.29	-0.18	0.45	0.37
FIN	0.13	-0.05	-0.05	0.10	0.10
FRA	-0.01	0.00	0.00	0.06	0.02
GRC	-0.07	-0.15	-0.21	0.39	0.55
IRL	0.14	0.17	0.05	-0.09	0.04
ITA	0.15	-0.08	-0.04	-0.39	0.18
LUX	0.04	-0.02	-0.02	-0.16	-0.20
NLD	-0.16	0.07	0.13	-0.03	-0.55
PRT	0.09	-0.06	-0.05	0.26	0.13

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