FIRM DYNAMICS AND RESIDUAL INEQUALITY IN OPEN ECONOMIES

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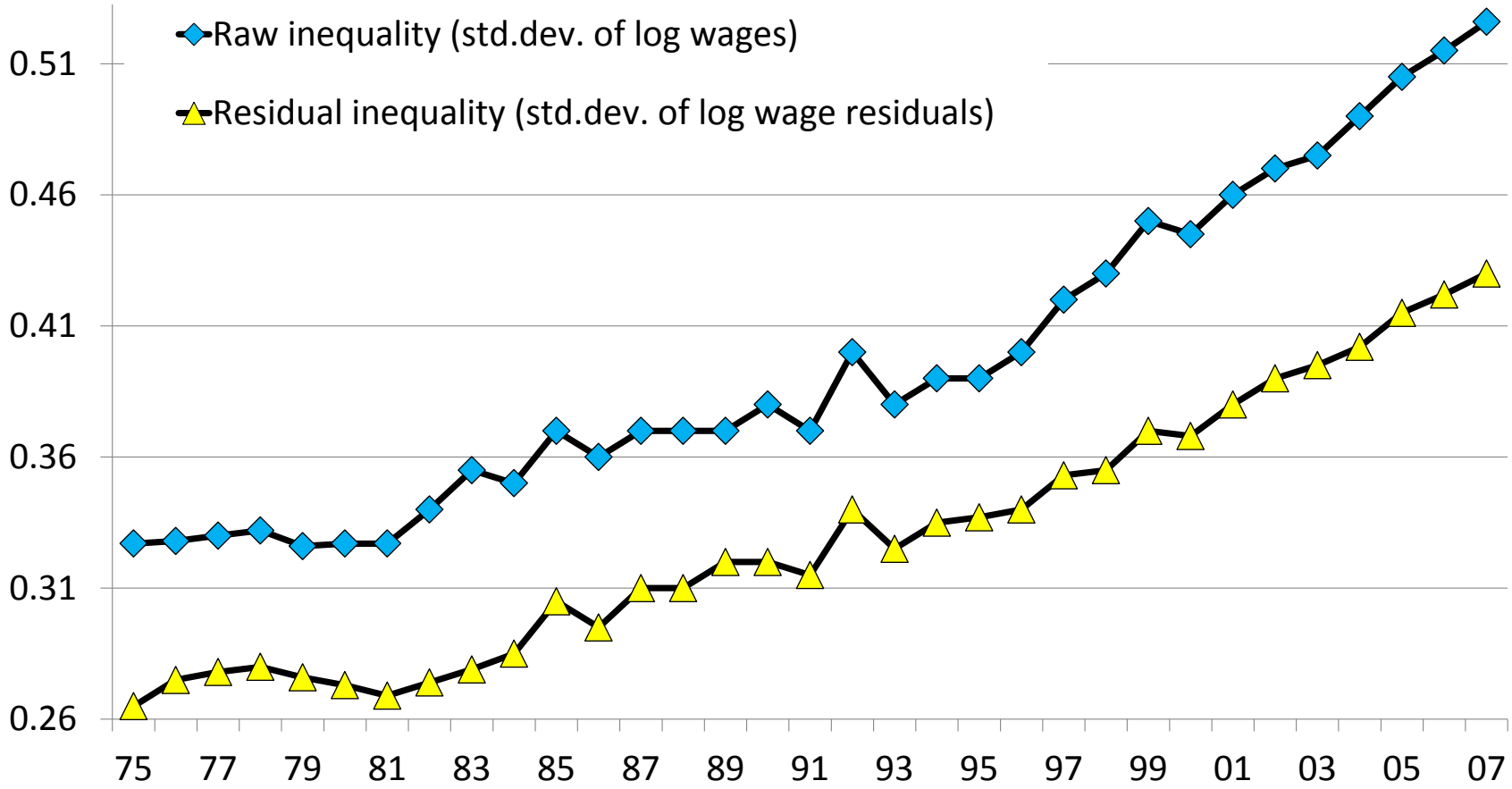
Residual Wage Inequality

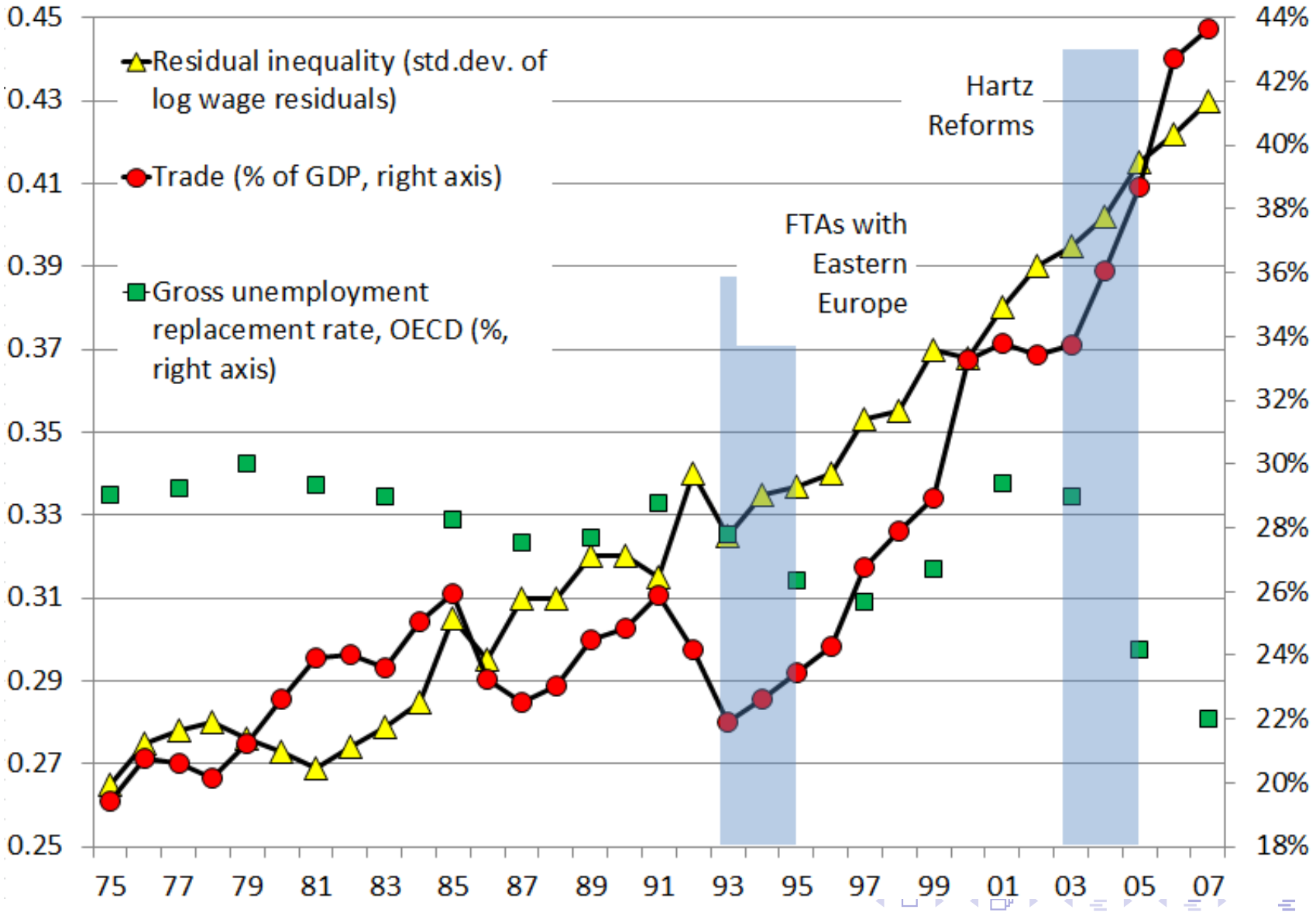
- Since 1990, increasing **wage inequality** in almost all OECD countries
- **Mincer regressions**: only 1/5 to 1/3 increase explained by worker observables: education, experience measures and their interactions (plus industry and region dummies)
- GER: Card (2013), UK: Blundell & Etheridge (2010), ITA: Jappelli & Pistaferri (2010), US: Heathcote et al. (2010), BRA: Helpman et al. (2012), SWE: Akerman et al. (2013), ...

Residual Inequality in West Germany

German social security records. Real daily wage, full-time, West German, male workers.



Wage Inequality and Trade in Germany: the Fall of the Iron Curtain



Labor and Product Market Reforms

- **Labor market Reforms**
  - **Hartz III**: reduction uneployment benefit by 30%
  - **Hartz IV**: reform of Federal Employment Agency to increase job search efficiency -> Hertweck and Sigrist (2012) estimate 20% increase in matching function efficiency
- **Product market Reforms**
  - **Single Market Program** in 1990s -> OECD index of product market regulation (PMR) intensity drops 24% by 2003 and a 36% by 2008.

Decomposition of Total Wage Variance

	1985-1991		1990-1996		1996-2002		2002-2009		Change	
	Contrib.	%	Contrib.	%	Contrib.	%	Contrib.	%	Abs.	%
Person effects	0.084	61	0.093	63	0.107	58	0.127	51	0.043	39
Plant effects	0.025	19	0.029	20	0.038	21	0.053	21	0.028	25
Covariate index	0.015	11	0.007	5	0.008	4	0.007	3	-0.008	-7
Cov(person, plant)	0.003	2	0.006	4	0.018	10	0.041	16	0.038	34
Sum	**0.137**		**0.147**		**0.184**		**0.249**		**0.112**	

Notes. Table based on variance decomposition in Card et al. (2012) using log daily wage data for West German, male, full-time workers, aged 20-60, as reported in German social security data; covariates include year dummies, a quadratic and cubic term in age, all fully interacted with educational attainment.

- **Firm** component and **assortative matching** are relevant, worker characteristics are not

Research Questions

- How do **trade** and **firm characteristics** shape the dynamics of residual inequality?
  - Model of **trade with firm heterogeneity** (Melitz, 2003) and **directed search** (Kass and Kircher, 2011) $\longrightarrow$ **wage dispersion** across **homogenous workers**
  - Effects of Trade, Labor and Product Market reforms on inequality
- Calibrate model to matched employer-employee (LIAB) **German** data and **quantify** link between trade, institutional reforms and inequality

Why Directed Search?

- **Matching key facts**: captures key features of firm and labor market dynamics in the data (Kaas & Kircher, 2011):

1. Workers **direct** their search, firms commit to long-term contracts (Hall & Krueger, 2012)
2. Vacancy **filling rates** correlate with firm's **growth** rates (Davis, Faberman, Haltiwanger, 2010) $\rightarrow$ DT provides a theory linking growth and wages
3. **Within-firm vintage** effects; recruitment wages fall with firm age (Haltiwanger, Jarmin, Miranda, 2010) $\rightarrow$ Within-firms inequality

Technology and Product Market

- Final good technology

$$Y = M^{-\frac{1}{\sigma-1}} \left[\int_{\omega \in \Omega} y(\omega)^{\frac{\sigma-1}{\sigma}} \, d\omega \right]^{\frac{\sigma}{\sigma-1}}, \ \sigma > 1 \ ,$$

M mass of varieties, $y(\omega)$ quantity of input, $M^{-1/(\sigma-1)}$ neutralizes love for variety.

Intermediate inputs

- Firm pay a sunk cost to draw a productivity z from an initial distribution G(z)
- Linear production function

$$y(z) = z\ell \ ,$$

- Fixed costs: domestic f and export f_X
- Iceberg-type variable trade cost $\tau \geq 1$
- Since $p_X(z) = \tau p_D(z)$ and $y_X(z) = \tau^{1-\sigma} y_D(z)$, from the isoelastic demand we obtain total revenues

$$R(\ell, I; z) = \left[\frac{Y}{M}\left(1 + \mathbb{I}(z)\tau^{1-\sigma}\right)\right]^{\frac{1}{\sigma}} (z\ell)^{\frac{\sigma-1}{\sigma}} \ ,$$

where $\mathbb{I}(z) > 0$ for exporters

Labor Market

- Firms post openings with a **fixed** wage offer
- Search is **directed**: Workers have info about job offers prior to search
- Labor market segmented over continuum of **submarkets** with different wage contracts
- Transaction impeded by **matching frictions**
  - $\theta \triangleq V/S$, ratios of open vacancies to job seekers
  - CRS matching function in each submarket: $q(\theta)$, vacancy-filling rate, $\theta q(\theta)$ job-finding rate.

Directed Labor Market Search

- Time is **continous**
- Shocks:
  - Two death shocks: **firm-specific** $\delta > 0$, **worker-specific** shock $\chi > 0$
- $b > 0$ unemployment benefits
- Assumption: **committment** $\rightarrow$ post contracts stipulating wages in every future period
- Simplification: workers are offered a constant income stream.

Directed Labor Market Search

- Workers' **asset values**

$$\begin{aligned} rE(w) &= w + (\delta + \chi)[U - E(w)] \\ w_r &\equiv rU = b + \theta q(\theta)[E(w) - U] \end{aligned}$$

imply

$$w_r = b + \underbrace{\theta q(\theta)\left(\frac{w(\theta) - w_r}{r + \delta + \chi}\right)}_{\triangleq \rho}.$$

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- Dynamic **worker indifference** condition

$$w(\theta) = w_r + \frac{1}{\theta q(\theta)}(r + \delta + \chi)\rho\ .$$

$\Longrightarrow$ Given w_r, negative correlation between $w(\theta)$ and job find rate $\theta q(\theta)$, positive between $w(\theta)$ and job fill rate $q(\theta)$.

Dynamic Problem of firm of age a

- State variables ℓ_a and cumulated wage bill $W_a \triangleq \int_0^a e^{-\chi(a-s)} q(\theta_s) v_s w(\theta_s)\, ds$
- W_a sunk at age a

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$$\Pi(\ell_a, W_a; z) \triangleq \max_{\{v_s, \theta_s, \mathbb{I}_s\}} \int_a^\infty e^{-(r+\delta)(s-a)} \left[R(.) - W_s - C(v_s) - f - \mathbb{I}_s f_x\right] ds$$

$$s.t.\ \dot{\ell}_s = q(\theta_s) v_s - \chi \ell_s \ ;$$

$$\dot{W}_s = q(\theta_s) v_s w(\theta_s) - \chi W_s \ ;$$

$$w(\theta_s) = w_r + \frac{\rho}{\theta_s q(\theta_s)} (r + \delta + \chi) \ .$$

Optimal Recruitment Policy

First order conditions with respect to v_s and θ_s yield

$$\theta_a = \frac{1-\eta}{\eta} \frac{\rho}{C'(v_a)}$$

- $\eta \ldots$ elasticity of the matching function

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- Firms face a trade off between job-fill rate and wages

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- ... and they pay higher wages
- Firms face a trade off between job-fill rate and wages
- With convex $C(v)$, firms grow by posting more vacancies and filling them faster (Davis et al., 2012, 2013)

Export Status

- Static problem given the non-sunk nature of f_X
- Optimal $\mathbb{I}_a$ solves

$$\mathbb{I}_a(z) = \arg \max_{\mathbb{I} \in \{0,1\}} \left\{ R\left(\ell, \mathbb{I}; z\right) - \mathbb{I} f_X \right\}$$

- Minimum size for starting export $\ell^X\left(z\right)$ for firm z
- Set of exporters is $\left\{ \left(z, a\right) | \ell_a\left(z\right) > \ell^X\left(z\right) \right\}$

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$\Longrightarrow$ I.e., firms grow into exporting; overlap of productivity distributions of exporters and non-exporters (Impullitti, Irrarazabal, Opromolla, 2013)

Optinal Firm Growth and Wage Schedule

Optimal evolution of ℓ satisfies

$$\begin{aligned} & \frac{\eta}{\rho}\left[R_1\left(\ell_a, \mathbb{I}_a; z\right) - w_r\right] \\ = & \left(\frac{\dot{\ell}_a + \chi\ell_a}{\xi_0}\right)^{\xi_1}\left[r + \delta + \chi - \xi_1 \frac{\ddot{\ell}_a + \chi\dot{\ell}_a}{\dot{\ell}_a + \chi\ell_a}\right], \end{aligned}$$

- with the constants $\xi_0 > 0, \xi_1 > 0$; closed form if $R(\ell, z) = z - \sigma\ell$

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- with the constants $\xi_0 > 0, \xi_1 > 0$; closed form if $R(\ell, z) = z - \sigma\ell$
- The **wage schedule** for firm z is

$$w_a\left(z\right) = w_r + \left(\frac{\dot{\ell}_a\left(z\right) + \chi\ell_a\left(z\right)}{\xi_0}\right)^{\xi_1}\left(r + \delta + \chi\right)\left(w_r - b\right)$$

General Equilibrium

- **Discounted profits**

$$\Pi(0,0;z) = \frac{1}{r+\delta}\left[\frac{C'(v_0(z))}{q(\theta_0(z))}\dot{l}_0(z) - C(v_0(z)) - f - e^{-(r+\delta)a_x(z)}f_x\right]$$

with $a_x(z) \triangleq \inf\{a : \mathbb{I}_a = 1\}$

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- **Productivity cutoffs**

$$\begin{aligned}
\text{Domestic cutoff } z_D^* &: \Pi(0,0;z_D^*) = 0 \\
\text{Export cutoff } z_X^* &: z_X^* = \inf\left\{ z : l(z) \geq l^X(z) \right\} \\
\text{Free entry condition} &: \int \Pi(0,0;z)\,\mu(z)dz = f_E/(r+\delta)
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to solve for $\{Y/M, w_r, z_D^*\}$

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- Determine M by aggregating $s(z) = l(z)/[\theta(z)q(z)]$ over all firms and ages
- Determine u by computing $L = M(1+\varrho)\int\left(\int_0^\infty l_a(z)\delta e^{-\delta a}da\right)\mu(z)dz$

One period model

Simplifying assumptions:

- Shut down firm and match level shocks: $\delta = 0$, $\chi = 0$
- No unemployment benefit: $b = 0$

Firm problem

- Combining first order conditions

$$\theta = \frac{1-\eta}{\eta}\left(\frac{W}{C'(v)}\right) .$$

- **Intuition**: convexity $\rightarrow$ costs increase over-proportionately with size $\rightarrow$ firms post higher wages to increase job filling rates (same as dynamic model)

Goods Market Equilibrium

Definition

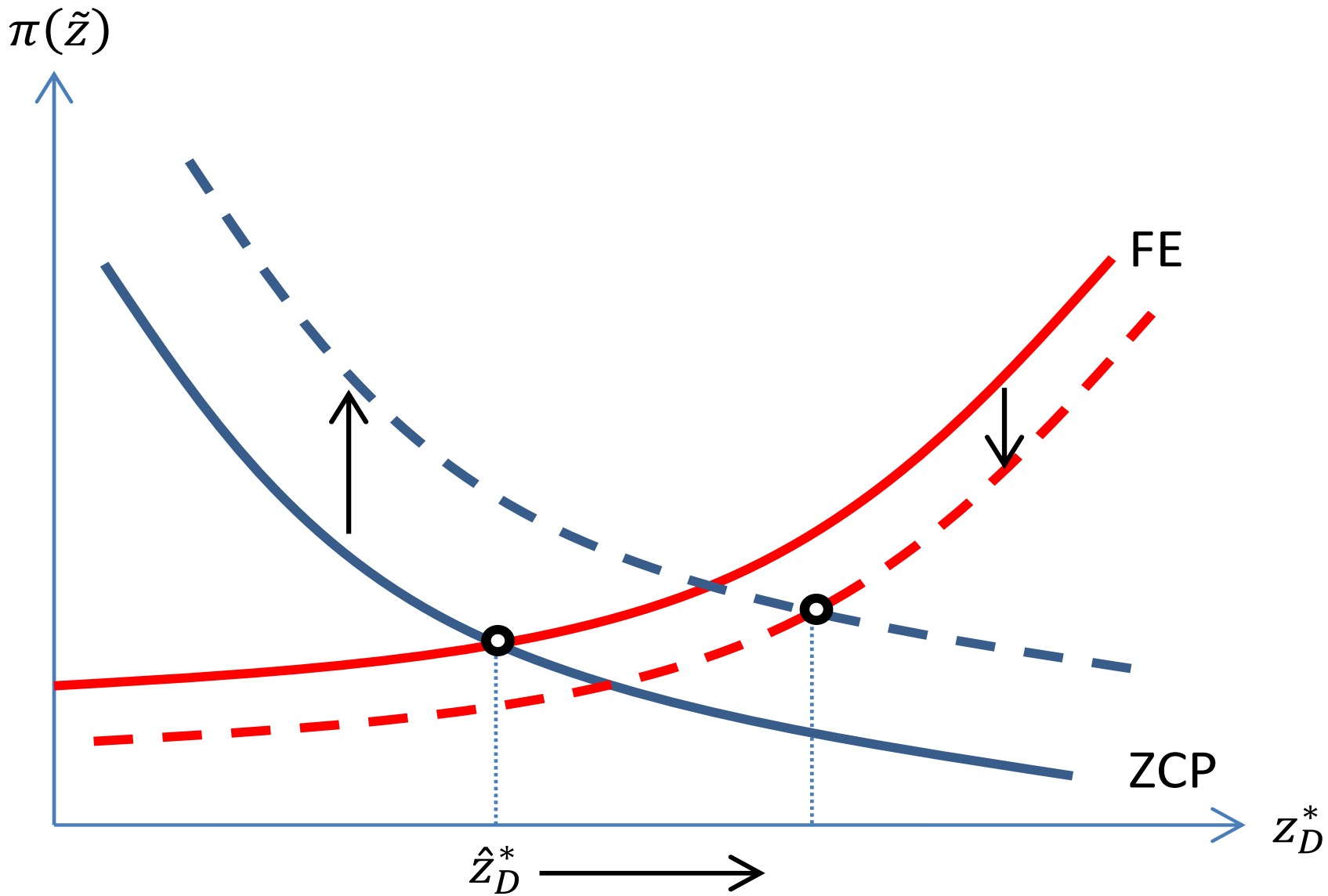
(Representative firm). Let $\tilde{z}$ be the productivity level such that $p_D(\tilde{z}) = 1$.

As in Melitz, Free entry and Cutoff condition determine $(\pi(\tilde{z}), z_D^*)$

$$(ZCP) \quad : \quad \pi(\tilde{z}) = f\left\{\left[\frac{\tilde{z}(z_D^*)}{z_D^*}\right]^{\beta} - 1\right\},$$

$$(FE) \quad : \quad \pi(\tilde{z}) = \frac{f_E + \{1 - G[z_X^*(z_D^*)]\}(f_X - f)}{2 - G(z_D^*) - G[z_X^*(z_D^*)]}.$$

Trade Liberalization



Trade and Avg. Wages

- Given equilibrium z_D^*, value of search W follows from cutoff condition

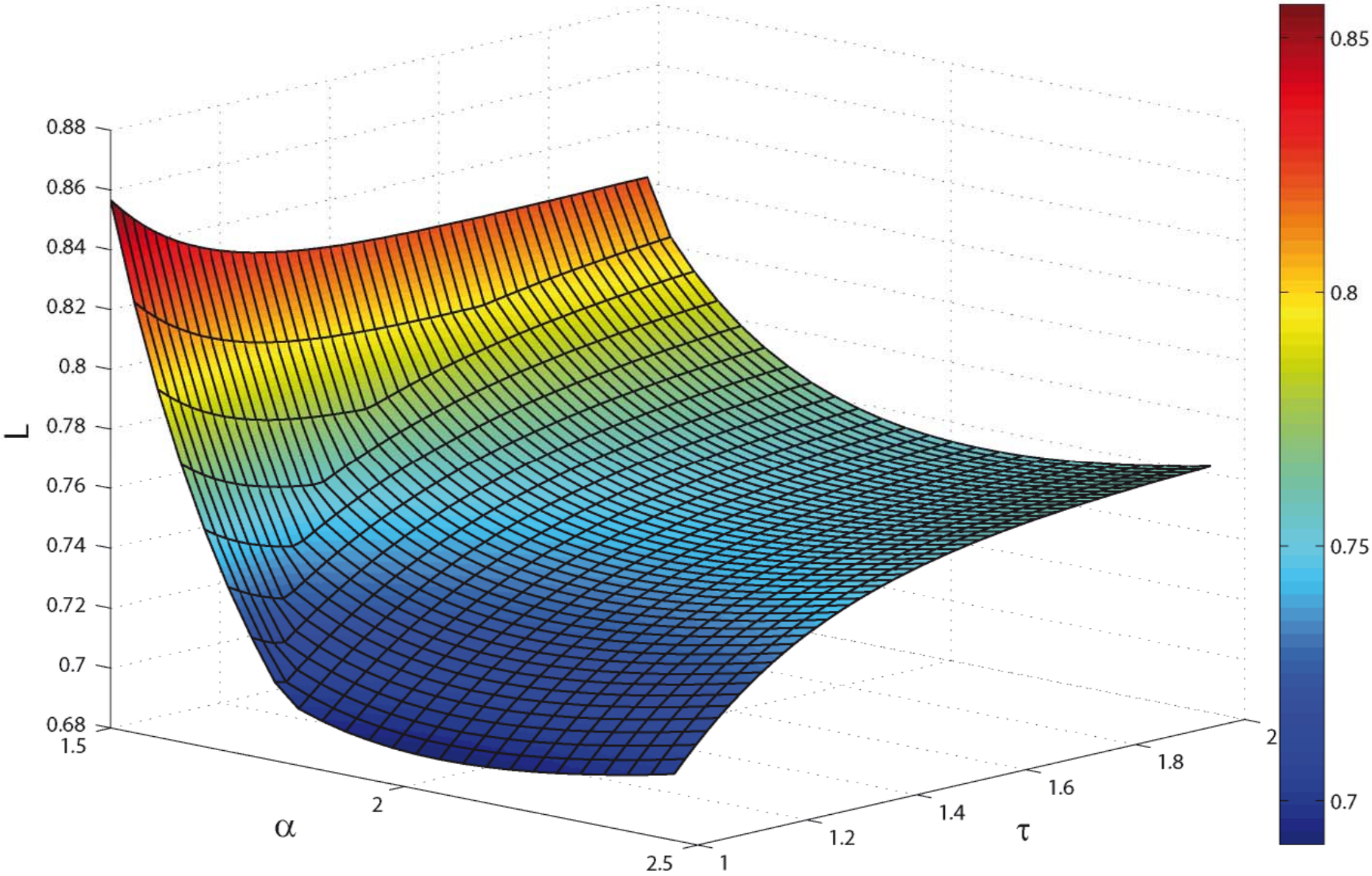
$$\pi(z_D^*; W) = KW^{-\frac{\eta}{1-\eta}\left(\frac{\alpha}{\alpha-1}\right)}\tilde{z}^{\gamma}z_D^{*\beta} - f = 0 \ .$$

  W increasing in z_D^* and $\tilde{z}$
- Trade increases efficiency $\rightarrow$ labor market more competitve $\rightarrow \uparrow W$

Trade and Employment

- Two offsetting forces
  - *Positive* ***Efficiency effect*** *on* W*: for each* w *firms must offer higher* $q(\theta)\theta$ *to attract workers*
  - *Negative* ***Composition effect*** $\rightarrow$ *firms become on average larger* $\rightarrow$ *they operate in submarkets with lower* θ
- Additional composition effect (**New Exporters**)
- If all firms have same θ (no inequality) $\Rightarrow$ composition effect disappears

Trade Liberalization



Trade liberalization: Wages

- Wages profile in logs

$$\ln w(z;\tilde{z}) = \ln\left(\eta\frac{\sigma-1}{\sigma}\right) + \underbrace{\frac{\beta}{\sigma-1}\ln\tilde{z}}_{\text{avg. efficiency}} + \left(1-\frac{\beta}{\sigma-1}\right)\ln z + \underbrace{(\sigma-1-\beta)\ln\left[1+\mathbb{I}(z)\tau^{1-\sigma}\right]}_{\text{Export Premium}}$$

- **Result**. *Trade liberalization increases real wages for all workers as well as the exporter premium.*
  - **Efficiency**: as firms become more productive $\rightarrow \uparrow W \rightarrow$ all firms must pay higher w
  - **Export Premium**: size premium for exporting increases $\rightarrow$ exporters willing to pay w

Wage Dispersion

- Wage dispersion

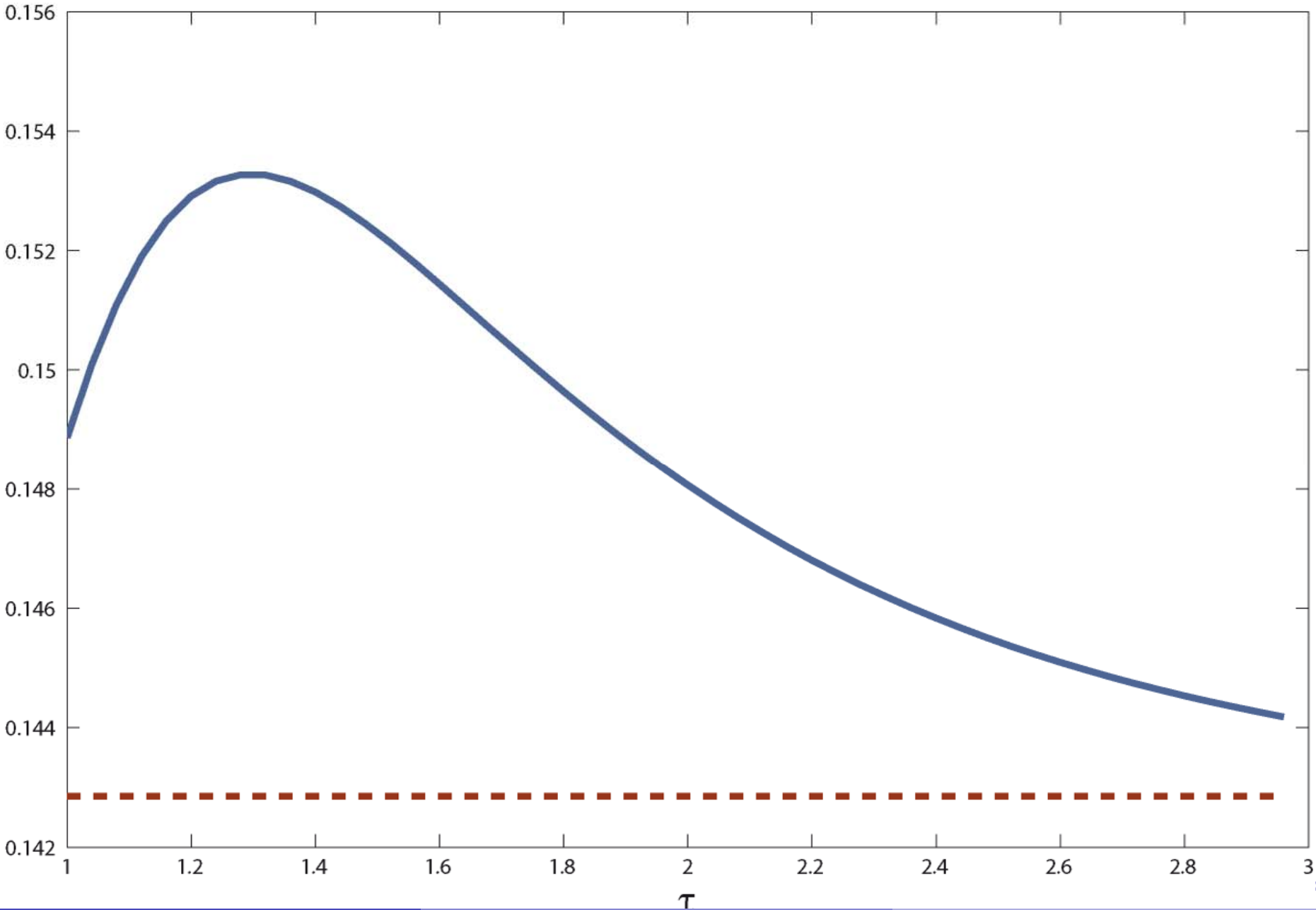
$$var\left[\ln w\left(z\right)\right] =$$
$$\left(\sigma-1-\beta\right)^{2}\left\{\frac{var\left[\ln z\right]}{\left(\sigma-1\right)^{2}}+var\left[\ln\left(1+\mathbb{I}(z)\tau^{1-\sigma}\right)\right]+\frac{2cov\left[\ln z,\ln\left(1+\mathbb{I}(z)\tau^{1-\sigma}\right)\right]}{\sigma-1}\right\}$$

all firms export, $\mathbb{I}(z)=1$, no firms export $\mathbb{I}(z)=0 \Longrightarrow$

$$var\left[\ln w\left(z\right)\right]=\left(\sigma-1-\beta\right)^{2}\frac{var\left[\ln z\right]}{\left(\sigma-1\right)^{2}}$$

- **Result (Inequality).** *Wage dispersion under autarky and free trade is the same. For intermediate values it is inverted U-shape*

Trade Liberalization



QUANTITATIVE ANALYSIS

- Calibration to German data $\rightarrow$ target 1996
- Matched employers-employees data (LIAB) 1996-2007, plus aggregate data

- Data fit potential $\rightarrow$ fitting key firm dynamics and labor market facts
- Exercise I (Trade): feed 1996-2007 change in trade shares $\rightarrow$ inequality
- Exercise II (Hartz): feed 1996-2007 change in unemployment benefit and matching efficiency $\rightarrow$ inequality
- Exercise III (Product Market Reforms):....

Aggregate Statistics for Germany

	1996	2007	Source
Openness			
Agg. export openness (VA based)[1)]	16.69%	27.75%	OECD-WTO TiVA data base
Share of plants with exports[2)]	18.00%	28.00%	LIAB data base
Share of exports in exporter sales[2)]	19.00%	31.00%	LIAB data base
Institutions			
Gross replacement rate[3)]	26.00%	22.00%	OECD, tax benefits models
Product market regulation (index)[4)]	2.00	1.27	OECD, Woelfl et al. (2009)
Labor market outcomes			
Std.dev. of raw log wages	0.40	0.53	SIAB data base
Std.dev. of residual log wages	0.34	0.43	SIAB data base
Gini coefficient of wage inequality	0.20	0.27	SIAB data base
85-15 quartile ratio	0.68	0.83	SIAB data base
50-15 quartile ratio	0.29	0.38	SIAB data base
Unemployment rate	9.90%	8.30%	Destatis
Firm-level average employment levels[2)]			
non-exporter plants	12.74	14.87	LIAB data base
exporter plants	96.61	89.47	LIAB data base
all plants	27.56	35.89	LIAB data base

Notes. [1)] Domestic value added embodied in foreign final demand as % of total value added (GDP); data refer to 1995 and 2008. [2)] based on information from LIAB data base, manufacturing sector. [3)] first year refers to 1995. [4)] years refer to 1998 and 2008.

Calibration

Parameters taken from external sources

Parameters	Value	Interpretation	Source
σ	4.0	Elasticity of substitution	Bernard et al., 2007
η	0.5	Elasticity matching function	Standard
r	0.04	Annual interest rate	Standard
b	0.35	Replacement rate	Kohlbrecher et al. (2013)*
δ	0.05	Firm destruction rate	Fuchs and Weyh (2010)*
χ	0.07	Match destruction rate	Fuchs and Weyh (2010)*

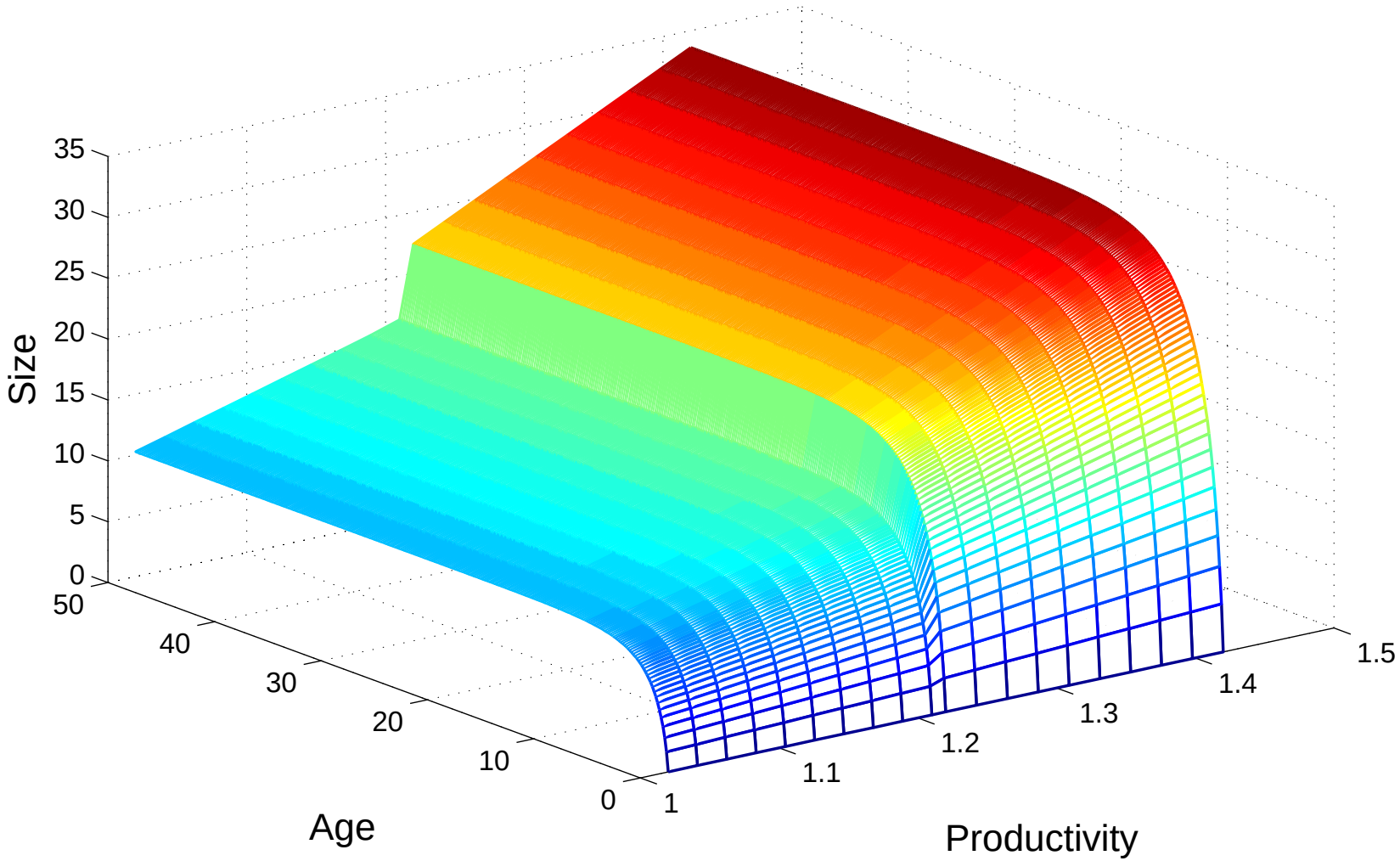
Calibrated Parameters

Parameters	Value	Moment	Model	Data
Fixed costs, f	1.82	Average firm size	26.7	27.5
Fixed export costs, f_x	0.82	Share of exporting firms	18.2%	18%
Iceberg Costs, τ	1.58	Exports share among exporters	20%	20%
Shape parameter, κ	3.19	Average size exporters	97.7	96.6
Entry costs, f_E	2.34	Export wage premium	9.6%	10.1%
Vacancy costs, α	2.59	Std. deviation log-wages	8.1%	8.2%
Matching function, A	3.25	Unemployment rate	9.9%	9.9%

Notes. When applicable, data refer to annual periodicity.

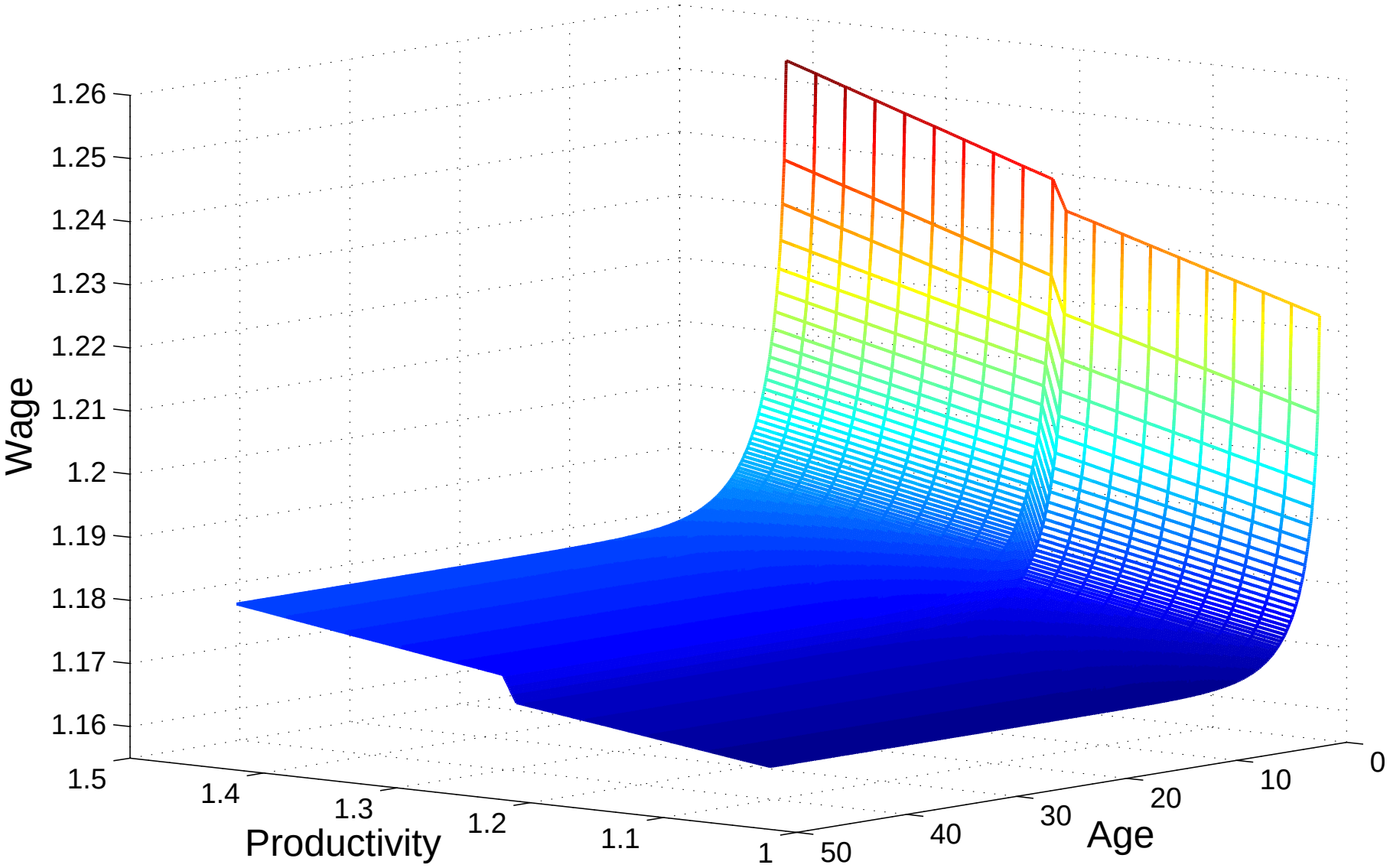
* Parameter estimates are based on German social security data provided by the IAB.

Size Distribution: base year



Wage Distribution: base year

Wages to new hires



Increase in Trade Shares

- Modify τ to capture increase in openness from 1996 to 2007

Moments	Model (1996)	Data (1996)	Model $\tau' = 1.326$	Data (2007)
Exp Share of Exporters	20%	20%	30%	30%
Share of Exp. Firms	18.2%	18%	34.5%	28%
Unemployment Rate	9.9%	9.9%	8.8%	8.3%
Avg. Firm Size	26.7	27.5	29	35.8
Avg. Size Exporters	97.8	96.6	64.2	89.4
Std. Wages (residual)	8.1%	8.2%	8.1%	11%
Export wage premium	9.6%	10.1%	8.9%	10.1%

Increase in Trade Shares

- Standard Selection Effects
- the model reproduces (qualitatively and/or quantitatively):
  - increase % exporting firms
  - increase avg. firm size
  - decrease avg. exporter size
  - reduction in unemployment
- We do not match: increase inequality!

Trade and Inequality: an Inverted U-Shape

Moments	$\tau' = 1.14$	$\tau' = 1.32$	$\tau' = 1.44$	$\tau_{bmk} = 1.58$	$\tau' = 1.78$	$\tau' = 2.08$
Exp Share of Exporters	40%	30%	25%	20%	15%	10%
Share of Exp. Firms	62.3%	34.5%	26.9%	18.26%	11.5%	4.04%
Unemployment Rate	7.4%	8.8%	9.4%	9.9%	10.4%	10.9%
Avg. Firm Size	32.1	29	27.9	26.7	25.8	24.9
Avg. Size Exporters	47.3	64.2	77.6	97.8	128.9	249
Average Wage	1.06	1.01	0.99	0.98	0.97	0.96
Std. Wages (residual)	8.06%	8.11%	8.11%	8.10%	8.07%	8.03%
Export wage premium	8.4%	8.9%	9.2%	9.6%	10.1%	12.1%

From 1996 to 2007: Quantitative Results

Adjustment in τ

- **Reduction of unemployment** rate as in data
- Trade liberalization alone **does not increase inequality**
  - Effect of trade costs on inequality is **hump-shaped**, and Germany close to the max
  - The inverted U is fairly flat: other mechanisms at work
- **Role of Firm Dynamics**: smooth firms growth process, attenuates effects of trade-induced reallocations on wages
- Bottom line: Trade is not the culprit for German inequality

Labor and Product Market Reforms

- **Labor market Reforms**
  - **Hartz III**: reduction uneployment benefit by 30%
  - **Hartz IV**: 20% increase in matching function efficiency
- **Product market Reforms**
  - OECD index of product market regulation (PMR) intensity drops 24% by 2003 and a 36% by 2008.

Labor and Product Market Reforms

Moments	Benchmark	$b' = 0.25$	$A' = 3.5$	$\sigma' = 4.2$	$f_E = 2$
Exp Share of Exporters	20%	20%	20%	20%	20%
Share of Exp. Firms	18.2%	17.9%	18.5%	20%	18.3%
Unemployment Rate	9.9%	9.2%	9.3%	10.5%	9.6%
Avg. Firm Size	26.7	26.2	27	29.2	25.5
Avg. Size Exporters	97.8	95.9	99.2	102.8	93.1
Avg. Wage	0.98	0.96	1	1.09	1.03
Std. Wages (residual)	8.1%	8.5%	7.8%	8.8%	7.9%
Std. Wages (within)	0.66%	0.69%	0.63%	0.52%	0.65%
Export wage premium	9.6%	10.3%	9.1%	10.6%	9.4%

Baseline situation: $b = 0.35; A = 3.25; \sigma = 4; f_E = 2.34$.

Labor and Product Market Reforms

- **Labor market Reforms**
  - **Hartz III** (unemployment benefits): reduces workers' outside options -> lower selection
  - negligible reduction in unemployment (lower avg productivity offsets lower wages)
  - **Hartz IV** (matching efficiency): substantial reduction in unemployment, but counterfactual reduction in inequality
- **Product market Reforms** -> large increase in inequality
  - mechanism: more competitive product market -> multiplier of the link btw. firm productivity and optimal size
  - Product market competition main driver of inequality in Germany!!
  - **Exogenous markups**: trade cannot affect markups in this model

Interaction between reforms

	Data		Specifications			
	1996	2007	(1)	(2)	(3)	(4)
Unemployment Rate	9.9%	8.3%	8.1%	10.7%	9.3%	9.3%
Std. Res. log Wages	8.1%	11.0%	8.4%	11.1%	10.1%	10.1%
Rev. Share Exp.	20%	30%	30%	30%	30%	30%
Share of Exporters	18%	28%	36%	42%	43%	30.2%
Avg. Firm Size	26.7	35.8	28.3	40.4	42.9	32
Avg. Exporter Size	97.8	89.4	63.1	83.4	88.5	90.4

Notes. Specifications are based on the benchmark calibration with the following differences: (1) $b = 0.25, \tau = 1.32$; (2) as (1) but $\tau = 1.25, \sigma = 4.8$; (3) as (2) but $A = 3.9$; (4) as (3) but $\sigma = 4.84, f = 1.2, f_E = 2.07$.

- **Reforms**: Trade ii) Hartz reforms iii) Product market reforms (25% drop in markup, 30% drop in domestic fixed cost and 17% drop in entry cost)
- **Outcomes**: 2/3 of increase in inequality and 1/2 of decline in unemployment

CONCLUSIONS

1. Tractable one-period **Melitz-type GE model with directed search**: trade, inequality and unemployment
2. **Dynamic insights**: distribution of firm growth rates and distribution of wage offers strongly related
3. **Quantitative insights**: if firms smooth growth, trade has minor implications for inequality
4. **German Inequality I**: key source is changes in product market competition
5. **German Inequality II**: Trade, Labor, and Product market reforms explain 2/3rd of inequality (channels left out: bargaining structure, technical change)
6. **Extensions**: aggregate transitional dynamics, endogenous markups