COEN TEULINGS
University of Cambridge

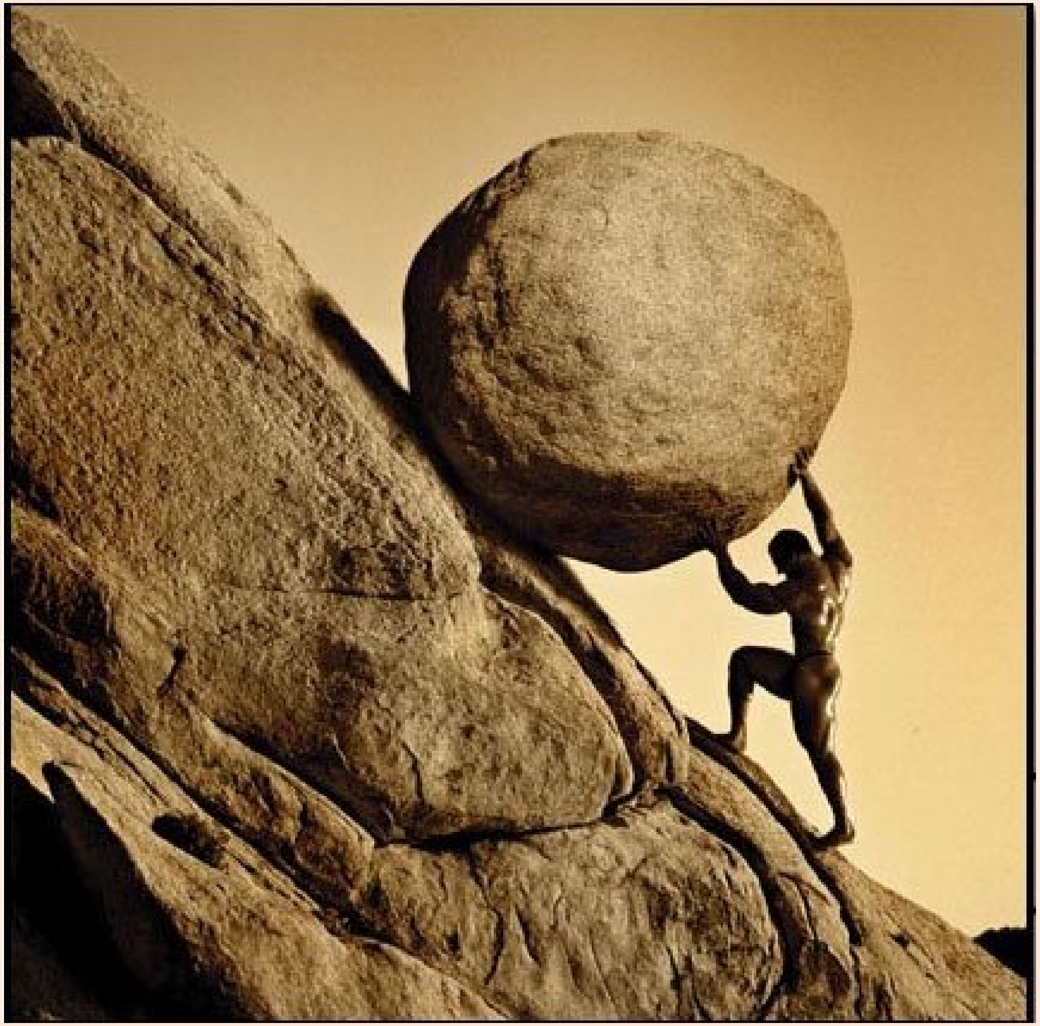
Wages, search frictions & sorting
Where do we stand?
Where should we go?

Keynote speech LEED conference
Coimbra
14 July 2017

Menu of the day

1. B&M and the sage of Sisyphos
2. Lessons from David Ricardo
3. When the recession hits…
4. The enigma of the minimum
5. Future avenues for research

The sage of Sisyphos



The sage of Sisyphos

“*In Greek mythology **Sisyphos**, the king of Corinth, was punished for his self-aggrandizing craftiness by being forced to roll an immense boulder up a hill, only to watch it come back to hit him, repeating this action for eternity.*” Wikipedia

A perfect metaphor for labour market search:

- Climbing the hill of rents by j-t-job mobility
- … only to be thrown off by a subsequent lay off

B&M and the sage of Sisyphos

- The perfect Sisyphos equivalent
  - Selecting jobs from a constant offer distribution
  - = climbing the hill of rents
  - Being laid off at a constant rate
  - = being pushed off
  - … an that as an eternal cycle
- Predictions
  - Wage growth while climbing the hill
  - Wage decline when falling off

B&M and the sage of Sisyphos

- Joint work with Axel Gottfries (2016)
- Concepts
  - Calendar time t vs. Labour market time λ_t
  - Employment Cycle: period between subsequent lay offs
    - $t = 0$: normalized to the start of the employment cycle
    - $t = a,b$: start,end date current job (hence: $a < t < b$)
  - Λ_t = sum over Employment Cycle of λ_t
  - **Problem**: # offers unobserved
- Results
  1. Λ_b measures # offers, best proxy match quality
  2. Λ_a provides no extra information
  3. Λ_a/Λ_b uniformly distributedReason: arrival rate max purely random

B&M and the sage of Sisyphos

- Regression equation
  - $lnW_t = \alpha_0 + \alpha_1 . u_t + \alpha_2 . ln\Lambda_b + \alpha_3 . Dummy\ quit$
  - Worker fixed effects
  - Controlls experience & tenure
- What identifies $ln\Lambda_b$? 2 sources of variation
  1. Difference between labour market & calendar time
  2. Random lay off shocks
- Why functional form $ln\Lambda_b$? Pareto distribution
  - α_2 = std.dev. distribution
  - Selectivity quits, hence: $\alpha_3 = -\alpha_2$

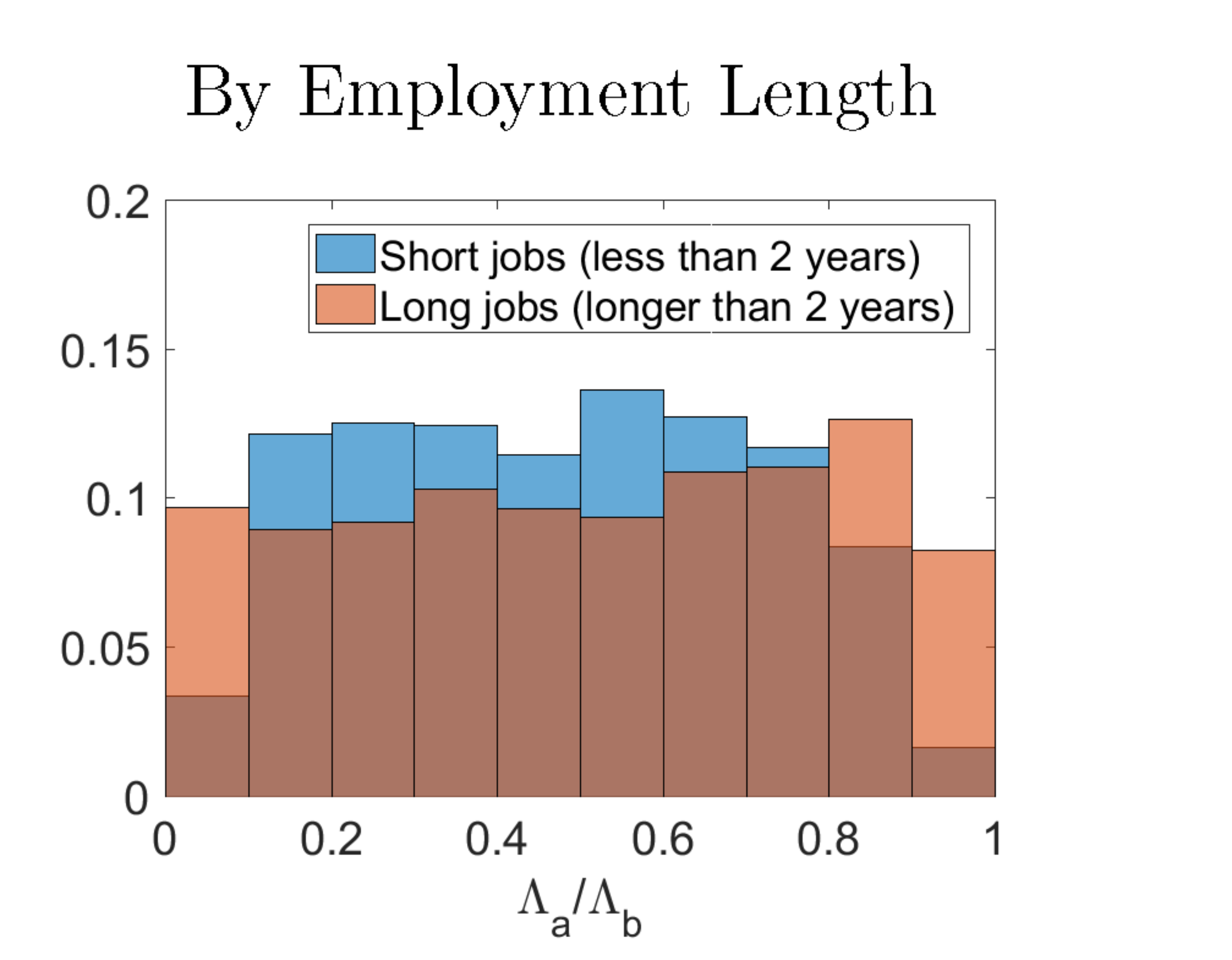
B&M and the sage of Sisyphos

Regression on log wages

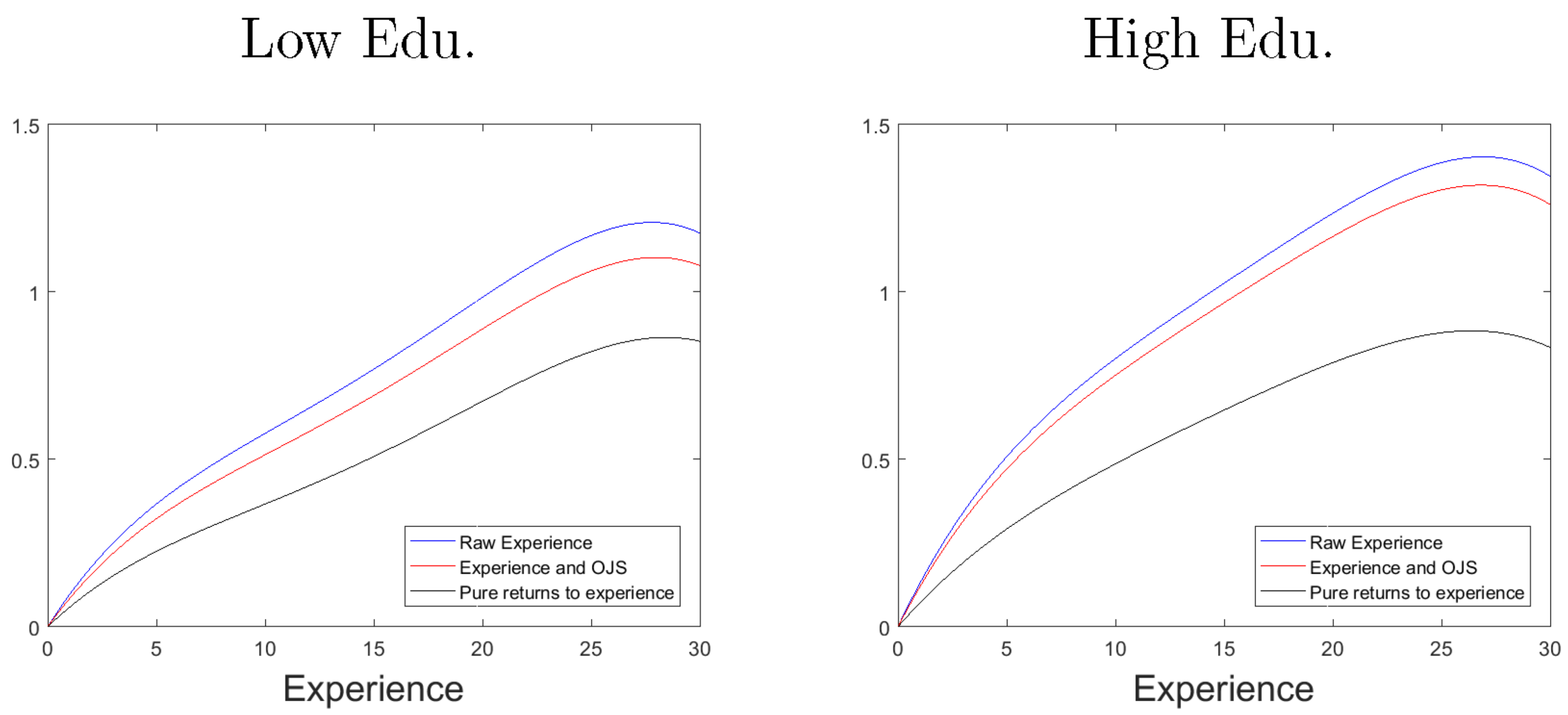
By Employment cycle

Variable	Coef	Std.err	Variable	Coef	Std.err
u_t	-0.012	.002	Dummy quit	-0.042	0.007
Cycle 1	0.121	0.011	Cycle 6	0.113	0.010
Cycle 2	0.120	0.008	Cycle 7	0.095	0.012
Cycle 3	0.123	0.007	Cycle 8	0.075	0.012
Cycle 4	0.111	0.008	Cycle >8	0.059	0.010
Cycle 5	0.097	0.009			

B&M and the sage of Sisyphos



B&M and the sage of Sisyphos



B&M and the sage of Sisyphos

Source	Variance
1. Length cycle	0.0075
2. # offers conditional length cycle	0.0016
3. Quality of best offer (= $\alpha_2^2\ \pi^2/6$)	0.0176
1.+2.+3. Total variance search	0.0266
Total variance log wages	0.2970
Share due to search	9%

B&M and the sage of Sisyphos

Conclusions

1. Strong confirmation B&M
   - By both sources of variation
   - Stability of offer distribution over life cycle
   - Uniform distribution of arrival of max
2. Wage offers distribution = Pareto
   - **Unbounded upper support!**
3. Search explains 9% of wage dispersion
4. Question: what are sources of heterogeneity?
   - Assignment frictions?
   - Rents?

Lessons from David Ricardo

Comparative Advantage Theory

Classical theories of international trade argued that nations gain mutual benefits by specializing in producing goods with lower opportunity costs.

David Ricardo refuted Adam Smith's absolute advantage theory: when a country could produce every good more efficiently than another nation, it would maximize those goods' productions. Ricardo formalized Robert Torrens' comparative advantage idea, in his *On the Principles of Political Economy and Taxation* (1817), using a classic example of trading English cloth and Portuguese wine.

Altho Portugal produced both goods with less labor input than did England, their relative costs differed: very hard to make English wine, less difficult to produce cloth. Thus, Portugal should produce excess wine, and trade it for English cloth. England benefits from free trade because its cost of producing cloth is unchanged, but English now drink wine at closer to the cost of cloth.

Lessons from David Ricardo

- What is necessary conditions for sorting?
  - Supermodularity?
  - Log supermodularity?

- David Ricardo:
  Portugal produces wine while England produces cotton because Portugal is <u>relatively</u> more productive

Lessons from David Ricardo

- Log output per worker *s* commodity/job *c*
  - $y(s,c) = \alpha s - ½ \gamma (s - c)^2$
  - Absolute advantage: $y_s(s,c) = \alpha - \gamma (s - c) > 0$
  - … better workers more productive in any job
  - Comparative advantage: $y_{sc}(s,c) = \gamma > 0$
  - … better workers are relatively more productive in higher jobs
  - …= log supermodularity

Lessons from David Ricardo

- Firms minimize cost per unit of output
  - Cost per unit of output: $lnW(s) - y(s,c)$
  - First order condition F.o.c.:
    - $lnW'(s) = y_s(s,c) = \alpha - \gamma\,(s - c)$
    - $lnW'(s)$ = return to h.c. (= human capital)
  - Optimal allocation $c(s)$ solves F.o.c.
- Return to h.c. increasing in optimal job $c(s)$
  - Keeping s constant

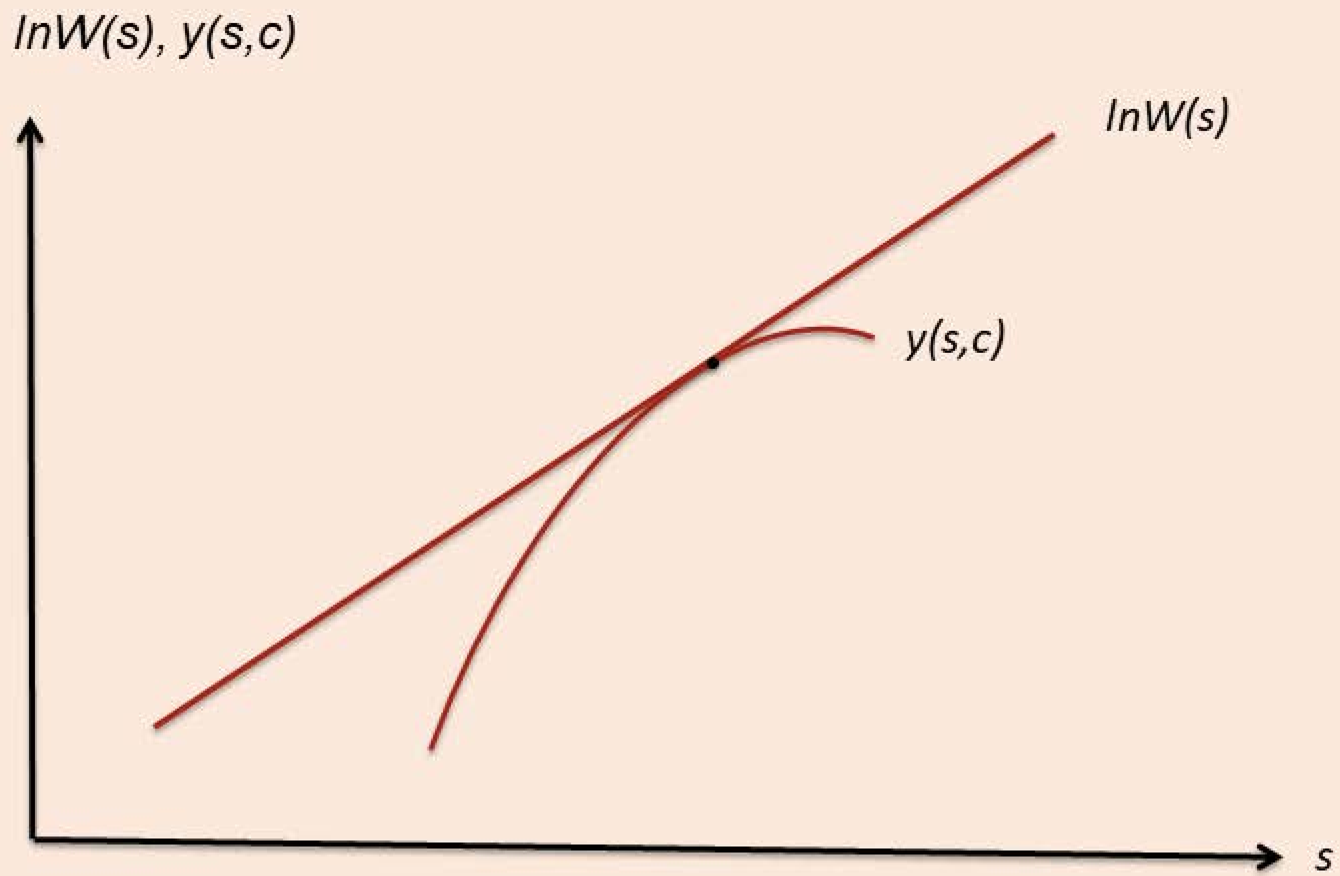
Lessons from David Ricardo

- Suppose $c(s) = s + C_0$ (mean shifter)
- Return to education & net demand for h.c.
  - $C_0 = c(s) - s$ = measure of net demand for h.c.
  - Upward mean shift of C_0: higher return to h.c.
- Non-identification
  - Hence: <u>perfect correlation</u> *s* and *c(s)*
  - <u>Non-identified</u> when both are in regression
  - Unobserved part of *s* proxied by *c*
    - … and the other way around
  - Estimates have no structural interpretation

Lessons from David Ricardo

- A source of confusion
  - Zero profit condition: $lnW(s) = y[s,c(s)]$
  - $y(s,c)$ reaches a max at $c = c(s)$, hump shaped
    - … job types beyond $c(s)$ yield lower output
  - "Better" jobs might yield "lower" wages!
- Why consistent with absolute advantage?!
  - Because each job type produces its own output
    - … which therefore has an endogenous price $P(c)$
  - Log nominal output = $y(s,c) + lnP(c)$
  - Ignored by many economists!

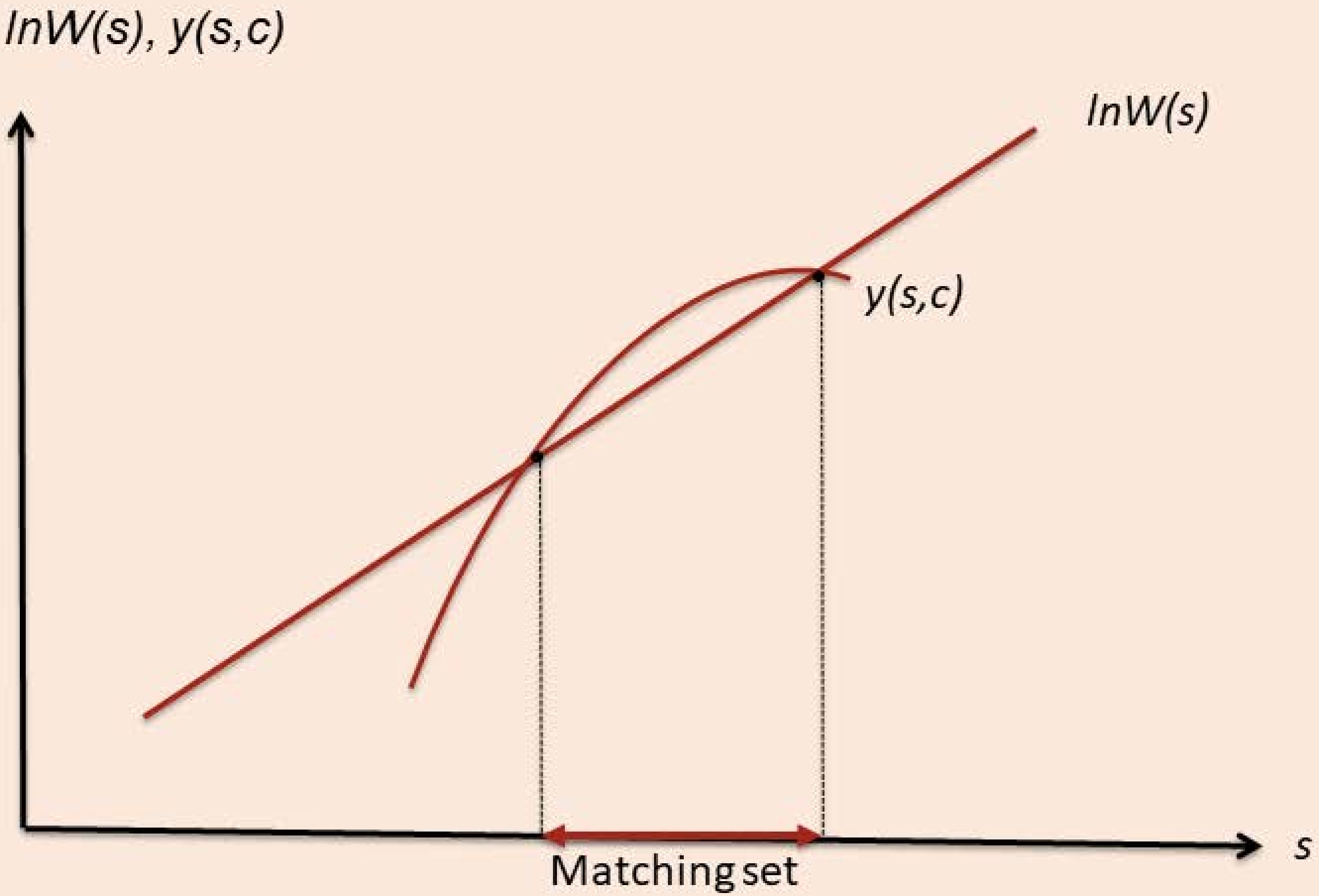
Lessons from David Ricardo



Lessons from David Ricardo

- Identification *y(s,c)* problematic
  - We only observe optimum *y[s,c(s)]*
    - … not out-of-equilibrium-point *y(s,c)*
- A&K&M(1999), Card&H&K(2013)
  - Worker + firm fixed effects
    - … explain 97% of variance log wages
  - Why adding non-linear terms?
- 3 problems
  1. Log additive, not log supermodular
  2. Non-identified
  3. Jobs within a firm homogeneous

Lessons from David Ricardo



Lessons from David Ricardo

- Joint work with Pieter Gautier (2006), (2015)
- Quadratic terms in wage regression
  1. Construct *s* and *c*
  2. $lnW = \beta_0 + \beta_1$.(h.c. variables),$s = \beta_1$.(h.c.)
  3. Similar for *c*
  4. $lnW = \alpha_0 + \alpha_1.s + \alpha_2.c + \alpha_3.(s - c)^2$
- Note: linearity is not a restriction!
  - Step 2 can accomodate any non-linearity

B&M and the sage of Sisyphos

Regression on log wages

Almost all coefficients highly significant

Country	s	c	s^2	c^2	sc
US	0.61	0.66	-0.17	-0.17	0.43
France	0.60	0.61	-0.39	-0.25	0.62
Germany	0.58	0.86	-0.38	-0.17	0.17
Netherlands	0.57	0.72	-0.05	-0.05	0.40
Portugal	0.66	0.61	-0.11	-0.11	0.29
UK	0.77	0.59	-0.53	-0.53	0.82

Lessons from David Ricardo

- Testable restrictions for each country
  - Sum 1^{st} order coefficients > 1
  - 3 sign-restrictions on 2^{nd} order coefficients
  - Cross term equal to sum of 2 square terms
- Biased?
  - α_1 and α_2 biased due to non-identification
  - α_3 not: $(s - c)^2$ uncorrelated to s and c
    - … if 3^{rd} moments = 0
    - … which is true for symmetric distribution

Lessons from David Ricardo

Conclusions

1. Sorting / log supermodularity matters
2. … but cannot explain all search frictions
   - Would yield bounded upper support
3. Card&H&K(2013) linearity conclusion?
   - Holds in a Walrasian equilibrium
   - … but not in world with search frictions
   - Question: why do we <u>not</u> find non-linearity?

When the recession hits…

When the recession hits…

- Again, joint work with Axel Gottfries (2017)
- B&M wage posting model
  - Hiring and retention premiums
  - Wage increasing function of match quality
    - Hence: **j-t-j transition are efficient**
- Long standing problem of wage rigidity
  - Wage posting is useful tool for analysis

The carrot of hiring & retention premiums

When the recession hits…

- Wage posting and wage rigidity
  - Posted wage = commitment to fixed wage
    - Needed as a carrot for hiring and retention
  - Wage rigidity needed for commitment (?)
    - Coles(2001),Moscarini-PV(2012),Gottfries(2017)
  - Hiring premium superfluous after hiring
    - Hence more difficult to commitment

When the recession hits…

- Assumptions
  1. Downwardly rigid wages in ongoing jobs
  2. Full wage flexibility in new jobs
  3. Only retention premiums
- Hence: less j-t-j transitions in downturn
  - **Inefficient!**
    - Unlike PV&Robin(2000) & Nash bargaining models

When the recession hits…

- Previous research on wage flexibility
  - Bils(1985): u-rate at data of hiring
  - Beaudry(1991): minimum u-rate since hiring
  - Both: no/small effect current u-rate
  - Hagedorn&Manovski(2012) critique
    - Addressed by our mismatch indicator

When the recession hits…

- Regression equation (similar to before)
  - $lnW_t \quad = \alpha_0 + \alpha_1 . ln\lambda_b + \alpha_2 . ln\Lambda_t + \alpha_3 . \min[ln\lambda_s]$
  - $lnQuit_t \quad = \beta_0 + \beta_1 . ln\lambda_t + \beta_2 . ln\Lambda_t + \beta_3 \{\max[ln\lambda_s] - ln\lambda_t\}$
    - s = any time during job spell
  - λ_t is close to u_t^{-1}
- Coefficients derived from known transition rates
  - $\alpha_1 = 0,\ \alpha_2 < 0,\ 0 < \alpha_3 < 1$
  - $\beta_1 = 1,\ \beta_2 = -1,\ \beta_3 < -1$
- Why $0 < \alpha_3 < 1$? Foresight downturn by firms
  - Explains puzzle of low wage flexibility

When the recession hits…

Variable	lnW_t	lnW_t	$ln\ Quit_t$	$ln\ Quit_t$
$ln\lambda_t$	0.063	0.029	0.319	0.779
	(0.015)	(0.015)	(0.128)	(0.150)
$ln\Lambda_b$ / $ln\Lambda_t$	0.109	0.105	-0.806	-0.637
	(0.005)	(0.006)	(0.033)	(0.041)
max[$ln\ \lambda_s$]		0.152		-1.577
		(0.025)		(0.198)

When the recession hits…

- Regressions do not controll for tenure
  - Does not matter for wages
  - Matters for quits
    - Conclusion less clear cut with tenure controlls
    - However: max[$ln\lambda_s$] remains significant
- On balance, strong confirmation of model
  - Both in sign of coefficients
  - … and in their magnitude

When the recession hits…

- Do firms pay hiring premiums?
  - Implication
    - Buffer for upward adjustment
    - Firms don’t find it in their interest to increase wages
  - Hence
    - Current wages should depend partly on hiring wage
    - … and less on highest wage since date of hiring
    - … the more so for small increases in λ_t

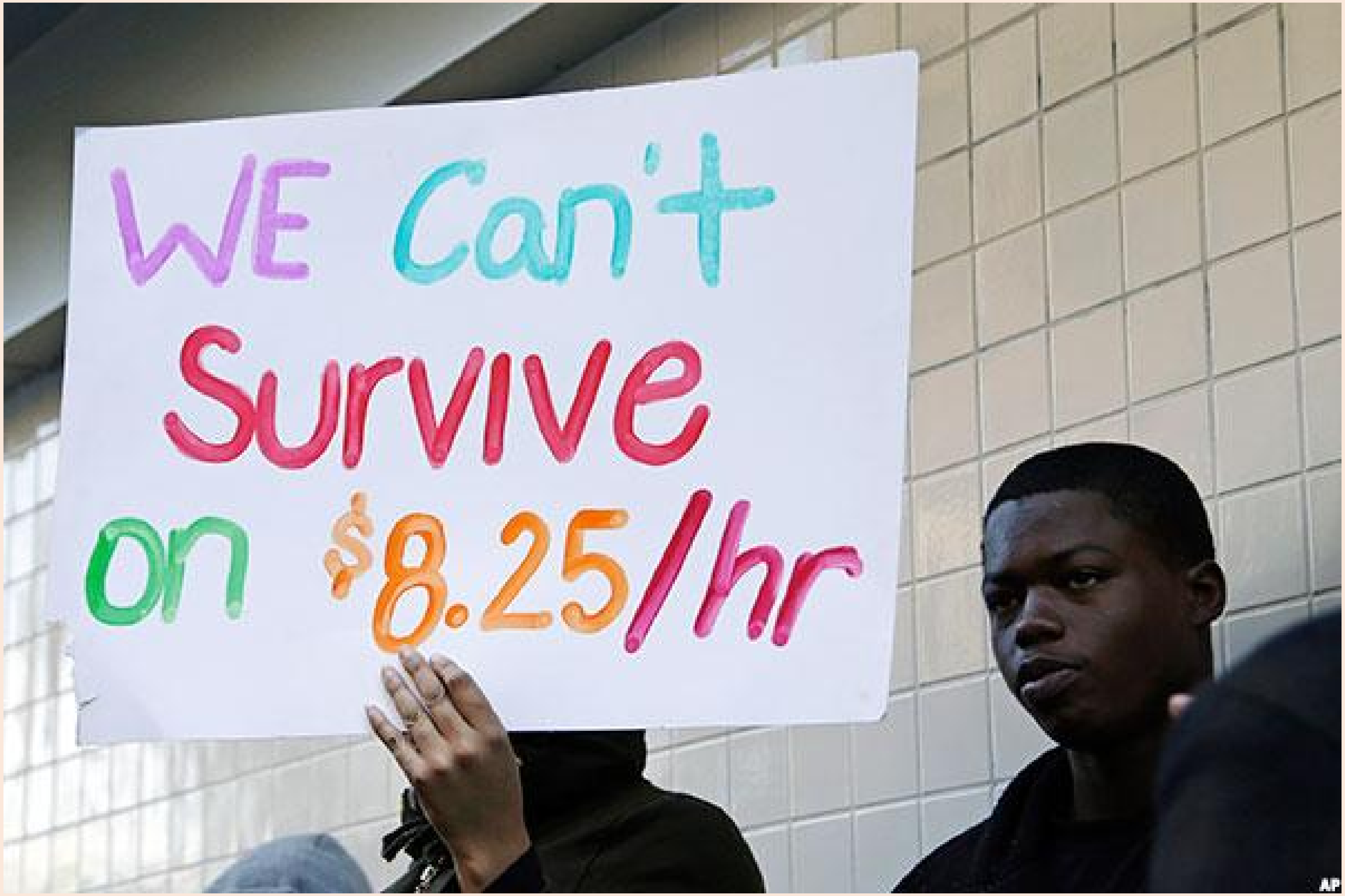
When the recession hits…

Variable			
$ln\ \lambda_t$	0.059	0.015	0.013
	(0.015)	(0.015)	(0.015)
$ln\ \lambda_a$	0.068	-0.004	-0.096
	(0.019)	(0.021)	(0.046)
$ln\ \Lambda_t$	0.098	0.088	0.088
	(0.004)	(0.004)	(0.005)
$\min[ln\lambda_s]$		0.226	0.320
		(0.024)	(0.048)
$(\min[ln\lambda_s] - ln\lambda_a)^2$			-0.189
			(0.085)

When the recession hits…

- Conclusions from empirical results
  1. Downwardly rigid wages in ongoing jobs
  2. Inefficiently low transitions during downturn
  3. Firms pay only retention premiums
- Macro-economic implications
  1. No hiring premiums, too low wages(?)
     - Gautier,Teulings&VanVuuren(2010)
  2. Wage rigidity hampers vacancy creation
     - By inefficiently low poaching
  3. Overshooting in downward wage adjustment

The enigma of the minimum



The enigma of the minimum

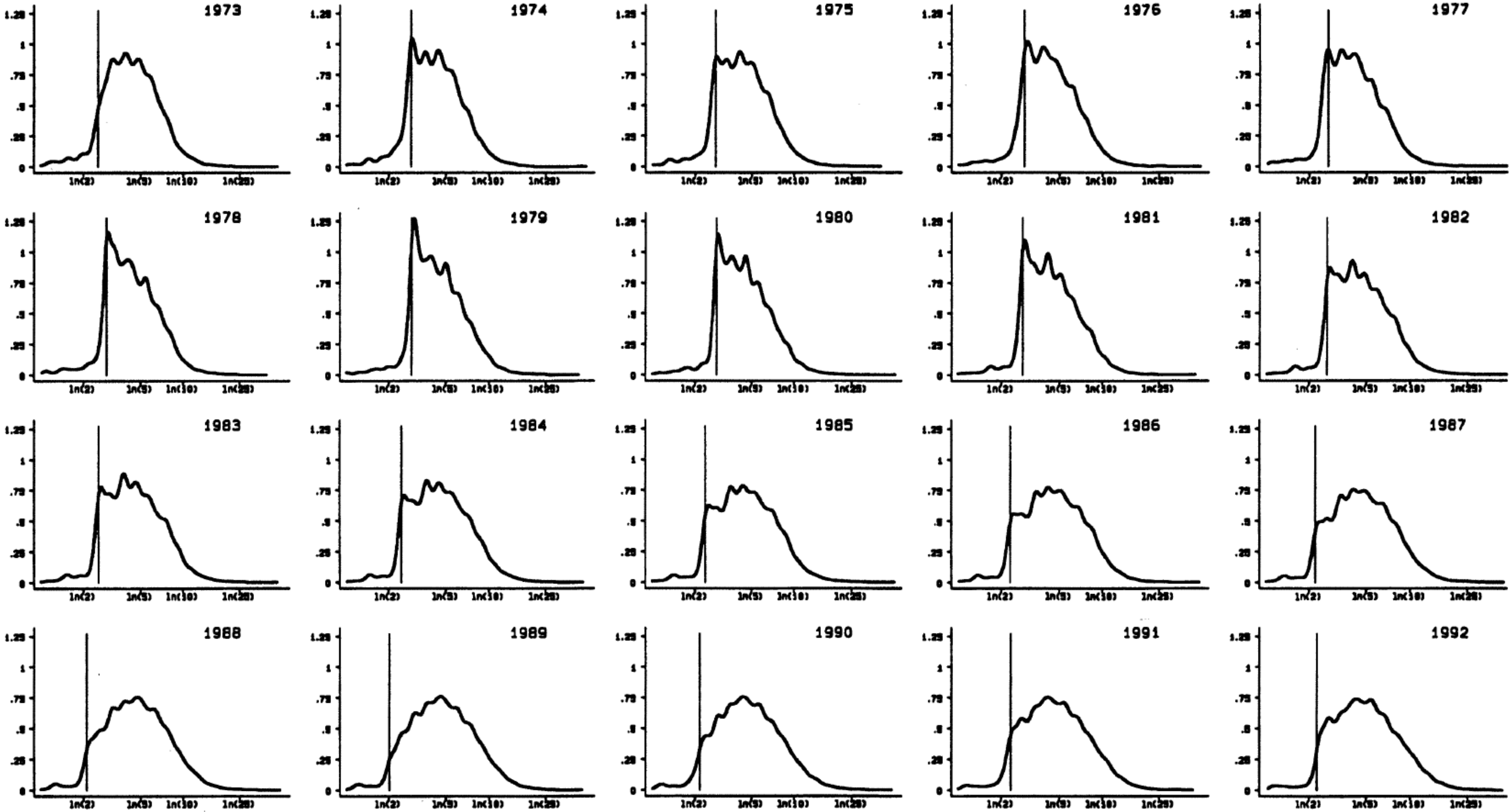
- Extensive policy debate on minimum wages
  - Recent introduction in Germany
  - Large increases in Brazil
  - Planned increase in UK
  - Debate on increase in US

- Remarkably, it is no longer a left wing topic

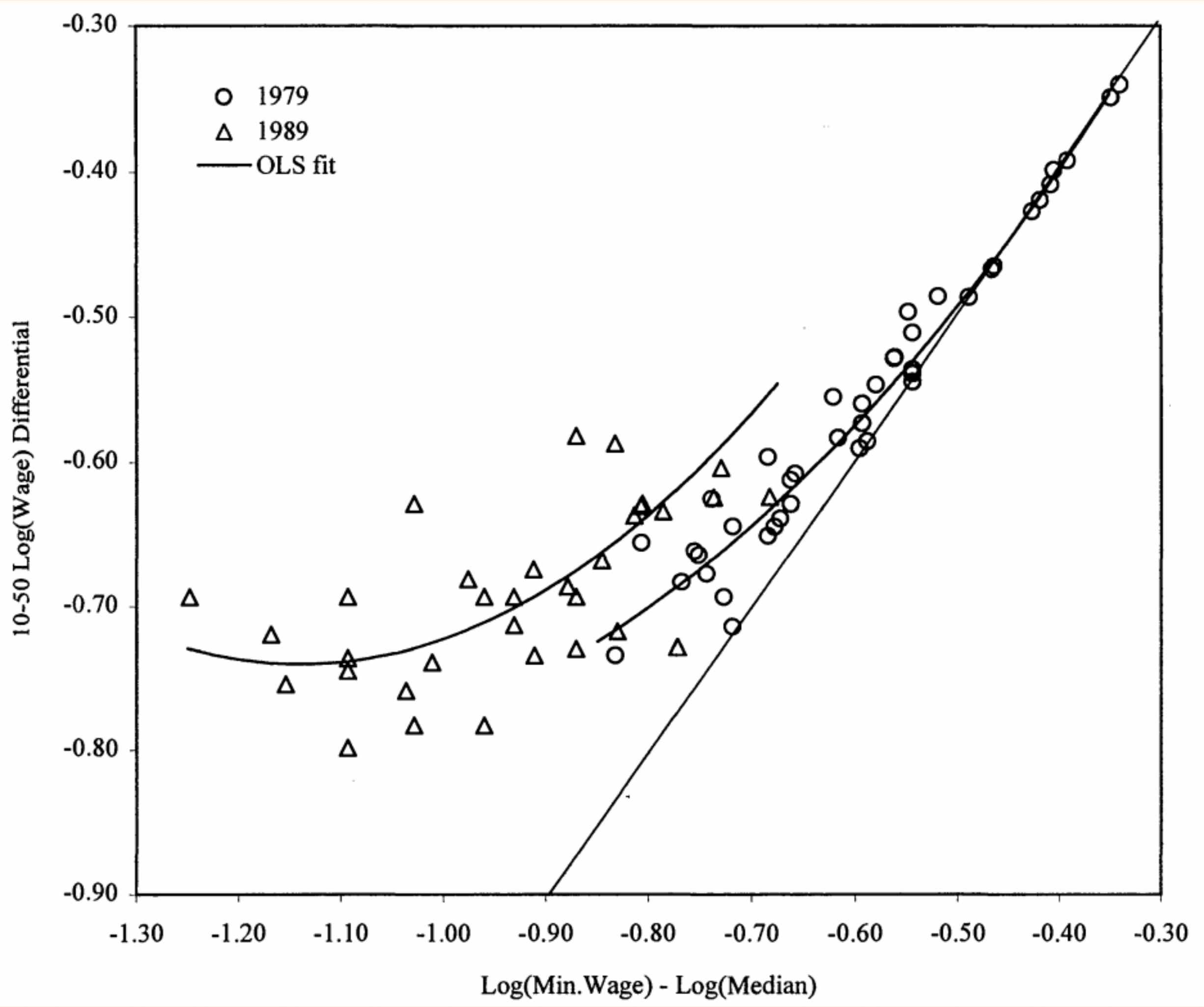
The enigma of the minimum

- Some relevant papers
  - Dinardo/Fortin/Lemieux(1996): institutions!
  - Lee(1999), Teulings(2003)
    - large effect on wage distribution
    - Minimum explains rise inequality in US during ‘80s
  - Autor/Manning/Smith(2016) some nuances
  - Dube/Lester/Reich(2010)
    - Small employment effects
  - Engbom/Moser(2016) for Brazil

The enigma of the minimum



The enigma of the minimum

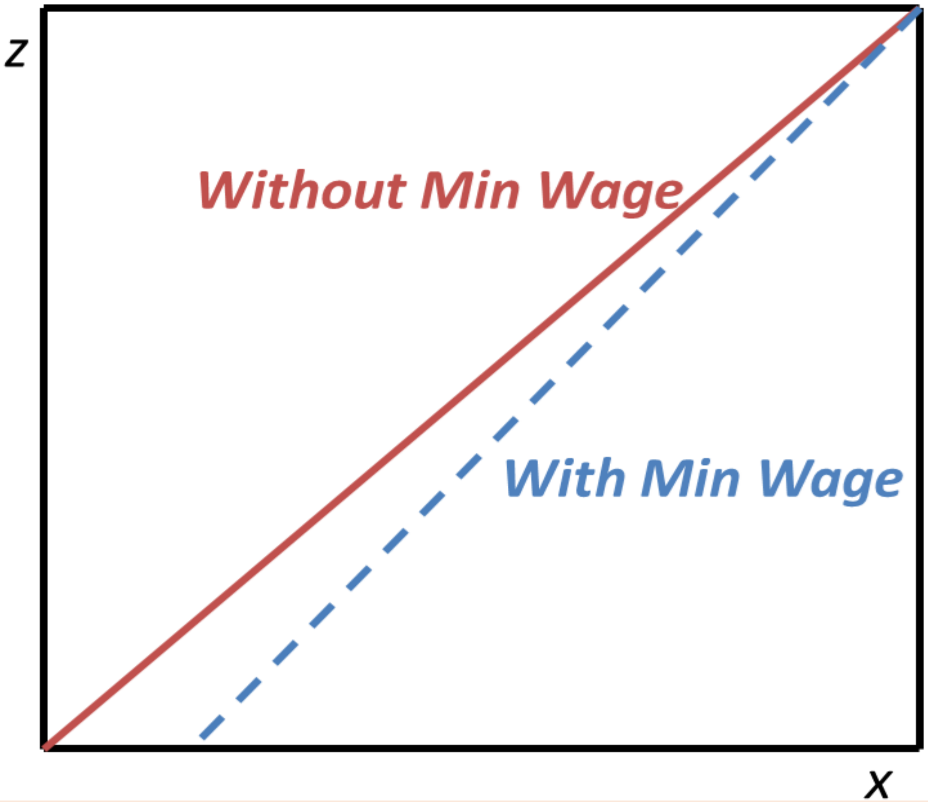


The enigma of the minimum

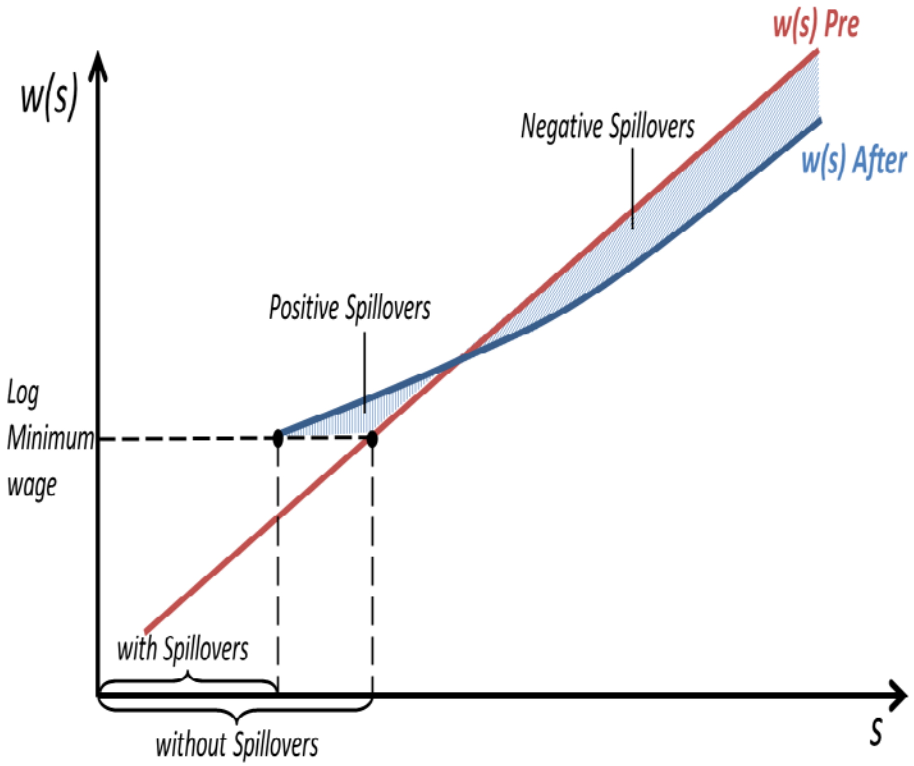
- General conclusions
  - Institutions matter
  - Rising profit share due to excess liberalization?
- Conclusions on minimum wage
  1. Small, or even positive employment effects
  2. Substantial spike at the minimum
  3. Substantial spill-overs
- 2 potential explanations
  1. Walrasian / comparative advantage
  2. B&M search model

The enigma of the minimum

Optimal assignment



Log wage function



The enigma of the minimum

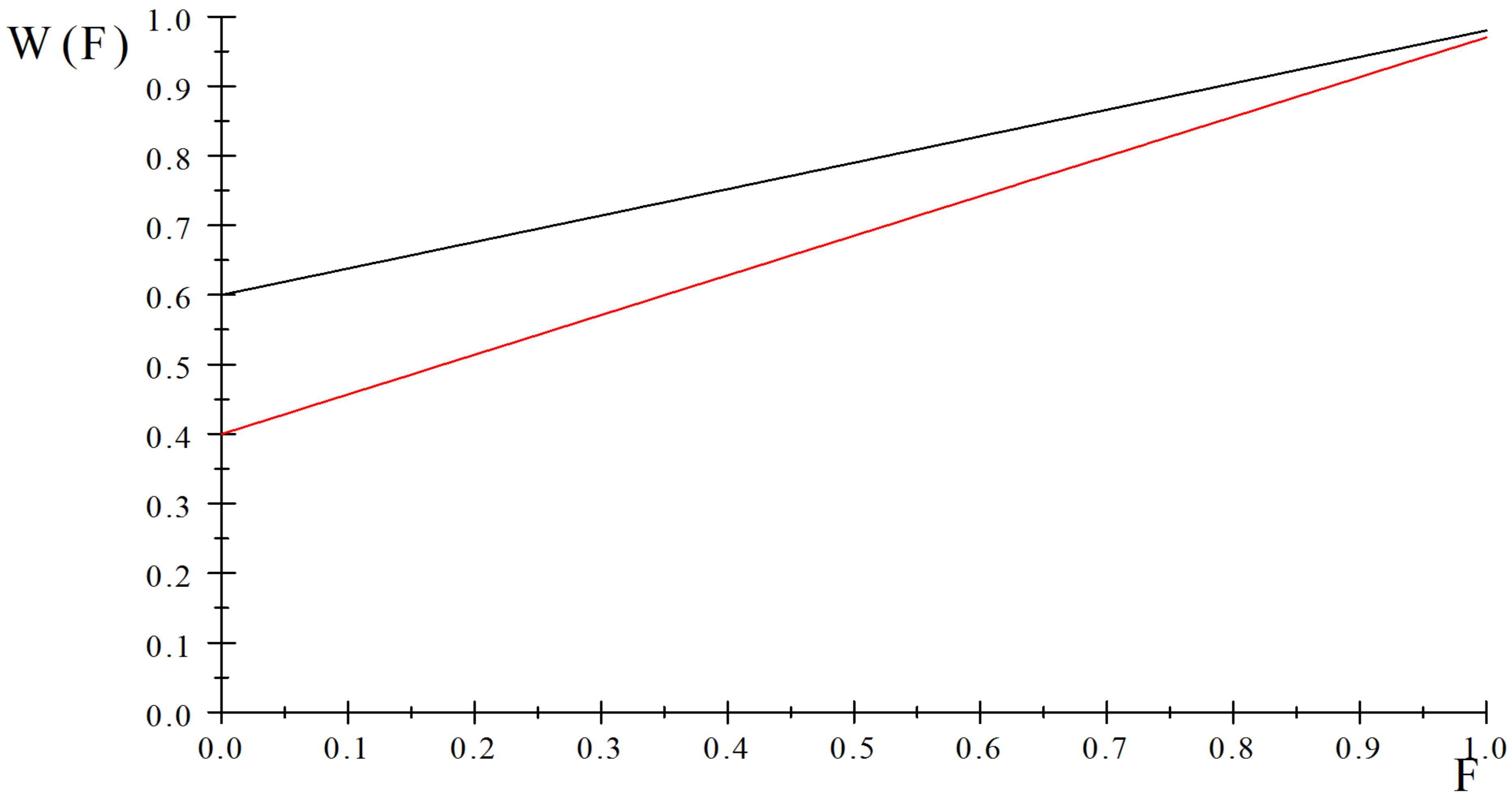
- Predictions introduction of minimum wage

1. Disemployment at bottom end, but small
2. For same *s*: lower *c(s)*
   - The more so at the bottom
   - Not at all at the top
3. Hence: flatter wage schedule
   - In particular at the bottom, not at all at the top
4. Higher wages at the bottom, lower at the top
   - Since substitution effects sum to zero
5. Higher employment effect just above minimum

The enigma of the minimum

- Job search model with only retention
  - $F \sim U(0,1)$: mismatch indicator of a job
    - $F = \Pr[\text{draw from offer distribution is better}]$
  - Value of job $J[W(F)]$
    - $(\rho + \delta + \lambda.F)\ J[W(F)] = X(F) - W(F)$
    - Lowest wage: $(\rho + \delta + \lambda)\ J(W^{min}) = X(1) - W^{min}$
  - Simple case: all firms equal $X(F) = X$
    - Equal profit condition $J[W(F)] = J(W^{min})$
    - $W(F) = [\lambda\ (1\text{-}F)\ X + (\rho + \delta + \lambda.F)\ W^{min}] / (\rho + \delta + \lambda)$
    - Lower F, lower impact W^{min}

The enigma of the minimum

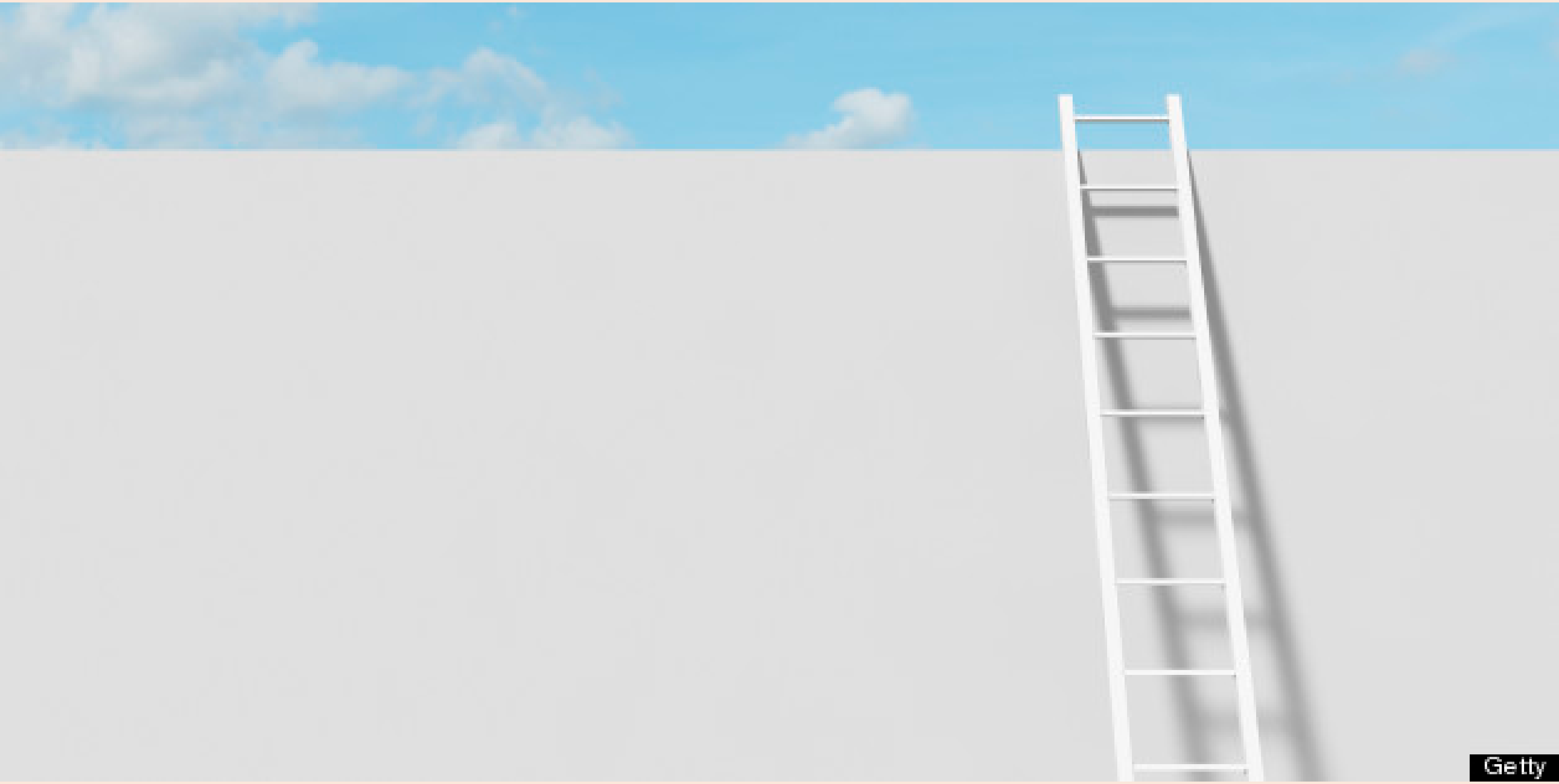


The enigma of the minimum

- Evaluation
  - Walras can explain low disemployment,
    - … not positive employment effects
  - Higher W^{min}, lower profits
    - Lower incentives for search for firms
    - … but higher for workers
  - Firms pay only retention premiums?
    - Inefficiently low incentives for workers
      - Gautier/Teulings/VanVuuren(2010)

- **Might a low minimum wage raise welfare?**

Future avenues for research



Future avenues for research

- Does G&T hold for other countries?
- Card&H&K(2013) consistent with results?
  - Job versus firm heterogeneity
    - $ln\ \Lambda_t$ as individual mismatch indicator
    - Lentz-ratio u-t-j/j-t-j hiring as firm mismatch indicator
  - Quadratic terms for mismatch
- Employment, search, and minimum wages