How Sticky Wages In Existing Jobs Can Affect Hiring

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1 Introduction

- Wages change relatively infrequently
  - — Daly and Hobijn (2014), CPS, year-over-year some with no change
  - — Barattieri, Basu, Gottschalk (2010), SIPP, hourly-paid wage duration 17 months

- Depart from sticky-wage literature by firms/workers bargaining over effort/output
  - — If wages stay high after negative shock; ask more of workers
  - — Reduces payoff to hiring–G.E. effect–Is stronger if aggregate labor demand less elastic

- Treat Mortensen-Pissarides model with wages flexible for new hires, but sticky within
  - Wages more cyclical for new matches (Pissarides, 2009)
- In M-P model wage stickiness in existing jobs doesn't matter–Not true in our model
- Can get wide difference in effort by vintage, impact short-lived
- If constrain workers to have same effort/pace, impact much larger
  - Get considerable wage inertia/unemployment volatility

- Difficult to measure cyclicality of effort

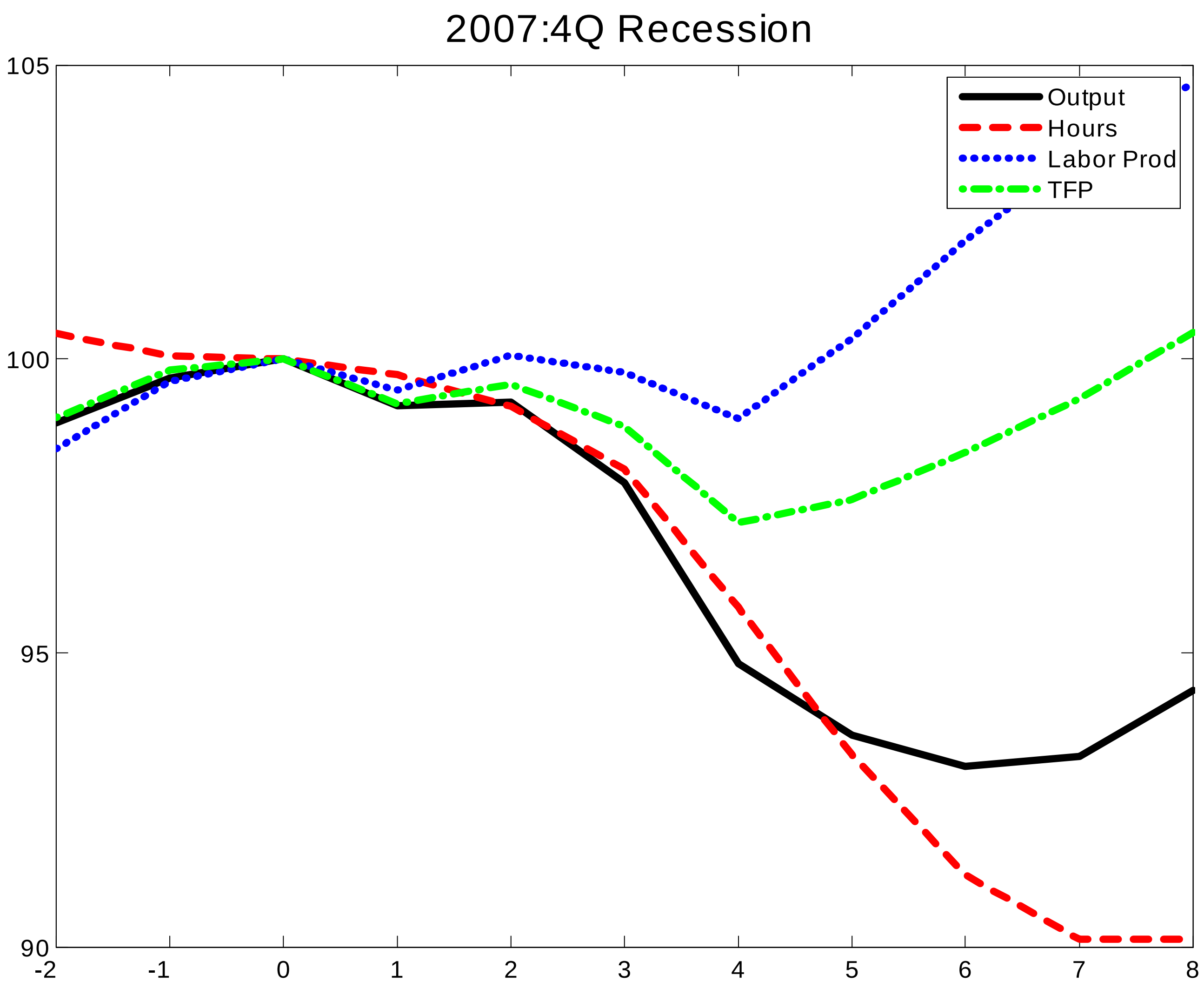
- Lazear, Shaw, and Stanton (2013) examine productivity of 20,000 workers at services company for June 2006 to May 2010: increase in local unemployment rate of 5 percentage points increases productivity 3.75%

- Anger (2011) unpaid overtime (extra) hours highly countercyclical for German workers for 1984 to 2004

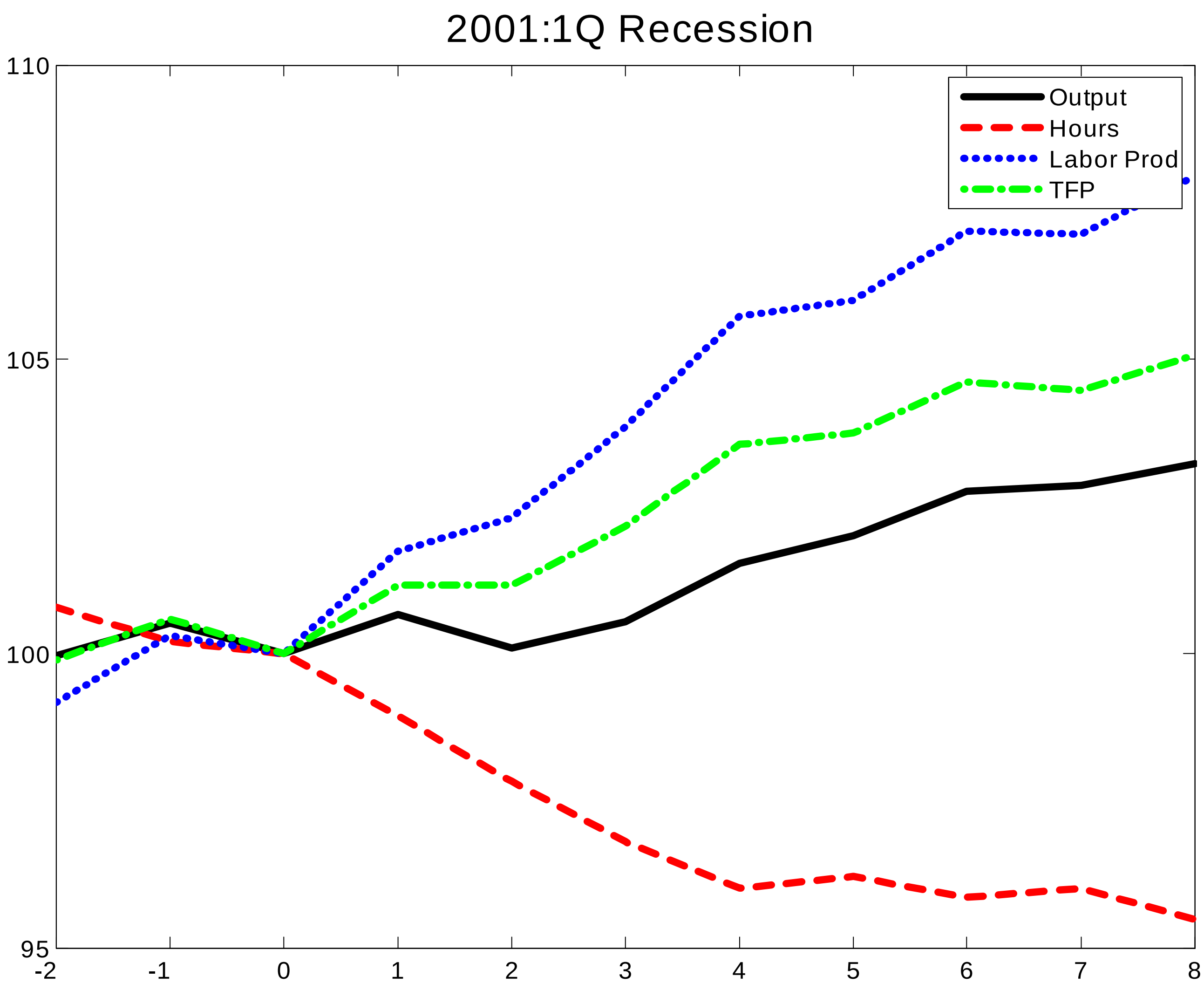
- ATUS: See more workers taking work home

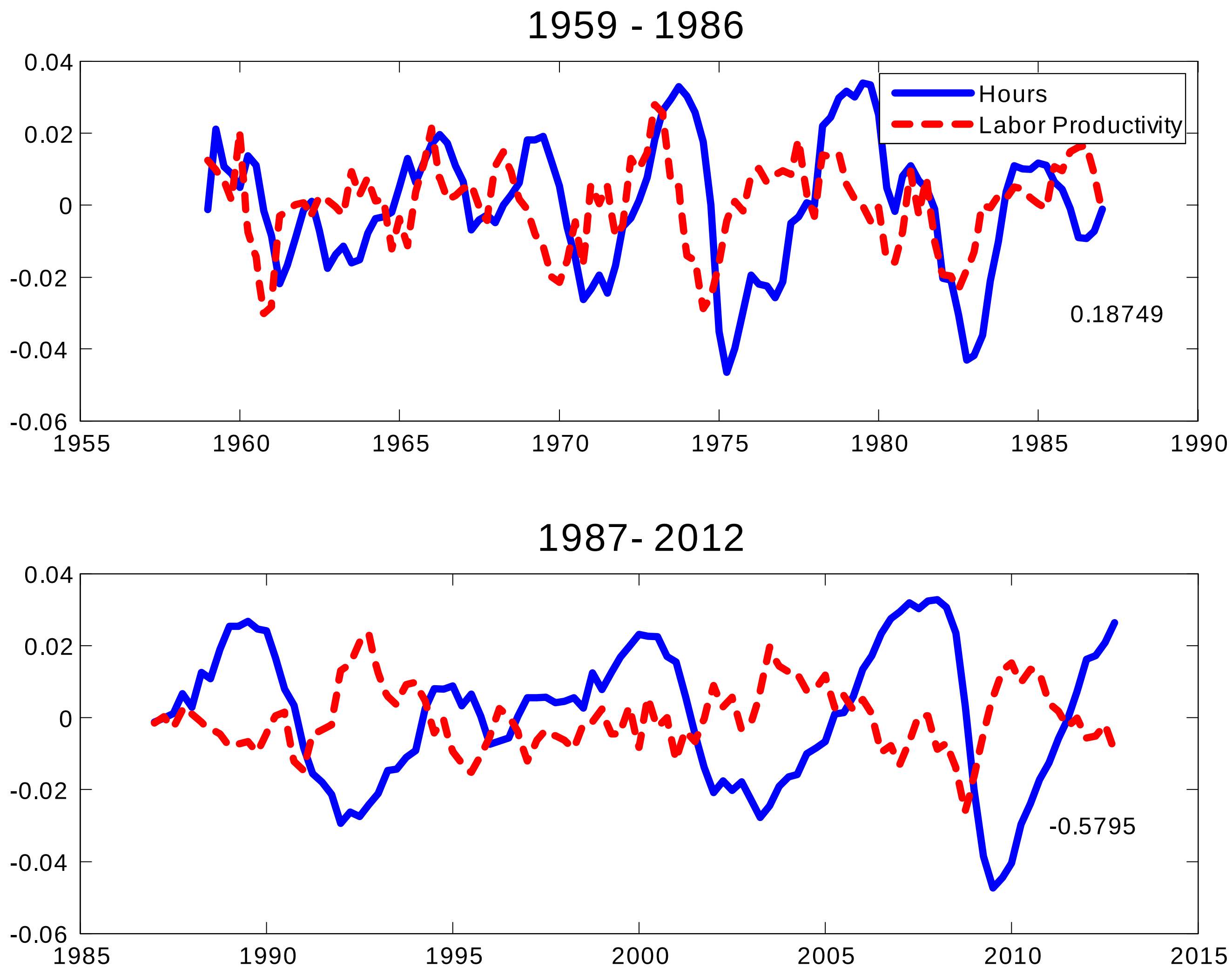

Work at Home
2000
1950
1900
Average Annual Hours
0.25
0.2
Fraction Some Work at Home
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year
Average Annual Hours
Fraction Some Work at Home

- Model consistent with little productivity/wage response in recessions
  - 2007 to 2009, 10% decline in hours compared to 6% in output
- Goes part way in rationalizing Shimer puzzle
  - Gives bigger response in employment to productivity shock
  - Makes measured TFP respond much less to that shock
- Examine whether consistent with behavior of TFP across industries
  - Stratify industries by measures of wage stickiness
  - Stickier wages yields countercyclical TFP, more cyclical hours



2007:4Q Recession
105
100
95
90
-2
-1
0
1
2
3
4
5
6
7
8
Output
Hours
Labor Prod
TFP


2001:1Q Recession
110
105
100
95
-2
-1
0
1
2
3
4
5
6
7
8
Output
Hours
Labor Prod
TFP


1959 - 1986
Hours
Labor Productivity
0.18749
0.04
0.02
0
-0.02
-0.04
-0.06
1955
1960
1965
1970
1975
1980
1985
1990
1987- 2012
-0.5795
0.04
0.02
0
-0.02
-0.04
-0.06
1985
1990
1995
2000
2005
2010
2015

Model

- Diamond-Mortensen-Pissarides matching model
- Exogenous Separation
- Staggering Wage Contracts
- Wages Flexible for Newly Matched Workers
- Effort is chosen through Nash Bargaining

Workers' Preferences

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ c_t + \psi \frac{(1-e_t)^{1-\gamma} - 1}{1-\gamma} \right\},$$

- c: consumption
- e: effort
- $\frac{e}{1-e}\frac{1}{\gamma}$: Frisch elasticity of effort w.r.t. wage

Firms' Production Technology

$$y_t = z_t e_t^{\alpha} (k_t e_t)^{1-\alpha},$$

- z: aggregate productivity
- k: capital per effort, equated over firms
- Aggregate capital fixed over cycle

Matching Technology

$$M(u_t, v_t) = \chi u_t^{1/2} v_t^{1/2},$$

$$\theta_t = \frac{v_t}{u_t},$$

Each period jobs are destroyed with exogenous probability δ.

Staggered Wage Contract

- When a match is formed, the wage is set according to a Nash bargaining.

- Wage is fixed for T periods.

Choice of Labor Effort

- Effort is determined according to the Nash bargaining.
- We consider three cases:
  - Effort level is fixed
  - Effort level is chosen individually
  - Common level of effort is chosen

Value of Employed whose wage contract is j-period old

For $j = 0, 1, ..., T - 2$,

$$W_j(w_j; z, \mu) = w_j + \psi \frac{(1-e)^{1-\gamma} - 1}{1-\gamma} + \beta \Big\{ (1-\delta) E\Big[W_{j+1}(w_j; z', \mu') | z \Big] + \delta E\Big[U(z', \mu') | z \Big] \Big\}.$$

subject to

$$z' \sim F(z'|z) = \text{Prob}(z_{t+1} \leq z' | z_t = z)$$

$$\mu' = \mathbf{T}(\mu, z)$$

where the transition operator $\mathbf{T}$ is characterized as:

$$\begin{pmatrix} w_0' \\ w_1' \\ \vdots \\ w_{T-1}' \end{pmatrix} = \begin{pmatrix} w^*(z', \mu') \\ w_0 \\ \vdots \\ w_{T-2} \end{pmatrix}, \tag{1}$$

$$\begin{pmatrix} N_0' \\ N_1' \\ \vdots \\ N_{T-1}' \end{pmatrix} = \begin{pmatrix} (1-\delta)N_{T-1} + M(u, v) \\ (1-\delta)N_0 \\ \vdots \\ (1-\delta)N_{T-2} \end{pmatrix}, \tag{2}$$

where $w^*(z', \mu')$ is newly-employed worker's wage in the next period.

For matched who will newly negotiate wage next period,
(i.e., $j = T - 1$):

$$W_{T-1}(w_{T-1}; z, \mu) = w_{T-1} + \psi \frac{(1-e)^{1-\gamma} - 1}{1-\gamma} + \beta \Big\{ (1-\delta) E\Big[W_0(w^*; z', \mu') | z \Big] + \delta E\Big[U(z', \mu') | z \Big] \Big\}.$$

Value of a Job matched with a worker whose wage contract is j-period old

For $j = 0, 1, ..., T-2$,

$$J_j(w_j; z, \mu) = \alpha y - w_j + \beta(1-\delta)E\Big[J_{j+1}(w_j; z', \mu')|z\Big].$$

For the job whose wage will be negotiated next period (i.e., $j = T-1$)

$$J_{T-1}(w_{T-1}; z, \mu) = \alpha y - w_{T-1} + \beta(1-\delta)E\Big[J_0(w^*; z', \mu')|z\Big],$$

Value of Unemployed (standard)

$$U(z,\mu) = b + \beta\Big\{p(\theta)E\Big[W_0(w^*;z',\mu')|z\Big] + \Big(1-p(\theta)\Big)E\Big[U(z',\mu')|z\Big]\Big\}.$$

Free Entry Condition (standard)

Firms post vacancies until expected value of hire equals cost of vacancy:

$$\kappa = q(\theta)\beta E\Big[J_0(w^*;z',\mu')|z\Big].$$

Nash Bargaining over Wages of New Bargains

Wage for new matches, $w^*(z, \mu)$, is determined by Nash bargain between set of workers and firm:

$$w^*(z, \mu) = argmax_w \Big(J_0(w; z, \mu) \Big)^{1/2} \Big(W_0(w; z, \mu) - U(z, \mu) \Big)^{1/2}.$$

First order condition for $w^*(z, \mu)$ is

$$J_0(w^*; z, \mu) = W_0(w^*; z, \mu) - U(z, \mu).$$

Choice of Effort

Given the wage w_j, effort determined by Nash bargaining. If by vintage:

$$e_j^*(w_j, z, \mu) = argmax_{e_j}\Big(J_j(e_j; w_j, z, \mu)\Big)^{1/2}\Big(W_j(e_j; w_j, z, \mu) - U(z, \mu)\Big)^{1/2}$$

First order condition for $e^*(z, \mu)$ is

$$\psi(1 - e_j)^{-\gamma} J_j(e_j; w_j, z, \mu) = \alpha z k^{1-\alpha}\Big(W_j(e_j; w_j, z, \mu) - U(z, \mu)\Big)$$

For $w_j = w^*(z, \mu)$ have efficient effort

$$\psi(1 - e_j)^{-\gamma} = \alpha z k^{1-\alpha}$$

Model with Common Level of Effort

We also consider the model with common level of effort across workers.

- Maybe unrealistic to operate at varying work rules across employee.
- Complementarity of labor across workers

Bargaining over the Common Level of Effort

The common effort level, $e(z, \mu)$, is determined by Nash bargaining over weighted average of surpluses across worker vintages.

$$e^*(z, \mu) = argmax_e \Big(J\Big)^{1/2} \Big(W - U\Big)^{1/2},$$

$$J = \textstyle\sum_{j=0}^{T-1} \left(\frac{N_j}{\sum_{j=0}^{T-1} N_j}\right) J_j,$$
$$W - U = \textstyle\sum_{j=0}^{T-1} \left(\frac{N_j}{\sum_{j=0}^{T-1} N_j}\right) (W_j - U).$$

Calibration

- Imposed Parameters

- Targeted Parameters

Calibration: Imposed Parameters

- $\beta = 0.99$.Labor elasticity: $\alpha = 0.64$. Rental Rate: $r + d = 3.5\%$.

- Frisch Elasticity of Effort: $\frac{1}{\gamma}\frac{(1-e)}{e} = 1$; ψ so S.S. effort, $e = 1/2$.

- Contract length: $T = 4$.

- Benefit b so replacement rate $b \Big/ \left(w_{ss} + \psi \frac{(1-e)^{1-\gamma} - 1}{1-\gamma} \right) = 70\%$.

Calibration: Targeted Parameters

- Normalize $\theta = 1$

- Vacancy posting cost and $\delta = 4\%$ to get S.S. $u = 6.25\%$ and finding rate $= 60\%$ (given replacement rate and free entry condition).

Impulse Responses to a 1% Decrease in Productivity

We will show models with:

- Fixed Effort (Flexible wage and Sticky wage)

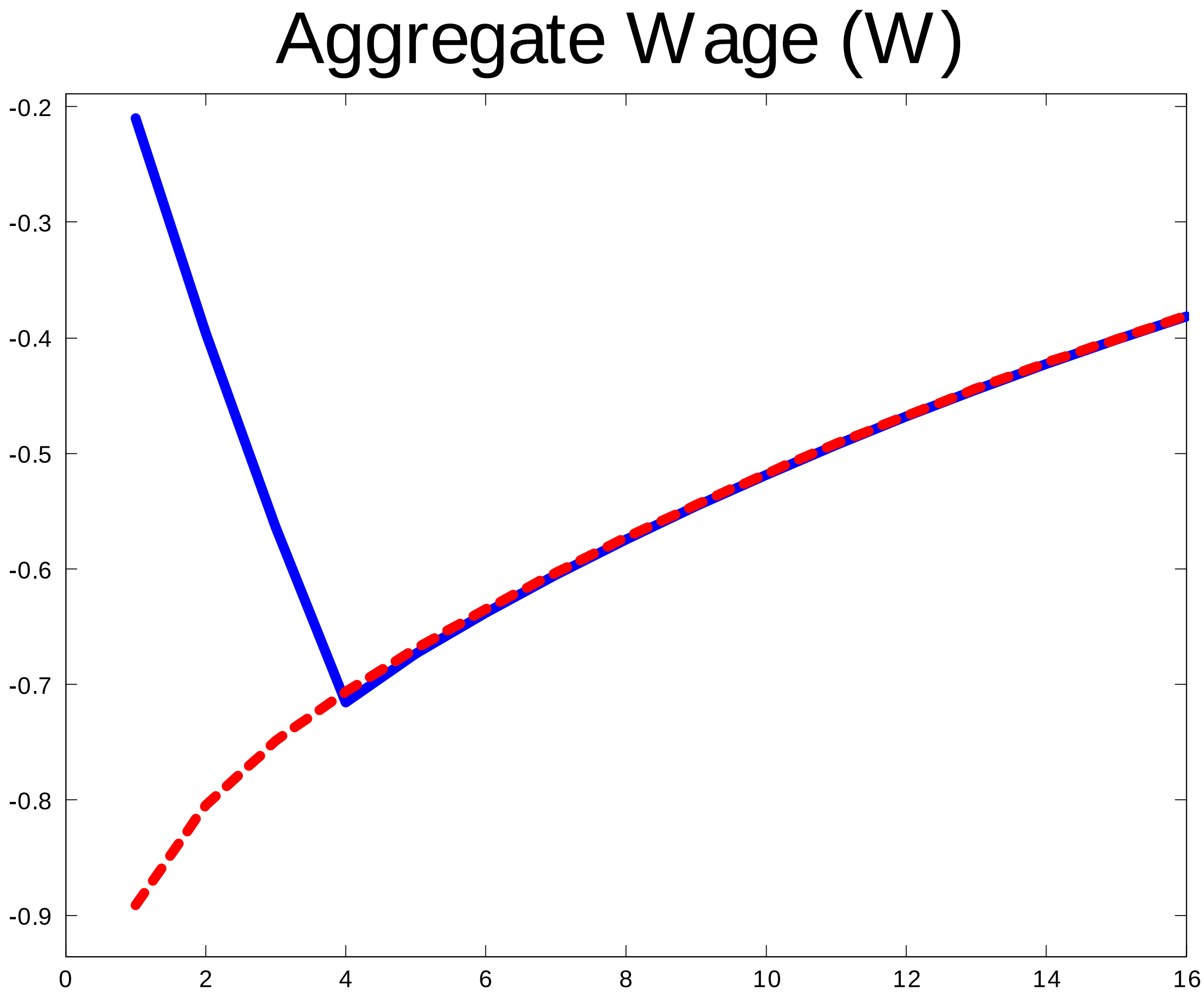
- Endogenous Effort

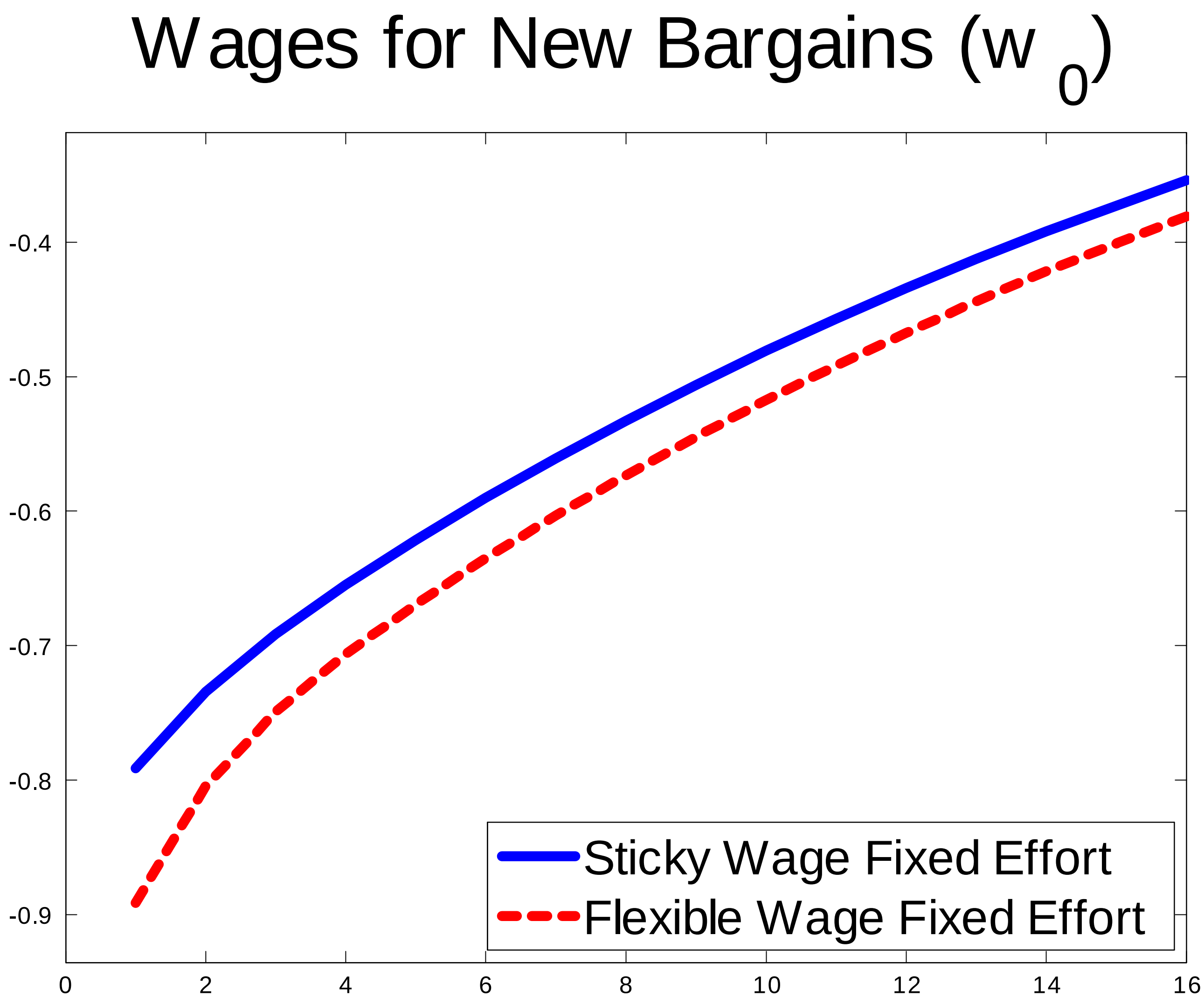
  - Flexible wage

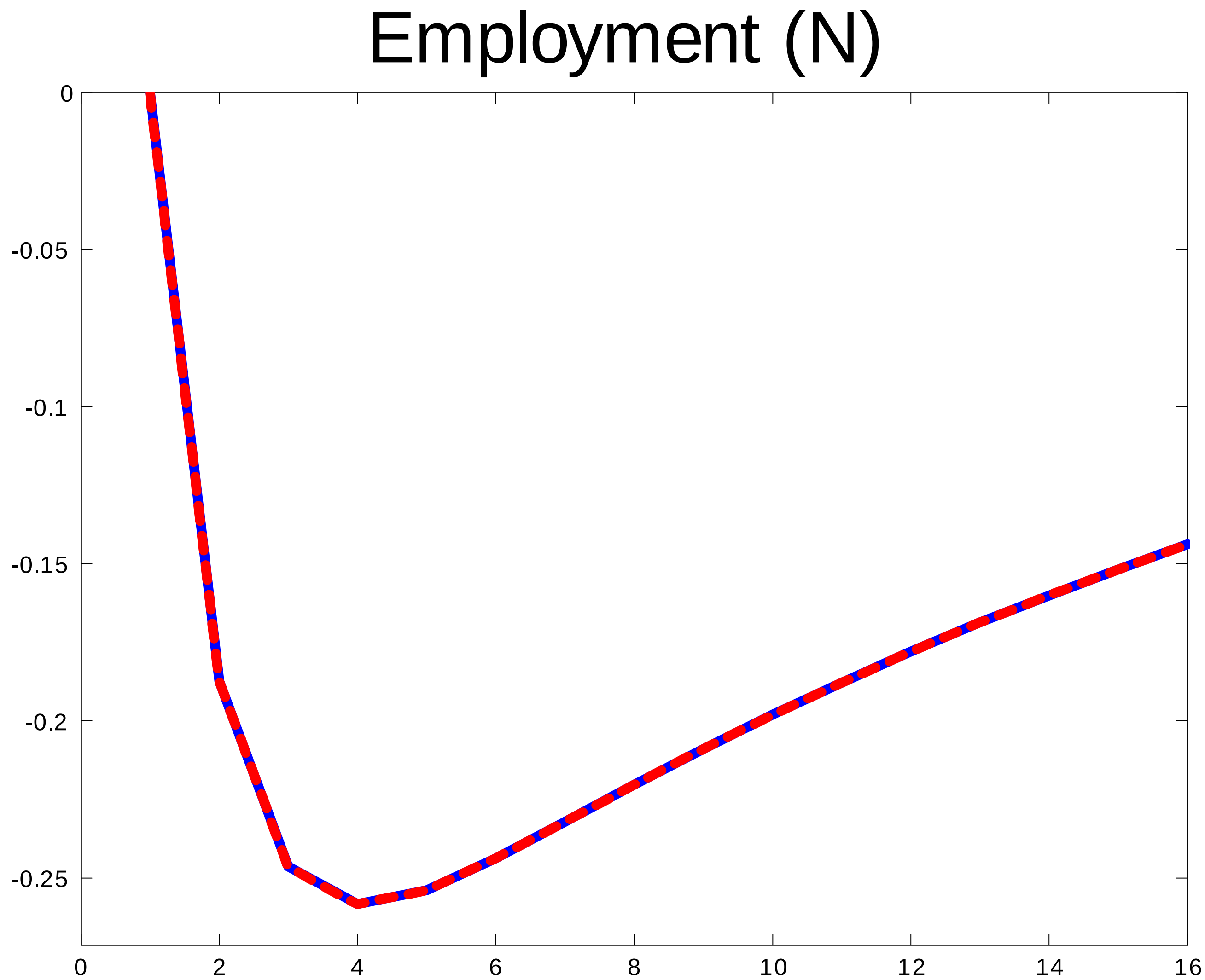
  - Sticky wage with individual effort level

  - Sticky wage with common effort level

Models with Fixed Effort


Aggregate Wage (W)
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
0
2
4
6
8
10
12
14
16


Wages for New Bargains (w_0)
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
0
2
4
6
8
10
12
14
16
Sticky Wage Fixed Effort
Flexible Wage Fixed Effort

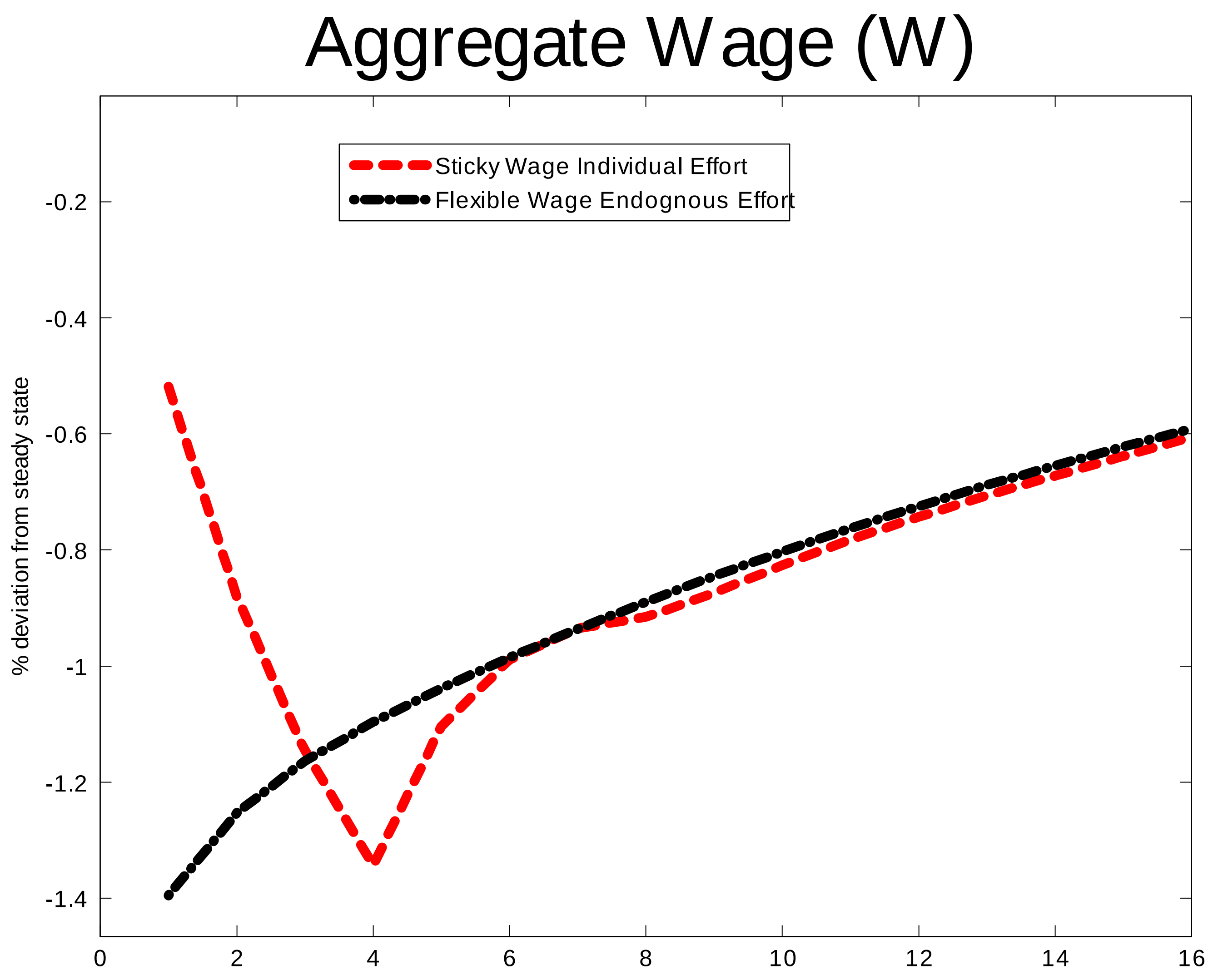

Employment (N)
0
-0.05
-0.1
-0.15
-0.2
-0.25
0
2
4
6
8
10
12
14
16

Models with Variable Effort:

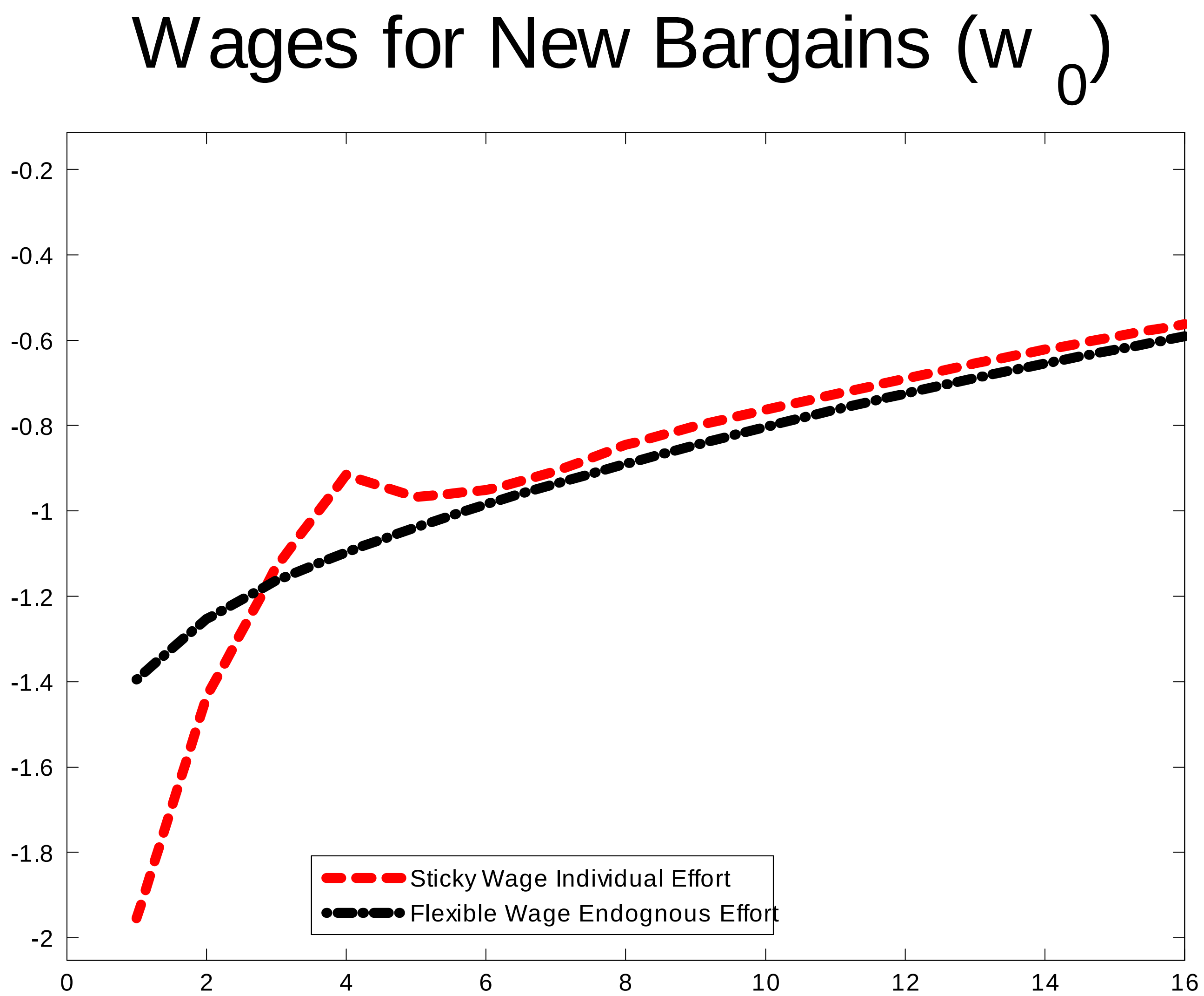
We consider cases with:

- Benchmark ($T = 4$, $\gamma = 1$, $\alpha = 0.64$)
- Longer Contract Length ($T = 8$)
- Smaller Frisch Elasticity ($\gamma = 2$)
- Smaller Labor Demand Elasticity ($\alpha = 0.28$)

Benchmark ($T = 4$, $\gamma = 1$, $\alpha = 0.64$)

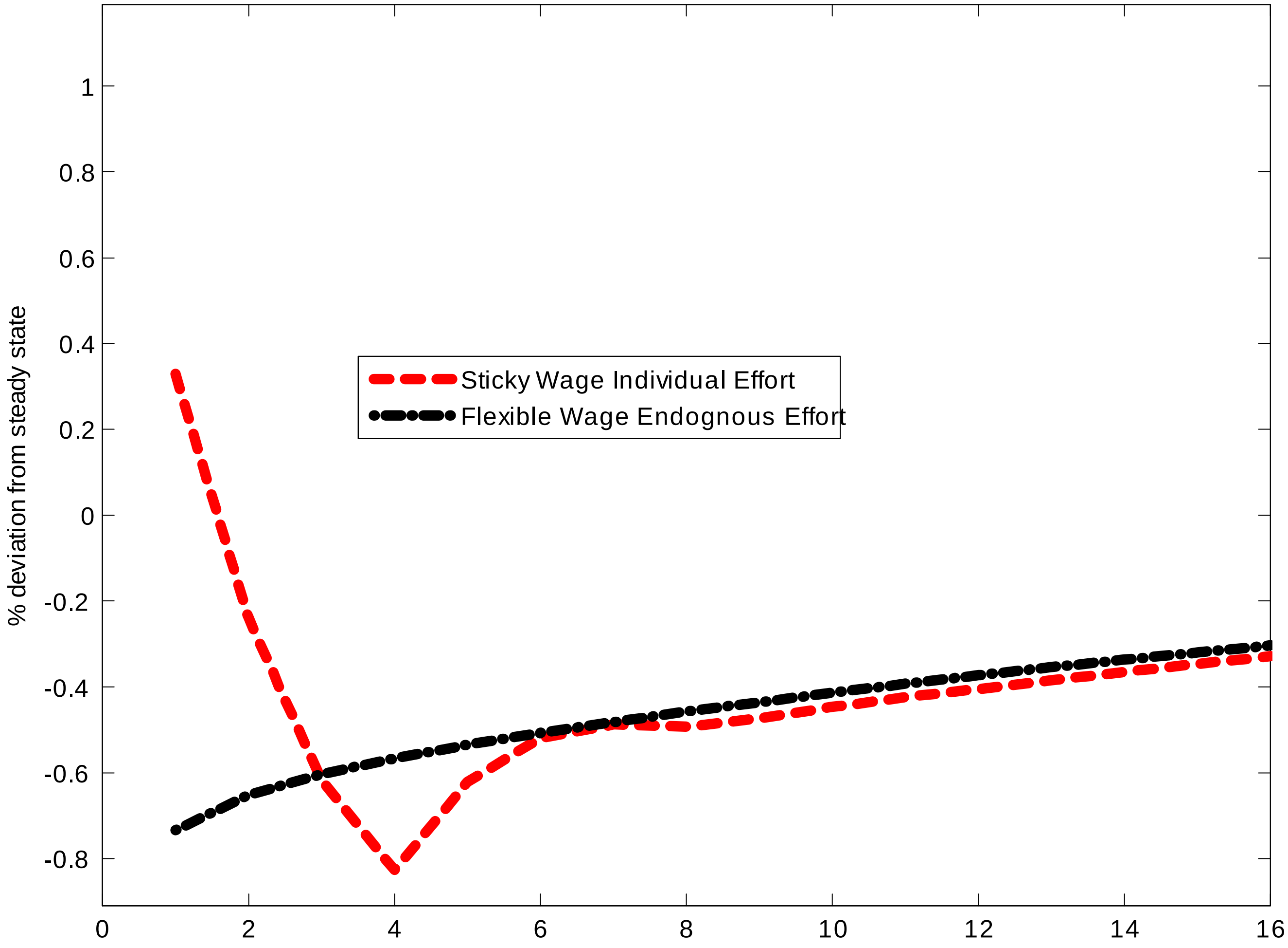


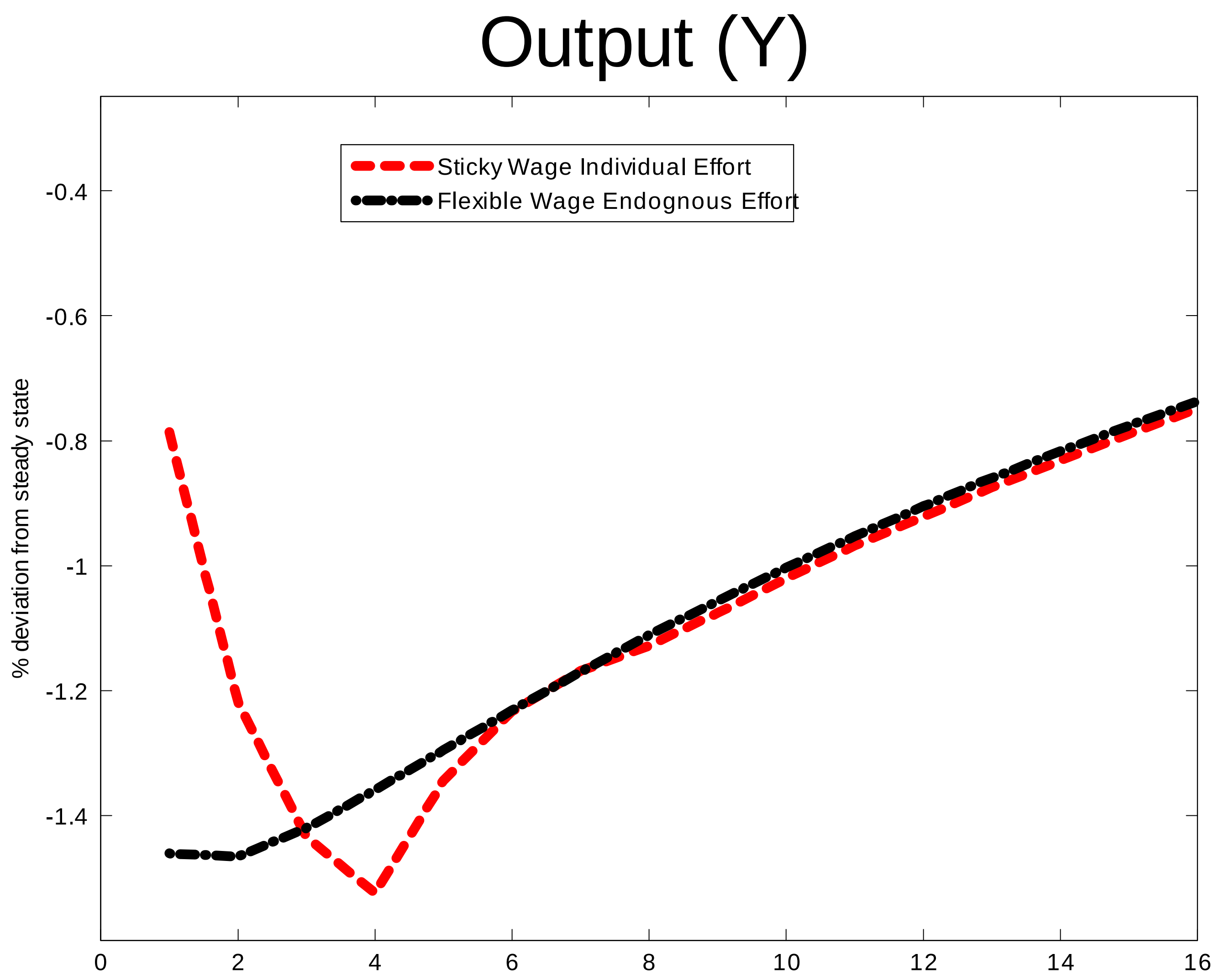
Aggregate Wage (W)
Sticky Wage Individual Effort
Flexible Wage Endognous Effort
% deviation from steady state
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
2
4
6
8
10
12
14
16

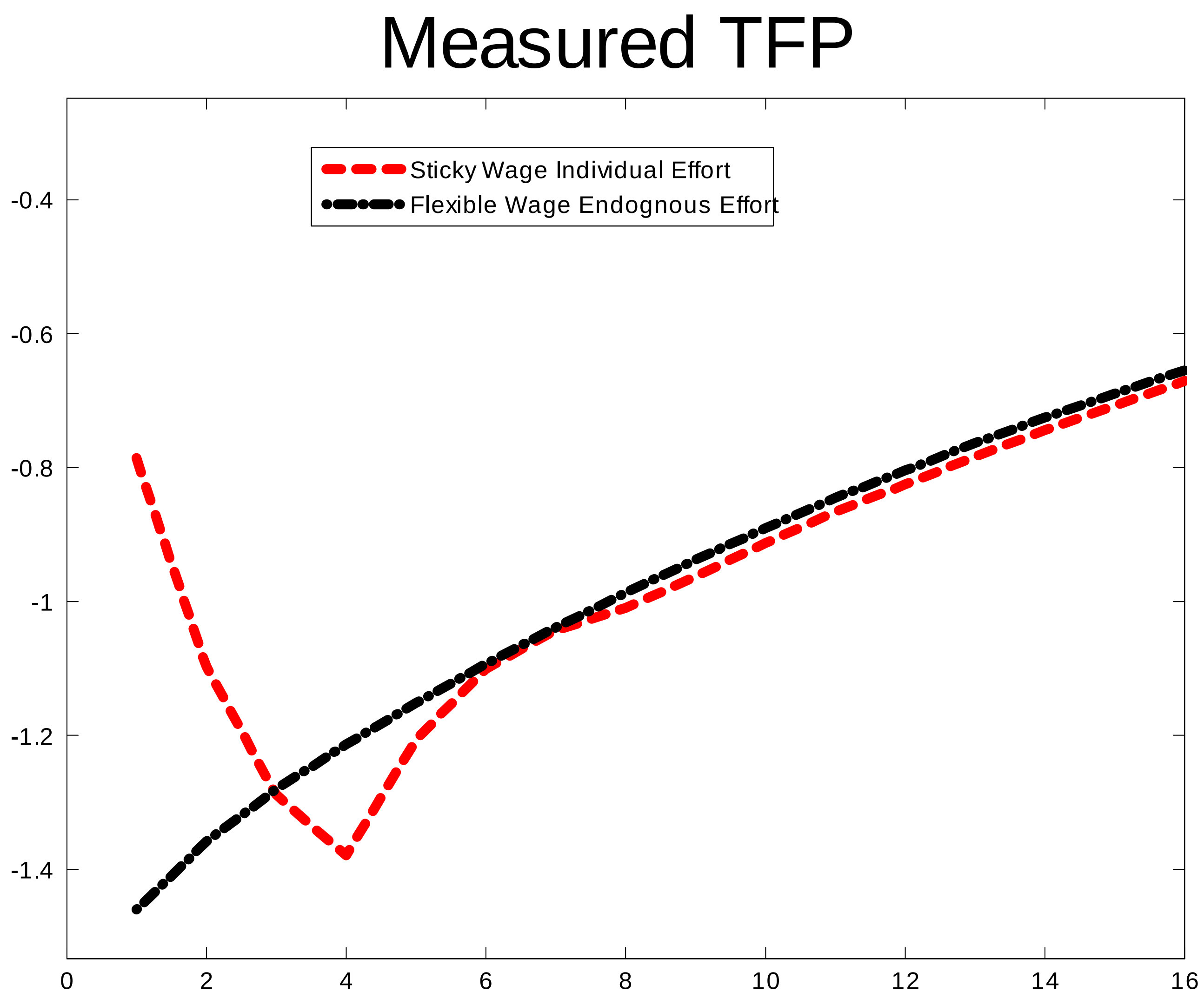


Wages for New Bargains (w_0)
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
0
2
4
6
8
10
12
14
16
Sticky Wage Individual Effort
Flexible Wage Endognous Effort

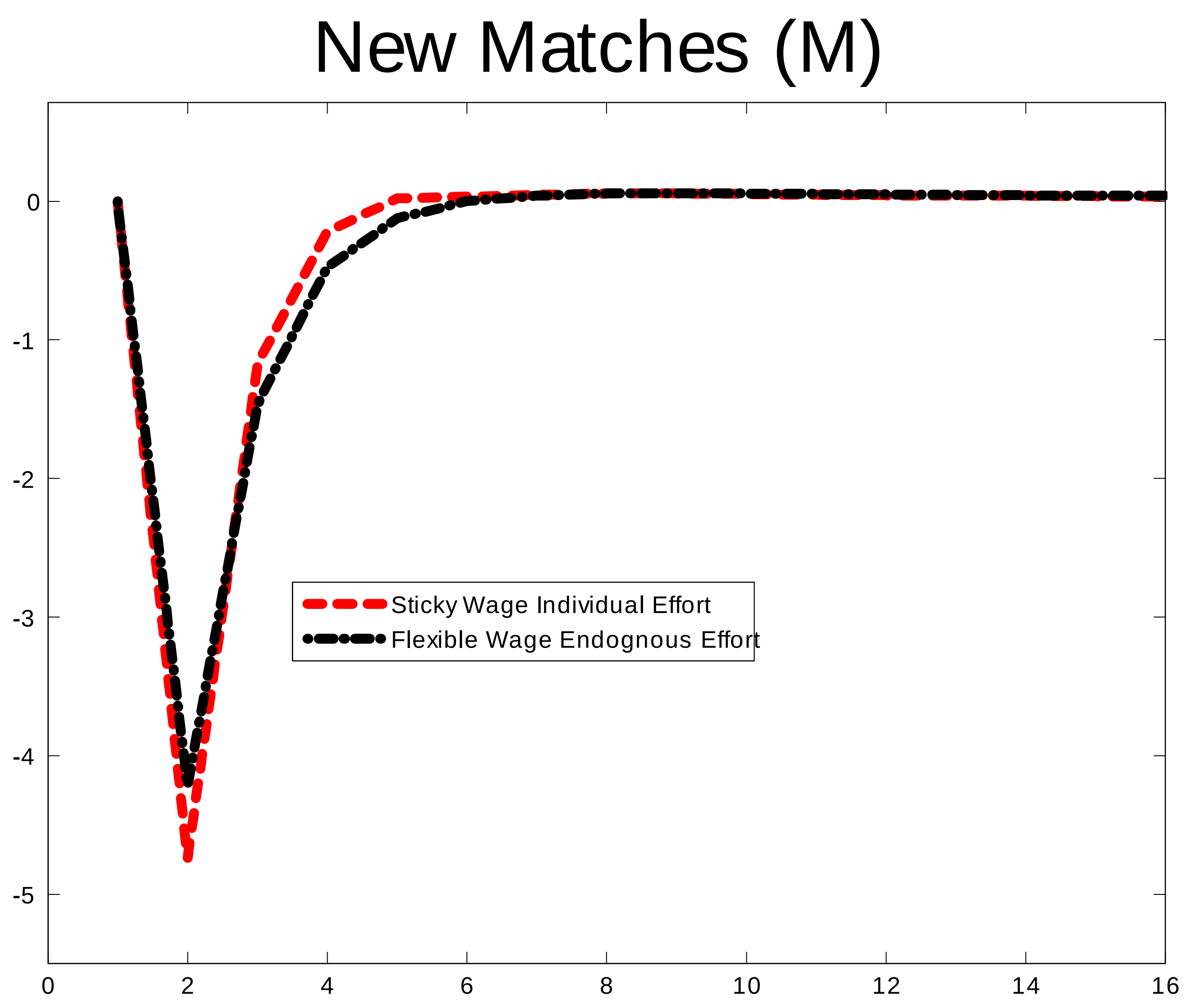
Average Effort (E)



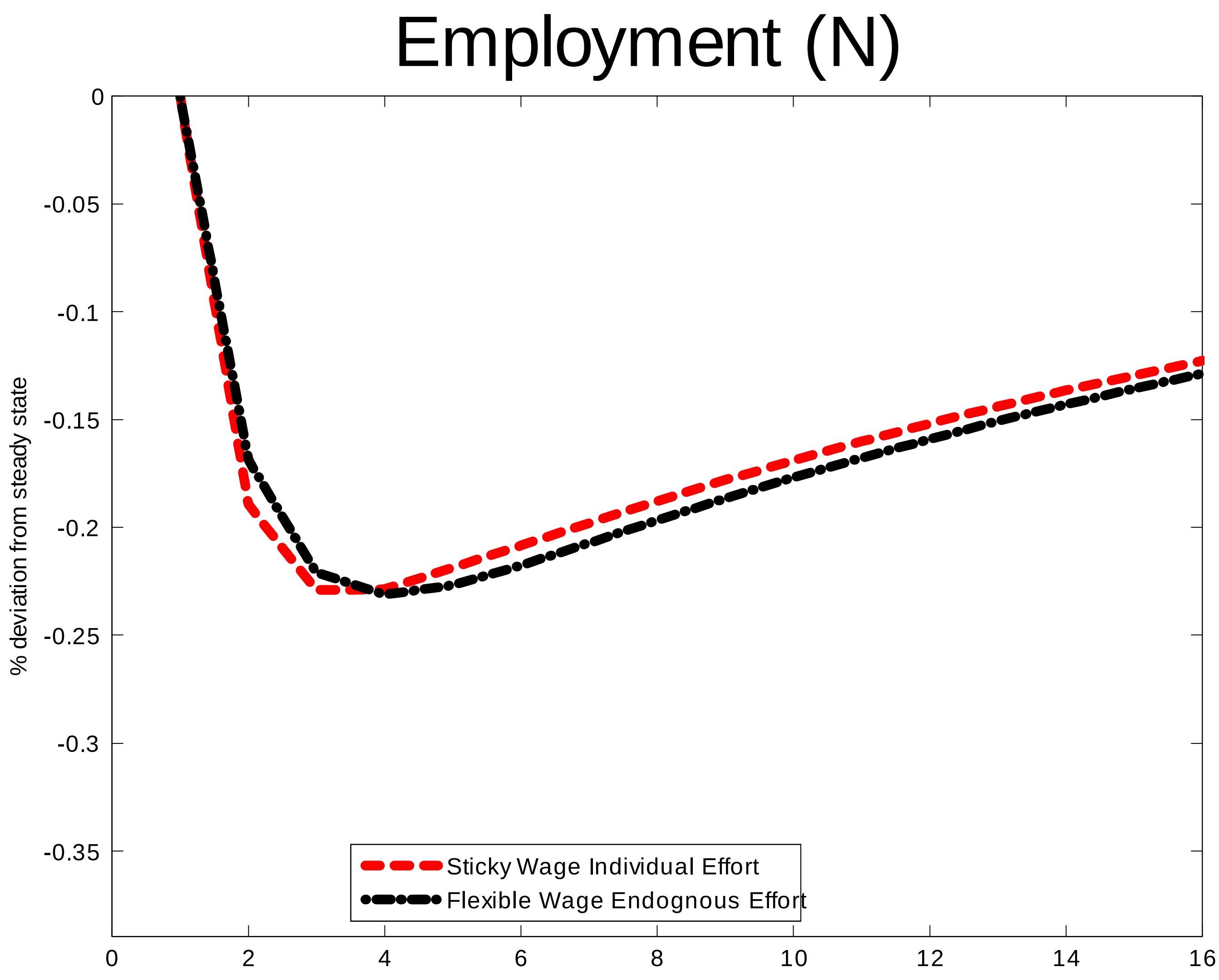

Output (Y)
Sticky Wage Individual Effort
Flexible Wage Endognous Effort
% deviation from steady state
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
2
4
6
8
10
12
14
16



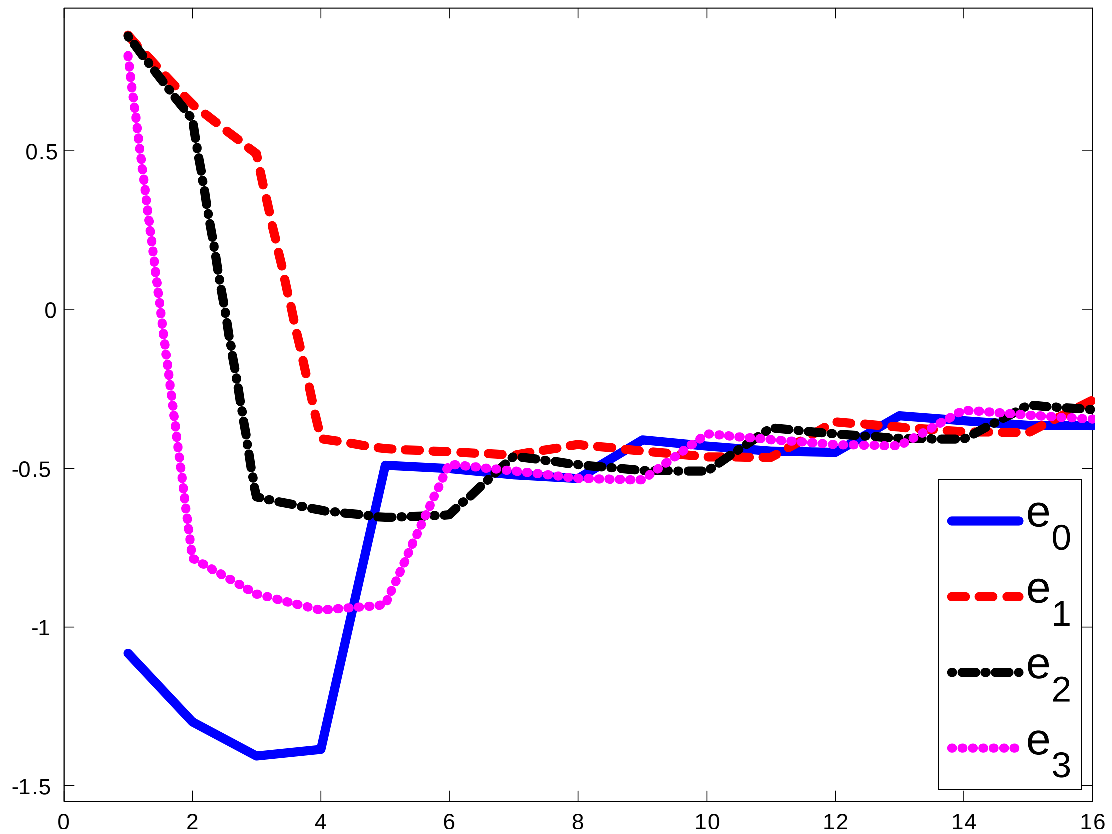
Measured TFP
Sticky Wage Individual Effort
Flexible Wage Endognous Effort
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
2
4
6
8
10
12
14
16



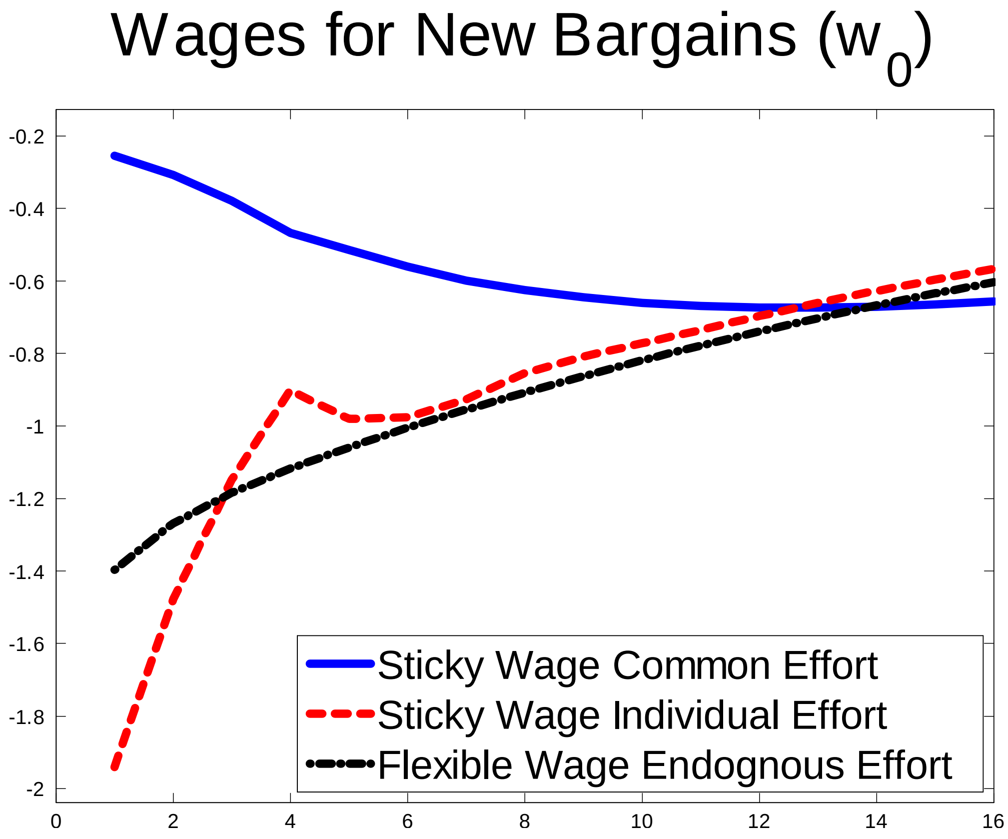
New Matches (M)
0
-1
-2
-3
-4
-5
0
2
4
6
8
10
12
14
16
Sticky Wage Individual Effort
Flexible Wage Endognous Effort


Employment (N)
% deviation from steady state
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
0
2
4
6
8
10
12
14
16
Sticky Wage Individual Effort
Flexible Wage Endognous Effort

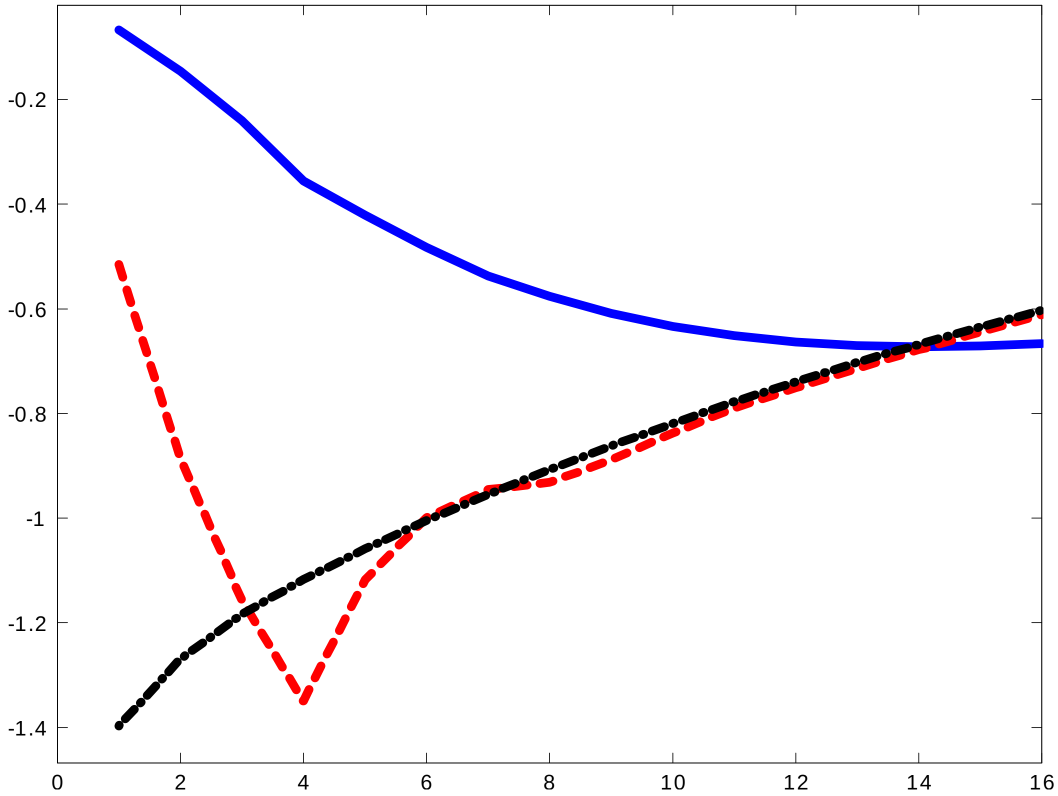
Individual Effort (e)

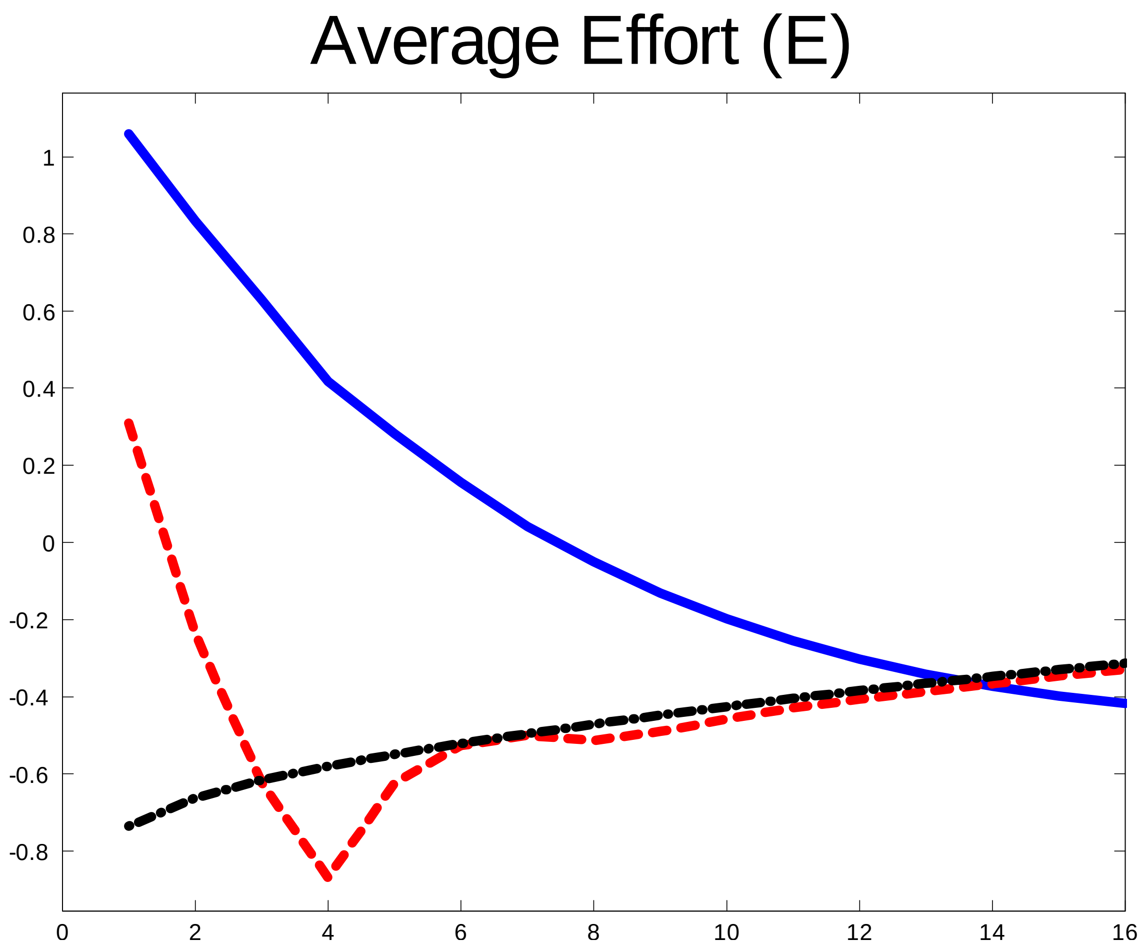


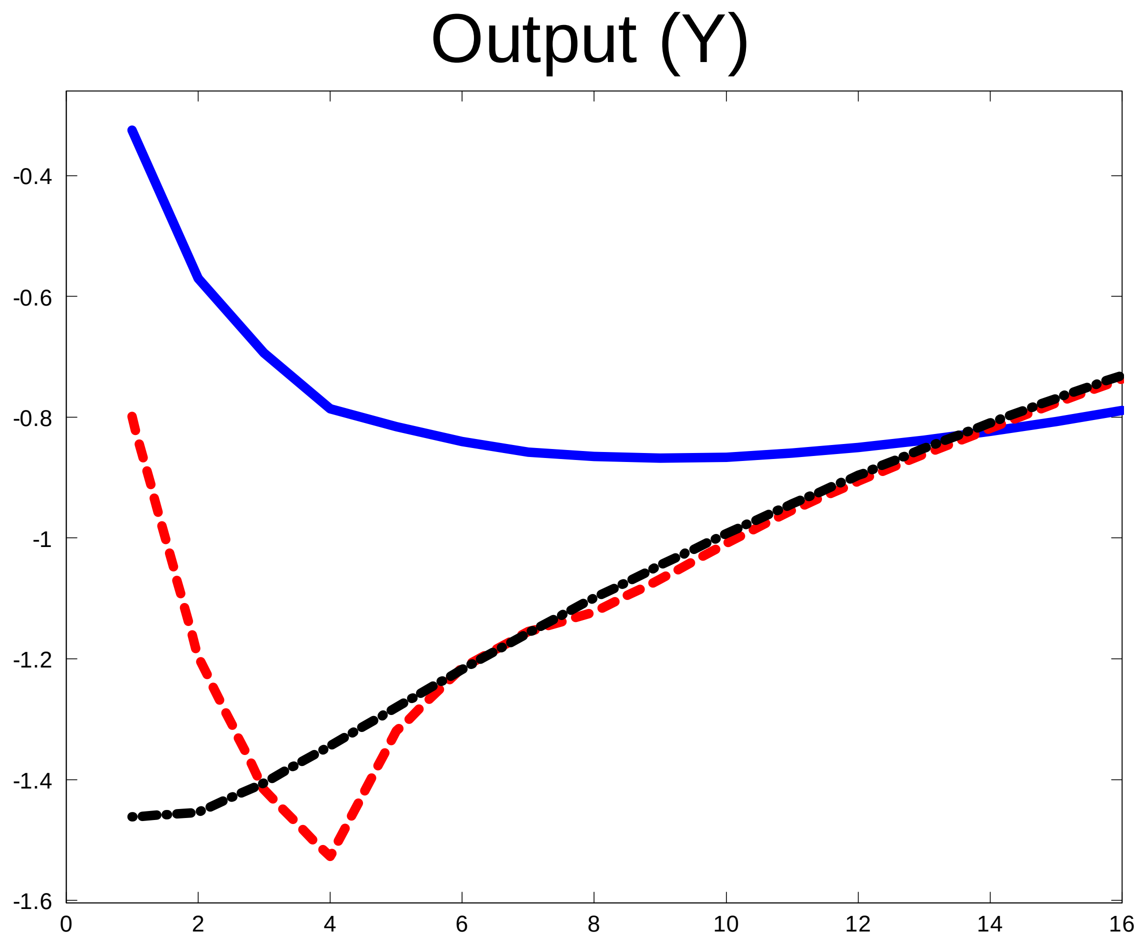
Benchmark ($T = 4$, $\gamma = 1$, $\alpha = 0.64$)



Aggregate Wage (W)

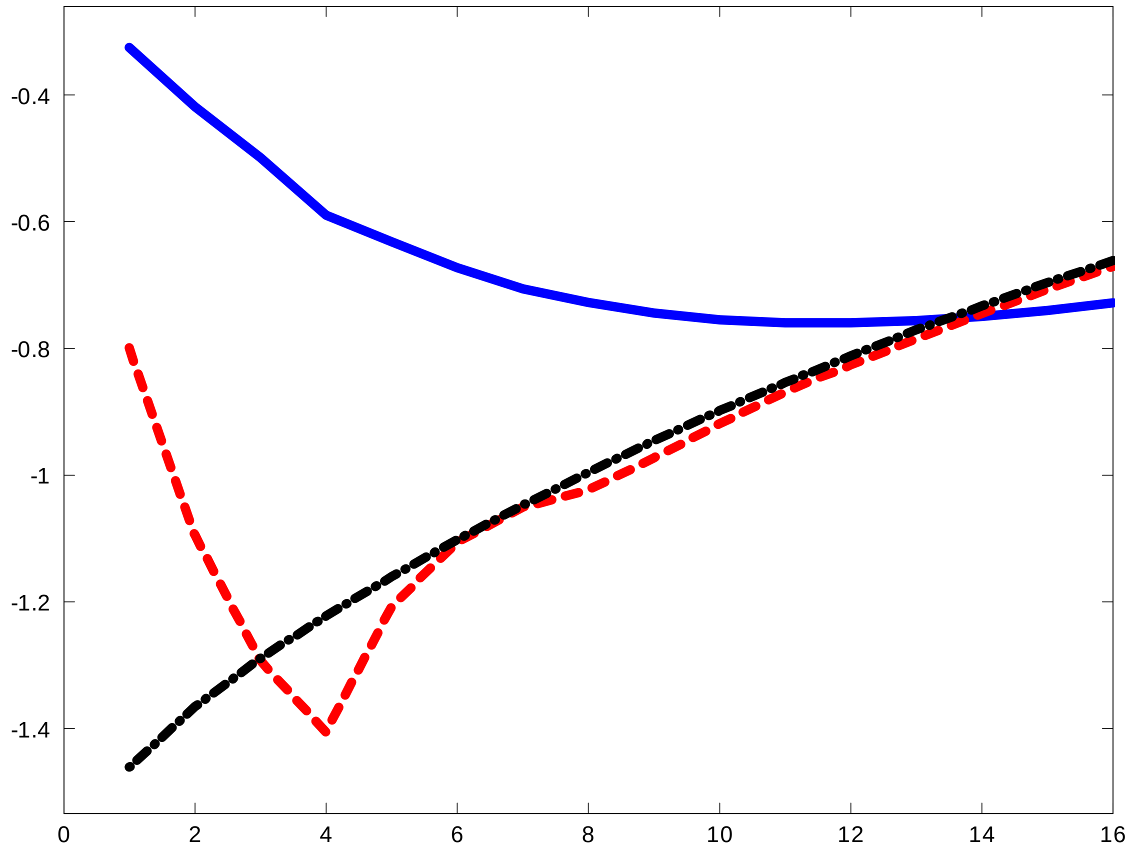



Average Effort (E)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
2
4
6
8
10
12
14
16

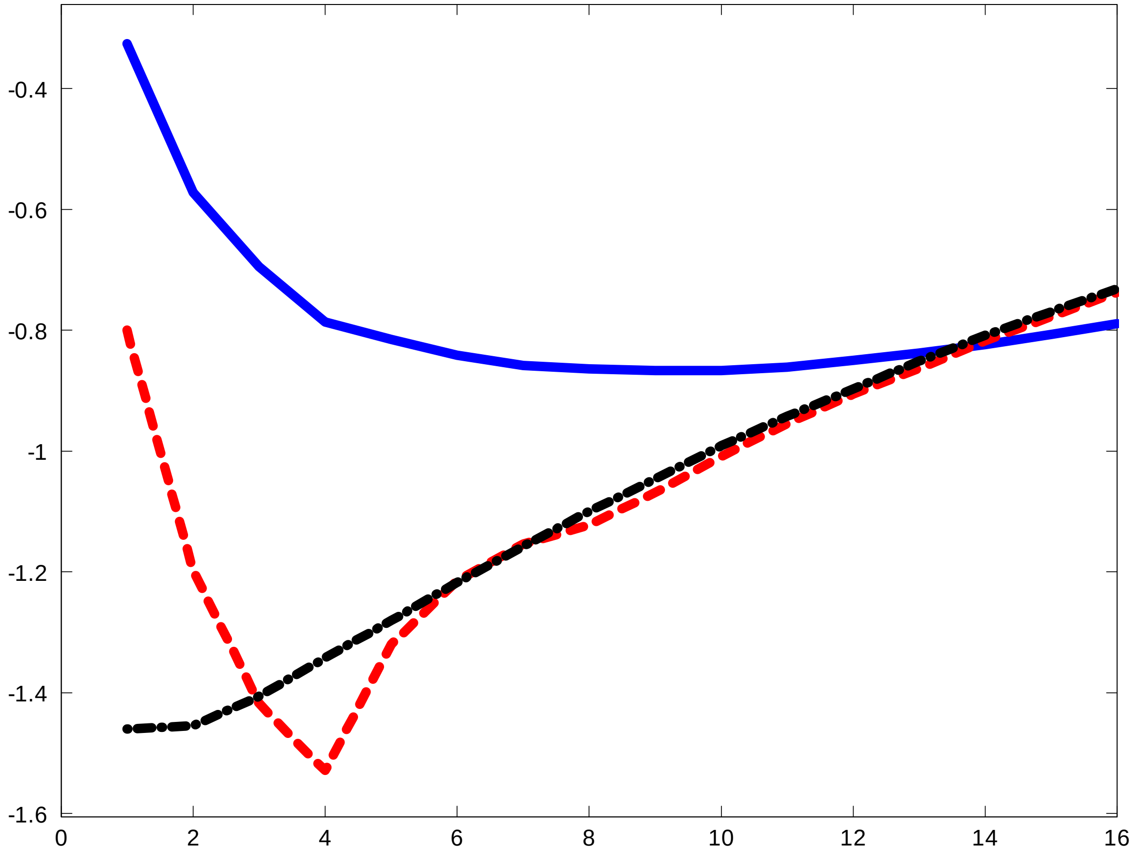


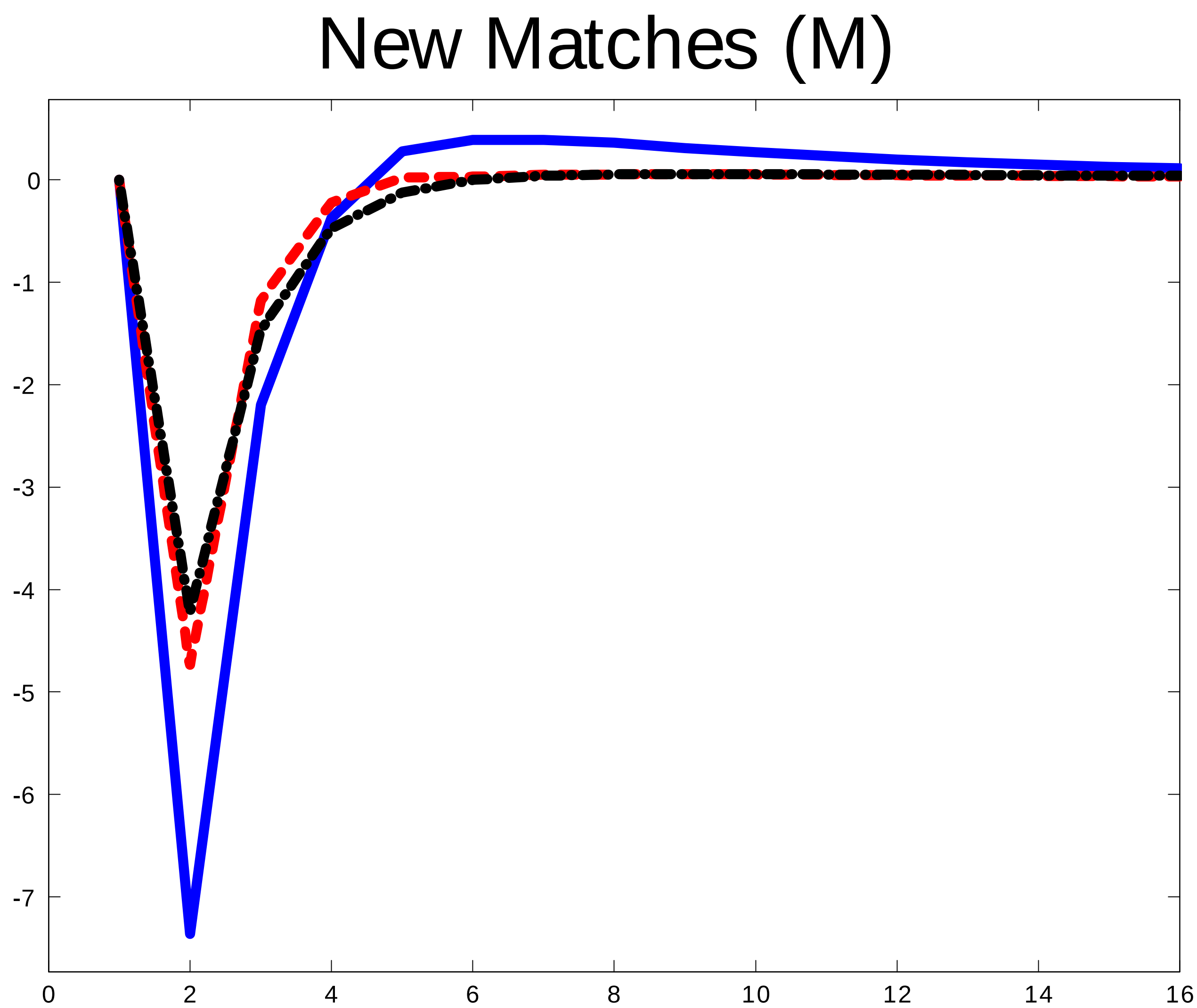
Output (Y)
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
0
2
4
6
8
10
12
14
16

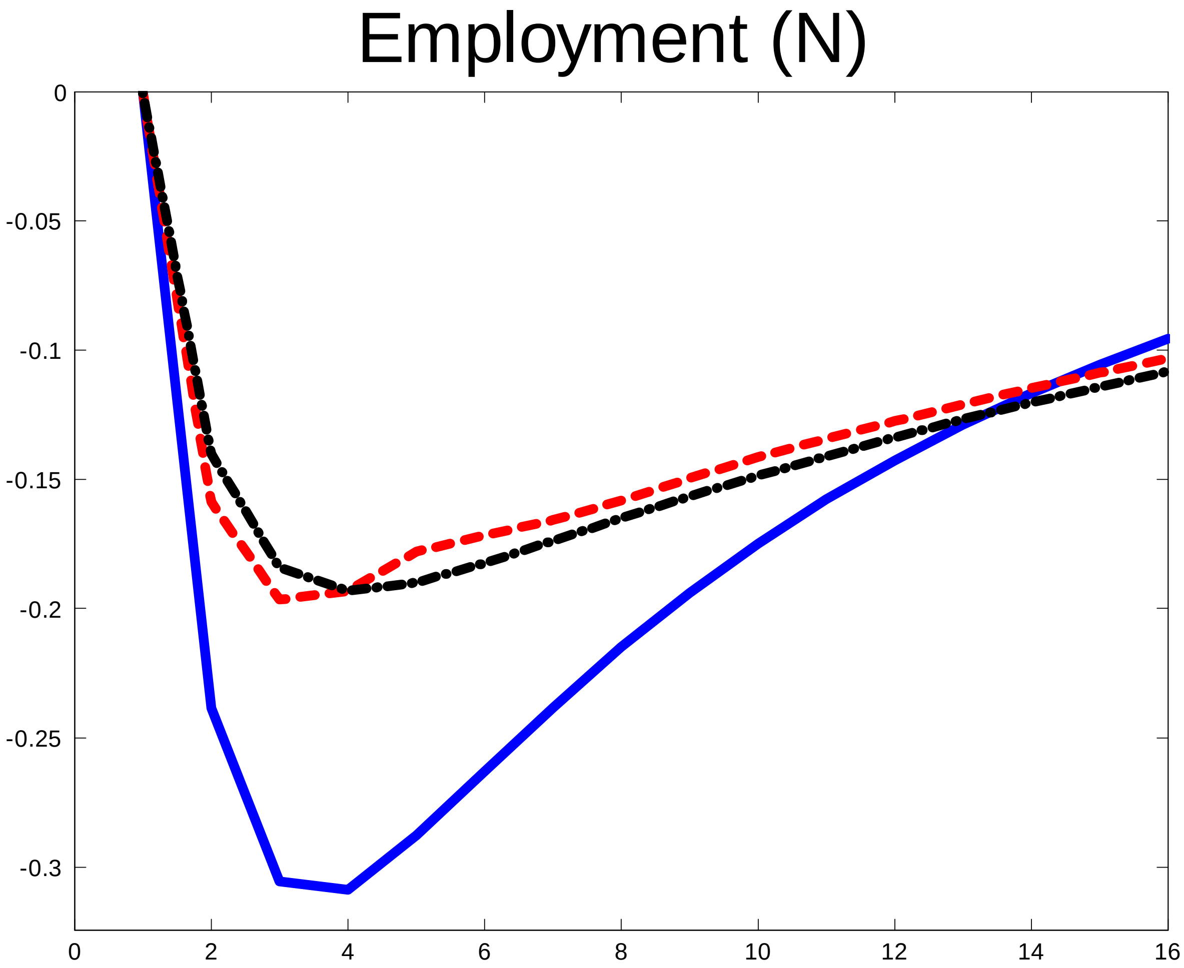
Measured TFP



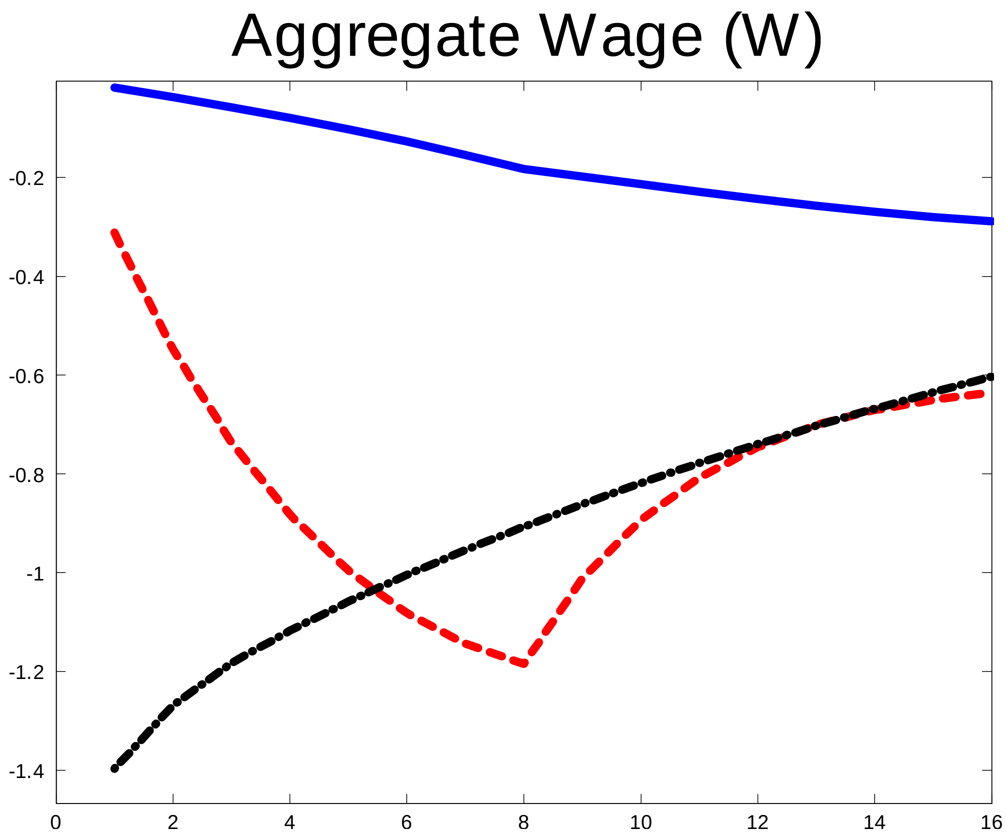
Rental Rate of Capital (R)

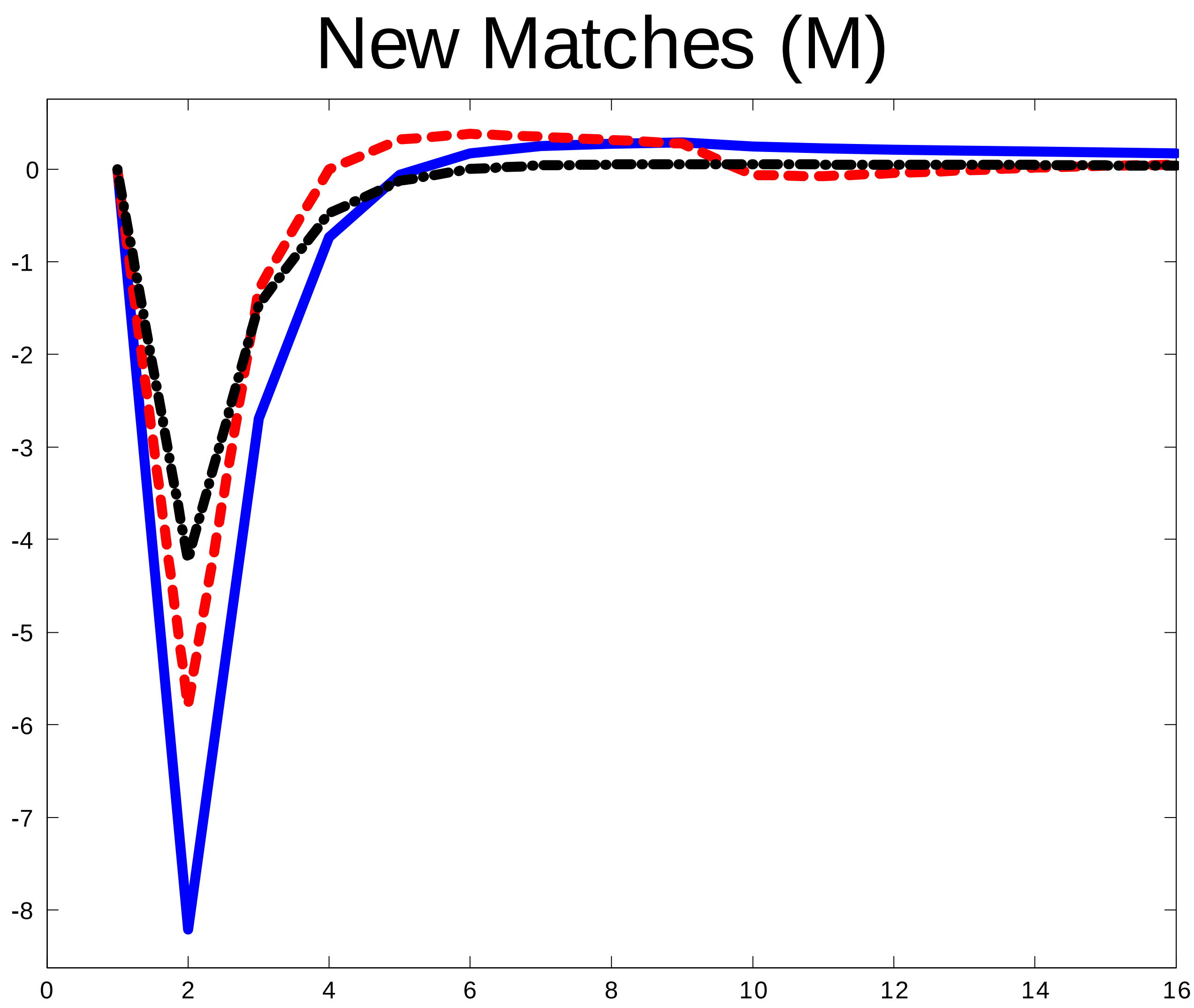



New Matches (M)
0
-1
-2
-3
-4
-5
-6
-7
0
2
4
6
8
10
12
14
16


Employment (N)
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
0
2
4
6
8
10
12
14
16

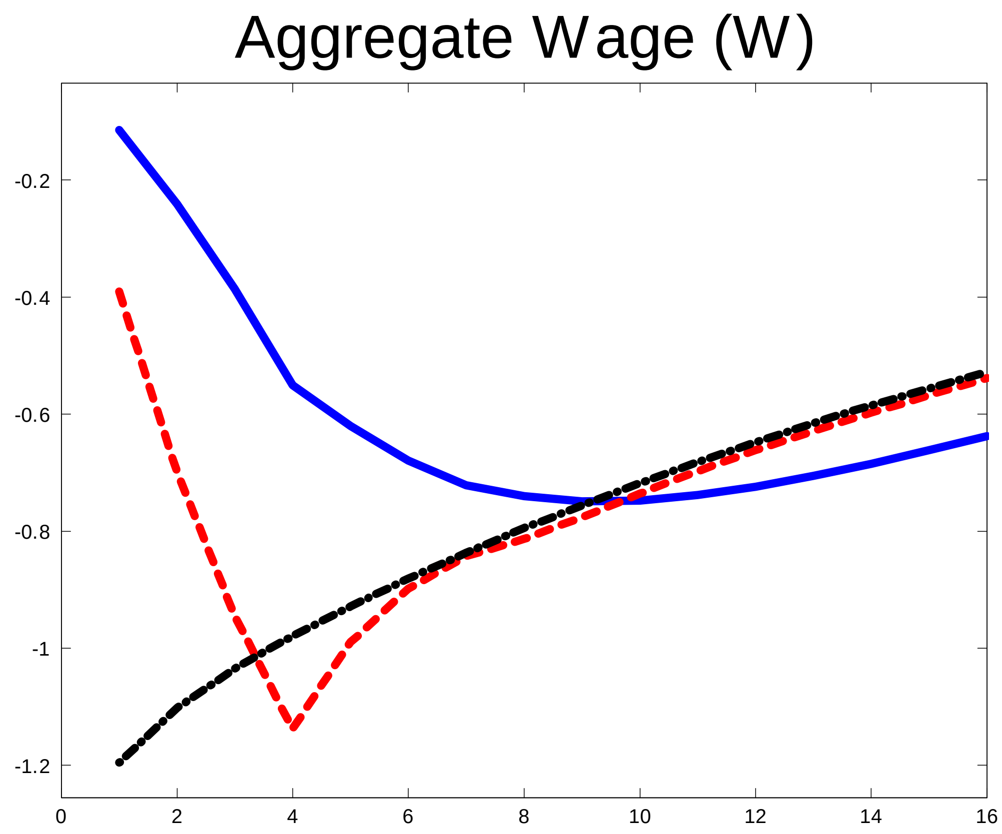
Longer Contract Length ($T = 8$)

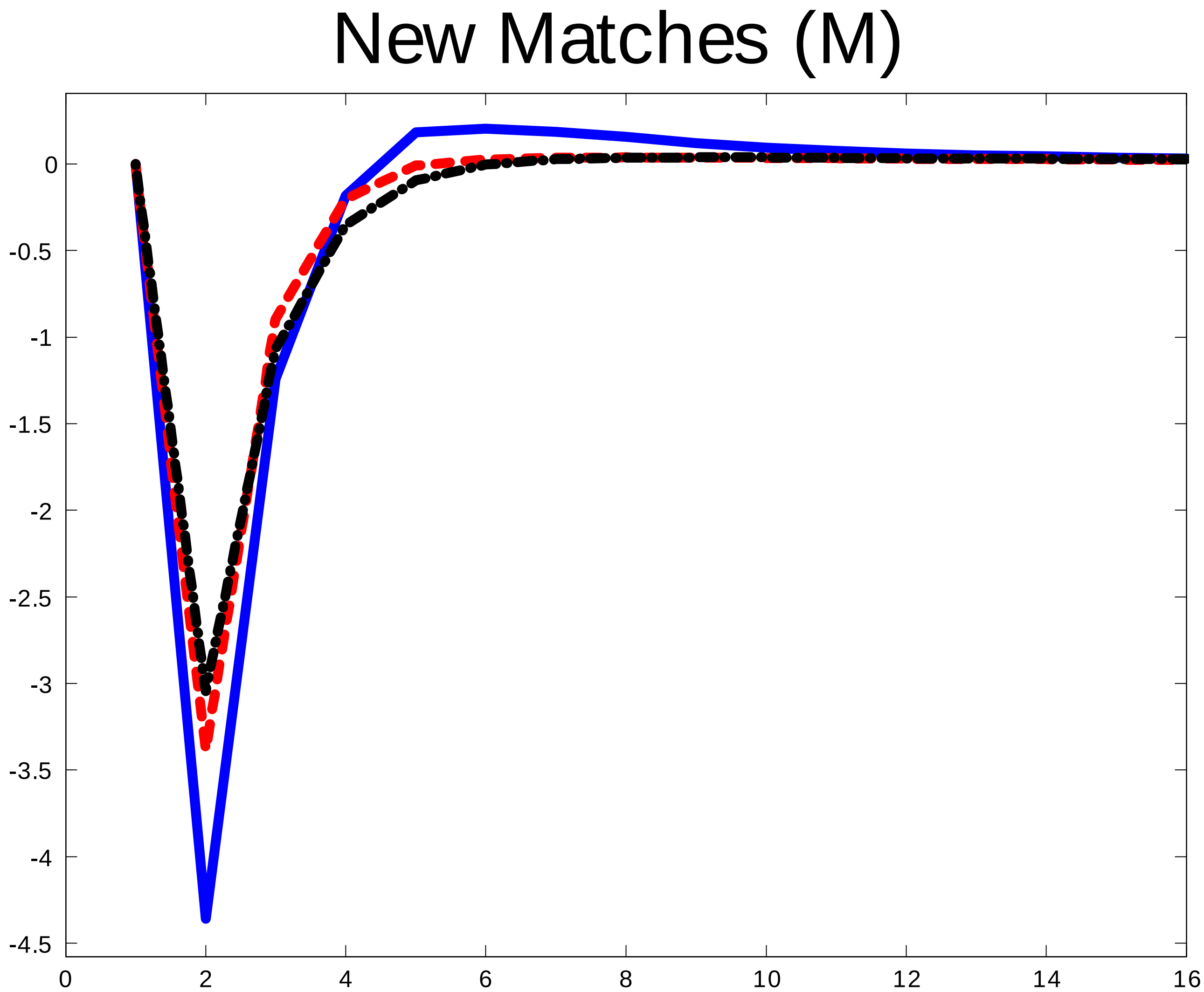




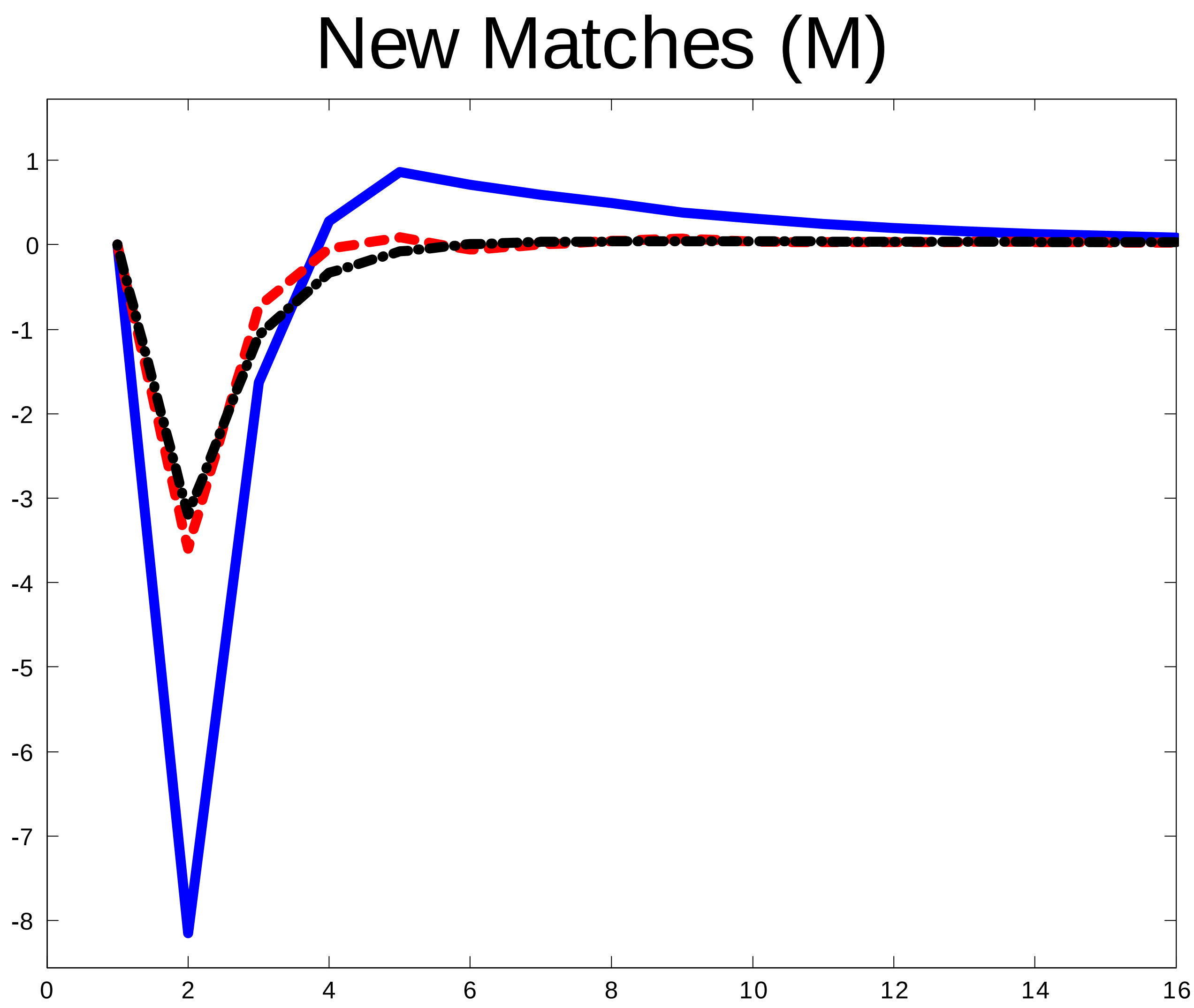
New Matches (M)
0
-1
-2
-3
-4
-5
-6
-7
-8
0
2
4
6
8
10
12
14
16

Smaller Frisch Elasticity ($\gamma = 2$)




New Matches (M)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5
0
2
4
6
8
10
12
14
16

Smaller Labor Demand Elasticity ($\alpha = 0.28$)


New Matches (M)
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
2
4
6
8
10
12
14
16

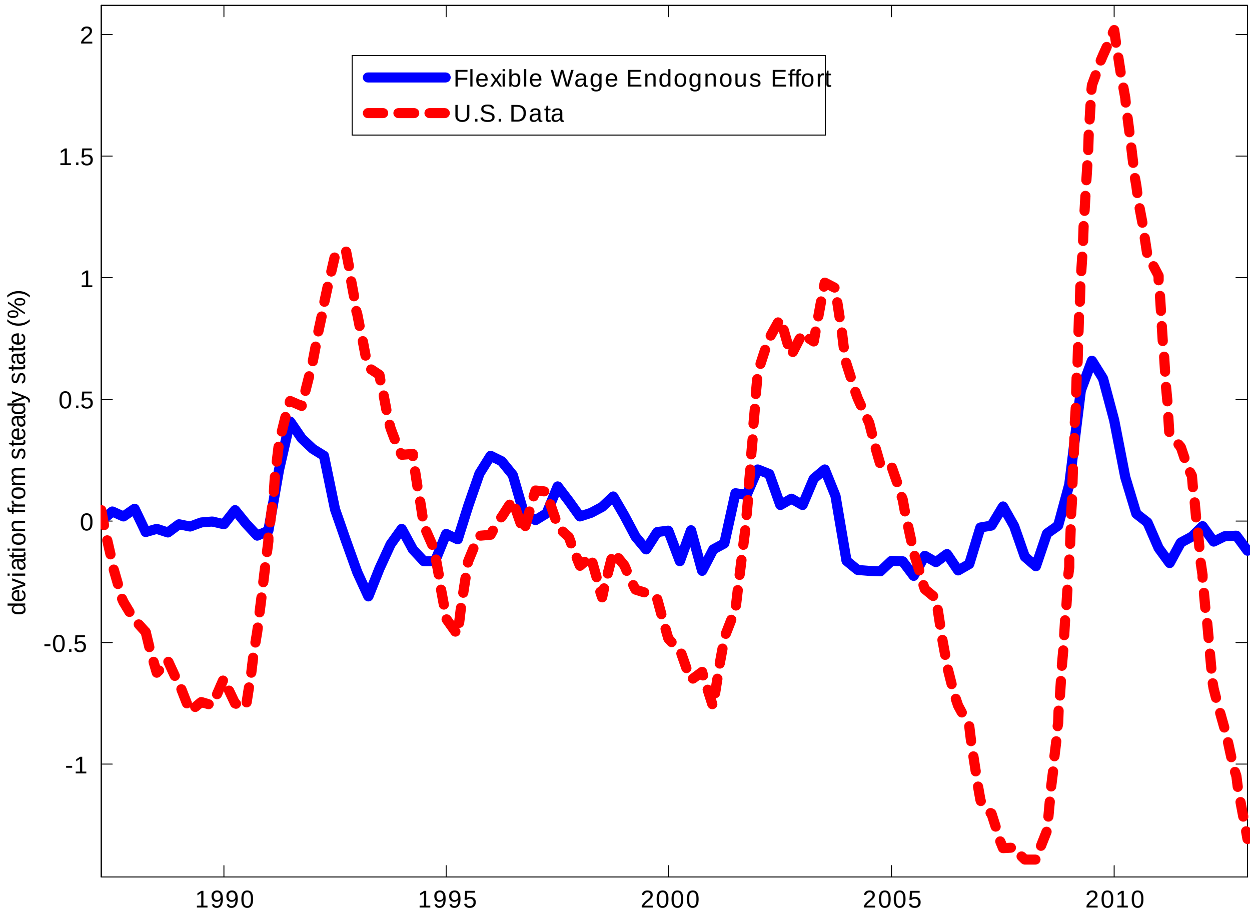
2 Model Helps Explain Volatility of Unemployment for Measured Productivity

- Partly by making employment respond more

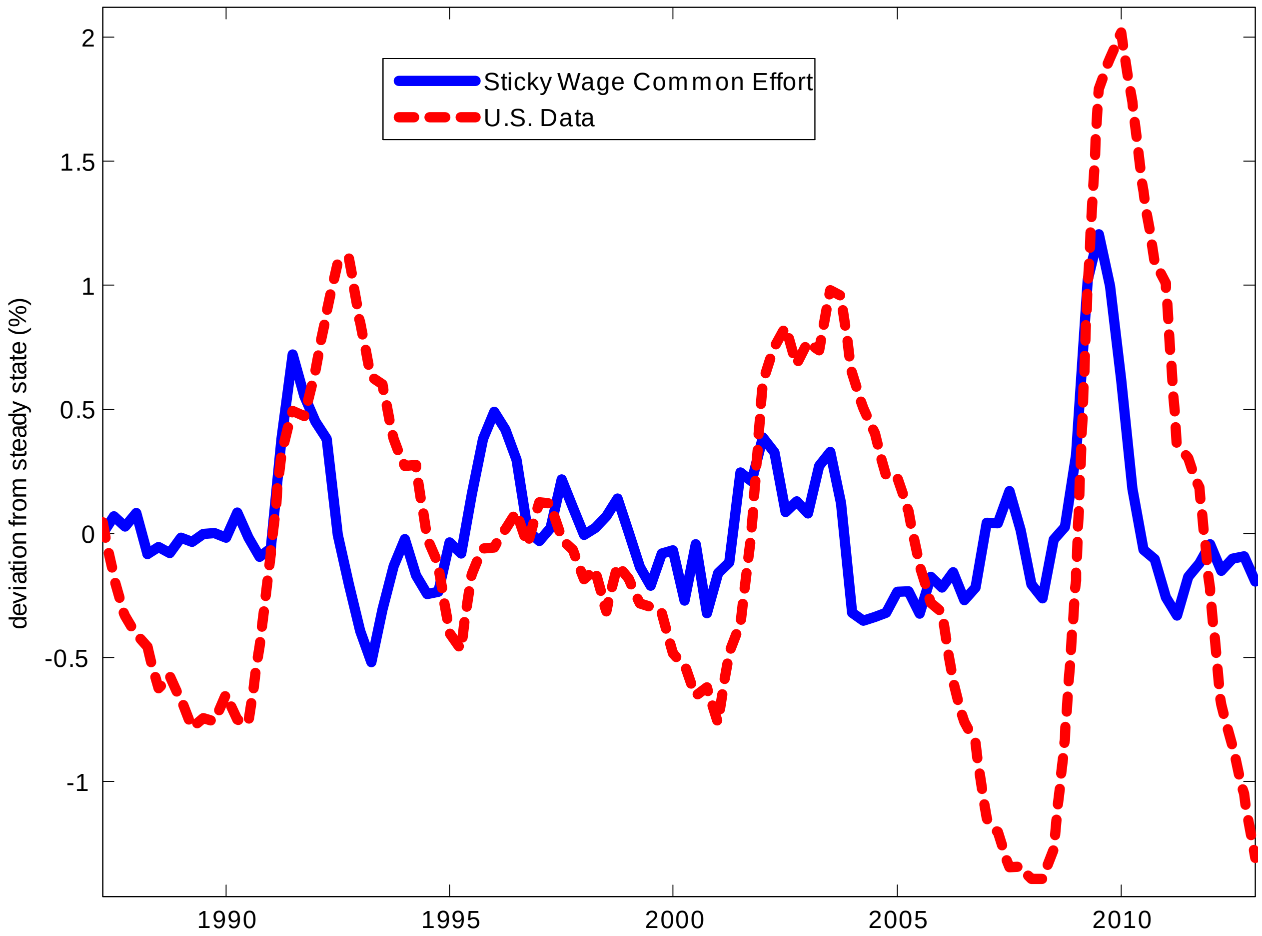
- Partly by making measured productivity less cyclical than shock

Productivitiy Shock = Measured TFP in US

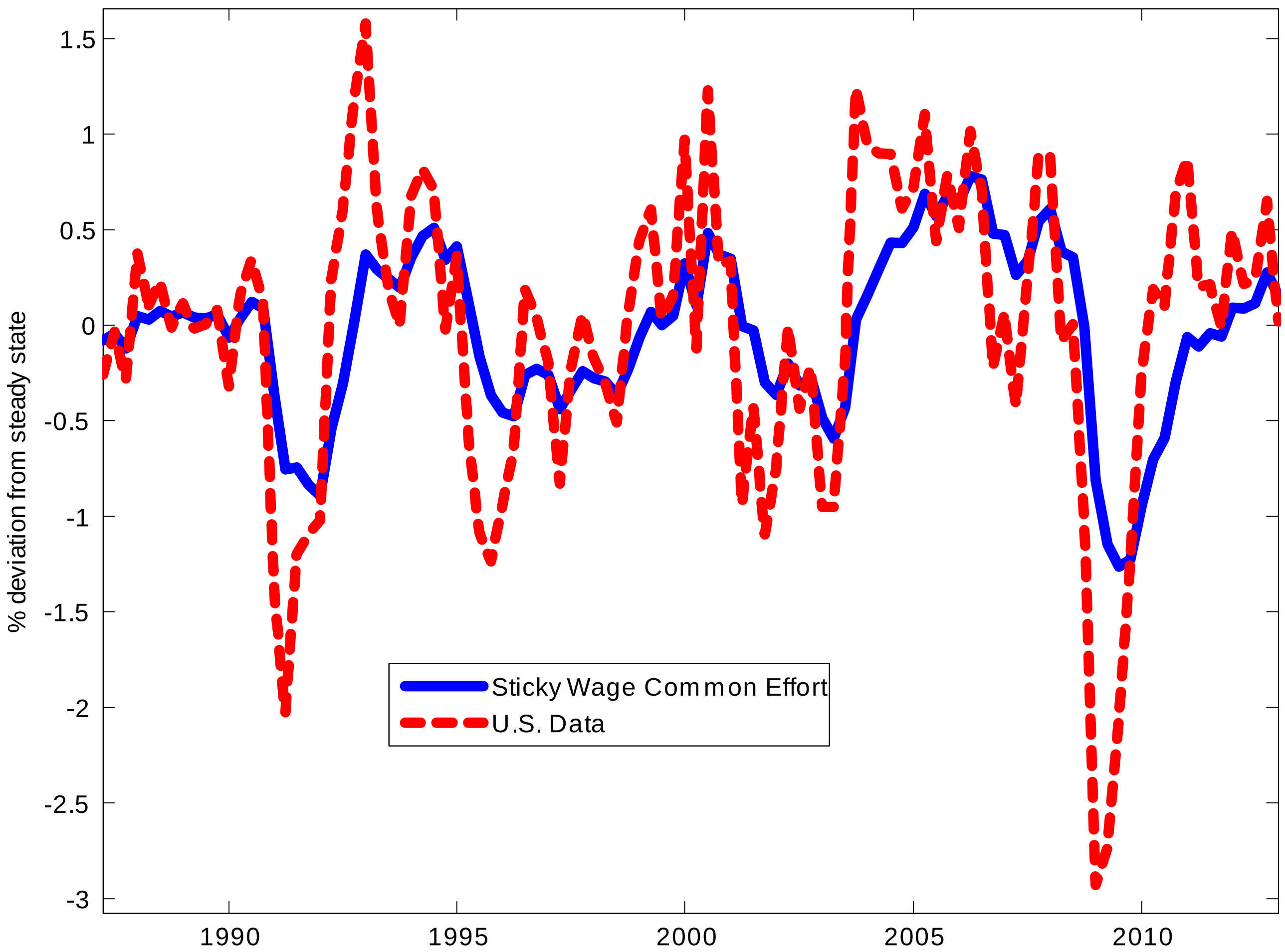
Unemployment (Model vs US Data)



Unemployment (Model vs US Data)

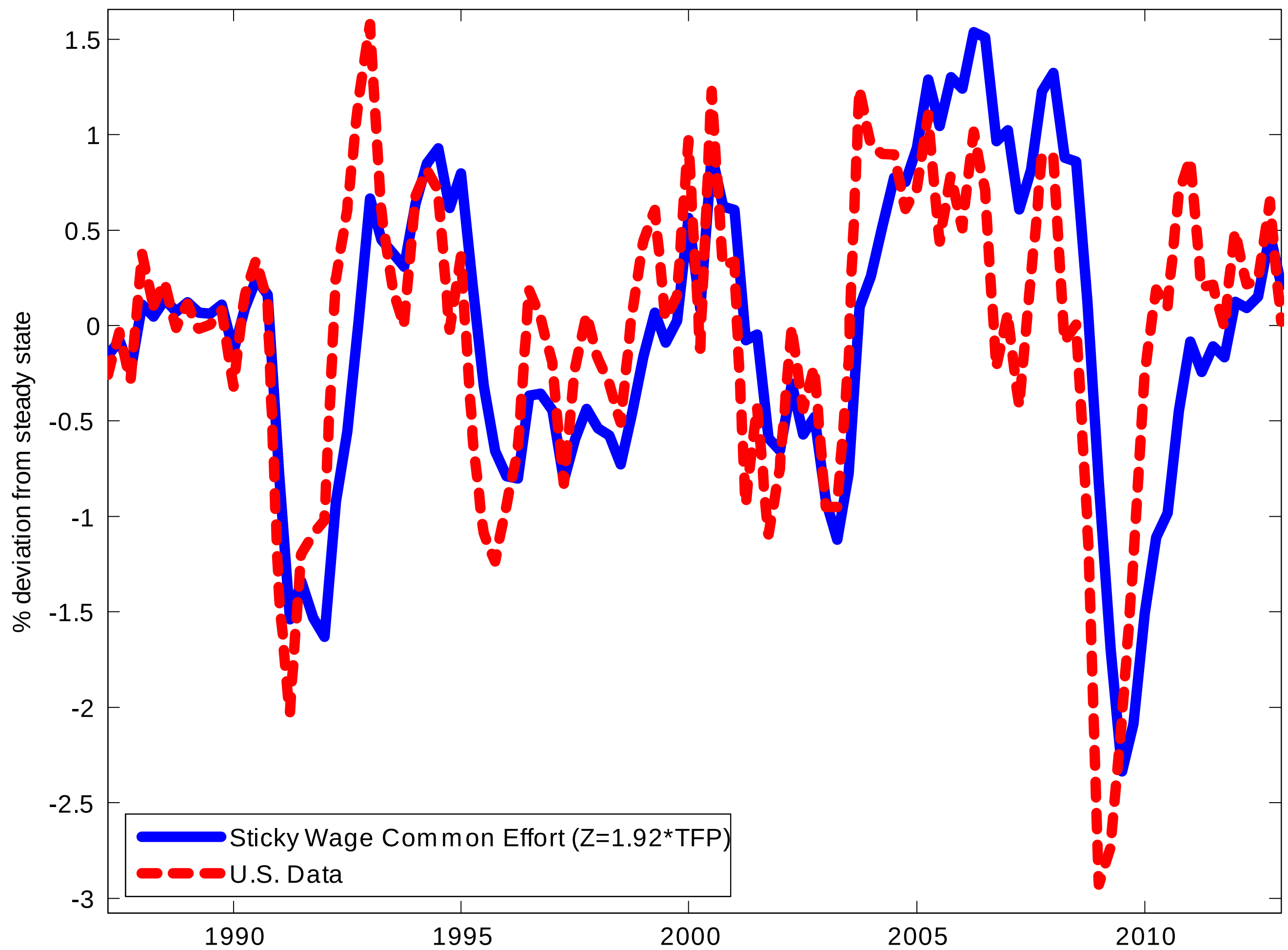


Measured TFP (Model vs US Data)

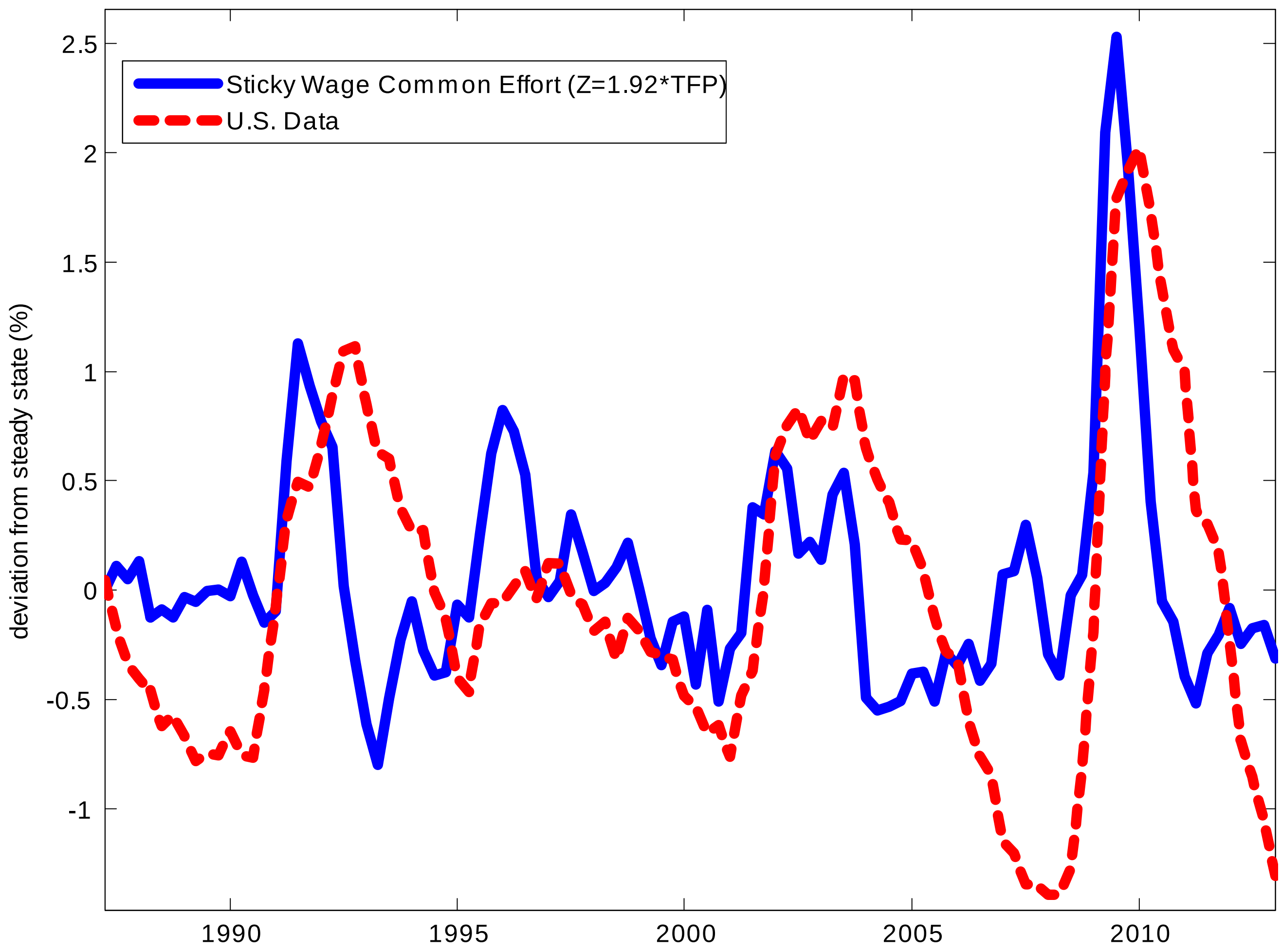


Productivitiy Shock = 1.92* Measured TFP in US

Measured TFP (Model vs US Data)



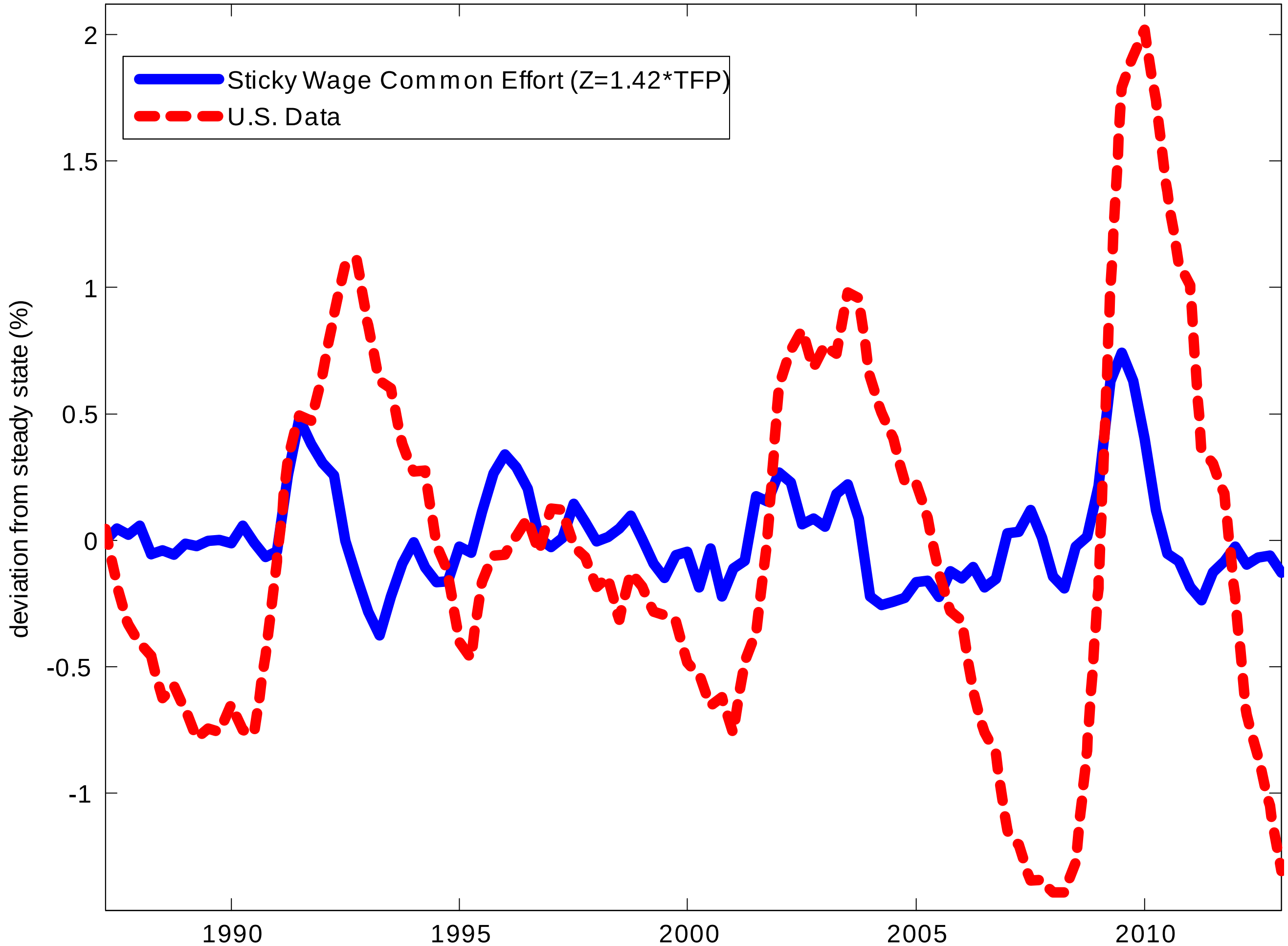
Unemployment (Model vs US Data)



Frisch Elast $=1/2$

Productivitiy Shock $=$ 1.42* Measured TFP in US

Unemployment (Model vs US Data)



3 Industry Wage and TFP Patterns

- Examine cyclicality of hours, TFP, and wages by stickiness

$$\begin{pmatrix} n_{it} \\ y_{it} - x_{it} \\ w_{it} \end{pmatrix} = \alpha Y_t + \beta \left[s_{it} - \overline{s}_{it} \right] Y_t + error_{it}$$

- U.S. KLEMS Data for 60 Industries 1987-2010

- Measure wage stickiness by industry from frequency of wage changes in SIPP data

U.S. Klems Data

- 60 Industries annually for 1987-2010: 24 Goods producing/36 Services
  - — Nominal and real output and inputs
  - — Calculate real value added and value added TFP
  - — Modify TFP for capital utilization and worker composition

Correlation Cyclical Relative Wage and TFP

- Highly correlated for (HP) industry cycle
  - — Only in proportion to labor's share

- TFP does not predict hours

Industry Wage and TFP Fluctuations

Dependent Variable = TFP for Value Added

Wage	0.54 (0.14)	−0.07 (0.24)
Wage*Labor's Share		1.12 (0.30)

60 industries for 24 years. Weighted by value added. Include full set of year dummies.

Measuring Wage Stickiness

- Use 1990 to 2001 SIPP panels
  - — Advantages of SIPP
  - — Measure 4 and 8-month frequencies of change
- Allow for measurement error–assume change exactly reversed signifies error
  - — Do under Calvo or Taylor: $\alpha_C = \dfrac{\Delta_8 - \Delta_4}{1 - \Delta_4}$

Frequency of Wage Changes SIPP, 1990-2011

	4-month	8-month	Error	Calvo	Taylor
1990-93 Panels (1990-95)	0.69	0.78	0.33	0.30	0.23
1996 Panel (1996-99)	0.74	0.83	0.34	0.38	0.28
2001 Panel (2001-04)	0.74	0.82	0.37	0.33	0.25
Average 1990-2001 Panels	0.71	0.81	0.35	0.33	0.25

Cyclicality by Industry Wage Stickiness

RHS variable is Duration (months)*Aggregate Real GDP

	Hours	TFP	Wage
All 60 Industries	0.08 (.06)	−0.14 (.09)	0.14 (.07)
24 Goods Industries	0.16 (.10)	−0.41 (.14)	0.03 (.08)
14 Durables Industries	0.13 (.08)	−0.82 (.26)	−0.13 (.14)

Cyclicality by Wage Stickiness for 24 Goods Industries

RHS variable is Duration(months)*Aggregate Real GDP

	Hours	TFP	Wage
12 Low-Labor-Share Goods Industries	0.12 (.07)	−0.25 (.08)	0.10 (.08)
12 High-Labor-Share Goods Industries	0.09 (.10)	−0.98 (.33)	−0.16 (.15)

Conclusion

- Breaks irrelevance of sticky wage for current workers

- Matters quantatively when tie effort levels–gives a lot of wage inertia

  — Bigger employment response

  — Mutes procyclical productivity

- Industry wage stickiness matters for cyclicality of TFP for industries with important labor share