Shocks and Economic Welfare: the Role of Factor Mobility

Kwang Hwan Kim[1] Myungkyu Shim[2]

[1]Yonsei University

[2]SUFE and Sogang University

July 21, KDI Macro Forum

Key Questions

- Are economic fluctuations costly?

Key Questions

- Are economic fluctuations costly?
  – usual belief: yes (while cost is small)

Key Questions

- Are economic fluctuations costly?
  – usual belief: yes (while cost is small)
  – Cho et al (2015), Lester et al (2014): maybe not in typical neoclassical model

Key Questions

- Are economic fluctuations costly?
  – usual belief: yes (while cost is small)
  – Cho et al (2015), Lester et al (2014): maybe not in typical neoclassical model
  – We assess this question in two-sector economy

Key Questions

- Are economic fluctuations costly?
  – usual belief: yes (while cost is small)
  – Cho et al (2015), Lester et al (2014): maybe not in typical neoclassical model
  – We assess this question in two-sector economy
- Does two-sector model deliver new implications?

Key Questions

- Are economic fluctuations costly?
  – usual belief: yes (while cost is small)
  – Cho et al (2015), Lester et al (2014): maybe not in typical neoclassical model
  – We assess this question in two-sector economy
- Does two-sector model deliver new implications?
  – We find..
  (1) origination of shock matters

Key Questions

- Are economic fluctuations costly?
  – usual belief: yes (while cost is small)
  – Cho et al (2015), Lester et al (2014): maybe not in typical neoclassical model
  – We assess this question in two-sector economy
- Does two-sector model deliver new implications?
  – We find..
  (1) origination of shock matters
  (2) factor mobility also plays important role

Welfare Cost of Business Cycles: Intro

- Are business cycles good or bad?
- Lucas (1987):

$$\sum_{t=0}^{\infty} \beta^t U(C) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U[(1+\lambda) C_t] \tag{1}$$

  - λ: compensating variation, measure for welfare cost – percentage by which average consumption has to be increased for consumer to be indifferent between certain path of consumption and volatile one

Literature

- Heterogeneity: Krusell and Smith (1999, RED), Storesletten, Telmer, and Yaron (2001, EER), Mukoyama and Şahin (2006, JME)
- Time-non-separable utility: Otrok (2001, IER), Dolmas (1998, RED)
- Relationship to growth: Ramey and Ramey (1995, AER), Barlevy (2004, AER)
- Role of labor supply: Cho, Cooley, and Kim (2015, RED), Lester, Pries, and Sims (2014, JEDC)

Literature

- Heterogeneity: Krusell and Smith (1999, RED), Storesletten, Telmer, and Yaron (2001, EER), Mukoyama and Şahin (2006, JME)
- Time-non-separable utility: Otrok (2001, IER), Dolmas (1998, RED)
- Relationship to growth: Ramey and Ramey (1995, AER), Barlevy (2004, AER)
- Role of labor supply: Cho, Cooley, and Kim (2015, RED), Lester, Pries, and Sims (2014, JEDC)

- One-sector model is typically adopted
  – exception: Otrok (2001, JME)

This Paper..

- Utilizes unique environment of two-sector model to study welfare cost of business cycles
  - various technology shocks: aggregate (neutral) shock & sectoral shocks
  - factor reallocation across sectors:
    – imperfect labor substitutability
    – imperfect capital mobility

Perfect Labor Substitutability

- Labor is assumed to be perfectly substitutable in typical one-sector model
  eg. consumption vs. investment sector

$$N_t = N_t^c + N_t^i \tag{2}$$

- (Problematic) Implications
  1. wage rates are same across sectors
     – inconsistent with data (Krueger and Summers (1988, ECMA))
  2. intersectoral labor comovement problem arises
     – corr(N_t, N_t^c)=corr(N_t, N_t^i)=0.98 in U.S. data
     – corr(N_t, N_t^c)=-0.43, corr(N_t, N_t^i)=0.98 from our model with perfect substitutability
- Otrok (2001) suffers from above problem
  $\Rightarrow$ leisure is not considered in welfare cost

Imperfect Labor Substitutability

- Assume instead labor inputs are *imperfectly* substitutable across sectors:
  – possibly captures sector-specific human capital $\Rightarrow$ intersectoral wage differentials
  – can resolve intersectoral labor comovement problem
- Previous studies focus on normative implications
  – Boldrin et al (2001, AER), Horvath (2000, JME), Huffman and Wynne (1999, JME), Katayama and Kim (2014)
  – we focus on positive implication

Key Findings

- 1. Nature of shock matters
  - I-specific shock: welfare-improving fluctuations
  - C-specific shock: welfare-detrimental fluctuations
  - Neutral shock: fluctuations can be both welfare-improving and welfare-detrimental, depending on parameter values

Key Findings

- Two effects of business cycles (Cho et al (2015))
  - fluctuations effect: risk-averse consumers dislike fluctuations (hate volatility)
  - mean effect: overall mean consumption is higher in fluctuating economy (prefer volatility)
- Shock helpful (resp. not helpful) for capital accumulation can be welfare-improving (resp. welfare-detrimental) b/c mean effect is large (resp. small)
  – Neutral shock: intermediate case

Key Findings

- 2. Welfare cost decreases in degree of intersectoral labor substitutability
  – high substitutability $\Rightarrow$ easy to reallocate hours across sectors
  $\rightarrow$ mean effect increases since workers can supply more labor into I-sector when positive shock hits economy

Key Findings

- 3. Welfare cost decreases in degree of capital mobility
  – similar logic applies
- Findings from labor and capital markets
  $\Rightarrow$ welfare cost can be systematically underestimated in one-sector model (negative welfare cost in recent literature)
  – in parameter space supported by data: business cycle is always costly

Roadmap

- Main Model
- Welfare Cost
- Conclusion

Model

Household

- Model: simplified version of Katayama and Kim (2014)
- Representative consumer solves

$$\max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \right] \tag{3}$$

subject to

$$C_t + \left(\frac{P_{i,t}}{P_{c,t}} \right) (I_{c,t} + I_{i,t}) \leq \sum_{j=c,i} \left(\frac{W_{j,t}}{P_{c,t}} \right) N_{j,t} + \sum_{j=c,i} \left(\frac{R_{j,t}}{P_{c,t}} \right) u_{j,t} K_{j,t} \tag{4}$$

Household

- King-Plosser-Rebelo type utility function:

$$U(C_t, N_t) = \frac{(C_t)^{1-\frac{1}{\sigma}} \left(1 + \left(\frac{1}{\sigma} - 1\right) v(N_t)\right)^{\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}} \tag{5}$$

  where $v(N_t) = \nu \frac{\eta}{1+\eta} N_t^{\frac{\eta+1}{\eta}}$ and $\sigma \leq 1$

- Aggregate labor index

$$N_t = \left[N_{c,t}^{\frac{\theta+1}{\theta}} + N_{i,t}^{\frac{\theta+1}{\theta}} \right]^{\frac{\theta}{\theta+1}}, \quad \theta \geq 0 \tag{6}$$

Intersectoral Labor Substitutability

- θ is elasticity of substitution of labor:

$$\frac{d \ln\left(\frac{N_{i,t}}{N_{c,t}}\right)}{d \ln\left(\frac{w_{i,t}}{w_{c,t}}\right)} \propto \theta \tag{7}$$

  - $\theta \to \infty$: move labor infinitely from sector c to sector i when relative wage in sector i increases
    – perfect substitutes (nests one-sector model)
  - $\theta \to 0$: no incentive to move labor between sectors
    – perfect complements
  - $\theta \in (0, \infty)$: imperfect substitutes

Household

- Law of motion for capital

$$K_{j,t+1} = I_{j,t}\left[1 - \phi\left(\frac{I_{j,t}}{I_{j,t-1}}\right)\right] + [1 - \delta(u_{j,t})]K_{j,t}, \quad j = c, i \tag{8}$$

where

$$\delta(u_{j,t}) = \delta_j^0 + \delta_j^1(u_{j,t} - 1) + \frac{\delta_j^2}{2}(u_{j,t} - 1)^2 \tag{9}$$

$$\phi\left(\frac{I_{j,t}}{I_{j,t-1}}\right) = \frac{\kappa_j}{2}\left(\frac{I_{j,t}}{I_{j,t-1}} - 1\right)^2 \tag{10}$$

Firm

- Production functions are given by

$$C_t = Z_t Z_{c,t} (u_{c,t} K_{c,t})^{\alpha} (N_{c,t})^{1-\alpha} \tag{11}$$

$$I_t = I_{c,t} + I_{i,t} = Z_t Z_{i,t} (u_{i,t} K_{i,t})^{\alpha} (N_{i,t})^{1-\alpha} \tag{12}$$

- Z_t: aggregate TFP shock

$$Z_t = (1 - \rho_z) Z + \rho_z Z_{t-1} + \xi_{z,t} \tag{13}$$

- $Z_{j,t}$: sector-specific technology shock:

$$Z_{j,t} = (1 - \rho_j) Z_j + \rho_j Z_{j,t-1} + \xi_{j,t}, \quad j = \{c, i\} \tag{14}$$

Discussion on Intersectoral Labor Comovement

- Assume separability between consumption and leisure. Then sectoral labor comovement is plausible if

$$\theta < \eta \tag{15}$$

- Previous papers on welfare cost of business cycles fail to satisfy above condition:
  eg) Otrok (2001), Lester et al (2014), Cho et al (2015)
- Under benchmark calibration, $\text{corr}(H_t, H_t^c)$, $\text{corr}(H_t, H_t^i) \geq 0.96$

Computing Welfare Cost

- Value of non-fluctuating economy

$$V^{NF} = \sum_{t=0}^{\infty} \beta^t U(C, N) \tag{16}$$

- Value of fluctuating economy

$$V^{F,\lambda} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U((1+\lambda) C_t, N_t) \tag{17}$$

- λ: compensating variation
  – λ is solution of $V^{NF} = V^{F,\lambda}$

Computing Welfare Cost

- Model is solved by perturbation method (Schmitt-Grohé and Uribe (2004))
- Conditional welfare cost of business cycles following Schmitt-Grohé and Uribe (2006): initial steady-state is $x_0 = x$ and scaling parameter, σ_z, is set to be 0 as follows

$$\lambda(x,0) = \left[\frac{V'(N)N}{\sigma\left(1+\left(\frac{1}{\sigma}-1\right)V(N)\right)} n_{\sigma_z\sigma_z} - c_{\sigma_z\sigma_z} \right] \frac{\sigma_z^2}{2} \quad (18)$$

where $n_{\sigma_z\sigma_z}$ and $c_{\sigma_z\sigma_z}$ are coefficients in solution and z is shock variable in economy.

Welfare Cost of Business Cycles

Parameterization

- Parameters are taken from Katayama and Kim (2014)

Table: Calibration

Parameter	Value	Description
α	0.36	Capital share
β	0.985	Discount factor
δ^0	0.025	s.s. depreciation rate
δ^1	0.0402	Coefficient in $\delta(\cdot)$
δ^2	0.025	Coefficient in $\delta(\cdot)$
κ_C	4.4186	Coefficient in $\phi(\cdot : C)$
κ_I	1.0939	Coefficient in $\phi(\cdot : I)$
η	0.80	Frisch elasticity
θ	0.3014	Elasticity of intratemporal substitution
σ	0.8392	Elasticity of intertemporal substitution

Shocks and Welfare Cost

- Three technology shocks are considered
  - I-shock, C-shock, neutral shocks
  - same AR(1) parameters: $\rho = 0.95$ and $\sigma_z = 0.01$

Shocks and Welfare Cost

Table: Welfare Cost of Business Cycles: Benchmark Case

	Welfare Cost (%)
I-Shock	-0.0010
C-Shock	0.0048
Neutral Shock	0.0037
Lucas (1987)	0.05
Otrok (2001)	0.0044

Note: Lucas (1987) follows Lucas' formula with log utility

Investment-Specific Technology Shock

Table: Welfare Cost: Investment-Specific Technology Shock

θ	$1,000,000$	$10,000$	0.3014	0.01	0.000001
Welfare Cost (%)	-0.0032	-0.0032	-0.0010	-0.0005	-0.0004

Consumption-Specific Technology Shock

Table: Welfare Cost: Consumption-Specific Technology Shock

θ	$1,000,000$	$1,000$	0.3014	0.01	0.000001
Welfare Cost (%)	0.0047	0.0047	0.0048	0.0048	0.0048

Neutral Technology Shock

Table: Welfare Cost: Neutral Technology Shock

θ	$1,000,000$	$10,000$	0.3014	0.01	0.000001
Welfare Cost (%)	0.0011	0.0011	0.0037	0.0043	0.0044

Favorable Shock

- Investment-specific technology shock
  – workers always prefer volatile economy
- Intuition
  - helpful for consumption-smoothing via efficient capital accumulation (higher mean effect)
  - relative wage in investment sector becomes much higher $\Rightarrow$ overall mean effect can be greater even when θ is low
- If capital fully depreciates every period ($\delta = 1$), welfare cost also becomes positive
  – I-shock is not helpful for capital accumulation

Unfavorable Shocks

- Consumption-specific technology shock and neutral technology shock
  – workers always prefer stable economy
- Intuition (C-shock)
  - productivity in consumption sector higher: other variables given, less labor in investment sector
    $\Rightarrow$ less capital accumulation (lower mean effect)

Simple Comparison

Table: Mean and Volatility

	Welfare Cost (%)	$E(\log C_t)$	$\sigma(\log C_t)$
I-Shock	-0.0010	1.5182	0.001
C-Shock	0.0048	1.5177	0.014
Neutral Shock	0.0037	1.5177	0.013

Numbers are multiplied by 100.

- Mean of consumption is highest but variance is lowest with I-shock
- C-shock and neutral shock are similar

1. Labor Reallocation

- θ governs degree of labor reallocation across sectors
  - $\theta \to 0$: no labor reallocation
  - $\theta \to \infty$: free labor reallocation
- We consider aggregate shock

Role of Labor Substitutability

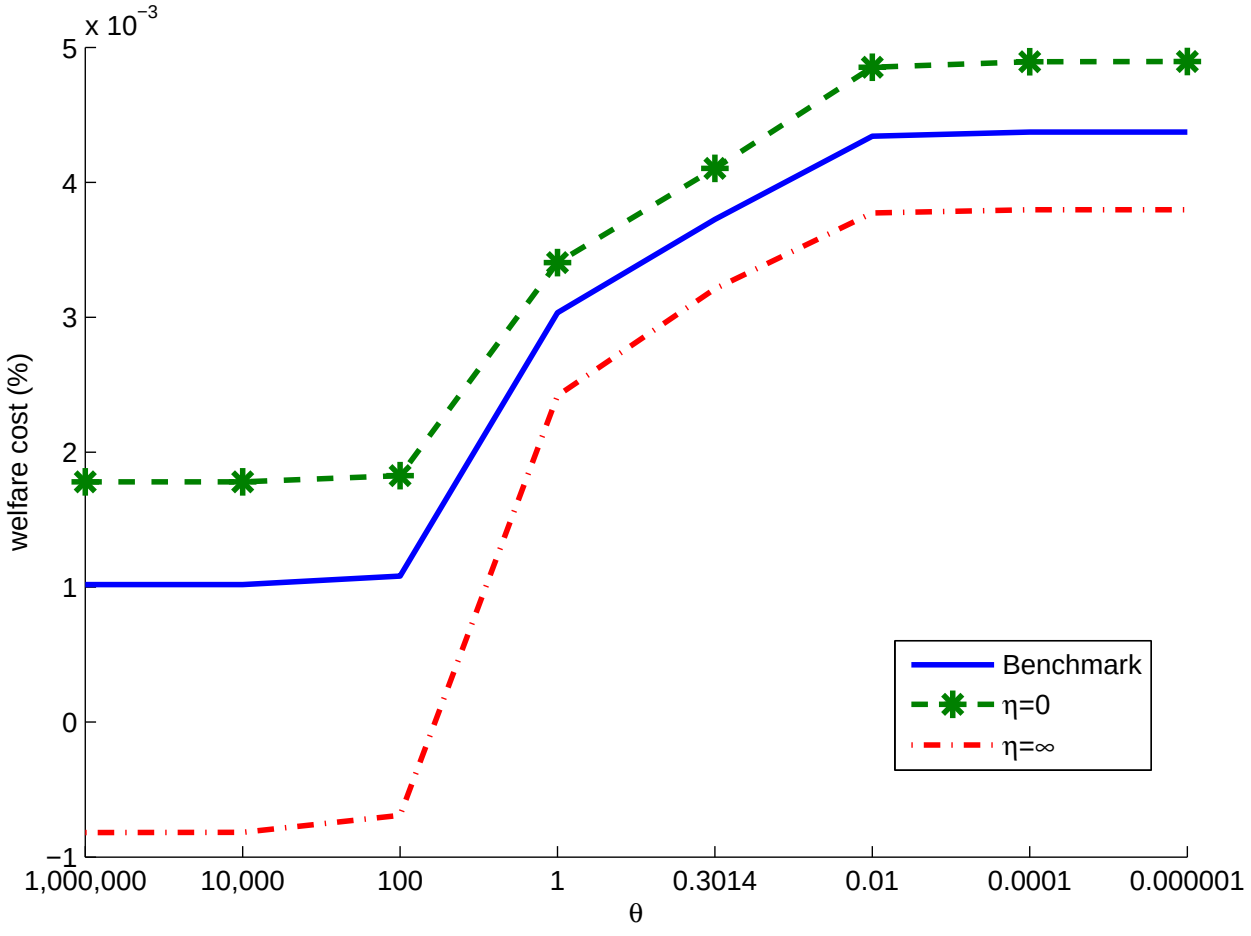

Figure: Welfare Cost (%): Role of Intersectoral Labor Substitutability

Role of Labor Substitutability

- Welfare cost decreases in θ
  – as θ increases, it becomes easier to reallocate hours from C sector to i sector
  $\rightarrow$ mean effect becomes higher

Role of Labor Substitutability

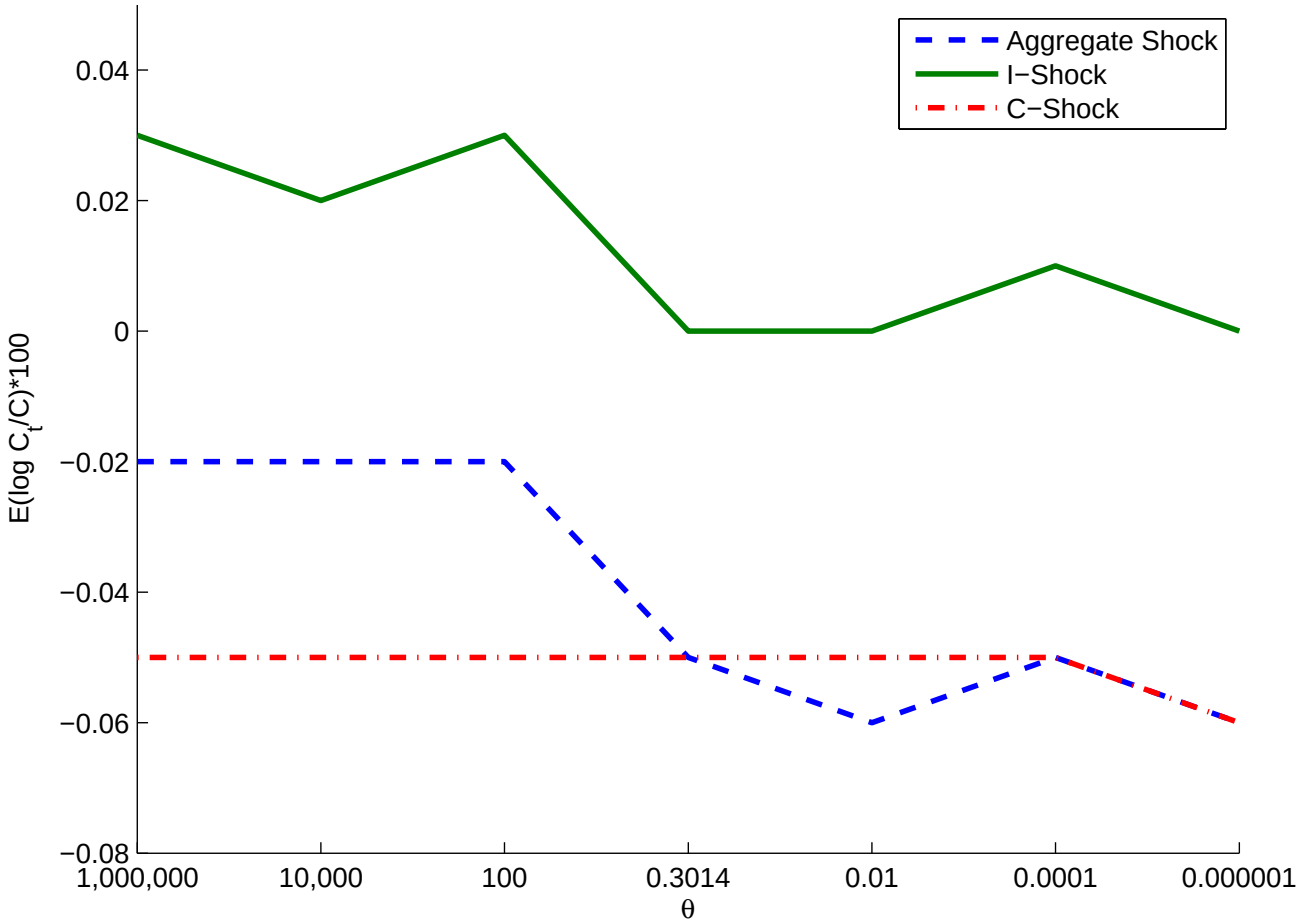

Figure: Mean Effect: Role of Intersectoral Labor Substitutability

Participation vs. Allocation Margin

- Two margins in aggregate labor market
  - participation margin: aggregate labor supply responding economic fluctuations
    – controlled by η
  - allocation margin: labor re-allocation between sectors
    – controlled by θ

Participation vs. Allocation Margin

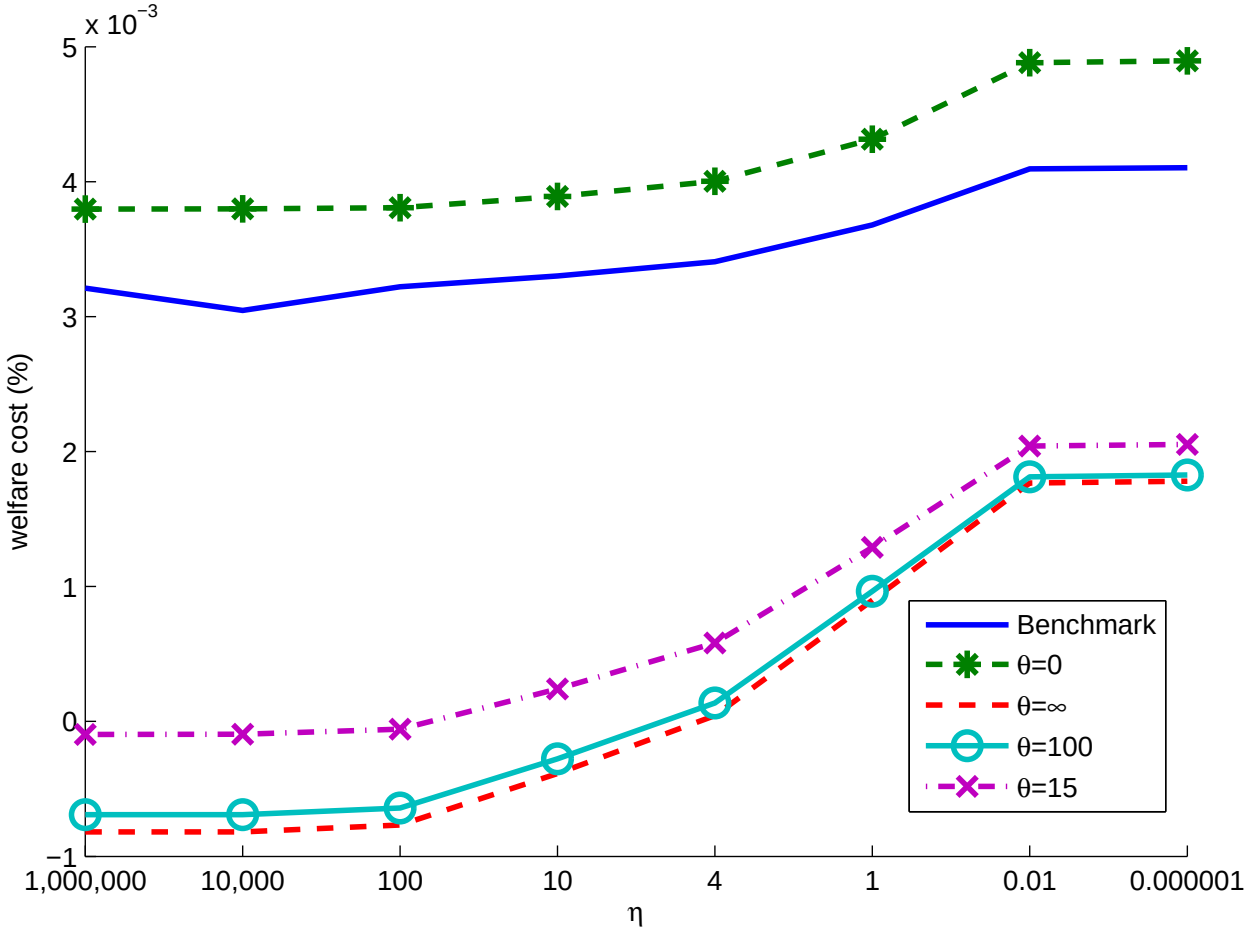

Figure: Welfare Cost (%): Conditional on η and θ

Participation vs. Allocation Margin

- Welfare cost decreases both in θ and η
- Welfare cost minimized when θ and η becomes infinite
  – consumers prefer volatility (mean effect maximized)
- Negative welfare cost empirically supported?
  – η: less than one (micro labor), usually less than 5 (macro labor)
  – θ: 0.34 (Katayama and Kim (2014)), 1 (Horvath (2000))

Robustness Check: Non-Separability of Utility

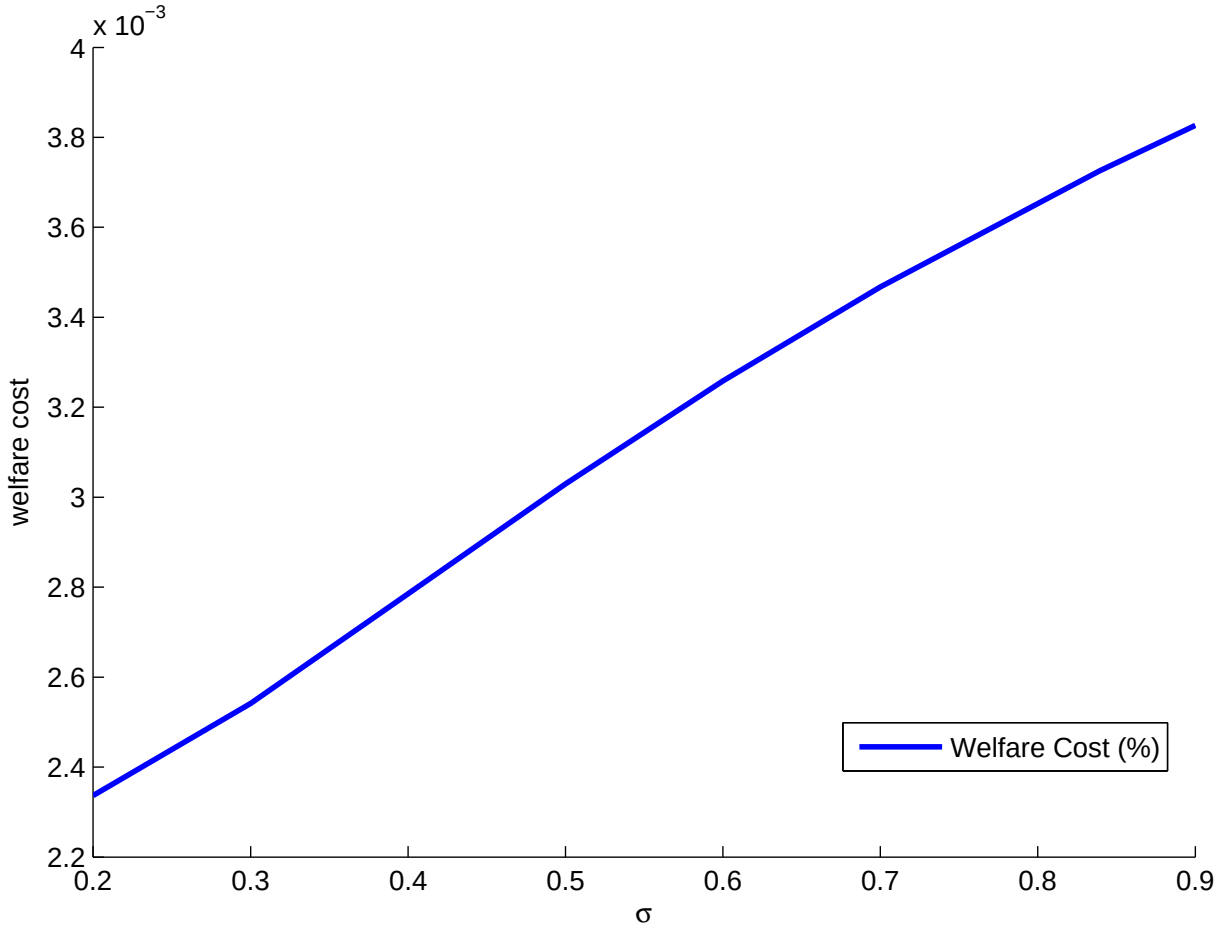

Figure: Welfare Cost (%): Conditional on σ

Role of Non-Separability between C and N

- Positive welfare cost regardless σ: why?
- Time-non-separability in utility (eg. habit formation): positively related to welfare cost
  – Dolmas (1998), Otrok (2001)
- No existing explanation on role of non-separability between C and N

Role of Non-Separability between C and N: Intuition

- Second-order approximation of U:

$$U(C, N) \propto U_{C,N}\sigma_{C,N} \tag{19}$$

- $U_{C,N} > 0$: consumer prefers positive correlation between C and N
  – $\sigma_{C,N} > 0$ in model $\Rightarrow$ utility increases in fluctuating economy but not in steady-state economy
- Separability increases in σ: fluctuations less attractive $\Rightarrow$ higher welfare cost

2. Role of Capital Immobilities

- Possible interactions between intersectoral capital immobility and labor substitutability
- Three economies are considered:
  - Economy 1: Economy with perfectly mobile capital ($\delta^2 = 0$)
    – if $\theta \to \infty$, model converges to one-sector model
  - Economy 2: Baseline economy ($\delta^2 = 0.025$)
  - Economy 3: Economy with $\delta^2 = 1,000,000$
    – capital is not mobile across sectors

Economy 1: Perfectly Mobile Capital

Table: Welfare Cost of Business Cycles in Economy 1: Economy with $\delta^2 = 0$

		κ				
		0.01	0.6	1	4	8
	$1,000,000$	-0.0045	-0.0060	-0.0030	0.0031	0.0049
	$1,000$	-0.0044	-0.0059	-0.0030	0.0031	0.0049
θ	0.3014	0.0046	0.0020	0.0021	0.0040	0.0052
	0.0001	0.0047	0.0029	0.0029	0.0041	0.0052
	0.000001	0.0047	0.0030	0.0029	0.0047	0.0052

Economy 2: Baseline economy ($\delta^2 = 0.025$)

Table: Welfare Cost of Business Cycles in Economy 2

		κ				
		0.01	0.6	1	4	8
	$1,000,000$	-0.0039	-0.0020	-0.0002	0.0037	0.0049
	$1,000$	-0.0039	-0.0020	-0.0002	0.0037	0.0049
θ	0.3014	0.0041	0.0037	0.0038	0.0045	0.0050
	0.0001	0.0047	0.0045	0.0045	0.0047	0.0050
	0.000001	0.0047	0.0045	0.00452	0.0047	0.0050

Economy 3: Economy with $\delta^2 = 1,000,000$

Table: Welfare Cost of Business Cycles in Economy 3

		κ				
		0.01	0.6	1	4	8
	$1,000,000$	0.0015	0.0003	0.0009	0.0038	0.0052
	$1,000$	0.0015	0.0003	0.0010	0.0038	0.0052
θ	0.3014	0.0047	0.0040	0.0038	0.0040	0.0048
	0.0001	0.0049	0.0047	0.0045	0.0041	0.0040
	0.000001	0.0049	0.0047	0.0045	0.0041	0.0040

Summary of Findings

- Welfare cost decreases in degree of intersectoral capital mobility
- Negative welfare cost is plausible in one-sector economy
  – when capital is highly mobile and labor in different sectors are easily substituted with each other (economy 3 $\rightarrow$ economy 1)
  – but not supported by data
  eg. sectoral labor comovement problem

Conclusion

Conclusion

- Source of fluctuations is important
- Factor reallocation is important
- Welfare cost of business cycles can be biased downward in typical one-sector model
- Policy implications
  – more welfare gain from stabilization policies in real economy consists of many sectors
  – need to (if possible) identify origin of fluctuations

THANK YOU!