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# **MONOPOLISTIC COMPETITION IN A DSGE MODEL: PART II**

**FEBRUARY 23, 2012**

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## BUILDING THE EQUILIBRIUM

### □ DS MODEL I or II

- Putting things together – impose symmetry across all  $i$

$$\frac{\varepsilon-1}{\varepsilon} p_t z_t f_k(k_t, n_t) = r_t \quad \& \quad \frac{\varepsilon-1}{\varepsilon} p_t z_t f_n(k_t, n_t) = w_t \quad \& \quad p_t = \frac{\varepsilon}{\varepsilon-1} \cdot mc_t$$

↓ implies

$$mc_t = \frac{w_t}{z_t f_n(k_t, n_t)} = \frac{r_t}{z_t f_k(k_t, n_t)}$$

Symmetric equilibrium *relative price* of an intermediate good?  
Substitute demand functions into DS aggregator and compute...

$$p_t = 1$$

$$mc_t = \frac{\varepsilon-1}{\varepsilon}$$

With measure one of intermediate firms, can think of as a normalization...but what if measure  $[0, N_t]$  of firms?

< 1 with  $\varepsilon > 1$  and  $\varepsilon < \text{infinity}$

Monopoly power causes factor prices to fall below marginal products... hence inefficiently low equilibrium factor use...hence inefficiently low total output

# MONOPOLISTICALLY-COMPETITIVE EQUILIBRIUM

□ **Equilibrium Conditions (symmetric across all differentiated goods)**

- **Consumption-leisure optimality condition**
- **Consumption-savings optimality condition**
- **Aggregate resource constraint**

$$c_t + k_{t+1} - (1 - \delta)k_t = z_t f(k_t, n_t) \quad (\text{possibly also include } g_t)$$

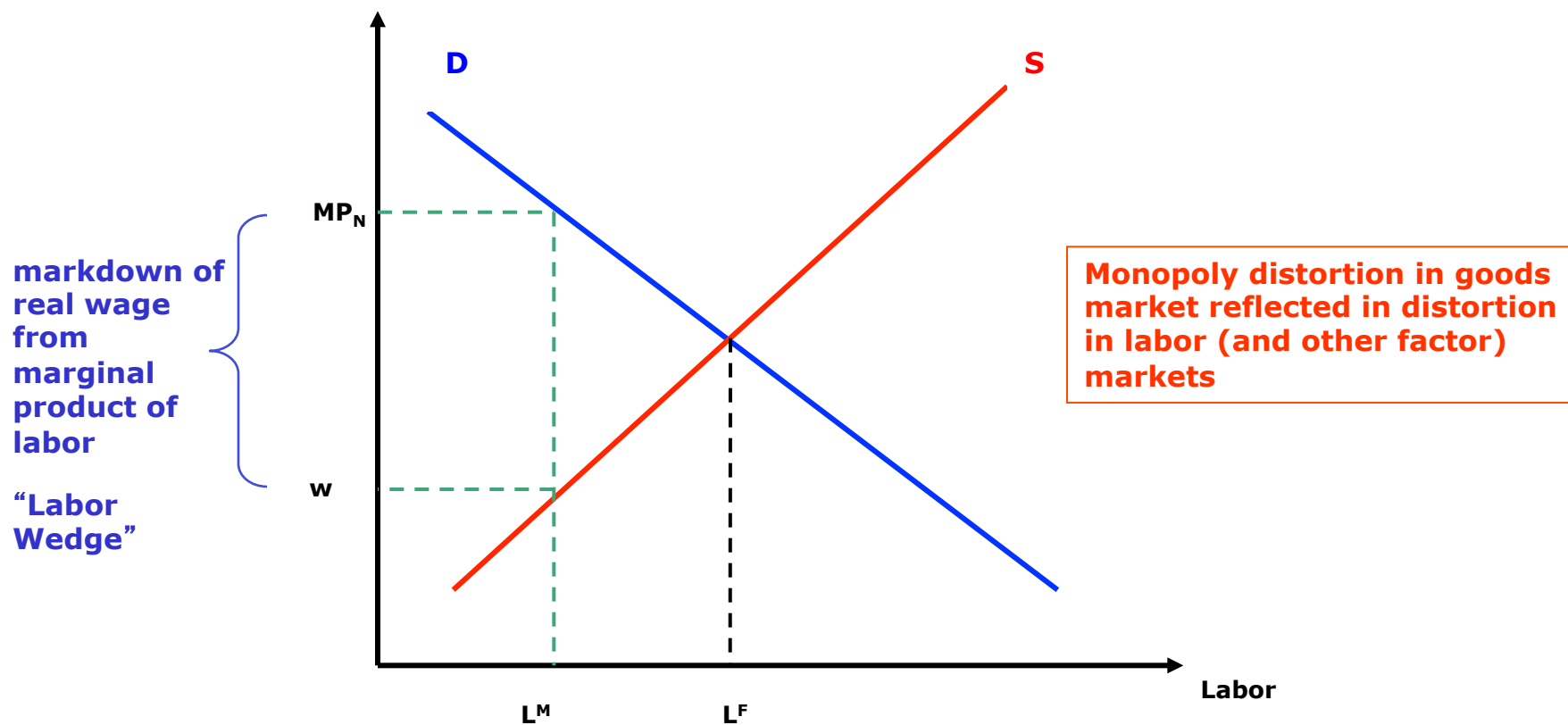
- **(Market clearing in labor, capital, and goods markets)**

- $mc_t = \frac{\varepsilon - 1}{\varepsilon} \quad \forall t \quad (< 1 \text{ with } \varepsilon > 1)$

- **Factor prices a *markdown* of marginal products**

$$w_t = \frac{\varepsilon - 1}{\varepsilon} \cdot z_t f_n(k_t, n_t), \quad k_t = \frac{\varepsilon - 1}{\varepsilon} \cdot z_t f_k(k_t, n_t)$$

# THE LABOR WEDGE



# BUSINESS CYCLE IMPLICATIONS OF MONOPOLY

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- ❑ **Embed D-S framework in standard RBC model**
- ❑ **Can approximate and simulate using “usual” methods**
  - ❑ **Rotemberg and Woodford use King, Plosser, Rebelo (1988) linear approximation method**
  
- ❑ **Empirical Issues**
  - ❑ **Are output fluctuations associated with labor demand shifts or labor supply shifts? For example, those induced by  $g$  shocks?**
  - ❑ **Empirical evidence on goods-market markups?**
  - ❑ **Variations in markups? Exogenous or Endogenous?**
  
- ❑ **Theoretical Issue: endogenous/self-fulfilling/sunspot fluctuations?**
  - ❑ **i.e., fluctuations **not** due to changes in primitives (technology, preferences, endowment, etc.) of economy**
  - ❑ **Cannot occur in RBC economy (unique equilibrium)**

# BUSINESS CYCLE IMPLICATIONS OF MONOPOLY

- Effects of TFP shocks in RBC model...and with monopolistic competition ( $\mu = 1.2$ )

	SD %		Relative SD: SD(x)/SD(GDP)	
	RBC Model	Imperfect Competition	RBC Model	Imperfect Competition
<b>GDP</b>	1.75	1.71	1	1
<b>Consumption</b>	1.31	1.41	0.745	0.826
<b>Gross Investment</b>	5.77	6.28	3.283	3.668
<b>Hours</b>	0.68	0.62	0.386	0.363
<b>Real Wage</b>	1.38	1.44	0.785	0.841
<b>Marginal Product of Labor</b>	1.38	1.44	0.785	0.841

# BUSINESS CYCLE IMPLICATIONS OF MONOPOLY

- Effects of TFP shocks in RBC model...and with monopolistic competition ( $\mu = 1.4$ )

	SD %		Relative SD: SD(x)/SD(GDP)	
	RBC Model	Imperfect Competition	RBC Model	Imperfect Competition
<b>GDP</b>	1.75	1.65	1	1
<b>Consumption</b>	1.31	1.49	0.745	0.898
<b>Gross Investment</b>	5.77	6.64	3.283	4.015
<b>Hours</b>	0.68	0.56	0.386	0.341
<b>Real Wage</b>	1.38	1.49	0.785	0.902
<b>Marginal Product of Labor</b>	1.38	1.49	0.785	0.902

# BUSINESS CYCLE IMPLICATIONS OF MONOPOLY

- Effects of government purchase shocks in RBC model...and with monopolistic competition (can depend on other details of model...)

	Relative SD: $SD(x)/SD(GDP)$			
	RBC Model	$\mu = 1.2$	$\mu = 1.4$	$\mu = 1.6$
<b>GDP</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>
<b>Consumption</b>	<b>0.998</b>	<b>0.925</b>	<b>0.882</b>	<b>0.857</b>
<b>Gross Investment</b>	<b>8.027</b>	<b>9.277</b>	<b>10.494</b>	<b>11.679</b>
<b>Hours</b>	<b>1.435</b>	<b>1.435</b>	<b>1.436</b>	<b>1.437</b>
<b>Real Wage</b>	<b>0.477</b>	<b>0.490</b>	<b>0.504</b>	<b>0.519</b>
<b>Marginal Product of Labor</b>	<b>0.477</b>	<b>0.490</b>	<b>0.504</b>	<b>0.519</b>



# BUSINESS CYCLE IMPLICATIONS OF MONOPOLY

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- ❑ **Main Message:** model fluctuations can (qualitatively and quantitatively) depend on nature of steady state
  
- ❑ **Distorted or efficient long-run equilibrium?**
  - ❑ **Can be important for cyclical properties of a model**
  - ❑ **Analogy:** welfare costs of “bad” monetary policy depend on presence/magnitude of other distortions (Cooley and Hansen 1991)
  
- ❑ **Monopoly power a static distortion on the equilibrium**
  - ❑ **Akin to a labor income tax**
  - ❑ **Introduces a **wedge** between  $u_n/u_c$  and marginal product of labor**
    - ❑ **But a constant wedge...so far...**

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    - ❑ **Cyclical behavior of “labor wedge” perhaps the most important challenge for business cycle modeling – Chari, Kehoe, McGrattan (2007 *Econometrica*), Shimer (2009 *AEJ:Macro*)**
- ❑ **Variable markups may be important for cyclical fluctuations**
  - ❑ **An active area of research: entry and exit of firms and product varieties over the business cycle**

# PRODUCT VARIETIES

$$\max_{\{N_{t+1}, N_{E,t}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \Xi_{t|0} \left[ \int_0^{N_t} (\rho_{it} - mc_t) q(\rho_{it}) di - mc_t f_{E,t} N_{E,t} \right]$$

$f_E$  the product development cost, in terms of labor units

s.t.

$$N_{t+1} = (1 - \delta)(N_t + N_{E,t})$$

Law of motion for number of product varieties, which turn over at rate  $\delta$

□ **FOCs**

$N_{t+1}$  :

$N_{E,t}$  :

□ **“Product creation condition,” aka “free entry condition”**

□ **Characterizes optimal investment in R&D/product development**

$$mc_t f_{E,t} = (1 - \delta) E_t \left\{ \Xi_{t+1|t} \left[ (\rho_{t+1} - mc_{t+1}) q(\rho_{t+1}) + mc_{t+1} f_{E,t+1} \right] \right\}$$

# PRODUCT VARIETIES

$$\max_{\{N_{t+1}, N_{E,t}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \Xi_{t|0} \left[ \int_0^{N_t} (\rho_{it} - mc_t) q(\rho_{it}) di - mc_t f_{E,t} N_{E,t} \right] \quad f_E \text{ the product development cost, in terms of labor units}$$

s.t.

$$N_{t+1} = (1 - \delta)(N_t + N_{E,t})$$

Law of motion for number of product varieties, which turn over at rate *delta*

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□  $\delta = 1 \rightarrow ? \dots$  so try instead  $N_{t+1} = (1 - \delta)N_t + N_{E,t}$

# PRODUCT VARIETIES

- Different forms of “final goods” aggregators

- Dixit-Stiglitz (1977)

$$y_t = \left[ \int_0^{N_t} y_{it}^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}$$

**EPSILON** measures elasticity of substitution across any two differentiated varieties

- Benassy (1996)

$$y_t = N_t^{\kappa+1-\frac{\epsilon}{\epsilon-1}} \left[ \int_0^{N_t} y_{it}^{\frac{\epsilon-1}{\epsilon}} di \right]^{\frac{\epsilon}{\epsilon-1}}$$

... recovers Dixit-Stiglitz

... measures “love of variety effect”

- Translog

- No closed-form aggregator exists

- Primitive is expenditure function

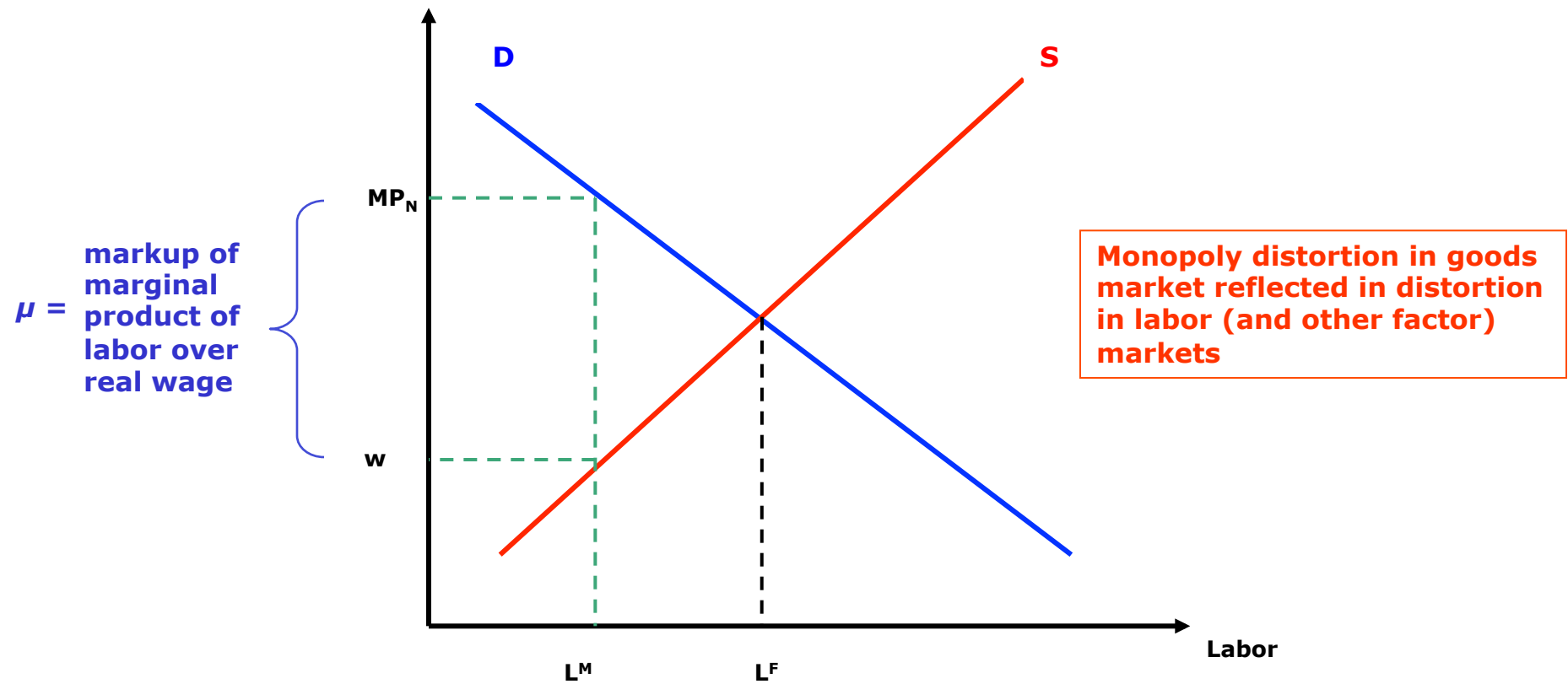
- See Feenstra (2003 *Economics Letters*) for good overview

Dixit-Stiglitz	Benassy	Translog
$\mu(N_t) = \mu = \frac{\theta}{\theta-1}$	$\mu(N_t) = \mu = \frac{\theta}{\theta-1}$	$\mu(N_t) = 1 + \frac{1}{\sigma N_t}$
$\rho(N_t) = N_t^{\mu\epsilon-1} = N_t^{\frac{1}{\theta-1}}$	$\rho(N_t) = N_t^\kappa$	$\rho(N_t) = \exp\left(-\frac{1}{2} \frac{\tilde{N}-N_t}{\sigma \tilde{N} N_t}\right)$ , $\tilde{N} \equiv \text{Mass}(\text{potential products})$
$\epsilon(N_t) = \mu - 1$	$\epsilon(N_t) = \kappa$	$\epsilon(N_t) = \frac{1}{2\sigma N_t} = \frac{1}{2}(\mu(N_t) - 1)$

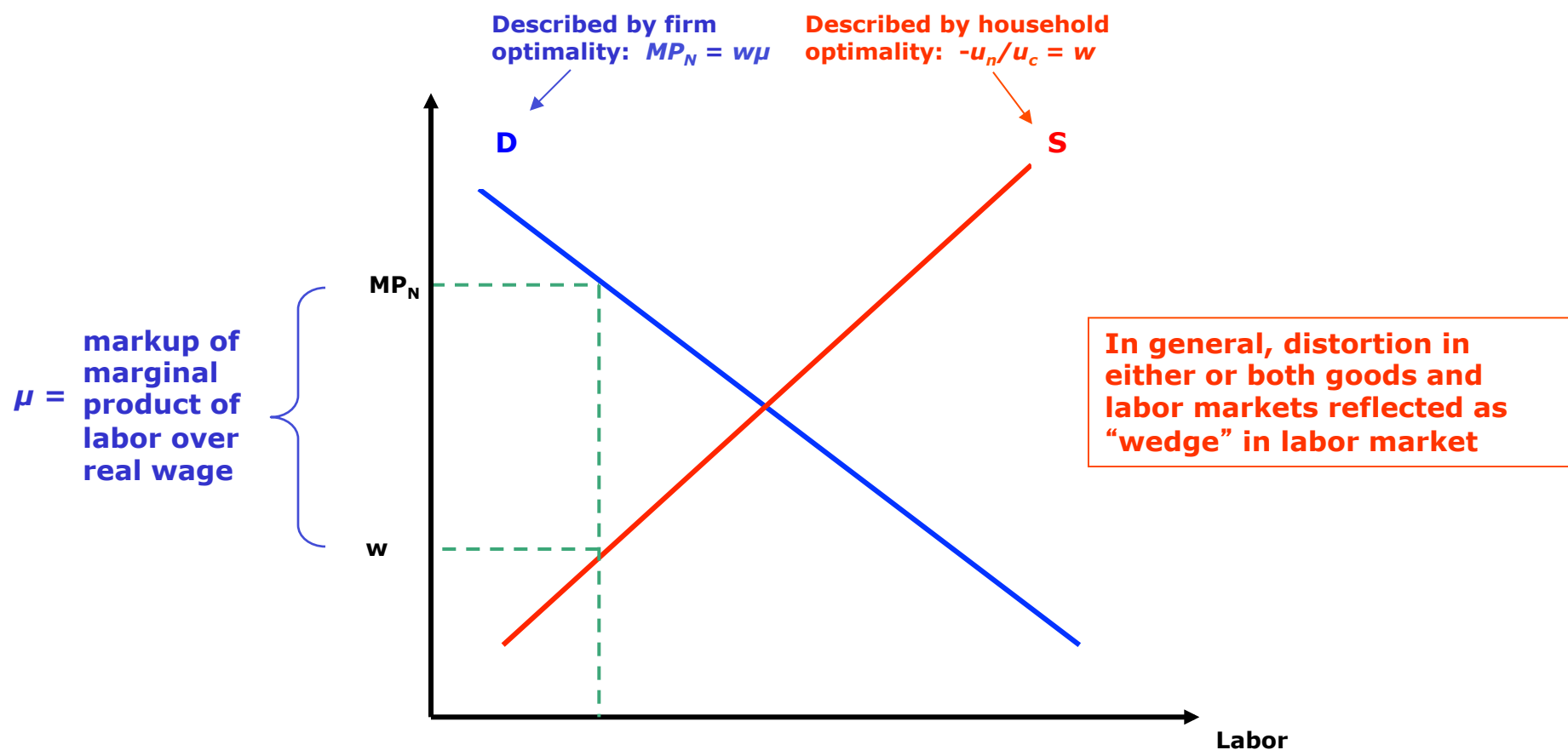
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    - ❑ **Cyclical behavior of “labor wedge” perhaps the most important challenge for business cycle modeling – Chari, Kehoe, McGrattan (2007 *Econometrica*), Shimer (2009 *AEJ:Macro*)**
      - ↓ **More generally, variable labor wedges important for cyclical fluctuations...**
- ❑ **Variable markups** may be important for cyclical fluctuations
  - ❑ **An active area of research: entry and exit of firms and product varieties over the business cycle**

# LABOR MARKET DYNAMICS



# LABOR MARKET DYNAMICS



- Labor wedge measurement and theory an active area of research
  - Shimer (2009 *AEJ:Macro*), Ohanian (2010 *JEP*), many others



# THE LABOR WEDGE

## □ Shimer (2009 *AEJ:Macroeconomics*)

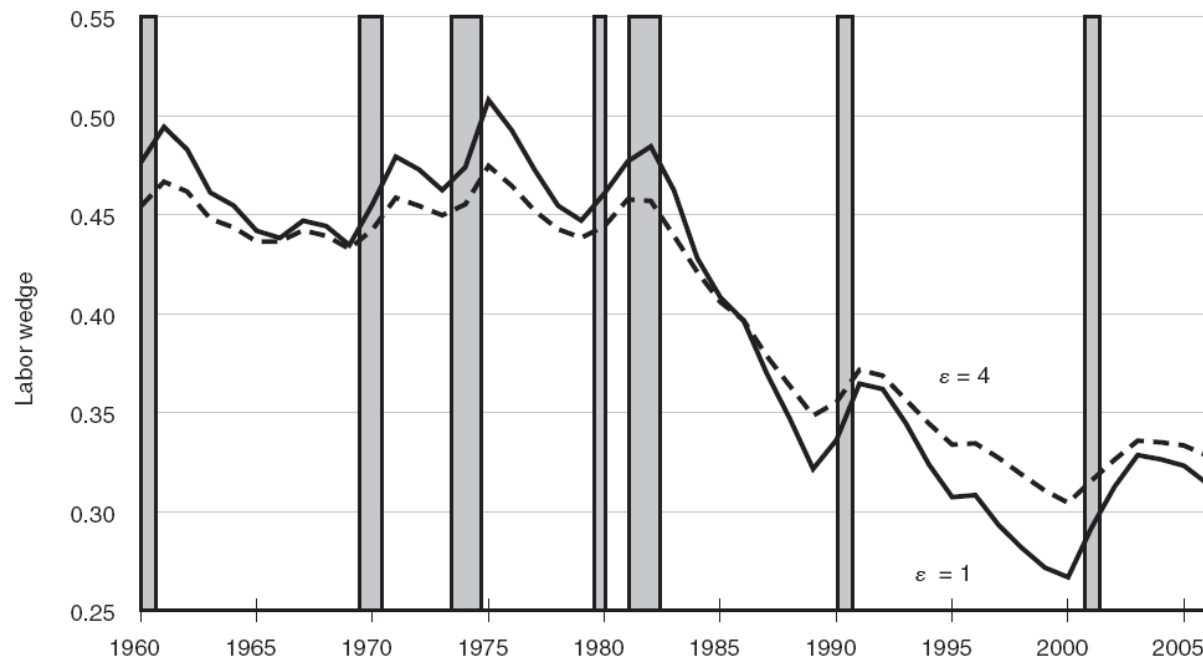


FIGURE 2

*Notes:* The US labor wedge from equation (8). The solid line shows  $\epsilon = 1$ , and the dashed line shows  $\epsilon = 4$ . In both cases, I fix the remaining parameters to ensure that the average labor wedge is 0.40. The gray bands show National Bureau of Economic Research (NBER) recession dates.

# THE LABOR WEDGE

## □ Ohanian (2010 *Journal of Economic Perspectives*)

*Table 2*  
**Recession Diagnostic Distortions**  
*(percent changes)*

	<i>Labor deviation</i>	<i>Capital deviation</i>	<i>Productivity deviation</i>
<b>A: U.S., Postwar Recessions vs. 2007–2009 Recession</b>			
Average postwar recessions	–2.4	1.8	–2.2
2007–09 recession (2007-Q4 to 2009-Q3)	–12.9	0.3	–0.1
<b>B: 2007–2009 Recession, U.S. vs. Other High-Income Countries</b>			
United States	–12.9	0.3	–0.1
Canada	–0.9	0.7	–7.0
France	1.7	1.3	–6.1
Germany	4.8	–1.1	–7.0
Italy	–0.8	0.3	–7.2
Japan	2.9	–0.4	–7.1
United Kingdom	–2.3	0.0	–8.2
Average other high-income countries	0.9	0.1	–7.1

*Notes:* The labor deviation is the percent difference between the marginal rate of substitution between consumption and leisure, and the marginal product of labor when actual data are plugged into that equation. The capital deviation is the percent difference between the intertemporal marginal rate of substitution between consumption and the marginal product of capital net of depreciation when actual data are plugged into that equation. The productivity deviation is the Solow residual.