Small and Orthodox Fiscal Multipliers at the Zero Lower Bound

R. Anton Braun (FRB Atlanta)
Lena Körber (LSE)
Yuichiro Waki (University of Queensland)

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Outline

Motivation

- The nominal interest rate has fallen to (almost) zero in many countries around the world.
- Does fiscal policy have large and qualitatively different effects when the nominal interest rate is zero?
- An emerging consensus in the New Keynesian (NK) literature is that the answer is yes.

Labor tax increase

- In normal times: labor tax $\uparrow \rightarrow$ hours $\downarrow$
- At the ZLB: labor tax $\uparrow \rightarrow$ hours $\uparrow$
  ("Paradox of Toil", Eggertsson(2011))

Government spending multiplier

- In normal times: government spending multiplier ≤ 1
- At the ZLB: government spending multiplier $>> 1$
  (Christiano, Eichenbaum and Rebelo (2011))

  $\longrightarrow$ Policy implication: Fiscal stimulus is particularly effective when monetary policy is constrained by the ZLB.

Our paper

- Provides new evidence that the properties of fiscal policy in the NK model *at the ZLB* and *away from the ZLB* are generally quite similar :
  - labor tax $\uparrow \rightarrow$ hours $\downarrow$, or hours are inelastic
  - government spending multiplier ≈ 1.
- How do we reach this conclusion?
  - Formulate a tractable, nonlinear, stochastic NK model with an occasionally binding ZLB.
  - Calibrate shock parameters to reproduce declines in GDP and inflation from the Great Recession and Great Depression.
  - Analyze the global properties of the model using analytical and numerical methods.

Fiscal multipliers are *generally* small

- Great Recession
  1. GDP government purchase multiplier is about 1.15 or less.
  2. Employment generally falls or shows no response at all to an increase in the labor tax.
- Great Depression
  1. GDP government purchase multiplier is 1.13 or less.
  2. Employment falls when the labor tax is increased.

Fiscal multiplier asymptotes

- Near asymptotes fiscal multipliers can be arbitrarily large and positive or large and negative.
- This region of the parameter space is small.
- Woodford (2011) and Carlstrom, Fuerst and Paustian (2012) have also documented asymptotes using loglinearized solutions.

What explains the difference between our results and the previous literature?

- Parameterization of the model
  - This paper uses parameterizations that can reproduce output and inflation responses from the Great Recession or the Great Depression.
  - Some previous work uses parameterizations of the NK model that cannot reproduce these responses.
- Solution method
  - Loglinear solutions may get the local dynamics of the model wrong.

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Overview

- Standard New Keynesian model of a closed economy.
- Nominal price rigidity á la Rotemberg (1996) adjustment costs.
- No need to loglinearize.
- Equilibrium employment and inflation in the ZLB state can be found by solving two nonlinear equations.

State of the economy

- State $s \in \{H, L\}$.
- 2 state Markov chain with L as the initial state.
- Stays in L with probability p. (Persistence)
- H is the absorbing state.
- Household's one-step discount factor and firms' technology depends on s.
- Fiscal policy is also Markov in s.

Households

- Momentary utility function:

$$\frac{c_t^{1-\sigma}}{1-\sigma} - \frac{h_t^{1+\nu}}{1+\nu}$$

- One-step preference discount factor $\beta \times d_{t+1}$ $(t+1 \to t)$.
- $d_{t+1} = d^L$ in the L state, $d_{t+1} = 1$ in the H state.
- Labor income subject to linear tax $\tau_{w,t}$.
- Optimality condition:

$$\begin{aligned} 1 &= \beta d_{t+1} E_t \left[\frac{c_{t+1}^{-\sigma}}{c_t^{-\sigma}} \frac{1}{1+\pi_{t+1}} \right] (1+R_t) \\ w_t &= \frac{h_t^{\nu}}{c_t^{-\sigma}(1-\tau_{w,t})} \end{aligned}$$

Final good firms

- Produce the final foods using intermediate goods $i \in [0, 1]$.
- CES aggregator:

$$y_t = \Big[\int_0^1 y_t(i)^{\frac{\theta}{\theta-1}} di \Big]^{\frac{\theta-1}{\theta}}.$$

- Profit maximizing input demand:

$$y_t^d(i) = \left(\frac{p_t(i)}{P_t} \right)^{-\theta} y_t$$

where $P_t = \big[\int_0^1 p_t(i)^{1-\theta} di \big]^{\frac{1}{1-\theta}}$ is the price of the final good and $p_t(i)$ is the price of intermediate good i.

Intermediate goods producers

- Use linear production function:

$$y_t(i) = z_t h_t(i),$$

  which implies that the marginal cost is

$$w_t / z_t.$$

- $z_t = z^L$ in the L state, $z_t = 1$ in the H state.

Intermediate goods producers

- Set prices $\{p_t(i)\}_{t=0}^{\infty}$ to maximize PV of profits subject to the demand function.
- Momentary profit function:

$$(1+\tau_s)\frac{p_t(i)}{P_t}y_t(i) - \frac{w_t}{z_t}y_t(i) - \frac{\gamma}{2}\left(\frac{p_t(i)}{p_{t-1}(i)} - 1\right)^2 y_t.$$

- $y_t = z_t h_t$ is the aggregate production.
- In a symmetric equilibrium the fraction $\frac{\gamma}{2}\pi_t^2$ of agg. production is used for price adjustment.

Policy

- Fiscal policy is Ricardian.
- The Central Bank follows a Taylor rule:

$$R_t = \max(0, r_t + \phi_\pi \pi_t + \phi_y \widehat{gdp}_t)$$

where $r_t = \frac{1}{\beta d_{t+1}} - 1$.

Aggregate resource constraint

- Aggregate resource constraint:

$$GDP_t \equiv c_t + g_t = (1 - \kappa_t) z_t h_t.$$

- $\kappa_t \equiv \frac{\gamma}{2}\pi_t^2$ represents the resource costs of price adjustment.
- κ_t plays an important role in a severe, deflationary recession.
  1. Magnitude and sign of employment and GDP responses can differ.
  2. κ disappears when loglinearized about a constant price steady-state.
  3. If the economy is far from the steady state this problem can be severe.
  4. Same issue arises under Calvo pricing.

ZLB Markov equilibrium of Eggertsson and Woodford (2003)

- Markov equilibrium with state $s \in \{L, H\}$.
  (Fiscal policy is also Markov in s.)
- Assume: Zero inflation steady-state occurs in state H.
- Assume: ZLB binds in state L. (Taylor rule checked).
- ZLB Equilibrium: (c^L, h^L, w^L, π^L).
  - Eqm condition reduces to two equations with (π^L, h^L).
  - "AD" and "AS" equations.

Equilibrium condition at the ZLB

1. NKPC:

$$\pi^L(1+\pi^L) = \frac{\theta}{\gamma}(\frac{w^L}{z^L} - 1) + p\beta d^L \pi^L(1+\pi^L)$$

2. Euler equation:

$$(c^L)^{-\sigma} = p\beta d^L \frac{(c^L)^{-\sigma}}{1+\pi^L} + (1-p)\beta d^L c^{-\sigma}$$

3. Labor supply:

$$w^L = (c^L)^{\sigma}(h^L)^{\nu}/(1-\tau_w^L).$$

4. Resource constraint:

$$c^L = (1-\eta^L-\kappa^L)z^L h^L. \quad (g^L = \eta^L z^L h^L.)$$

Equilibrium employment and inflation at the ZLB

1. AS: Price setting condition (+ labor supply and resource constraint)

$$\pi^L(1+\pi^L) = \frac{\theta}{\gamma}\left(\frac{(1-\kappa^L-\eta^L)^\sigma (h^L)^{\sigma+\nu}}{(1-\tau_w^L)(z^L)^{1-\sigma}} - 1\right) + p\beta d^L \pi^L(1+\pi^L)$$

2. AD: Euler equation (+ production function and resource constraint)

$$1 = p\left(\frac{\beta d^L}{1+\pi^L}\right) + (1-p)\beta d^L\left(\frac{(1-\kappa^L-\eta^L)^\sigma (h^L)^\sigma}{(1-\eta)^\sigma h^\sigma}\right)$$

3. $R^{Taylor} < 0$

Outline

Estimated parameters

- Key parameters are estimated by Bayesian methods using the loglinear equilibrium conditions.
- Data: output gap, inflation and the FFR (1985:I-2007:IV).
- Model: loglinearized three-equation model (quarterly)
- Shocks: technology, demand, and monetary policy.

Parameter	Prior			Posterior		
	distribution	mean	std. dev.	mode	5%	95%
ν Labour supply elasticity	gamma	0.5	0.25	0.28	0.08	0.63
γ **Price adj. costs**	normal	**150**	200	**458**	315	704
ϕ_y TR coefficient on GDP	normal	0	1	1.63	1.06	2.33
ϕ_π TR coefficient on inflation	normal	3	1	3.46	2.38	4.77
ρ_r TR coefficient on R_{t-1}	beta	0.75	0.1	0.86	0.81	0.90

Other parameters

- The remaining parameters are fixed a priori as follows:

Parameter		Value
β	Discount factor	0.997
σ	Relative risk aversion	1
$\frac{\theta}{\theta-1}$	Steady state gross markup	1.15

- Resulting slope of NK Phillips Curve is: 0.021.
- Close to estimate of Rotemberg and Woodford (1997): 0.024.

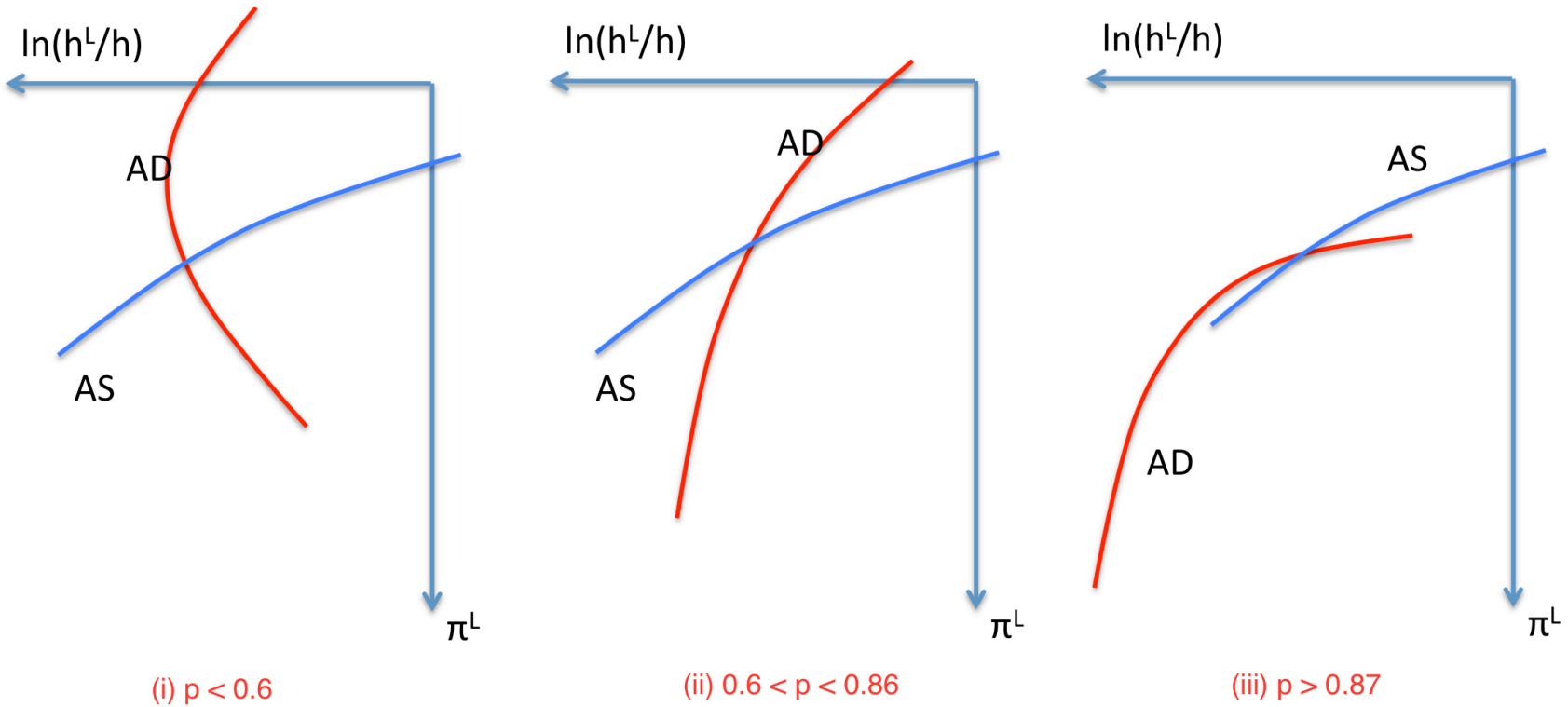
Targets from the Great Recession and the Great Depression

	Inflation	GDP
Great Recession (2008-09)	-1%	-7%
Great Depression (1929-30s)	-10%	-30%

- Consider a wide range of p (duration of the ZLB) $\in [0, 0.95]$.
- For each p we adjust z^L and d^L to reproduce these numbers at ZLB.
- This presentation focuses on the GR calibration.

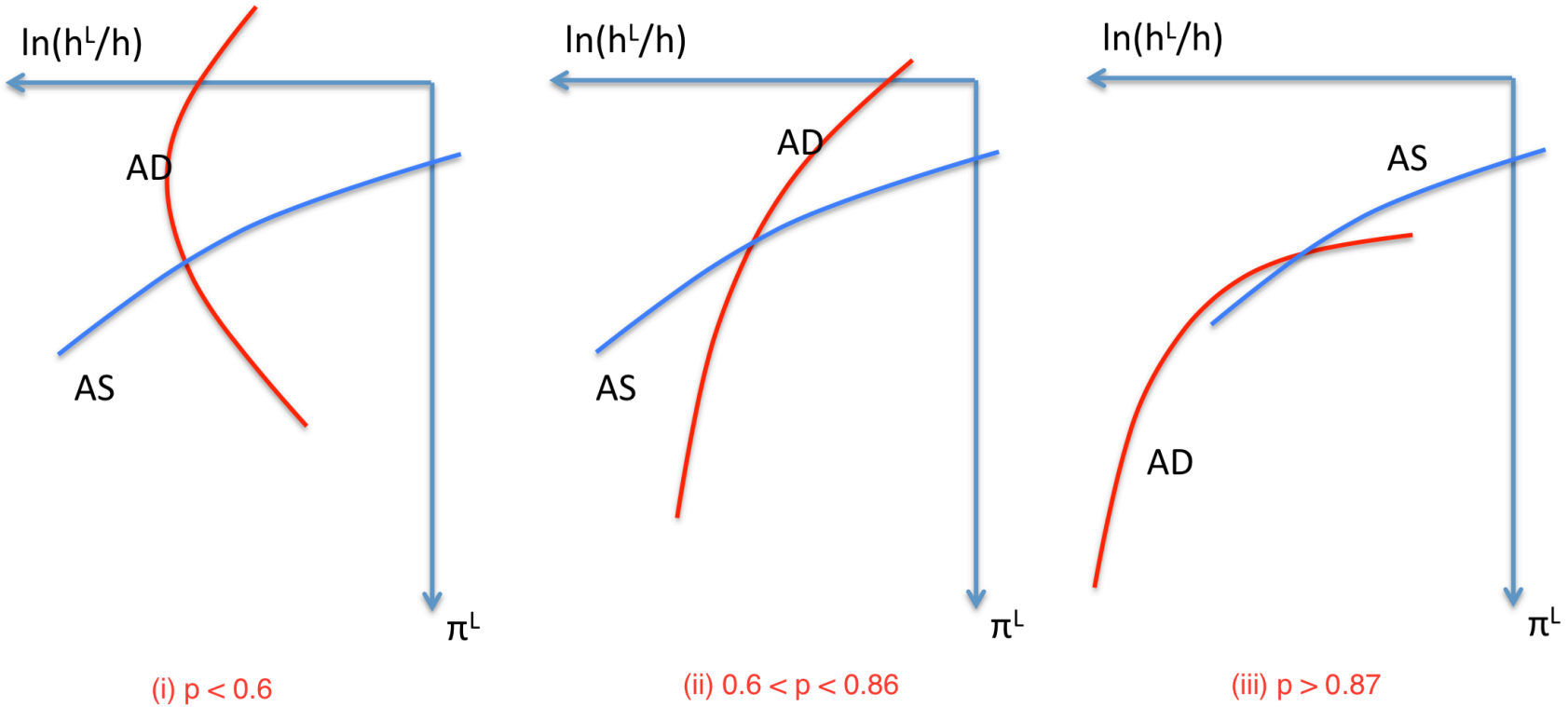
Outline

Three configurations for the AD-AS schedules



- All equilibria are MSV solutions.
- Left case doesn't occur if loglinearized around zero inflation steady-state.
- Measure policy effects by perturbing fiscal policy in state L.

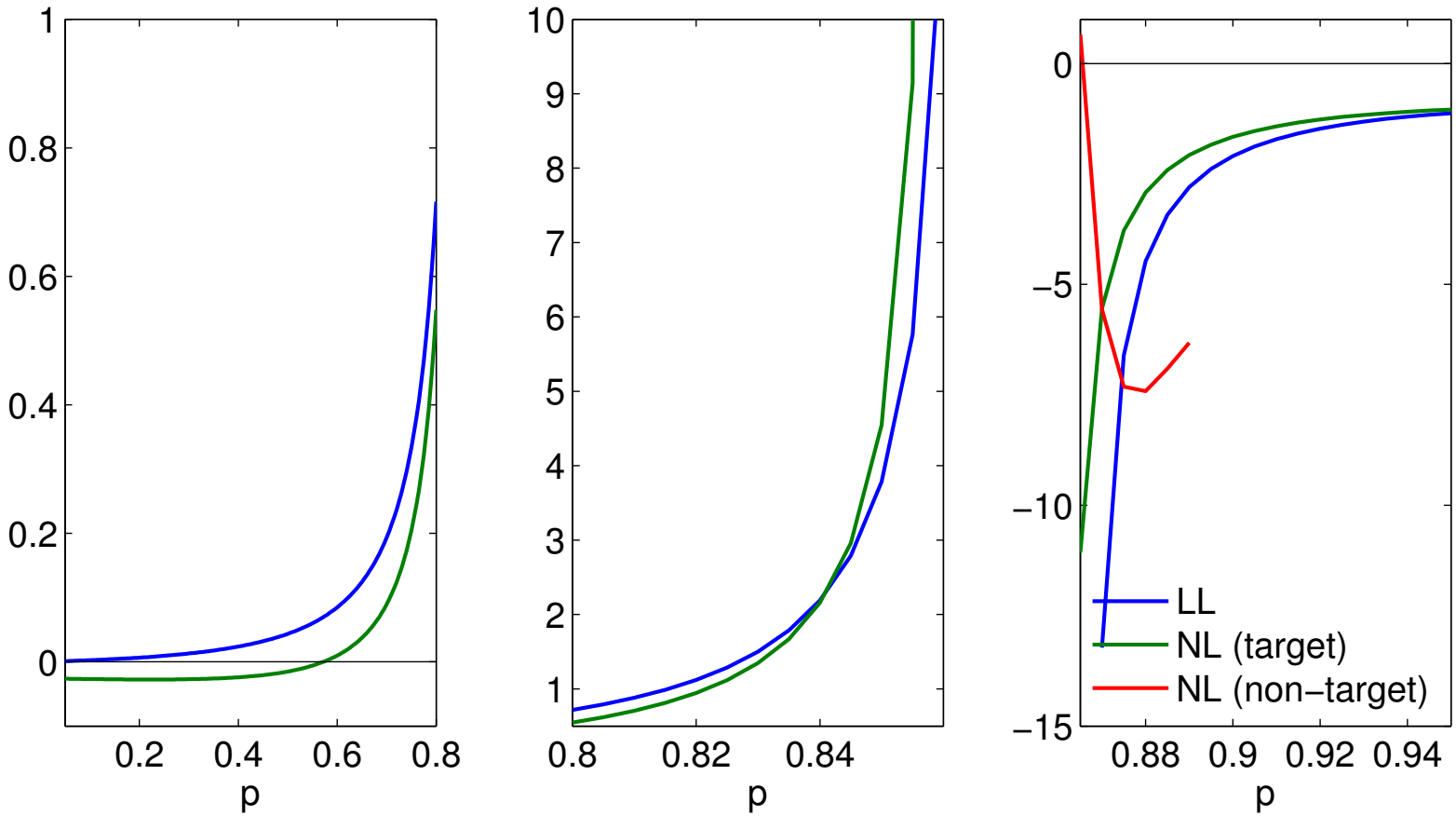
The response of hours to a labor tax increase



(i) $p < 0.6$ (ii) $0.6 < p < 0.86$ (iii) $p > 0.87$

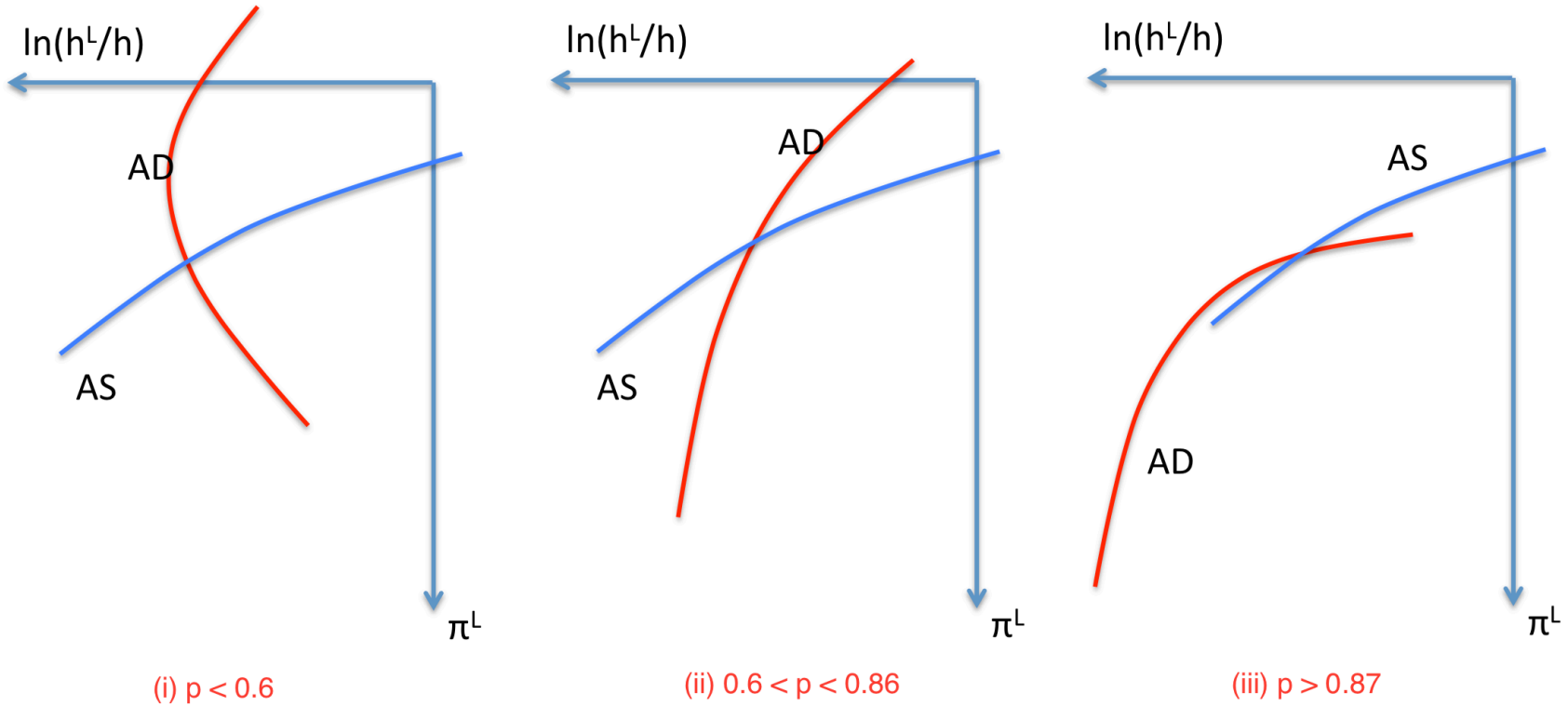
- Labor tax $\uparrow \Rightarrow$ AS shifts up.
- Employment $\downarrow$ for the left and the right cases.
- Employment $\uparrow$ for the middle case.

The response of hours to a labor tax increase



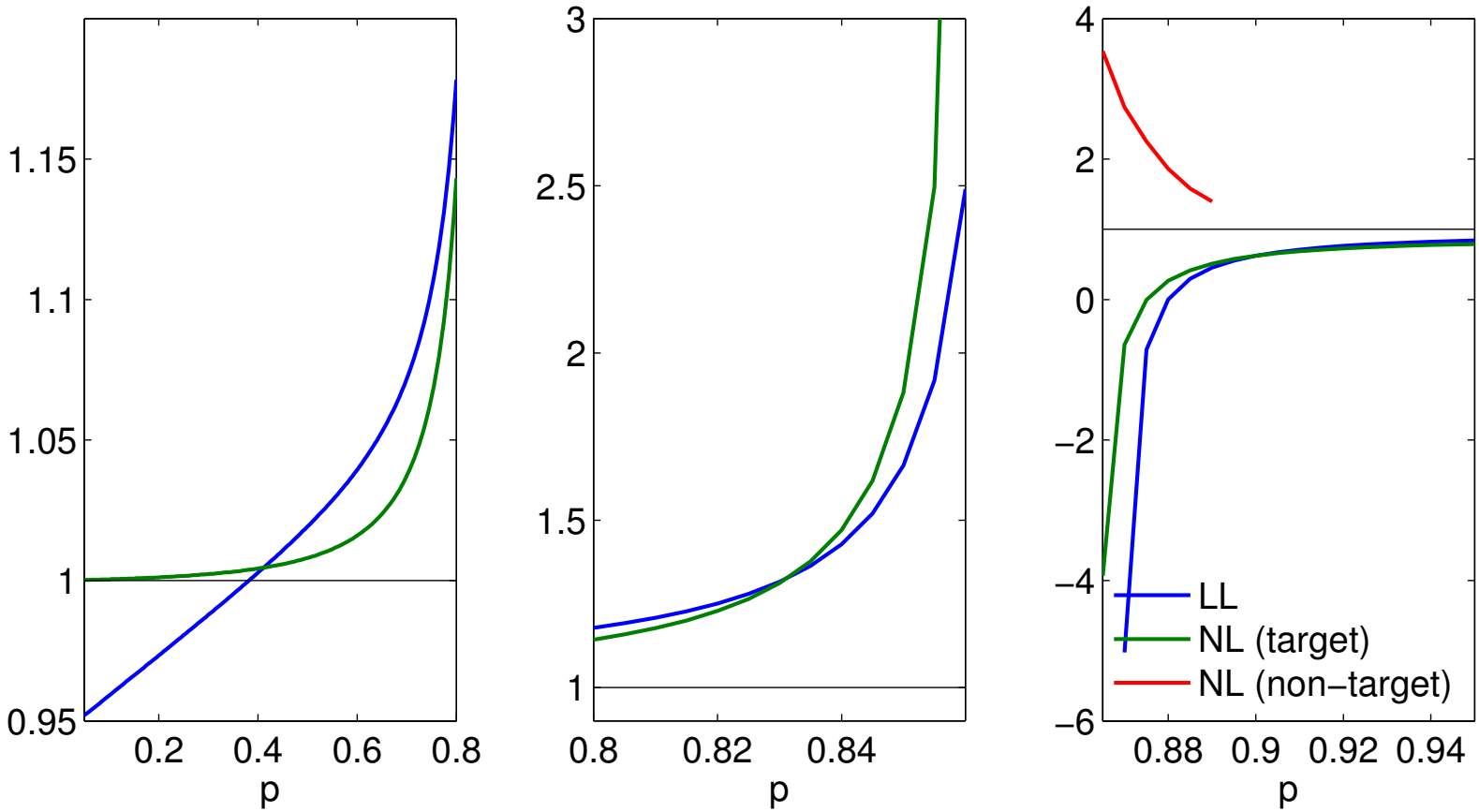
- Third equilibrium can exist (red).
- Labor tax multiplier proportional to $\frac{1}{slope(AD)/slope(AS)-1}$.

Government spending multiplier



- Government spending $\uparrow \approx$ AD shifts toward the right.
- Inflation $\uparrow$ for the left and the middle cases. $\rightarrow$ C $\uparrow \Rightarrow$ Multiplier > 1.
- Inflation $\downarrow$ for the right case $\rightarrow$ C $\downarrow \Rightarrow$ Multiplier < 1.

Government spending multiplier



- Very large multiplier only around the asymptote.
- Right panel corresponds to Mertens and Ravn (2014).

Outline

Conclusions

- Our findings:
  - For a broad and empirically relevant range of parameter/shock configurations
  - labor tax $\uparrow \rightarrow$ hours $\downarrow$ or hours are inelastic
  - government spending multiplier ≈ 1
- Fiscal multipliers can be very large and positive or large and negative near asymptotes.
- These properties also hold in
  - Specifications with preference shock only, and
  - Specifications that are calibrated to Great Depression.