A Model of Secular Stagnation

Gauti B. Eggertsson and Neil R. Mehrotra

Brown University

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Secular Stagnation Hypothesis

> *I wonder if a set of older ideas … under the phrase secular stagnation are not profoundly important in understanding Japan's experience, and may not be without relevance to America's experience — Lawrence Summers*

Original hypothesis:

- Alvin Hansen (1938)
- Reduction in population growth and investment opportunities
- Concerns about insufficient demand ended with WWII and subsequent baby boom

Secular stagnation resurrected:

- Lawrence Summers (2013)
- Highly persistent decline in the natural rate of interest
- Chronically binding zero lower bound

Why are we so confident interest rates will rise soon?

Interest rates in the US during the Great Depression:

- Started falling in 1929
- Reached zero in 1933
- Interest rates only started increasing in 1947

Started dropping in Japan in 1994:

- Remains at zero today

Why are we so confident interest rates are increasing in the next few years?

Interest Rates, 1929-1951

Shortcomings of Some Existing Models

Representative agent models:

$$r_{ss} = \frac{1}{\beta}$$

- Real interest rate must be positive in steady state
- Households problem not well defined if $\beta \geq 1$
- ZLB driven by temporary shocks to discount rate (Eggertsson and Woodford (2003))

Patient-impatient agent models:

- Steady state typically pinned down by the discount factor of the representative saver (Eggertsson and Krugman (2012))
- Deleveraging only has temporary effect

Question and Approach

Question

- Can we formalize the idea of secular stagnation?
- Is a permanent slump a theoretical possibility?

Elements

- Permanently binding zero lower bound:
  - Three-generation OLG model (Samuelson, 1958)
  - Natural rate that can be permanently negative
- Permanent slump in output:
  - Downward nominal wage rigidity with partial adjustment
  - Persistent slump in periods of deflation

Preview of Results

Negative natural rate of interest can be triggered by:

- Deleveraging shock
- Slowdown in population growth
- Increase in income inequality
- Fall in relative price of investment

Stagnation steady state

- Permanently binding zero lower bound
- Low inflation or deflation
- Permanent shortfall in output from potential

Monetary and fiscal policy responses

- Raising the inflation target
- Increases in public debt
- Increases in government purchases

Economic Environment

Endowment economy

- Time: $t = 0, 1, 2, ...$
- Goods: consumption good (c)
- Agents: 3-generations: $i \epsilon \{y, m, o\}$
- Assets: riskless bonds (B^i)
- Technology: exogenous borrowing constraint D

Households

Objective function:

$$\max_{C^y_{t,}, C^m_{t+1}, C^o_{t+2}} U = \mathbb{E}_t \left\{ \log\left(C^y_t\right) + \beta \log\left(C^m_{t+1}\right) + \beta^2 \log\left(C^o_{t+2}\right) \right\}$$

Budget constraints:

$$\begin{aligned} C^y_t &= B^y_t \\ C^m_{t+1} &= Y^m_{t+1} - (1+r_t)B^y_t + B^m_{t+1} \\ C^o_{t+2} &= Y^o_{t+2} - (1+r_{t+1})B^m_{t+1} \\ (1+r_t)B^i_t &\leq D_t \end{aligned}$$

Consumption and Saving

Credit-constrained youngest generation:

$$C_t^y = B_t^y = \frac{D_t}{1 + r_t}$$

Saving by the middle generation:

$$\frac{1}{C_t^m} = \beta \mathbb{E}_t \frac{1 + r_t}{C_{t+1}^o}$$

Spending by the old:

$$C_t^o = Y_t^o - (1 + r_{t-1}) B_{t-1}^m$$

Determination of the Real Interest Rate

Asset market equilibrium:

$$N_t B_t^y = -N_{t-1} B_t^m$$
$$(1+g_t) B_t^y = -B_t^m$$

Demand and supply of loans:

$$L_t^d = \frac{1+g_t}{1+r_t} D_t$$
$$L_t^s = \frac{\beta}{1+\beta}\left(Y_t^m - D_{t-1}\right) - \frac{1}{1+\beta}\frac{Y_{t+1}^o}{1+r_t}$$

Determination of the Real Interest Rate

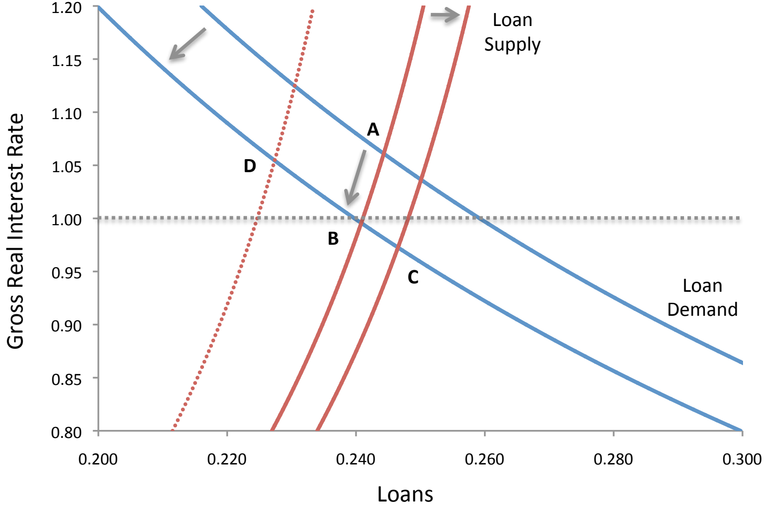
Expression for the real interest rate (perfect foresight):

$$1 + r_t = \frac{1+\beta}{\beta} \frac{(1+g_t)D_t}{Y_t^m - D_{t-1}} + \frac{1}{\beta} \frac{Y_{t+1}^o}{Y_t^m - D_{t-1}}$$

Determinants of the real interest rate:

- Tighter collateral constraint reduces the real interest rate
- Lower rate of population growth reduces the real interest rate
- Higher middle age income reduces real interest rate
- Higher old income increases real interest rate

Effect of a Deleveraging Shock



Income Inequality and Real Interest Rate

Credit constrained middle income:

- Fraction η_s of middle income households are credit constrained
- True for low enough income in middle generation and high enough income in retirement
- Fraction $1 - \eta_s$ lend to both young and constrained middle-generation households

Expression for the real interest rate:

$$1 + r_t = \frac{1+\beta}{\beta} \frac{(1 + g_t + \eta_s)\, D_t}{(1-\eta_s)\left(Y_t^{m,h} - D_{t-1}\right)} + \frac{1}{\beta\,(1-\eta_s)} \frac{Y_{t+1}^{o}}{\left(Y_t^{m,h} - D_{t-1}\right)}$$

Price Level Determination

Euler equation for nominal bonds:

$$\frac{1}{C_t^m} = \beta \mathbb{E}_t \frac{1}{C_{t+1}^o}(1+i_t)\frac{P_t}{P_{t+1}}$$

$$i_t \geq 0$$

Bound on steady state inflation:

$$\bar{\Pi} \geq \frac{1}{1+r}$$

- If steady state real rate is negative, steady state inflation must be positive
- No equilibrium with stable inflation
- But what happens when prices are NOT flexible and the central bank does not tolerate inflation?

Aggregate Supply

Output and labor demand:

$$Y_t = L_t^{\alpha}$$
$$\frac{W_t}{P_t} = \alpha L_t^{\alpha-1}$$

Labor supply:

- Middle-generation households supply a constant level of labor $\bar{L}$
- Implies a constant market clearing real wage $\bar{W} = \alpha \bar{L}^{\alpha-1}$
- Implies a constant full-employment level of output: $Y_{fe} = \bar{L}^{\alpha}$

Downward Nominal Wage Rigidity

Partial wage adjustment:

$$W_t = \max\left\{\tilde{W}_t, P_t \alpha \bar{L}^{\alpha-1}\right\}$$

$$\text{where } \tilde{W}_t = \gamma W_{t-1} + (1-\gamma) P_t \alpha \bar{L}^{\alpha-1}$$

Wage rigidity and unemployment:

- $\tilde{W}_t$ is a wage norm
- If real wages exceed market clearing level, employment is rationed
- Unemployment: $U_t = \bar{L} - L_t$
- Similar assumption in Kocherlakota (2013) and Schmitt-Grohe and Uribe (2013)

Derivation of Aggregate Supply

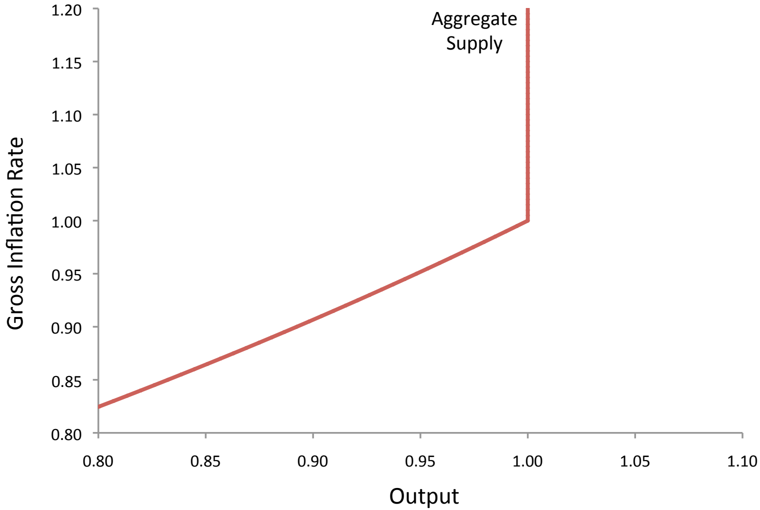
With inflation:

$$w_t = \bar{W} = \alpha \bar{L}^{(\alpha - 1)}$$
$$Y_t = Y_{fe}$$

With deflation:

$$w_t = \gamma \frac{w_{t-1}}{\Pi_t} + (1 - \gamma)\, \bar{W}$$
$$w_t = \alpha L_t^{\alpha - 1}$$
$$Y_t = L_t^{\alpha}$$

Aggregate Supply Relation



Derivation of Aggregate Demand

Monetary policy rule:

$$1 + i_t = \max\left(1, (1 + i^*)\left(\frac{\Pi_t}{\Pi^*}\right)^{\phi_\pi}\right)$$

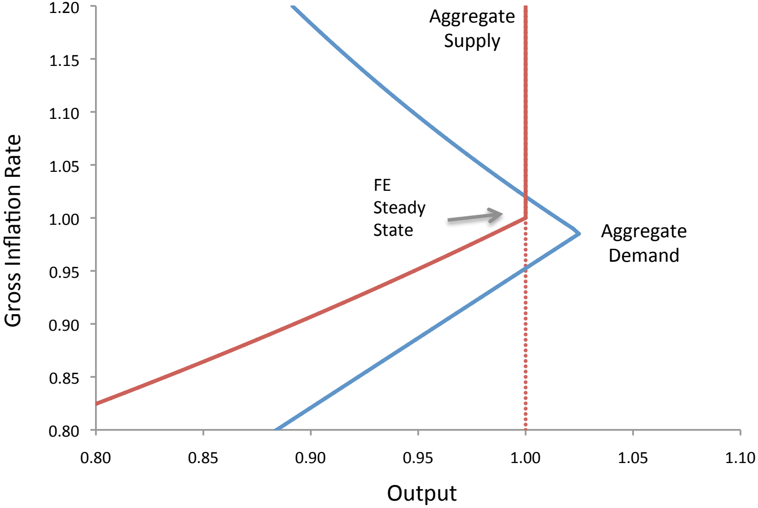
Above binding ZLB:

$$\frac{1 + i^*}{\Pi_{t+1}}\left(\frac{\Pi_t}{\Pi^*}\right)^{\phi_\pi} = \frac{1 + \beta}{\beta}\frac{(1 + g_t)D_t}{Y_t - D_{t-1}}$$

Binding ZLB:

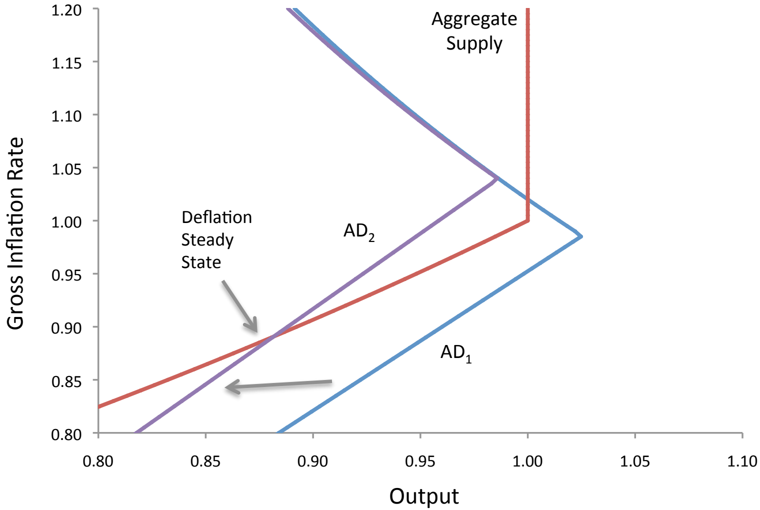
$$\frac{1}{\Pi_{t+1}} = \frac{1 + \beta}{\beta}\frac{(1 + g_t)D_t}{Y_t - D_{t-1}}$$

Full Employment Steady State



Parameter Values

Effect of a Collateral Shock



Properties of the Stagnation Steady State

Long slump:

- Binding zero lower bound so long as natural rate is negative
- Deflation raises real wages above market-clearing level
- Output persistently below full-employment level

Existence and stability:

- Secular stagnation steady state exists so long as $\gamma > 0$
- If $\Pi^* = 1$, secular stagnation steady state is unique and determinate
- Contrast to deflation steady state emphasized in Benhabib, Schmitt-Grohe and Uribe (2001)

Linearized Conditions

Monetary Policy Responses

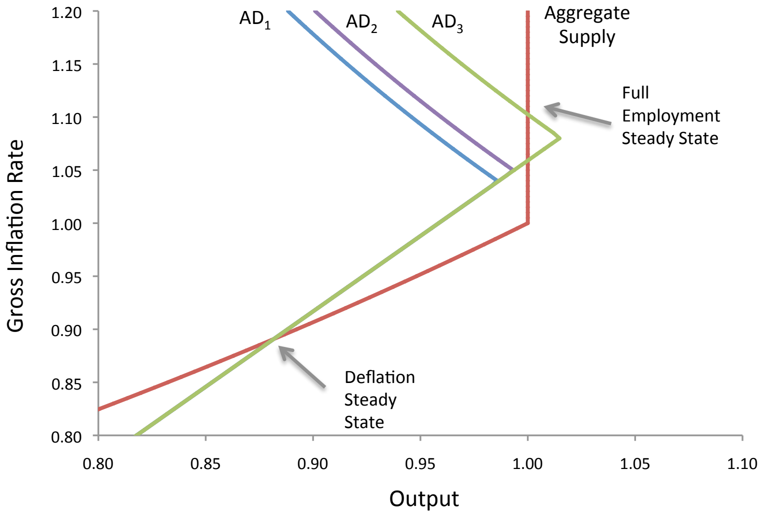
Forward guidance:

- Extended commitment to keep nominal rates low?
- Ineffective if households/firms expect rates to remain low indefinitely
- IS curve not forward-looking in the same manner as New Keynesian IS curve

Raising the inflation target:

- For sufficiently high inflation target, full employment steady state exists.
- Timidity trap (Krugman (2014))
- Multiple determinate steady states

Raising the Inflation Target



Fiscal Policy

Fiscal policy and the real interest rate:

$$L_t^d = \frac{1+g_t}{1+r_t} D_t + B_t^g$$

$$L_t^s = \frac{\beta}{1+\beta} \left(Y_t^m - D_{t-1} - T_t^m \right) - \frac{1}{1+\beta} \frac{Y_{t+1}^o - T_{t+1}^o}{1+r_t}$$

Government budget constraint:

$$B_t^g + T_t^y \left(1+g_t\right) + T_t^m + \frac{1}{1+g_{t-1}} T_t^o = G_t + \frac{1+r_t}{1+g_{t-1}} B_{t-1}^g$$

Fiscal instruments:

$$G_t, B_t^g, T_t^y, T_t^m, T_t^o$$

Temporary Increase in Public Debt

Under constant population and set $G_t = T_t^y = B_{t-1}^g = 0$:

$$T_t^m = -B_t^g$$
$$T_{t+1}^o = (1 + r_t) B_t^g$$

Implications for natural rate:

- Loan demand and loan supply effects cancel out
- Temporary increases in public debt ineffective in raising real rate
- Temporary monetary expansion equivalent to temporary expansion in public debt at the zero lower bound
- Effect of an increase in public debt depends on beliefs about future fiscal policy

Permanent Increase in Public Debt

Consider steady state following fiscal rule:

$$T^o = \beta(1+r)\,T^m$$

$$L^d = \frac{1+g}{1+r}D + B^g$$

$$L^s = \frac{\beta}{1+\beta}\left(Y^m - D\right) - \frac{1}{1+\beta}\frac{Y^o}{1+r}$$

Implications for natural rate:

- Changes in taxation have no effects on loan supply
- Permanent rise in public debt always raises the real rate
- Equivalent to helicopter drop at the zero lower bound
- Public debt circumvents the tightening credit friction (Woodford (1990))

GOVERNMENT PURCHASES MULTIPLIER

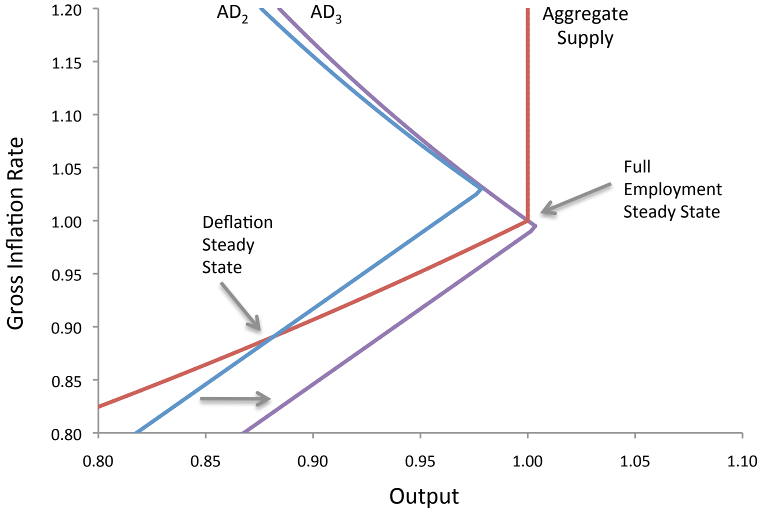
Slope of the AD and AS curves:

$$\psi = \frac{1+\beta}{\beta}(1+g)D$$
$$\kappa = \frac{1-\alpha}{\alpha}\frac{1-\gamma}{\gamma}$$

Purchases multiplier at the zero lower bound:

Financing	Multiplier	Value
Increase in public debt	$\frac{1+\beta}{\beta}\frac{1}{1-\kappa\psi}$	> 2
Tax on young generation	0	0
Tax on middle generation	$\frac{1}{1-\kappa\psi}$	> 1
Tax on old generation	$-\frac{1+g}{\beta}\frac{1}{1-\kappa\psi}$	< 0

Expansionary Fiscal Policy



Capital and Secular Stagnation

Rental rate and real interest rate:

$$r_t^k = p_t^k - p_{t+1}^k \frac{1-\delta}{1+r_t} \geq 0$$

$$r_{ss} \geq -\delta$$

- Negative real rate now constrained by fact that rental rate must be positive

Relative price of capital goods:

- Decline in relative price of capital goods
- Need less savings to build the same capital stock
- Global decline in price of capital goods (Karabarbounis and Neiman, 2014)

Land

Going forward: Financial stability

Low equilibrium rates:

- Possibility of rational asset price bubbles
- Dynamic inefficiency
- Future dividends relatively more important than current dividends
- Bubbles may be welfare-enhancing

Policy responses:

- Higher inflation target leaves natural rate unchanged
- Favor fiscal policy responses that raise natural rate of interest rather than accommodate lower natural rates

Conclusions

Policy implications:

- Higher inflation target needed
- Limits to forward guidance
- Role for fiscal policy
- Possible implications for financial stability

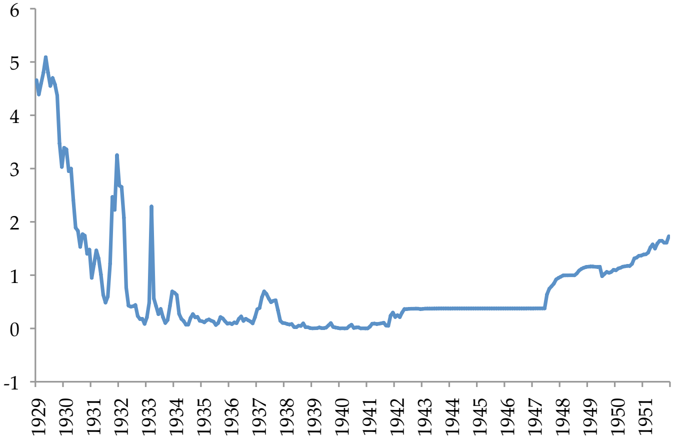
Key takeaway:

- NOT that we will stay in a slump forever
- Slump of arbitrary duration
- OLG framework to model interest rates

Additional Slides

US Interest Rates, 1929-1951

Interest rate on 3-month Treasury bills



Source: NBER Macrohistory Database

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Parameter Values in Numerical Examples

Description	Parameter	Value
Population growth	g	0.2
Collateral constraint	D	0.28
Discount rate	β	0.77
Labor share	α	0.7
Wage adjustment	γ	0.3
Taylor coefficient	ϕ_π	2
Gross inflation target	Π^*	1.01
Labor supply	L	1
Depreciation	δ	0.79

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Dynamic Efficiency

Planner's optimality conditions:

$$\frac{C_o}{C_m} = \beta\left(1+g\right)$$

$$\left(1-\alpha\right) K^{-\alpha} = 1 - \frac{1-\delta}{1+g}$$

$$D\left(1+g\right) + C_m + \frac{1}{1+g} C_o = K^{1-\alpha} \bar{L}^{\alpha} - K\left(1 - \frac{1-\delta}{1+g}\right)$$

Implications:

- Competitive equilibrium does not necessarily coincide with constrained optimal allocation
- If $r > g$, steady state of our model with capital is dynamically efficient
- Negative natural rate only implies dynamic inefficiency if population growth rate is negative

Dynamic Efficiency

Is dynamic efficiency empirically plausible?

- Classic study in Abel, Mankiw, Summers and Zeckhauser (1989) says no
- Revisited in Geerolf (2013) and cannot reject condition for dynamic inefficiency in developed economies today

Absence of risk premia:

- No risk premia on capital in our model
- Negative short-term natural rate but positive net return on capital
- Abel et al. (2013) emphasize that low real interest rates not inconsistent with dynamic efficiency

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LAND

Land with dividends:

$$p_t^{land} = D_t + \frac{p_{t+1}^{land}}{1 + r_t}$$

- Land that pays a real dividend rules out a secular stagnation

Land without dividends:

- If $r > 0$, price of land equals its fundamental value
- If $r < 0$, price of land is indeterminate and land offers a negative return r

Absence of risk premia:

- No risk premia on land
- Negative short-term natural rate but positive net return on capital

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Linearized Equilibrium Conditions

Linearized AS and AD curves:

$$i_t = E_t \pi_{t+1} - s_y (y_t - g_t) + (1 - s_w) E_t (y_{t+1} - g_{t+1}) + s_w d_t + s_d d_{t-1}$$
$$y_t = \gamma_w y_{t-1} + \gamma_w \frac{\alpha}{1-\alpha} \pi_t$$

Elements:

- Exogenous shocks: g_t, d_t
- Retains forward-looking intertemporal IS curve of New Keynesian model
- IS curve is "less" forward-looking" than New Keynesian version

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