Stagnation Traps

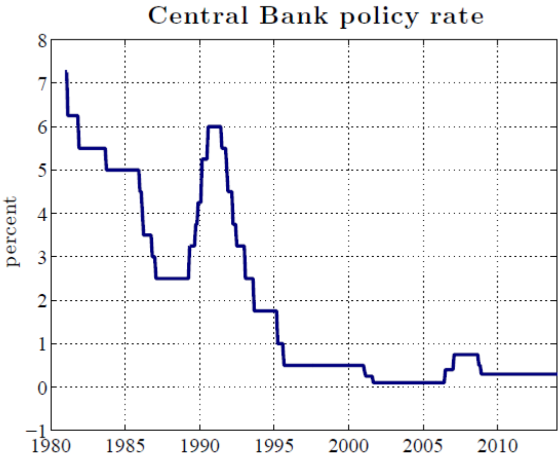
Gianluca Benigno (London School of Economics), Luca Fornaro (CREI)

2nd Annual Conference National Bank of Ukraine,
Kiyv 18-19 May 2017.

Motivation

- Can insufficient aggregate demand lead to economic stagnation?
- Recent debate on Post Crisis Slumps and Secular Stagnation (Summers, 2013).
- Aftermath of the Global Financial Crisis.
    - Two decades-long stagnation affecting Japan since early 1990s;
    - Slow recoveries from the 2008 global financial crisis in the US, Europe and UK;
- All episodes feature:
    - Long-lasting slumps with policy rates close to the lower bound;
    - Slowdown in potential output growth.

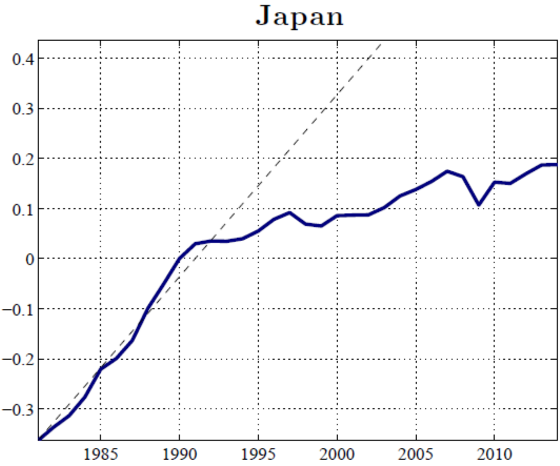
Japan: Policy Rate



Japan: unemployment rate

Japan: real GDP per hour worked

Japan: real GDP (log)



Summary of evidence

Table 1: Japan, United States, Euro area: before/during slump

	Japan		United States		Euro area	
	1982-1991	1992-2014	1998-2007	2008-2014	1999-2007	2008-2014
Policy rate nom.	4.25	0.65	3.68	0.35	2.91	1.15
Policy rate real	2.64	0.23	1.44	-1.57	1.46	-0.38
Unemployment rate	2.49	4.10	4.90	7.88	8.67	10.37
Labor prod. growth	4.03	1.94	2.61	1.24	1.27	0.66

Notes: All the values are subsample averages expressed in percentage points. Labor productivity is real GDP/hours worked.

Our perspective

- *Keynesian Growth* framework;
  - Unemployment due to weak aggregate demand when monetary policy is constrained at the zero lower bound.
  - Growth is the result of investment choices by profit maximizing firms.
- Two-way interaction between aggregate demand and growth
  - Weak aggregate demand has a negative impact on firms' profits and investment in innovation resulting in low growth;
  - Slow growth reduces wealth and depresses aggregate demand (especially when interest rates are close to the zero lower bound).

Key results

- Key result: permanent, or very persistent, slumps characterized by high unemployment and low growth are possible.
- Two steady states
  - Full employment, high growth and positive nominal interest rate.
  - Unemployment, low growth, zero lower bound that binds → *stagnation trap*
- Fluctuations determined by expectations.
- Policies that foster growth can eliminate the stagnation trap equilibrium if they are sufficiently aggressive.

Outline

- *Model;*
- Sentiments, growth and stagnation traps;
- Policy analysis.

The model

- Model of vertical innovation *a la* Aghion and Howitt (1992) and Grossman and Helpman(1991) augmented with nominal wage rigidities and zero lower bound on nominal interest rate.
- Infinite horizon closed economy.
  - Firms produce goods and invest in research/innovation;
  - Household supply labor and consume;
  - Central Bank sets monetary policy.
- No fundamental shocks.

Household

- Representative household with expected lifetime utility

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma} - 1}{1-\sigma} \right) \right]$$

- One unit labor endowment, no labor disutility, but unemployment possible due to nominal wage rigidities
- Households own firms, have access to nominal bonds paying nominal interest rate i:

$$P_t C_t + \frac{b_{t+1}}{1+i_t} = W_t L_t + b_t + d_t$$

- Euler equation

$$C_t^{-\sigma} = \beta(1+i_t) E_t \left[\frac{C_{t+1}^{-\sigma}}{\pi_{t+1}} \right] \quad \text{where} \quad \pi_{t+1} \equiv \frac{P_{t+1}}{P_t}$$

Model

Firms

- Large number of competitive firms producing according to

$$Y_t = L_t^{1-\alpha} \int_0^1 A_{jt}^{1-\alpha} x_{jt}^{\alpha} dj$$

- x_j is an intermediate input of productivity A_j
- Fixed number of intermediate inputs, quality growing over time
- Profit maximization implies the following demand functions

$$P_t(1-\alpha)L_t^{-\alpha} \int_0^1 A_{jt}^{1-\alpha} x_{jt}^{\alpha} dj = W_t$$

$$P_t \alpha L_t^{1-\alpha} A_{jt}^{1-\alpha} x_{jt}^{\alpha-1} = P_{jt}$$

Firms: intermediate goods production

- Every sector j is populated by

$$\text{A Leader producing quality } A_j$$

$$\text{Competitors producing quality } \frac{A_j}{\gamma} \text{ with } \gamma > 1$$

- One unit of final good is needed to manufacture one unit of intermediate good $\Rightarrow$ marginal cost $= P_t$

$$\text{Optimal price} \quad P_{jt} = \xi P_t \quad \text{where} \quad \xi \equiv \min\left(\gamma^{\frac{\alpha}{1-\alpha}}, \frac{1}{\alpha}\right) > 1$$

- Profits are incresing in market size, or aggregate demand as captured by L_t

$$\text{Real profits} \quad \varpi A_{jt} L_t$$

Model

Research and innovation

- Large number of entrepreneurs that can innovate upon existing products (γ is the innovation step)
- Entrepeneur investing I_{jt} discovers improved version of product j with probability

$$\mu_{jt} = \min\left(\frac{\chi I_{jt}}{A_{jt}}, 1\right)$$

- We assume that probability that two or more entrepreneurs innovate on the same product is negligible.
- Probability that a new version of good j is discovered is the sum of success proabilities of all the entrepreneurs targeting that product

Research and innovation

- Successful entrepreneur obtains a pated and becomes new monopolist
- Value of a successful innovation in sector j ($V_t(A_{jt})$) is

$$\beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\underbrace{P_{t+1} \varpi \gamma A_{jt} L_{t+1}}_{\text{profits in } t+1} + \underbrace{\left(1 - \mu_{jt+1} - \eta\right) V_{t+1}(\gamma A_{jt})}_{\text{value of patent in } t+1} \right) \right]$$

- Reward to innovation increasing in future aggregate demand (L_{t+1})
- Simplifying assumption: patent lasts a single period after which it is allocated randomly to another entrepreneur ($\eta = 1$)

Model

Research and innovation

- Free entry implies:

$$\underbrace{P_t I_{jt}}_{\text{cost of innovation}} \geq \underbrace{\mu_{jt} V_t(\gamma A_{jt})}_{\text{expected return}} \quad \text{for all} \quad j$$

- Focus on symmetric equilibrium

$$\mu_{jt} = \mu_t \quad \text{for all} \quad j$$

- Productivity growth

$$g_{t+1} \equiv \frac{A_{t+1}}{A_t} = 1 + \underbrace{\mu_t (\gamma - 1)}_{\text{innovating sectors x innovation step}}$$

Equilibrium

- Aggregate production

$$Y_t - \int_0^1 x_{jt} dj = \theta L_t A_t$$

with $A_t \equiv \int_0^1 A_{jt} dj$.

- Unitary labor endowment:
  - $L_t = 1 \Rightarrow$ full employment;
  - $L_t < 1 \Rightarrow$ unemployment and negative output gap
- Market clearing for final good

$$\theta L_t A_t = C_t + I_t$$

Wages and Prices

Price setting

- We consider (initially) the case of constant nominal wage inflation

$$W_t = \bar{\pi}^w W_{t-1}$$

- Extension of the model consider downward wage rigidities, give rise to wage Phillips curve
- Price setting

$$P_t = \frac{1}{1-\alpha} \left(\frac{\xi}{\alpha} \right)^{\frac{\alpha}{1-\alpha}} \frac{W_t}{A_t}$$

- Price inflation

$$\pi_t = \frac{\pi_t^w}{g_t} = \frac{\bar{\pi}^w}{g_t}$$

Monetary policy

- Central bank follows truncated interest rate rule

$$1 + i_t = \max\left((1+\bar{\imath})\, L_t^{\phi}, 1\right)$$

- Monetary policy constrained by the zero lower bound $i \geq 0$

Equilibrium condition

- Euler Equation

$$c_t^{\sigma} = \frac{g_{t+1}^{\sigma-1}\bar{\pi}^{w}}{\beta(1+i_t)E_t\left[c_{t+1}^{-\sigma}\right]} \quad \text{where} \quad c_t \equiv \frac{C_t}{A_t}$$

focus on $\sigma > 1$ so that $\uparrow g_{t+1} \rightarrow \uparrow c_t$.

- **Aggregate demand** (Euler equation + policy rule)

$$c_t^{\sigma} = \frac{g_{t+1}^{\sigma-1}\bar{\pi}^{w}}{\beta \max\left((1+\bar{\imath})\,L_t^{\phi}, 1\right) E_t\left[c_{t+1}^{-\sigma}\right]}$$

- **Growth Equation**

$$(g_{t+1}-1)\left(g_{t+1}^{\sigma} - \beta E_t\left[\left(\frac{c_t}{c_{t+1}}\right)^{\sigma}\chi\gamma\varpi L_{t+1}\right]\right) = 0$$

- **Market clearing**

$$\theta L_t = c_t + \frac{g_{t+1}-1}{\chi(\gamma-1)}$$

- Rational expectation equilibrium is a set of processes $\{L_t, c_t, g_{t+1}\}_{t=0}^{\infty}$ satisfying the previous equations

Non Stochastic Steady State

- Aggregate Demand

$$g^{\sigma-1} = \frac{\beta}{\bar{\pi}^w} \max\left((1+\bar{\imath})L^{\phi}, 1\right)$$

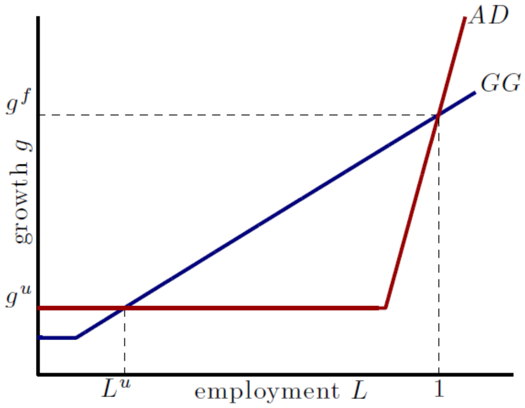
- Growth Equation

$$g^{\sigma} = \max\left(\beta\chi\gamma\varpi L, 1\right)$$

- Market Clearing

$$\theta L = c + \frac{g-1}{\chi(\gamma-1)}$$

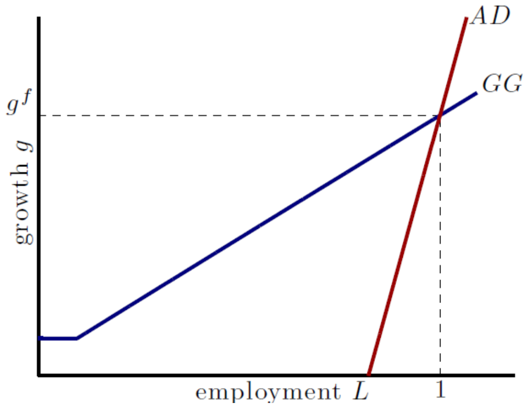
Two Steady States



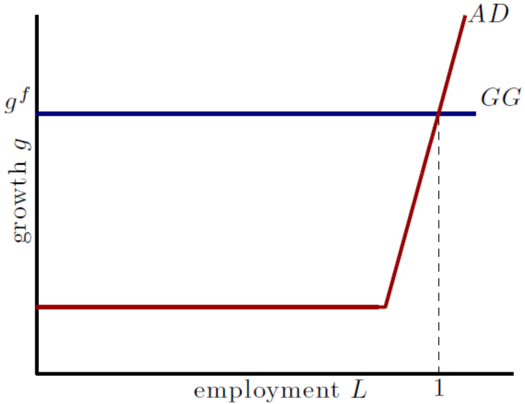
Understanding Stagnation Traps

- Aside from the usual full employment steady state, the economy can find itself in permanent liquidity trap with:
  1. Negative output gap ($y^u < 1$)
  2. Weak growth ($g^u < g^f$)
  3. Monetary policy constrained by the zero lower bound ($i^u = 0$)
- Stagnation trap: the combination of liquidity and growth trap.
- The zero lower bound constraint and the dependence of growth from current output gap are both crucial in generating the stagnation trap.

No zero lower bound



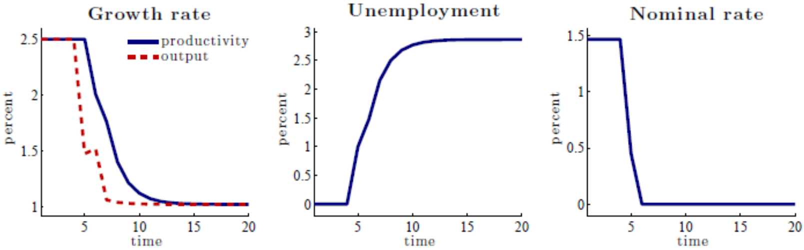
No dependence of growth from output gap



The role of confidence shock

- Equilibrium is determined by expectations.
  - Suppose agents expect that growth will be low
  - Low expectations of future income imply low aggregate demand
  - Due to zero lower bound, central bank is not able to lower the interest rate enough to sustain full employment.
  - Firms' profits are low, weak investment in innovation
  - Expectations of weak growth are verified.
- Expectations of low growth can give rise to permanent, or very long lasting, liquidity traps characterized by low growth.

Transition towards Stagnation Steady State



Extensions: Phillips curve

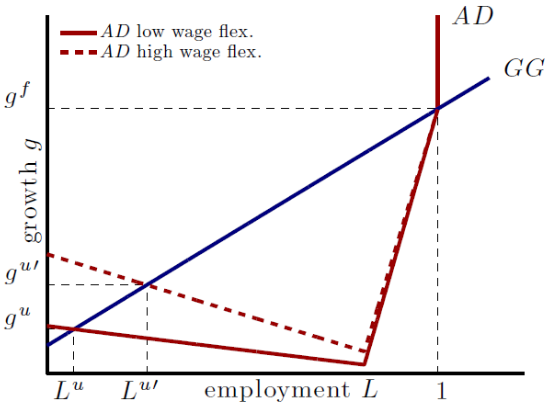
- Downward nominal wage rigidities

$$W_t \geq \psi\left(L_t\right) W_{t-1} \quad \text{with} \quad \psi'(\cdot) > 0$$

- Non-linear wage Phillips curve
  - If $\pi_t^w \leq \psi(1)$ then $\uparrow L_t \uparrow \pi_t^w$
  - If $\pi_t^w > \psi(1)$ then $L_t = 1$
- Monetary Policy

$$1 + i_t = \max\left((1+\bar{\imath})\left(\frac{\pi_t^w}{\pi^*}\right)^{\phi}, 1\right)$$

The role of nominal wage rigidities



Negative Steady State Real Interest Rates

- In the baseline model, the unemployment steady state features positive real rate and $\pi^u < 1$

$$1 + r^u = \frac{1}{\pi^u} = \frac{(g^u)^\sigma}{\beta}$$

- Financial frictions create room for permanent liquidity traps with positive inflation and negative real rate
  - For instance, this happens if we introduce uninsurable unemployment risk as in Aiyagari (1991)

$$1 + r^u = \frac{1}{\pi^u} = \frac{(g^u)^\sigma}{\rho\beta}$$

  - $\rho > 1$ captures precautionary saving motives.

Numerical Analysis

Table 3: Calibrated examples

	Full emp. steady state	Unemp. steady state		
		Inn. by entrants	Inn. by incumbents	Inn. by inc. with spillovers
Prod. growth	2.00	1.67	1.37	1.21
Output gap	0.00	7.50	7.50	7.50
Nominal rate	3.53	0.00	0.00	0.00
Real rate	1.50	0.85	0.26	−0.06
Price inflation	2.00	−0.84	−0.26	0.06
Wage inflation	4.04	0.81	1.11	1.28

Note: All the values are expressed in percentage points. The output gap is defined as the distance of actual output from potential, measured by $1 - L$.

Policy Intervention

- Following Schmitt-Grohe and Uribe (2012), consider the rule

$$i_t = \begin{cases} \max\left((1+\bar{\imath})\, L_t^{\phi} - 1, 0 \right) & \text{if } s_t = 0 \\ i_f & \text{otherwise} \end{cases}$$

where

$$\text{where} \quad s_t = \begin{cases} 1 & \text{if } i_{t-1} = 0 \\ 0 & \text{if } g_t \geq g_f \\ s_{t-1} & \text{otherwise} \end{cases}$$

- Under this rule, persistent liquidity traps are not possible, because the central bank commits to keep $i_t = 0$ for one period at most.
- This rule eliminates the unemployment steady state and persistent stagnation traps.

Policy Intervention

- Under discretion, the central bank maximizes households' utility taking future variables as given.
- Optimal policy for every period t

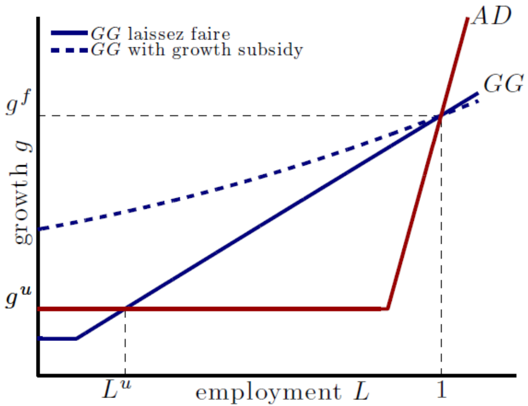
$$i_t \left(L_t - 1\right) = 0$$

- Intuitively, central bank sets $i_t = 0$ if there is some slack in the economy.
- If expectations coordinate on unemployment steady state central bank sets $i_t = 0$, validating pessimistic expectations.
- Under discretion both permanent and termporary self-fulfilling liquidity traps area possible.

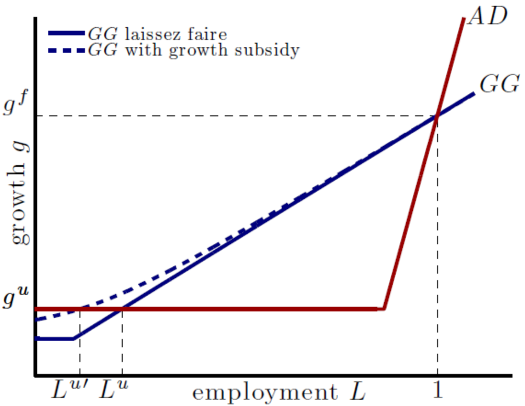
Policy implications:

- Recent emphasis on job creating growth
- Indeed an appropriate designed growth policy can eliminate liquidity traps driven by confidence shocks.
- Consider a countercyclical subsidy $s_t = s(1 - y_t)$.
- If s is sufficiently large, this policy rules out the liquidity trap steady state, while leaving unchanged the full employment steady state.

Countercyclical subsidy



Countercyclical subsidy



Conclusions

- We develop a *Keynesian growth* model in which endogenous growth interacts with the possibility of slumps driven by weak aggregate demand
- The model features two equilibria. One is a *stagnation trap*, a permanent liquidity trap characterized by weak growth.
- Large policy interventions to support growth can lead the economy out of the stagnation trap.
- Inverse of Say's lawy: lack of demand creates its own lack of supply.