Rodríguez-Clare et al. (2020): Simplified Model Solution and Exposition of Extension

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Setup:

- 4 Regions
  - 2 US, 1 C, 1 ROW
- 3 Sectors
  - (A)griculture, (M)anufacturing, (S)ervices
  - 1 Broad sector
    - $\Longrightarrow$ one wage per region
  - No home production
    - $\Longrightarrow$ 100% LFP
- 4 time periods
  - Period 0 just initial W, L conditions
  - 1, 2, 3 "real" periods

Parameters:

$$\delta = 0.984$$

$$\gamma = 1$$

$$\kappa = 5.9$$

$$\eta = \infty$$

$$\bar{L}_i = 1 \quad \forall i$$

$$\sigma_s = 1 \quad \forall s$$

$$\alpha_{j,s} = \frac{1}{3} \quad \forall j, \forall s$$

$$\phi_{j,k} = \frac{1}{3} \quad \forall j, \forall k$$

$$\phi_{j,sk} = \frac{2}{9} \quad \forall j, \forall s, \forall k$$

$$\tau_{ij,k,t} = 1 \quad \forall i, \forall j, \forall k, \forall t$$

$$D_{j,t} = 0 \quad \forall j, \forall t$$

$$\beta = 0.95$$

China Shock:

TFP table:

$k \setminus i$	US1	US2	CHN	ROW
A	2	2	1	1
M	4	4	X	1
S	8	8	1	1

$$X = \begin{cases} 1 & \text{if } t = 1 \\ 1.2 & \text{if } t = 2 \\ 5 & \text{if } t = 3 \end{cases}$$

Period 1:

- No shock
- Initial state of the world

vars $\setminus i$	US1	US2	CHN	ROW
W_{free}	0.3641	0.3641	0.1359	0.1359
W	0.3641	0.3641	0.1359	0.1359
P	8.3970	8.3970	8.3970	8.3970
W/P	0.0434	0.0434	0.0162	0.0162
L	1	1	1	1
l	1	1	1	1
$u(\%)$	0	0	0	0

Period 2:

- Small shock
- DNWR doesn't bind

vars $\setminus i$	US1	US2	CHN	ROW
W_{free}	0.3617	0.3617	0.1414	0.1351
W	0.3617	0.3617	0.1414	0.1351
P	8.4236	8.4236	8.4236	8.4236
W/P	0.0429	0.0429	0.0168	0.0160
L	1	1	1	1
l	1	1	1	1
$u(\%)$	0	0	0	0

Period 2:

- Large shock
- DNWR binds

vars \ i	US1	US2	CHN	ROW
W_{free}	0.3330	0.3330	0.2084	0.1256
W	0.3497	0.3497	0.2084	0.1256
P	8.8158	8.8158	8.8158	8.8158
W/P	0.0397	0.0397	0.0236	0.0142
L	0.9523	0.9523	1	1
l	1	1	1	1
$u(\%)$	4.77	4.77	0	0

Autor, Dorn, and Hanson (2013) (ADH):
For regions within US, facing negative Term of Trade shocks (from China) lead to decline in real wage and increase in unemployment and nonemployment.

The previous trade model can not capture those mechanisms well (Costinot et.al, 2014).

Rodríguez-Clare, Ulate, and Vasquez (2020) (RUV):
Built a model with downward nominal wage rigidity that explains these facts, and used it to analyze welfare effects of the "China shock".

But their model uses the nonstandard monetary mechanism of a nominal anchor.

Research Question: Can the nominal anchor be replaced with a more standard Taylor rule mechanism? :

- Introduce ability to save.
- Saving depends on future interest rates.
- Interest rates set by monetary authority(ies).
- Eliminate need for nominal anchor.

Labor and Utility in RUV:

- Before, utility function (non-home production) involved log of expected real wage:

$$U_{i,b,t} = \ln(\omega_{i,b,t}) + z_b$$

- Expected real wage is real wage times the probability of being employed:

$$\omega_{i,b,t} = \frac{W_{i,b,t} L_{i,b,t}}{P_{i,t} l_{i,b,t}}$$

- Utility from (expected) real wage because it represents consumption per capita
- z_b distribution gives labor force participation rate, $\pi_{i,t}$, sectoral share of employment in sector b, $\pi_{i,b,t}$, aggregated expected real wage, $\omega_{i,t}$ and welfare function, $u_{i,t}$:

$$\pi_{i,t} = \frac{\omega_{i,t}^{\kappa}}{\mu_i^{\kappa} + \omega_{i,t}^{\kappa}} \qquad \pi_{i,b,t} = \frac{\omega_{i,b,t}^{\eta}}{\omega_{i,t}^{\eta}} \qquad \omega_{i,t} \equiv \left(\sum_{b=1}^{B} \omega_{i,b,t}^{\eta} \right)^{1/\eta} \qquad u_{i,t} \propto (\mu_i^{\kappa} + \omega_{i,t}^{\kappa})^{1/\kappa}$$

New Labor and Utility:

- Need utility to come explicitly from consumption, not wages
- No clear way to do this
- $C_{i,b,t}$ never mentioned in paper

$$C_{i,b,t} \equiv \frac{W_{i,b,t}L_{i,b,t}}{P_{i,t}} = \frac{\omega_{i,b,t}}{l_{i,b,t}} = C_{i,k,t}, \forall k \in b$$

- Replace $\omega_{i,t}$ and thus utility:

$$\omega_{i,t} = \left(\sum_{b=1}^{B}(C_{i,b,t}l_{i,b,t})^{\eta}\right)^{1/\eta} \qquad u_{i,t} \propto \left(\mu_i^{\kappa} + \left(\left(\sum_{b=1}^{B}(C_{i,b,t}l_{i,b,t})^{\eta}\right)^{1/\eta}\right)^{\kappa}\right)^{1/\kappa}$$

- Budget constraint:

$$P_{i,t}\sum_{b=1}^{B}C_{i,b,t} = \sum_{b=1}^{B}W_{i,b,t}L_{i,b,t}$$

Objective Function and Budget Constraint:

- Objective function:

$$U_i = \sum_{t=0}^{\infty} \beta_i^t u_{i,t}(\{C_{i,b,t}\}_{b=1}^{B})$$

- Where

$$u_{i,t} = \left(\mu_i^{\kappa} + \left(\left(\sum_{b=1}^{B} (C_{i,b,t} l_{i,b,t})^{\eta} \right)^{1/\eta} \right)^{\kappa} \right)^{1/\kappa}$$

- Now have constraint include saving:

$$P_{i,t} \sum_{b=1}^{B} C_{i,b,t} + a_{i,t+1} = \sum_{b=1}^{B} W_{i,b,t} L_{i,b,t} + (1 + i_{i,t-1}) a_{i,t}$$

Budget Constraint Discussion:

- Repeat:

$$P_{i,t}\sum_{b=1}^{B} C_{i,b,t} + a_{i,t+1} = \sum_{b=1}^{B} W_{i,b,t}L_{i,b,t} + (1 + i_{i,t-1})a_{i,t}$$

- a could be capital, assets, bonds, etc. (would change equilibrium condition)
- In this setup, a just inter-temporal transfer from region i to i
- Could enrich this to multiple a's:
  - Save in different regions and/or sectors at different interest rates
  - w/ or w/o frictions

Euler equation:

- FOC's of the Lagrangian:
  - $C_{i,b,t}$

$$\beta_i^t \frac{\partial u_{i,t}}{\partial C_{i,b,t}} + \lambda_{i,t} P_{i,t} = 0$$

  - $a_{i,t+1}$

$$\lambda_{i,t} - \lambda_{i,t+1}(1 + i_{i,t}) = 0$$

  - EE

$$\frac{\partial u_{i,t}}{\partial C_{i,b,t}} = \beta_i \frac{P_{i,t}}{P_{i,t+1}}(1 + i_{i,t}) \frac{\partial u_{i,t+1}}{\partial C_{i,b,t+1}}$$

- EE replaces RUV's nominal anchor

Taylor Rule:

- ZLB Taylor Rule:

$$i_{i,t} = \max\left(0, \frac{1-\beta_i}{\beta_i} + \pi_i^* + \phi_{\pi,i}(\pi_{i,t} - \pi_i^*) + \phi_{u,i}(u_{i,t} - \bar{u}_i)\right)$$

- Where inflation is

$$\pi_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}$$

- With the monetary authority's target given by π^*, and unemployment is

$$u_{i,t} = 1 - \frac{\sum_{b=1}^{B} L_{i,b,t}}{\sum_{b=1}^{B} l_{i,b,t}}$$

- Where the flexible price unemployment rate $\bar{u}_i = 0$
  - Easy to use output gap instead

Value Added:

- Replaced nominal anchor with EE and Taylor Rule
- Introduced forward looking agents
- Generalizes nicely
  - Bonds, assets, capital
  - Different types for different regions/sectors
- Stochasticity seems doable

Thank You!