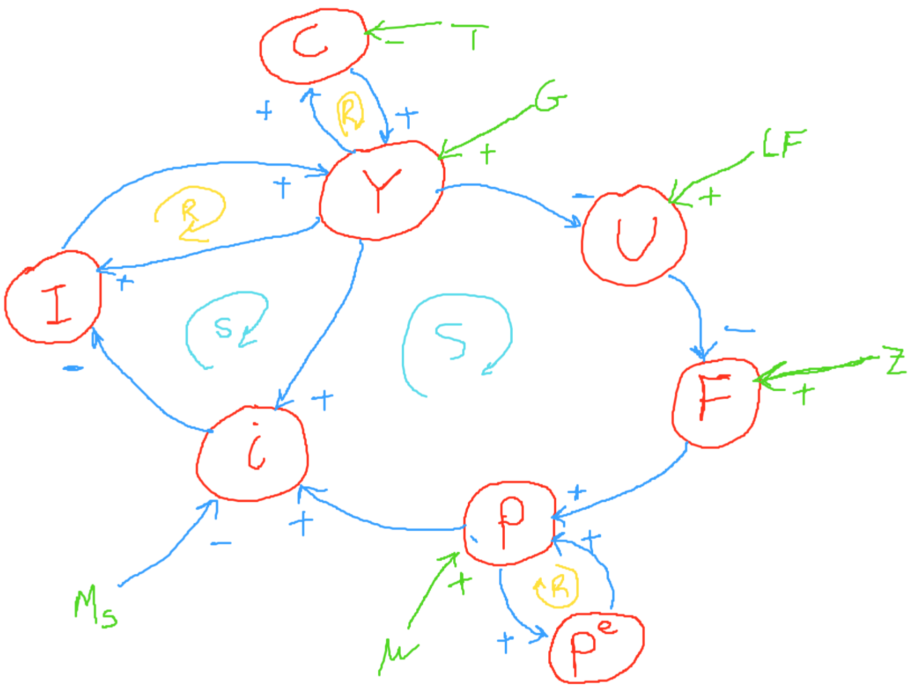
The following CLD represents a simplified model for macroeconomic dynamics in the medium run.



The links connecting the variables C, Y, I and i with one another and with exogenous inputs are faster, with delay equal to one time step. On the other hand, the links that involve U, F, P and P^e are significantly slower. We will represent this by averaging their inputs over the previous τ time steps. To begin with, let $\tau = 4$.

At each time step, all the variables are updated simultaneously, according to the following formulas for each link:

$Y \leftarrow C + I + G$, i.e. $Y(t + 1) = C(t) + I(t) + G(t)$

$C \leftarrow \gamma\, max(Y - T, 0)$, where $\gamma \geq 0$

$I \leftarrow \frac{\beta Y}{1+i}$, where $\beta \geq 0$

$i \leftarrow \frac{\beta Y P}{M_s}$

$P^e \leftarrow P$, i.e. $P^e(t + 4) = \frac{1}{4}(P(t) + P(t + 1) + P(t + 2) + P(t + 3))$

$U \leftarrow max\left(1 - \frac{Y}{LF}, 0\right)$

$F \leftarrow \frac{z}{U}$, where $0 \leq z \leq 1$

$P \leftarrow (1 + \mu)P^e F$

1. Do the state variables experience oscillations?
2. Do these oscillations die off or do they persist?
3. How do these oscillations depend on the values of the parameters τ, β and γ?
4. Do there exist fixed values of the exogenous variables that minimize the oscillations?
5. Are there ways to dynamically manage the exogenous variables in order to minimize the resulting oscillations even further?

For concreteness, you can consider starting the economy at $Y = 1$, $C = 0.75$, $U = 0.05$, $i = 0.04$, $I = 0.2$, $P = 1$, $P^e = 1$, $F = 0.6$, with $\gamma = 0.3$, $\beta = 0.03$, $\tau = 4$, and $M_s = 0.8$, $\mu = 0.4$, $z = 0.35$, $LF = 1.2$, $G = 0.2$ and $T = 0.25$.