Household

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

$$W_t L_t + (1+i) B_{t-1} + \Pi_t = P_t C_t + B_t + T,$$

$$\underbrace{\frac{1}{P_t} u'(C_t)}_{pain} = \underbrace{\beta \frac{1+i}{P_{t+1}} u'(C_{t+1})}_{gain}$$

$$\Rightarrow u'(C_t) = \beta(1+r_t) u'(C_{t+1}).$$

Noting that $u'(C) = \frac{1}{C_t^\theta}$

$$C_t^{-\theta} = \beta(1+r_t) C_{t+1}^{-\theta}$$

$$u'(C_t) = \beta(1 + r_t)u'(C_{t+1}).$$

$$\frac{W_t}{P_t}u'(C_t) = v'(L_t) \Rightarrow \frac{W_t}{P_t}\frac{1}{C_t^\theta} = L_t^\sigma$$

$$L_t = \left(\frac{W_t}{P_t}\frac{1}{C_t^\theta}\right)^{\frac{1}{\sigma}}$$

$$\lim_{t\to\infty} \beta^t u'(C_t)B_t = 0$$

B_0 given. Expectations? Perfect Foresight: $EX_t = X_t$.

Noting that $u'(C) = \frac{1}{C_t^\theta}$

$$C_t^{-\theta} = \beta(1 + r_t)C_{t+1}^{-\theta}$$

where $\beta \equiv \frac{1}{1+\rho}$. Taking logs gives

$$-\theta \log C_t = \log \beta + \log(1 + r_t) - \theta \log(C_{t+1})$$

Letting $c_t = \log C_t$

$$c_t = \frac{\rho - r_t}{\theta} + c_{t+1}$$

Let $\log G_t = g_t$, total (log) demand is

$$d_t = c_t + g_t = \frac{\rho - r_t}{\theta} + c_{t+1} + g_t$$

Goods market equilibrium is $y_t = d_t$.

$$y_t = \frac{\rho - r_t}{\theta} + c_{t+1} + g_t$$

Highly simplistic (could introduce balance sheet effects, investment, forex etc). All we need is negative relationship between r and y.

In long-run equilibrium (where g is fixed) output is at natural rate (i.e., potential) and the int rate is at natural rate too. Therefore:

$$y_n = \frac{\rho - r_n}{\theta} + c_{t+1} + g_t$$

This is why Taylor Rule tries to aim for natural rate; it is the level consistent with demand equal to *potential*. (Recall that in the short-run the economy will not automatically go to natural rate itself—a central Keynesian point.)

N monopolistically competitive firms. N very large so firm takes aggregates Y and P as given. Key is all firms face downwardly sloping demand curves. (Not price takers, though take wage as given; wage depends on labour market conditions and is flexible.)

For starters, think of economy at potential. Drop time subscripts.

The firms faces demand

$$Y_i = \left(\frac{P_i}{P}\right)^{-\eta} \frac{Y}{N}$$

So in a boom Y_i will rise, since Y is higher.

By choosing P_i firm implicitly chooses Y_i too.

Note that demand depends on *relative price*. This is what the firm will keep in mind. Even if firm has higher price, there is still demand.

Love of variety. η depends on substitutability between goods (and will determine markup).

Its production function is

$$f(L) = L$$

where L is number of workers hired by firm. $MPL = 1$. (Could also be $f(L) = AL$.)

Thus if firm wants to produces Y_i units, it needs to hire Y_i workers.

Firms revenue is $P_i \left(\frac{P_i}{P}\right)^{-\eta} \frac{Y}{N}$. It costs are $WL_i = WY_i$. Therefore, profits are

$$P_i Y_i - W L_i$$

$$P_i Y_i - W Y_i$$

where Y_i is given above. Only choice variable is P_i. Wage is exogenous to firm (will depend on national labour market).

The answer will be

$$P_i = \frac{\eta}{\eta - 1} MC$$

(MR=MC) where

$$MC = W$$

Hence to maximize profits firm sets

$$P_i = \frac{\eta}{\eta - 1} W$$

Firms target markup is $\frac{\eta}{\eta - 1}$. *No matter what happens, the firm will always aim for this markup.*

This is a key point to consider esp when we deviate from equilibrium level. Firms ideal relative price—what it really cares about—is then

$$\frac{P_i}{P} = \frac{\eta}{\eta - 1}\frac{W}{P} = \frac{\eta}{\eta - 1}\frac{MC}{P}$$

This is firms *ideal* relative price if it were free to adjust. So if wages rose, $\frac{P_i}{P}$ would rise proportionally. It cares about relative price since thats what determines demand and real profits.

Substituting price into demand function gives firms demand: $\left(\frac{\frac{\eta}{\eta-1}W}{P}\right)^{-\eta}\frac{Y}{N}$

Equilibrium Output at equilibrium wage. Determined by fundamentals.

In any equilibrium production will have to equal demand. In natural equilibrium demand equals potential. (Roughly, people earn income, and use this to buy stuff, so this is natural. Supply creates own demand.)

In symmetric equilibrium, all firms will charge the same price, so $P_i = P$. (This is true, since all firms face same marginal cost, W, and same aggregate demand.)

In symmetric equilibrium, real wage is $\frac{\eta-1}{\eta}$. Importantly, $\frac{\eta-1}{\eta} < 1 = MPL$. Equilibrium production by any firm is then $\left(\frac{\frac{\eta}{\eta-1}W}{P}\right)^{-\eta} \frac{Y}{N}$

So with equilibrium real wage of $\frac{W}{P} = \frac{\eta-1}{\eta}$, equilibrium production by any firm is $\frac{Y}{N}$. Hence,

by symmetry, total equilibrium production in the economy will by Y. From looking at demand curve, this is also equilibrium aggregate demand.

So what's Y, anyway? This is labour demand.

Now, theres an obvious way to find out what equilibrium production is. See, production is determined solely by labour supply. Theres no other way to get more output, given the production function. So just find out what labour supply is at equilibrium wage, $\frac{\eta-1}{\eta}$. We can get this from the labour supply curve. I wont go into details here, but just think of picking the point on the labour supply curve where real wage is $\frac{\eta-1}{\eta}$. This will pin down equilibrium labour supply and hence equilibrium output/production. This level will be the level of *potential or natural* output. Because output=aggregate demand in equilibrium, this will

also be the equilibrium level of demand in economy. Everything determined by the interaction of firm and household maximization problems. A truly "micro-founded" model.

Each firm will produce $\frac{1}{N}$th. The worker will work at each firm.

Thats it. We now have equilibrium real wage, equilibrium output/production/demand and equilibrium labour supply. All actions are consistent. Labour demand equals labour supply. Goods market clearing ensures Y supply equals Y demand. $Y = C + G$. Goods and labour market clearing. Money too.

More generally, can have welfare systems affecting NAIRU.

Potential also called flexible price equilibrium.

$$u'(y - g) = (1 + r)\beta u'(y_{t+1} - g)$$

$$\frac{M}{P} = L(r_n, y_n)$$

Here Y_n and r_n are determined by fundamentals. Thus a rise in M just rises P.

Market clearing is

$$Y = L = demand$$

ASSUME PRICES FIXED. We start off at equilibrium/potential, Y_n, derived a moment ago. Then, money supply increases. What happens? First recall money market equilibrium condition. Because prices are fixed, real interest rate falls below natural rate, r_n. Then by IS curve, aggregate demand increases to $Y > Y_n$.

$$Y_i = \left(\frac{P_i}{P}\right)^{-\eta} \frac{Y}{N}$$

Each firm faces increase in demand. Prices are fixed, by assumption. What will firm do? Can increase profits by producing more, since $P_i > MC$. Labour Demand increases. (In a flexible price economy, we assume all this happens in an instant.) Now for bad news: To increase labour supply, wages must rise.

$$\frac{W_t}{P_t}\frac{1}{C_t^{\theta}} = L_t^{\sigma}$$

Given C_t this defines a labour supply function:

$$L_t = \left(\frac{W_t}{P_t}\frac{1}{C_t^{\theta}}\right)^{\frac{1}{\sigma}}$$

Because this is a transitory increase in wage, we can treat C_t as fixed. Namely, any transitory change is spread over lifetime by the PIH, so effect on C_t is negligible. So treat above as a relationship between $\frac{W_t}{P_t}$ and N_t. Point is, to increase L, $\frac{W_t}{P_t}$ must rise. By how much? Depends of course on σ.

Getting back to firm, the firm would now like to raise price, which you'll recall is increasing in wages. But it can't by assumption. Best thing it can do is still meet demand since $p > MC$ (as long as MC doesnt rise too much to $p < MC$!)

Now, turning to markups. Recall that target markup given implicitly by

$$\frac{P_i}{P} = \frac{\eta}{\eta - 1}\frac{W}{P}$$

That is, firm always wants markup of $\frac{\eta}{\eta-1}$. But more generally, for *any* arbitrary price (not necessarily the optimal one):

$$\frac{P_i}{P} = \text{MARKUP}\frac{W}{P}$$

But because P_i is fixed, and $\frac{W}{P}$ has risen, markup deviates from desired one, $\frac{\eta}{\eta-1}$. In particular, markup is now less than equilibrium markup $\frac{\eta}{\eta-1}$. Not good for firm!

Given firm's profit maximization objective, this suboptimal markup is not sustainable. Eventually (in "long-run") firms start raising prices to get back optimal markups. For this reason,

price *level* rises. This causes real interest rate to rise, causing real demand to fall. All previous actions reversed. (Useful to recall money supply/demand equilibrium here $\frac{M}{P} = L(r, y)$. So a rise in P lowers real money balances and raises r. Think of firms charging high prices and then you have less money to spend on other firms goods. Consistent with idea that FED only affects output when prices are fixed.)

Labour demand falls and wages fall. Return to initial equilibrium.

Model shows how classical dichotomy breaks down in short-run. Sticky prices obviously central to story. Shows mechanism by which sticky prices in short run leads to money-induced output fluctuations. This *is* a big deal. This is consistent with FED affect rates temporarily and the reality that FED cant affect activity forever.

WE can say increase in prices leaves less money for every other firm so demand falls.

Upward pressure on price level.

Output demand determined.

Why are prices sticky?

In our model, must be wages (but prices of inputs rise for many reasons e.g., oil surcharge)

Menu Costs (Nominal Rigidity) (no matter what happens wages)

Menu costs (nominal rigidity) not enough.

What happens to real marginal costs? Diminishing returns to labour etc. Inelastic labour; reduce prices too.

Evidence suggests steep labour supply (i.e., not what we need for real ridigity). School year.

Sticky real marginal costs a large source of stickiness (Real rigidity)

Procyclical elasticities of demand.

Efficiency wages/downward rigidity. Wages play lots of other roles. Unions.

Costs fall more generally; balance sheet effects; low wages leaves lemons (adverse selection)

External finance premium; cost of capital lower.

IRS; externalities; disutility of labour; social norm

Desired markups change

These reduce responses of costs to demand changes

Adverse selection

Implicit contracts