Lecture 13: Endogenous Labor Supply and Money Demand

ECON 30020: Intermediate Macroeconomics

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Readings

GLS Ch. 12 and 14

Real vs. Nominal

Up to this point, every thing in this course has been in real units

In reality, we typically measure prices (and many quantities) in nominal units

In theory, real vs. nominal:

- Real: measured in units of goods (e.g., fruit, cars, TVs)
- Nominal: measured in units of money (e.g., dollars, euros, pesos)

In practice, real vs. nominal:

- Real: measured in constant dollar (i.e., base year) prices
- Nominal: measured in current dollar prices

Money

If nominal prices are measured in units of money, what is money?

Money is an asset that can be used to transfers resources across time

Of course, there are many assets, most "backed" by something

Money is a special asset in that it can be used in exchange and is typically "backed" by nothing

Functions of Money

With most things we define them according to intrinsic characteristics

With money, we instead give a <u>functional</u> definition

Money is any asset that serves the following three functions:

1. Medium of exchange
2. Store of value
3. Unit of account

Medium of Exchange

The most important role played by money is its role as a medium of exchange

This solves the "double coincidence of wants" problem associated with barter

Bonds and capital can serve as stores of values (any asset does so, so money is not unique), and anything can serve as a unit of account in principle

But money is unique in its role as medium of exchange

Money's role as a medium of exchange has been critical to the historical growth in economic activity via specialization

<u>Fiat money</u> is backed by nothing at all, other than a declaration from the issuer (i.e., government or central bank) that it is acceptable in exchange for goods and services

Putting Money in a Model

This is actually quite difficult

Money's usefulness derives from a multitude of different goods and services (i.e., double coincidence of wants)

Most macro models assume, for tractability, one type of good (e.g., fruit)

Unlike bonds or capital, money offers no rate of return

To get a household to hold it, we take a shortcut: money in the utility function

Labor Supply

Unlike in the Solow model, where we assumed labor was inelastically supplied, we want to model endogenous labor supply

Intuitively:

- Households are endowed with some time each period
- They can split their time endowment between leisure (L_t) and labor (N_t)
- Households receive utility flows from leisure (equivalently, disutility from work)
- The wage is the opportunity cost of leisure

Modeling Labor Supply and Money Demand

Household lives for two periods. Flow utility is now:

$$U = u\left(C_t, 1 - N_t\right) + v\left(\frac{M_t}{P_t}\right) + \beta u\left(C_{t+1}, 1 - N_{t+1}\right)$$

New variables:

- M_t: units of money (e.g., dollars)
- P_t: nominal price (e.g., dollars per good)
- $m_t = M_t / P_t$: real money balances (i.e., number of equivalent goods one holds in money)
- N_t: labor (units are time, e.g., hours)
- $L_t = 1 - N_t$: leisure (time endowment normalized to one)

Money is held <u>across</u> periods, utility received in period t

Properties of Functional Forms

Utility functions:

- $u_C(\cdot) > 0$, $u_{CC}(\cdot) < 0$ (increasing at a decreasing rate)
- $u_L(\cdot) > 0$, $u_{LL}(\cdot) < 0$
    - Note: $\uparrow N_t \rightarrow \downarrow L_t \rightarrow \downarrow u(\cdot)$
    - e.g., $u(C_t, 1 - N_t) = \ln C_t + \theta_t \ln(1 - N_t)$
    - e.g., $u(C_t, 1 - N_t) = \ln\left[C_t + \theta_t \ln(1 - N_t)\right]$
        - Called GHH preferences (Greenwood, Hercowitz, and Huffman 1988)
    - θ_t: exogenous (and potentially time-varying) preference shock
- $v'(\cdot) > 0$, $v''(\cdot) < 0$
    - e.g., $v(M_t/P_t) = \psi \ln\left(M_t/P_t\right)$, $\psi \geq 0$ is a preference parameter

Flow Budget Constraints

Write the budget constraints in <u>nominal</u> rather than real terms:

$$P_t C_t + P_t S_t + M_t \leq W_t N_t - P_t T_t + P_t D_t$$

$$\begin{aligned} &P_{t+1} C_{t+1} + P_{t+1} S_{t+1} - P_t S_t + M_{t+1} - M_t \leq \\ &\quad W_{t+1} N_{t+1} + i_t P_t S_t - P_{t+1} T_{t+1} + P_{t+1} D_{t+1} + P_{t+1} D^I_{t+1} \end{aligned}$$

New variables:

- W_t: <u>nominal</u> wage (dollars per unit of time)
- i_t: <u>nominal</u> interest rate (percent return on dollars of bonds carried across time)
- D_t: real dividend received from firm
- D^I_{t+1}: real dividend from financial intermediary

In budget constraints, M_t (dollars of money) and S_t (real savings in bonds) enter the same way, except bonds pay interest and money doesn't

Terminal Conditions and Re-Writing in Real Terms

Two terminal conditions: $S_{t+1} = 0$ and $M_{t+1} = 0$

To write in real terms, divide each period constraint by that period's price:

$$C_t + S_t + \frac{M_t}{P_t} \leq w_t N_t - T_t + D_t$$

$$C_{t+1} \leq w_{t+1} N_{t+1} + \frac{M_t}{P_{t+1}} + (1 + i_t)\frac{P_t}{P_{t+1}} S_t - T_{t+1} + D_{t+1}$$

$w_t = W_t / P_t$ is the real wage (units of good per unit of time worked)

The Fisher Relationship

Earlier, we had second-period constraint:

$$C_{t+1} \leq Y_{t+1} + (1 + r_t) S_t$$

Fisher relationship: relates real to nominal interest rate:

$$1 + r_t = (1 + i_t) \frac{P_t}{P_{t+1}}$$

Define gross inflation, Π_t, as (π_t is net inflation):

$$\Pi_t = \frac{P_t}{P_{t-1}} = (1 + \pi_t)$$

$$\Rightarrow 1 + r_t = (1 + i_t) \Pi_{t+1}^{-1}$$

$$r_t \approx i_t - \pi_{t+1}$$

Treat $\pi_{t+1} = \pi_{t+1}^e$, where π_{t+1}^e is exogenous

Real Intertemporal Budget Constraint

$$C_t + \frac{C_{t+1}}{1+r_t} + \frac{i_t}{1+i_t}\frac{M_t}{P_t} = w_t N_t - T_t + D_t + \frac{w_{t+1}N_{t+1} - T_{t+1} + D_{t+1} + D^I_{t+1}}{1+r_t}$$

The same as we had before, except we added money and endogenized income

$\frac{i_t}{1+i_t}\frac{1}{P_t}$ is essentially the "price" of money measured in units of consumption, just as $\frac{1}{1+r_t}$ is the price of future consumption in terms of current consumption

- Save via money instead of bonds: forego i_t units of future nominal consumption, or i_t / P_{t+1} units of future real consumption.
- In terms of future real consumption, discount this loss by $\frac{1}{1+r_t}$. So $\frac{i_t}{1+r_t}\frac{1}{P_{t+1}}$ is the "price" of holding money.
- Using Fisher relationship, this can be written $\frac{i_t}{1+i_t}\frac{1}{P_t}$