Summary Models/Empirics of Short Run Fluctuations-Business Cycles

Simple ISLM Model (Standard Keynesian Model 1950s-1980s)

y = f(consumption, investment): IS function
Ms = Md = f(income, interest): LM function
often written as below
Goods Markets (IS): $Y = C[Y-\tau(Y)] + I(R) + G$
Lending/Money Markets (LM): $Ms = Md(r, Y)$

A simple linearized, macroeconometric version (See Webb Richmond Fed):
(coefficients stand in for partial derivatives, e.g. $b_1 = \partial c/\partial y$)

(1) Basic GDP definition: $Y = C + I + G$
(assume supply (lhs) responds to demand, C+I+G)

(2) Consumption Function: $C = b_1*[Y- \tau*Y]$

(3) Investment Function: $I = b_2*r$

(4) Money Demand Function: $M = b_{31}*Y + b_{32}*r$

Key Variables/Parameters

y = income
c = consumption expenditure
τ = marginal tax on income
i = investment expenditure
r = real interest rate = R – P(e)
g = government expenditure
Ms = money supply
Md = Money demand
P = price level
Yp = percent of potential output
b_1 = marginal propensity to consume from more income (> 0)
b_2 = marginal effect of interest rate on investment (< 0)
a1 = effect of higher output gap on prices (< 0)
a2 = effect of past prices on current price expectations (> 0)
b_{31} = marginal effect of income on money holdings (>0)
b_{32} = marginal effect of interest rate on money holdings (< 0)

Goods (IS) Side:

(5) $Y = b_1*[Y- \tau *Y] + b_2*r + G$ (substituting for C, I, G in GDP definition)

(6) $dY = b_1(dY - \tau *dY] + b_2*dr + dG$ (taking total derivative)

(7) $dY - b_1*dY(1- \tau) = b_2*dr + dG$ (rearranging and collecting terms)

(8) $dY[1-b1(1- \tau)] = b_2*dr + dG$ (simplifying)

Slope of IS Curve (dr/dY, holding dG constant):

(9**) dr/dy** = $[1-b_1(1- \tau)]/b_2$ (dividing terms from (4); this relationship is negative because b2 is negative)

- Steepness/flatness of curve depends on b_1 (propensity to consume); when it is higher, curve is steeper
- Steepness/flatness of curve depends on b_2 (investment response to higher rates; when higher, curve is flatter)
- In this simple model, price level expectations have no impact on output; producers respond to all spending increases as if they reflect higher demand/greater purchasing power

Money (LM)Side:

(10) $M = b_{31}*Y + b_{32}*r$

(10a) $dM = b_{31}*dY + b_{32}*dr$ (take total derivative)

Slope of LM "Curve"(dr/dY, holding Ms, P constant)

(11) $-b_{32}*dr – b_{32}*= b_{31}*dY$ (set dM =0 and move dr term to lhs)

(12) dr/dY = $- b_{31}/b_{32}$ (rearrange to get dr/dY on lhs; relationship is positive because $b_{32} < 0$)

- Slope is positive because the relationship between higher interest and money demand (b_{32}) is negative;
- The derivations above don't explicitly include prices; the simplest way to think about their effect is to consider them increasing the size of the interest rate/money relationship; With higher output percentages (less slack), prices and price expectations increase, lowering money demand by more than it would be otherwise

Income/Output Multipliers (policy implications of the model)

To determine the (simple model) impacts of more government spending or more money, set the IS and LM equations equal to each other and solve for dY/dG or dY/dM; in simple cases, each multiplier is derived assuming changes in the other policy variable are zero:

A quick solution is to solve (4) and (6) for dr, and then set equal to each other:
(13) $\{(dY[1-b_1(1-\tau)]) - dG\}/b_2 = (dM - b_{31}*dY)/b_{32}$

A little algebra (moving the denominators to the other side, moving dG to the rhs, and then dividing through by dG yields:

Government spending multiplier (effect of higher G on Y)
(14) dY/dG = $b_{32}/\{b_{32}[1-b_1(1-\tau)] + b_2*b_{31}\}$

- Marginal Propensity to Consume ($b_1 = \partial c/\partial y$) is key term; when it is higher, the G-multiplier is higher; "paradox of thrift" – more spending better than more saving (in short run);
- Other key term is impact of interest on investment (b_2); when this is larger, multiplier is smaller because gov't spending is "crowding out" some private investment; same with interest impact on money demand (b_{32})
- Gov't budget constraints: If tax rates adjust to higher G (or expectations of future tax rates adjust), then the denominator is larger and the government spending multiplier is smaller

Money-Income multiplier (effect of more M on Y)
(15) dY/dM = $b_2/\{b_{32}[1-b_1(1-\tau)] + b2*b_{31}\}$

Main Results of Simple ISLM Model:

- **Demand-oriented; limited household choice/response**
- **Key sources of shocks ("exogenous" variables): G, M, r, τ, c**
- **Key propagation mechanisms ("endogenous" relationships):**
  - **Strength of consumption-income ("propensity to consume): (∂c/∂y)**
  - **Strength of investment-interest relationship (∂i/∂r)**
  - **Strength of money demand-income and interest relationships (∂Md/∂y)/ (∂Md/∂r)**

Questions/Expansions:

- Reaction of consumption to temporary v. permanent changes?
- Reaction of tax/tax expectations to higher G (govt budget constraints)?
- Reaction of price expectations and prices/wages to higher M?
- Production-side reactions
- Behavior over time?

These questions and others became source of modifying the basic ISLM model to incorporate more accurate and micro-based perspectives and evidence on behavior; for example, an early and simplistic way to incorporate pricing responses is (see Webb Richmond Fed)

Modified Investment: $I(r,Pe) = b_2(R-Pe)$;
Pricing Functions: $Pe(t) = b_4*P(t-1)$; $P(t) = b_5*Yp$

- Investment lower for given nominal interest rate and higher expected inflation;
- Prices are higher (lower) when potential GDP (Yp) is closer (farther from) to 100%;
- Current price expectations lag behind last period's actual prices: $dPe/dt = dP(t-1)/dt$;

- Or, higher price expectations can reduce Md so b_{33} is negative and
- Modified Md: $Md(t) = b_{31}*Y(t) + b_{32}*r(t) + b_{33}*Pe(t)$
- Money influenced Prices: $P(t) = b_5*Yp(t) + b_6*M(t)$
- "Rational" Expectations: $Pe(t) = P(t)$ + random error
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- **dY/dM** = $b_2/\{b_{32}[1-b_1(1-\tau)] + b_2*b_{31}\} + b_{33}*(dPe/dM) = \{.\} + b33*b5*d(P)$
- Rising price expectations offset the injection of money (more on this later)

Micro-Based Models -- Neoclassical Synthesis

Key Variables/Parameters
Y = income
c = consumption expenditure
τ = marginal tax on income
i = investment expenditure
r = real interest rate = R – P(e)
G = government expenditure
Ms = money supply
Md = Money demand
P = price level
T = tax revenue
L = Labor hours
K = capital
A = general productivity or "technology"
θ = labor share, MP of labor
α = utility-leisure parameter

Rather than modifying the ISLM and macroecometric versions of it in with wage equations, md equations, production function for Ys, and other features, in the 1970s and onward, many reseachrs began to build the models up from basic micro-econ foundations. The basic framework for these models mimic the long run models such as Prescott.

Aggregate Production:
(16) $Y = AL^{\theta}K^{1-\theta}$
$dlnY = dlnA + \theta\, dlnL + 1-\theta\, dlnK$ (same function expanded into logarithmic form)

Household Preferences:
(17) E

Budget Constraints:
(18) $c_t(1+\tau) + i_t(1+\tau) = w_t * L_t(1-\tau) + K_t(1-\tau)(r-\delta) + T$ (households)
$G(t) = T(t) + D(t) + M(t)$ (Government)
NPG Condition on Debt (Government)

(19) Market Equilibrium: $Y = C + I + G$

These kinds of models often now labeled as DSGE (Dynamic, Stochastic, General Equilibrium). Analytical solutions to this kind of setup requires finding the household maximum given the constraints using time-based, dynamic optimization calculus. Numerical solutions (simulations) can be generated given calibrated values for the parameters and a computer program such as Prescott's.

The Prescott Model and associated simulation program provides an example:

genr CH (consumption-labor ratio) = Z^(1-theta)*KH^theta - (g+delta)*KH
genr cw (individual consumption) = 1/(alpha/((1-tauh)*w) + Npop/(CH*Nwork))
genr hi (individual labor hours) = 1 - alpha*cw/(w*(1-tauh))
genr w = Z^(1-theta)*(1-theta)*(HK)^(-theta)

Main Results of Micro-Based Models

- **Households choosing labor, consumption based on leisure preference and key parameters like productivity of capital, tax rates, ...**
- **Households forward-looking**
- **Labor/wages determined by household choices and MP of labor**
- **Labor, Total output can vary because of random fluctuations in production; include a term that makes Z or g fluctuate in a probabilistic way**

- **Key shocks (exogenous influences):**
  -- supply/production/"technological" changes and productivity
  -- demand side/household influences including leisure/labor preferences (α)
  -- in general, random variation in underlying processes like prices, tech, ...
- **Key propagation mechanisms (endogenous relationships):**
  Strength of relationship between income and taxation
  Expectations: If expected Price Level (P) changes, Md not constant in face of Ms changes; expected disposable income not constant in face of g or g-debt changes.
- Modifications: Pricing decisions; labor contracts, wage flexibility/inflexibility, Credit markets, Fed reaction, ... can all be incorporated with additional equations

Key empirical questions:

- What are the underlying features of economic fluctuations? To what extent are ups and downs (expansions, recessions) part of the same processes and to what extent are they different?
- What variables are really exogenous?
- What is the relative importance of production side influences versus demand side influences?
- What is a technological shock (narrow sense and broad sense)?
- How much to households/firms look forward to gauge future income, taxes, prices ... in making decisions?
- What are the sizes of endogenous relationships that amplify/dampen these exogenous changes?
  - -- Are prices "sticky" and do these influence fluctuations?
  - -- How do financial/credit conditions influence fluctuations?
- Can policy responses (fiscal or monetary stimulus) offset downturns?
  - -- Do fiscal stimulus prompt more spending?

Evidence – General & Exogenous Shocks

- Barsky-Miron (1989 JPE): Seasonal fluctuations account for 80% of GDP and 60% of unemployment movements in raw (not de-seasonalized) data
- Barro (2008): Dampening of Post WWII Cycles but not big differences if pre-1914 and post 1947 compared
- Hamilton (2000, StL Fed): Labor markets behave differently during recessions; Regime shifting (recessionary periods different "process") model fits unemployment better than single process model
- Hamilton (JPE 1983 and related literature) showing important connection between oil shocks and recessions
- Cochrane (Carnegie-Rochester Series 1993): VAR impulse response study of variety of shocks (c, M, credit, oil); identifying what is truly "exogenous" not easy; separating shocks and propogation effects not easy;
- xxxxx (2010): Data not extensive enough to permit identification of relationships; Cochrane (2010) says same type of thing, indicating that absence of solid empirical tests puts burden on analytics
- Finance/Credit role – see later lecture

Evidence -- Endogenous Amplifiers/Dampeners (propagation of shocks)

(Propensity to consume (c-y); forward-looking behavior offsetting)

- Landsberger (1970): Germany gifts to Israel only 20% consumed out of gift of about 1 year's income
- Hsieh (AER 2003): Alaskan oil royalty payments anticipated income changes generated little change in consumption
- Souleles (1999): tax refunds generate only a 10% change in non-durable consumption

(Intertemporal Labor Supply): short run responses to supply-side influences

- Mulligan (1995 Pop Research Center): Alaskan gas pipeline 1974-77 and Valdez spill 1989 temp high real wage; 10% increase in real wage created 20% increase or greater in labor hours;

(Slow-Adjusting, "Sticky Prices")

- Bils-Klenow (JPE 2004): 75,000 prices, 1995-1997; 22% changed monthly; median duration of price 4.5 months
- Nakamura-Steinsson (Harvard 2006): 1988-2005, 4.5 months on all prices (incl. sales), 10 months on "regular" prices; average size of price change 8%
- Golosov-Lucas (MIT 2006): Simulation economy with Nakamura-Steinsson size price inflexibility; economies with low inflation, most prices changes due to demand/tech changes; in economies with high inflation, monetary disturbances change prices

(Labor Contracts): Do Labor Markets Contain Frictions so that Supply-Demand Don't Work in the Micro Way?

- Ahmed (1987) 19 Canadian industries 1961-74; compare those with and without indexation in contracts; Monetary shock effects nearly same in both types
- Bils (JPE 1989): 12 US manufacturing industries and behavior of wages/employment before after new contracts; a few (like motor vehicles) showed employment changes just after; no changes in real wages
- Olivei and Tenreyro (AER 2007): seasonal effects of wage setting practices – near end of year; bigger M-policy effects when near start of year;
- Barro (2008 book): Actual price level movements countercyclical, price misperceptions models predict procyclical; real wage actually procyclical, misperceptions model countercyclical

(Money Demand)

- Mulligan-Sala-i-Martin(JPE 2000): Md more sensitive to interest changes at higher rates

(Multiplier Estimates)
Class Discussion