SHOCKS

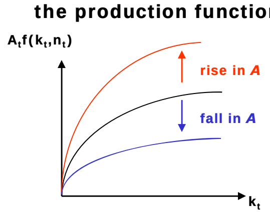
OCTOBER 31, 2011

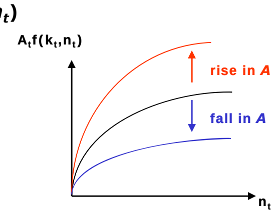
BASICS

- **Shock / shifter**
  - **<u>Definition</u>: Some unexpected event that affects economic fundamentals and hence decisions, but which is unexplained or unexplainable**
- **Introducing shocks into our frameworks (consumption-leisure, consumption-savings, infinite-period) will "get them moving"**
- **Will consider (for now) two types of shocks**

"SUPPLY SHOCK"

  - **Total Factor Productivity (TFP) Shocks – unexpected changes in A_t in the production function $A_t f(k_t, n_t)$**





"DEMAND SHOCK"

  - **Preference Shocks – unexpected changes in representative consumer's utility function; causes rotations of indifference maps**

TFP IN COBB-DOUGLAS PRODUCTION FUNCTION

- **Revisit the commonly-used functional form in modern quantitative macroeconomic analysis**

$$\text{output}_t = A_t f(k_t, n_t) = A_t k_t^{\alpha} n_t^{1-\alpha}$$

- **Describes the empirical relationship between aggregate output, aggregate capital, aggregate labor, and level of sophistication of technology (TFP)**
  - **(How to measure TFP in Chapter 13)**
- **Cobb-Douglas form useful for illustrating effects of TFP shocks**
- **Unexpected change (i.e., a shock) in A_t**
  - **Causes change in marginal product of labor**

$$mpn_t = \frac{\partial \text{output}_t}{\partial n_t} = A_t f_n(k_t, n_t) = A_t (1-\alpha) k_t^{\alpha} n_t^{-\alpha}$$

Recall *mpn* is foundation for labor demand

  - **Causes change in marginal product of capital**

$$mpk_t = \frac{\partial \text{output}_t}{\partial k_t} = A_t f_k(k_t, n_t) = A_t \alpha k_t^{\alpha-1} n_t^{1-\alpha}$$

Recall *mpk* is foundation for capital/investment demand

TFP SHOCKS AND LABOR DEMAND

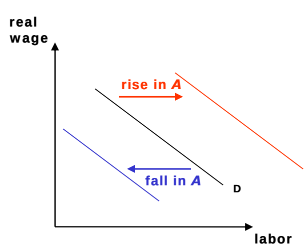
- **Firm-level demand for labor defined by the relation**

$$w_t = A_t (1-\alpha) k_t^{\alpha} n_t^{-\alpha} \; (= mpn_t)$$

Because exponent ($-\alpha$) is a negative number, can move to denominator

$$w_t = A_t (1-\alpha) \left(\frac{k_t}{n_t} \right)^{\alpha}$$

FOR GIVEN r_t and w_t, rise (fall) in A_t raises (lowers) n_t



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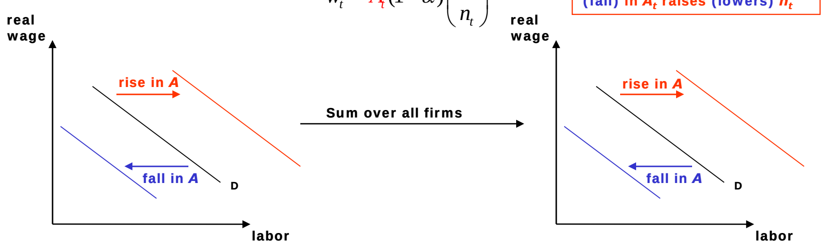


Firm-level labor demand function

Aggregate-level labor demand function

- **IMPORTANT**: TFP shocks shift the labor demand curve

TFP Shocks and Capital Demand

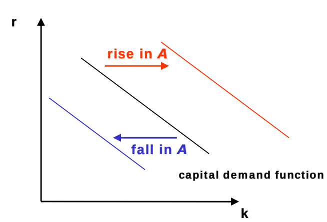
- Firm-level demand for capital **defined** by the relation

$$r_t = A_t\alpha k_t^{\alpha-1}n_t^{1-\alpha} \,(= mpk_t)$$

Because exponent ($\alpha - 1$) is a negative number, can move to denominator

$$r_t = A_t\alpha\left(\frac{n_t}{k_t}\right)^{1-\alpha}$$

FOR GIVEN r_t and w_t, rise (fall) in A_t raises (lowers) k_t



TFP Shocks

TFP Shocks and Capital/Investment Demand

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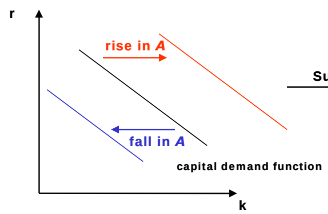
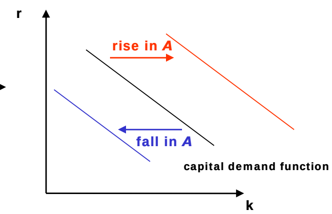


Firm-level capital demand function

Sum over all firms →



Aggregate-level capital demand function

- **IMPORTANT**: TFP shocks shift the capital demand (and hence investment demand – recall $inv_t = k_{t+1} - k_t$) curve

Preference Shocks

Preference Shocks

- Illustrate idea using consumption-leisure framework
  - Preference shocks in consumption-savings framework: Practice Problem Set 7

- Utility function (modified from Chapter 2): $u(Bc, l)$
  - c: consumption
  - l: leisure
  - B: preference shifter, with $B > 0$
    - Chapter 2: were implicitly considering $B = 1$

PREFERENCE SHOCKS

- **Illustrate idea using consumption-leisure framework**
  - **Preference shocks in consumption-savings framework: Practice Problem Set 7**
- **Utility function (modified from Chapter 2): *u*(*Bc*, *l*)**
  - ***c*: consumption**
  - ***l*: leisure**
  - ***B*: preference shifter, with *B* > 0**
    - **Chapter 2: were implicitly considering *B* = 1**
- **Mechanics of *B***
  - **Makes *each* unit of *c* more (high *B*) desirable…**
  - **…or less (low *B*) desirable**
- **Interpretation of *B***
  - **"Cultural" events that alter individuals' *desires***
  - **"Political" events that alter individuals' *desires***
  - **Any other events that alter individuals' *desires***

  Society-wide **events that alter a *given* person's desires – hence "taken as given" by an individual**

PREFERENCE SHOCKS

- **MRS between consumption and leisure**
  - **Definition is same as always**

    $$MRS_{c,l} = \frac{\partial u / \partial l}{\partial u / \partial c}$$

  - **But now need chain rule of calculus to compute $\partial u / \partial c$**
    - **Because first argument of *u*(.) is now the *composite* *Bc*, not simply *c***
- **Chain rule: $\partial u / \partial c = u_1(Bc, l) \cdot B$ (grab the *B* term inside the first argument)**

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- **Chain rule:** $\partial u / \partial c = u_1(Bc,l) \cdot B$ **(grab the *B* term inside the first argument)**
- **MU of leisure same as always:** $\partial u / \partial l = u_2(Bc,l)$
- **→ MRS between consumption and leisure**
  - ***B* affects MRS in "two" ways**

The effects of *B* here affect indifference curves

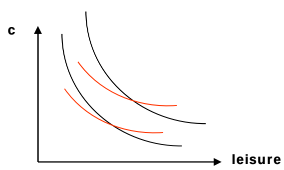
$$MRS_{c,l} = \frac{\partial u / \partial l}{\partial u / \partial c} = \frac{1}{B} \cdot \frac{u_2(Bc,l)}{u_1(Bc,l)}$$

The effects of *B* here cancel out (affects numerator and denominator in same way)

PREFERENCE SHOCKS AND INDIFFERENCE MAPS

$$MRS_{c,l} = \frac{\partial u / \partial l}{\partial u / \partial c} = \frac{1}{B} \cdot \frac{u_2(Bc,l)}{u_1(Bc,l)}$$

IF *B* RISES



Rise in *B* flattens all indifference curves (i.e., lowers *MRS* at any point in *c-l* space).

Interpretation: each unit of *c* more valuable, so *decreased willingness* to trade *c* for one more unit of *l*

PREFERENCE SHOCKS AND INDIFFERENCE MAPS

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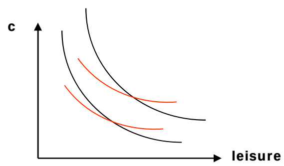
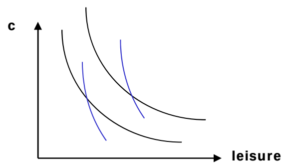


Rise in ***B*** flattens all indifference curves (i.e., lowers ***MRS*** at any point in ***c-l*** space).

Interpretation: each unit of ***c*** more valuable, so ***decreased willingness*** to trade ***c*** for one more unit of ***l***

Superimpose a budget line: optimal choice of ***c*** and ***l*** clearly affected by shock to ***B***

IF *B* FALLS

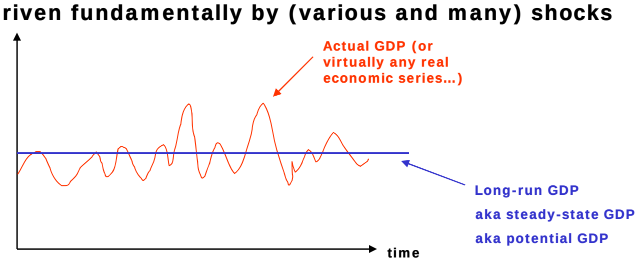


Fall in ***B*** steepens all indifference curves (i.e., raises ***MRS*** at any point in ***c-l*** space).

Interpretation: each unit of ***c*** less valuable, so ***increased willingness*** to trade ***c*** for one more unit of ***l***

PREVIEW OF BUSINESS CYCLE THEORY

- ❑ **Modern macro view: periodic ups and downs of macroeconomic activity driven fundamentally by (various and many) shocks**



  - ❑ **Supply shocks: TFP shocks, others**
  - ❑ **Demand shocks: preference shocks, monetary policy shocks (Chapter 14), others**

- ❑ **Shocks over time lead to changes over time in**
  - ❑ **Consumers' incentives to work, save, and consume**
  - ❑ **Firms' incentives to hire, invest, and produce**

} Economy's response(s) to shocks mediated through labor markets, capital markets, and goods markets

INTERTEMPORAL CONSUMPTION-LEISURE FRAMEWORK

OCTOBER 31, 2011

BASICS

- **Consumption-Leisure Framework**
  - **Foundation for goods-market demand and labor-market supply**
  - **Optimality condition**

$$\frac{\partial u / \partial l}{\partial u / \partial c} = (1-t)w$$

- **Consumption-Savings Framework**
  - **Foundation for (period-*t*) goods-market demand and asset-market supply**
  - **Optimality condition**

$$\frac{\partial u / \partial c_1}{\partial u / \partial c_2} = 1+r$$

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  - Optimality condition

$$\frac{\partial u / \partial c_1}{\partial u / \partial c_2} = 1 + r$$

- Bring together consumption-savings margin with the consumption-leisure margin

Can put a β here

- Utility function: $v(c_1, l_1, c_2, l_2) = u(c_1, l_1) + u(c_2, l_2)$
  - Dropping the assumption from simple (Chapter 3 and 4) two-period framework that income "falls from the sky"
  - Representative consumer has to work for his (labor) income in ***each*** period

UTILITY AND BUDGET CONSTRAINTS

- Utility function: $v(c_1, l_1, c_2, l_2) = u(c_1, l_1) + u(c_2, l_2)$

- Budget constraints
  - Period-1 budget constraint (nominal terms)

$$P_1 c_1 + A_1 - A_0 = iA_0 + (1-t_1)W_1(168 - l_1)$$

  - Period-2 budget constraint (nominal terms)

$$P_2 c_2 + A_2 - A_1 = iA_1 + (1-t_2)W_2(168 - l_2)$$

UTILITY AND BUDGET CONSTRAINTS

- **Utility function: $v(c_1, l_1, c_2, l_2) = u(c_1, l_1) + u(c_2, l_2)$**
- **Budget constraints**
  - **Period-1 budget constraint (nominal terms)**
    $$P_1c_1 + A_1 - A_0 = iA_0 + (1-t_1)W_1(168-l_1)$$
  - **Period-2 budget constraint (nominal terms)**
    $$P_2c_2 + A_2 - A_1 = iA_1 + (1-t_2)W_2(168-l_2)$$
- **Derive (nominal) LBC as usual (solve P2BC for A_1 and insert in P1BC)**
  $$P_1c_1 + \frac{P_2c_2}{1+i} = (1-t_1)W_1(168-l_1) + \frac{(1-t_2)W_2(168-l_2)}{1+i} + (1+i)A_0$$
- **Or in real terms (work out details yourself)**
  $$c_1 + \frac{c_2}{1+r} = (1-t_1)w_1(168-l_1) + \frac{(1-t_2)w_2(168-l_2)}{1+r} + (1+r)a_0$$
- **Or if infinite number of periods**
  $$\sum_{t=0}^{\infty}\frac{c_t}{(1+r)^t} = \sum_{t=0}^{\infty}\frac{(1-t_t)w_t(168-l_t)}{(1+r)^t} + (1+r)a_0$$
  - **Assuming r is constant every period (slightly more complicated expression if r_t varies every period)**

CONSUMPTION-SAVINGS MARGIN

- **Describes decision of how much to consume in "short-run" (period t) versus save for "long-run" (period $t+1$)**
  - **A decision that spans periods**
- **Think of as orthogonal to (i.e., independent of) the consumption-leisure margin**
- **Optimal choice (two-period framework) described by**
  $$\frac{\partial u/\partial c_1}{\partial u/\partial c_2} = 1+r$$
- **Optimal choice (infinite-period framework) described by**
  $$\frac{\partial u/\partial c_t}{\partial u/\partial c_{t+1}} = 1+r_t$$

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$$\frac{\partial u / \partial c_1}{\partial u / \partial c_2} = 1 + r$$

- Optimal choice (infinite-period framework) described by

$$\frac{\partial u / \partial c_t}{\partial u / \partial c_{t+1}} = 1 + r_t, \quad \frac{\partial u / \partial c_{t+1}}{\partial u / \partial c_{t+2}} = 1 + r_{t+1}, \quad \frac{\partial u / \partial c_{t+2}}{\partial u / \partial c_{t+3}} = 1 + r_{t+2}, \quad \frac{\partial u / \partial c_{t+4}}{\partial u / \partial c_{t+5}} = 1 + r_{t+4}, \quad \text{etc.}$$

  - Recall: can think of infinite-period framework as sequence of overlapping two-period frameworks

CONSUMPTION-LEISURE MARGIN

- Describes decision **within a period** (i.e., focusing just on the "short-run") of how much to consume versus how much to work
  - A decision that does ***not*** span periods
- Think of as orthogonal to (i.e., independent of) the consumption-savings margin
- Optimal choice (two-period framework) described by

$$\frac{\partial u / \partial l_1}{\partial u / \partial c_1} = (1 - t_1) w_1 \qquad \frac{\partial u / \partial l_2}{\partial u / \partial c_2} = (1 - t_2) w_2$$

i.e., for ***each*** of the two periods

Consumption-Leisure Margin

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- Think of as orthogonal to (i.e., independent of) the consumption-savings margin
- Optimal choice (two-period framework) described by

$$\frac{\partial u / \partial l_1}{\partial u / \partial c_1} = (1 - t_1) w_1 \qquad \frac{\partial u / \partial l_2}{\partial u / \partial c_2} = (1 - t_2) w_2$$

i.e., for ***each*** of the two periods

- Optimal choice (infinite-period framework) described by

$$\frac{\partial u / \partial l_t}{\partial u / \partial c_t} = (1 - t_t) w_t, \frac{\partial u / \partial l_{t+1}}{\partial u / \partial c_{t+1}} = (1 - t_{t+1}) w_{t+1}, \frac{\partial u / \partial l_{t+2}}{\partial u / \partial c_{t+2}} = (1 - t_{t+2}) w_{t+2},$$

etc.

  - Consumption-leisure decision "looks the same every period" in infinite-period environment

Building Blocks of Modern Macro Theory

- Intertemporal consumption-leisure framework is the foundation of modern macroeconomic analysis
  - Referred to as **Dynamic General Equilibrium (DGE) Theory**
  - Both Real Business Cycle (RBC) theory and New Keynesian (NK) theory (the two dominant current schools of macroeconomic thinking)
- Power of DGE approach demonstrated by RBC theorists in early 1980's – idea of DGE theory has been adopted by nearly all other macro camps
  - Even though important ideological differences between NK Theory and RBC Theory
  - DGE ***methodology*** has been universally adopted
- Three seminal phases of the history of macroeconomic thought/practice
  - Measuring macroeconomic activity (1930's – 1950)
  - Keynesian-inspired macroeconometric models (1950 – 1970's)
  - DGE methodology (1980's – today)