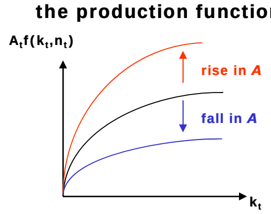
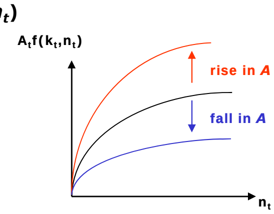
SHOCKS

OCTOBER 29, 2013

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

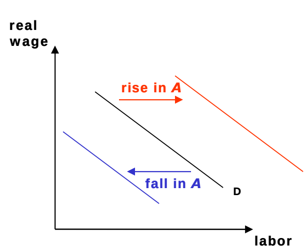
- **Firm-level demand for labor defined by the relation**

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

Because exponent (-α) 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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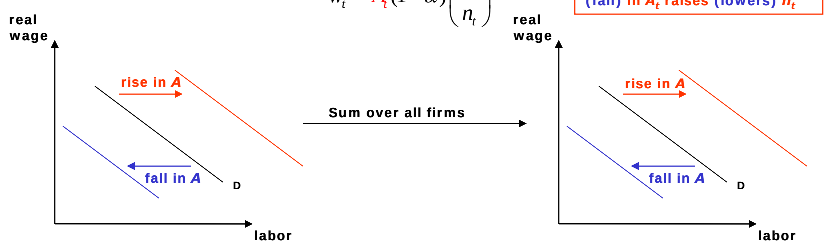


Firm-level labor demand function

Aggregate-level labor demand function

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

TFP Shocks and Capital Demand

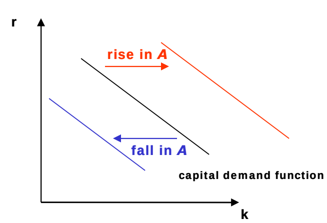
- Firm-level demand for capital **defined** by the relation

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

↓ Because exponent (*α* – 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 AND CAPITAL / INVESTMENT DEMAND

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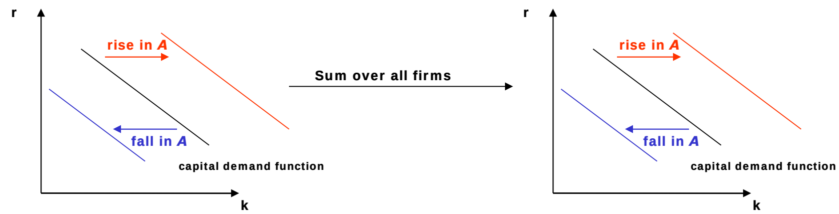

Firm-level capital demand function

Aggregate-level capital demand function

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

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

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  - ***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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    - **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)**
- **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

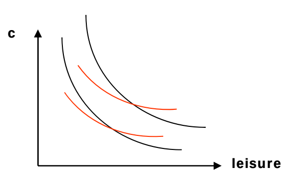
$$MRS_{c,l} = \frac{\partial u / \partial l}{\partial u / \partial c} = \frac{1}{B} \cdot \frac{u_2(Bc,l)}{u_1(Bc,l)}$$

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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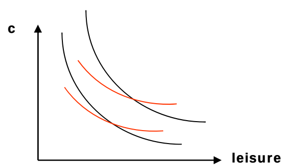
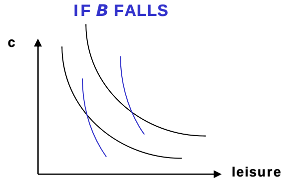


Rise in *B* flattens all indifference curves (i.e., lowers *MRS* at any point in *c-l* space).

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

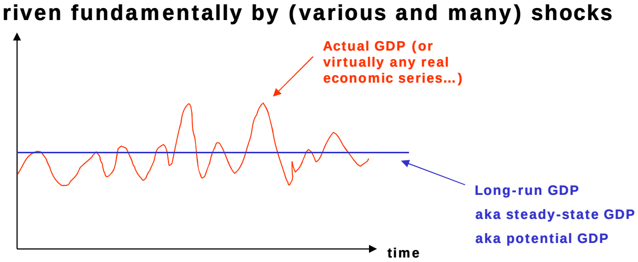


Fall in *B* steepens all indifference curves (i.e., raises *MRS* at any point in *c-l* space).

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 29, 2013

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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- Bring together consumption-savings margin with the consumption-leisure margin
- Utility function: $v(c_1, l_1, c_2, l_2) = u(c_1, l_1) + u(c_2, l_2)$ (Can put a β here)
  - 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: $v(c_1, l_1, c_2, l_2) = u(c_1, l_1) + u(c_2, l_2)$**

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

  - 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

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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)