# A New Revolution in Economics Education

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## Abstract

New trends are emerging in education of economics following rapid development in economic theories for static, dynamic and strategic analysis, increasing applications of general equilibrium modelling for evaluation of economic policies at national, regional and global level and overwhelming advancement in econometric techniques developed to test those theories. A concise knowledge of these theories and techniques is essential for understanding micro and macro economic processes and to influence policy making for achieving greater efficiency and satisfaction of mankind. How careful design of curriculum and thoughtful implementations could be instrumental in achieving higher standard of teaching and research is analysed using the practical experience over the years in the University of Hull.

# New Revolution

# Creative Learning and Teaching

$$D = \alpha - \beta P \tag{1}$$

$$S = -\gamma + \delta P \tag{2}$$

- Problems with multiple markets

$$X_1^d = 10 - 2p_1 + p_2 \tag{3}$$

$$X_1^S = -2 + 3p_1 + p_2 \tag{4}$$

- Market 2:

$$X_2^d = 15 + p_1 - p_2 \tag{5}$$

$$X_2^S = -1 + 2p_2 \tag{6}$$

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# Importance of Matrix

- $X_1^d = X_1^S$ implies $10 - 2p_1 + p_2 = -2 + 3p_1 + p_2$
- $X_1^d = X_1^S$ implies $15 + p_1 - p_2 = -1 + 2p_2$

$$\begin{bmatrix} 5 & -1 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \end{bmatrix} = \begin{bmatrix} 12 \\ 16 \end{bmatrix} \tag{7}$$

$$\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} = \begin{bmatrix} 5 & -1 \\ -1 & 3 \end{bmatrix}^{-1} \begin{bmatrix} 12 \\ 16 \end{bmatrix} \tag{8}$$

- Deseasonalisation of data $Y_i^d = \frac{Y_i}{\overline{z}_i}$ and irregular component should be $i = \frac{z_t}{\overline{z}_i}$.

# Cramer's Rule

$$p1 = \frac{\begin{vmatrix} 12 & -1 \\ 16 & 3 \end{vmatrix}}{\begin{vmatrix} 5 & -1 \\ -1 & 3 \end{vmatrix}} = \frac{36+16}{15-1} = \frac{26}{7};\ p2 = \frac{\begin{vmatrix} 5 & 12 \\ -1 & 16 \end{vmatrix}}{\begin{vmatrix} 5 & -1 \\ -1 & 3 \end{vmatrix}} = \frac{80+12}{15-1} = \frac{46}{7} \tag{9}$$

Market 1:

$$LHS = 10 - 2p_1 + p_2 = 10 - 2\left(\frac{26}{7}\right) + \frac{46}{7} = \frac{64}{7} = -2 + 3p_1 = \frac{64}{7} = RHS \tag{10}$$

Market 2:

$$LHS = 15 + p_1 - p_2 = 15 + \frac{26}{7} - \frac{46}{7} = \frac{85}{7} = -1 + 2p_2 = \frac{85}{7} = RHS \tag{11}$$

QED.

Extension to N-markets is obvious; a confidence for solving large models.

# Jacobian

$$y = -5x_1^2 + 10x_1 + x_1x_3 - 2x_2^2 + 4x_2 + 2x_1x_3 - 4x_3^2 \tag{12}$$

$$\frac{\partial y}{\partial x_1} = -10x_1 + 10 + x_3 = 0 \tag{13}$$

$$\frac{\partial y}{\partial x_2} = -4x_2 + 4 + 2x_3 = 0 \tag{14}$$

$$\frac{\partial y}{\partial x_3} = x_1 + 2x_2 - 8x_3 = 0 \tag{15}$$

$$\begin{bmatrix} -10 & 0 & 1 \\ 0 & -4 & 2 \\ 1 & 2 & -8 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -10 \\ -4 \\ 0 \end{bmatrix} \tag{16}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} -10 & 0 & 1 \\ 0 & -4 & 2 \\ 1 & 2 & -8 \end{bmatrix}^{-1} \begin{bmatrix} -10 \\ -4 \\ 0 \end{bmatrix} = \begin{bmatrix} 1.043478261 \\ 1.217391304 \\ 0.434782609 \end{bmatrix} \tag{17}$$

Stability Analysis

$$y_t = a_{10} + a_{12} y_{t-1} + a_{12} z_{t-1} + e_{1t} \tag{18}$$

$$z_t = a_{20} + a_{21} y_{t-1} + a_{22} z_{t-1} + e_{2t} \tag{19}$$

Using lag operators

$$y_t = a_{10} + a_{12} L y_t + a_{12} L z_t + e_{1t} \tag{20}$$

$$z_t = a_{20} + a_{21} L y_t + a_{22} L z_t + e_{2t} \tag{21}$$

# Stability Analysis

solve the second equation for $z_t$ and substitute into $y_t$ equation

$$z_t = \frac{a_{20} + a_{21} L y_t + e_{2t}}{(1 - a_{22} L)} \tag{22}$$

Putting $z_t$ into $y_t$ equation

$$(1 - a_{12} L)\, y_t = a_{10} + a_{12} L \left[ \frac{a_{20} + a_{21} L y_t + e_{2t}}{(1 - a_{22} L)} \right] + e_{1t} \tag{23}$$

Collecting terms:

$$(1 - a_{12} L)(1 - a_{22} L)\, y_t = a_{10}(1 - a_{22} L) + a_{12} a_{20} + \left[ a_{12} a_{21} L^2 y_t + a_{12} L e_{2t} \right] + \tag{24}$$

$$(1 - a_{12} L)(1 - a_{22} L)\, y_t - a_{12} a_{21} L^2 y_t = a_{10}(1 - a_{22} L) + a_{12} a_{20} + a_{12} L e_{2t} + ( \tag{25}$$

# Equilibrium Path

$$y_t = \frac{a_{10}\left(1 - a_{22}\right) + a_{12}a_{20} + a_{12}e_{2t} + \left(1 - a_{22}L\right)e_{1t}}{\left(1 - a_{12}L\right)\left(1 - a_{22}L\right) - a_{12}a_{21}L^2} \tag{26}$$

$$z_t = \frac{a_{10}\left(1 - a_{11}\right) + a_{21}a_{10} + a_{21}e_{2t-1} + \left(1 - a_{11}L\right)e_{2t}}{\left(1 - a_{12}L\right)\left(1 - a_{22}L\right) - a_{12}a_{21}L^2} \tag{27}$$

- $\lambda_1, \lambda_2 = \frac{(a_{11}+a_{22}) \pm \sqrt{(a_{11}+a_{22})^2 - 4(a_{11}a_{22}+a_{22}a_{21})}}{2}$

# Pure exchange and Trade

Preferences in consumption:

$$max \quad U^1 = \left(C_1^1\right)^{\alpha^1} \left(C_2^u\right)^{1-\alpha^1} \tag{28}$$

Income

$$I^1 = P_1 L_1^1 + P_1 L_2^1 + TR^1 \tag{29}$$

Technology constraints in sector 1 in country 1

$$X_1^1 = a_1^1 . L_1^1 \tag{30}$$

Technology constraints in sector 2 in the country 1

$$X_2^1 = a_2^1 . L_2^1 \tag{31}$$

# Resourse contraints in 1

Resource constraint in the country 1

$$L^1 = L_1^1 + L_2^1 \tag{32}$$

Production possibility of the country 1

$$Y^1 = \frac{1}{a_1^1}.X_1^1 + \frac{1}{a_2^1}.X_2^1 \tag{33}$$

Consumers problem in country 2

$$max \quad U^2 = \left(C_1^2\right)^{\alpha^2} \left(C_2^2\right)^{1-\alpha^2} \tag{34}$$

Subject to budget constraint

$$I^2 = P_1 L_1^2 + P_1 L_2^2 + TR^2 \tag{35}$$

Technology constraints in sector 1 in the country 2

$$X_1^2 = a_1^2.L_1^2 \tag{36}$$

# Resource constraint in 2

Production possibility country 2

$$Y^2 = \frac{1}{a_1^2}.X_1^2 + \frac{1}{a_2^2}.X_2^2 \tag{39}$$

Income of the country 2

$$I^2 = P_1 L_1^2 + P_1 L_2^2 + TR^2 \tag{40}$$

Demand for good 1 in the country 1

$$C_1^1 = \frac{\alpha^1.I^1}{P_1} \tag{41}$$

Demand for good 2 in the country 1

$$C_2^1 = \frac{\left(1-\alpha^1\right).I^1}{P_2} \tag{42}$$

Demand for good 1 in country 2

# Global market clearing

Demand for good 2 in country 2

$$C_2^2 = \frac{\left(1-\alpha^2\right).I^2}{P_2} \tag{44}$$

Global market clearing for good 1

$$C_1^1 + C_1^2 = X_1^1 + X_1^2 \tag{45}$$

Global market clearing for good 2

$$C_2^1 + C_2^2 = X_2^1 + X_2^2 \tag{46}$$

# Solutions of global market model

Choose good 1 as numeraire, then $P_1 = 1$. Under complete specialization country 1 country 1 produces services $X_2$ and country 2 produces manufacturing goods.
$I^1 = P_1 L_1^1 = 1 \times 365 = 365; I^2 = P_2 L_2^2 = P_2 \times 1200$

| | $\alpha$ | $a_1$ | $a_2$ | $L$ |
|---|---|---|---|---|
| Country 1 | 0.4 | 2 | 5 | 365 |
| Country 2 | 0.6 | 5 | 2 | 1200 |

$$\frac{\alpha^1.I^1}{P_1} + \frac{\alpha^2.I^2}{P_1} = 1825 \tag{47}$$

$$\frac{\left(1-\alpha^1\right).I^1}{P_2} + \frac{\left(1-\alpha^2\right).I^2}{P_2} = \frac{0.6 \times 365}{P_2} + \frac{0.4 \times P_2 \times 1200}{P_2} = 6000 \tag{48}$$

$$\frac{291}{P_2} = 5520; P_2 = \frac{291}{5520} = 0.0397 \tag{49}$$

$I^2 = P_2 \times 1200 = 0.0397 \times 1200 = 47.64$

# Dynamic equilibrium with human capital 1

$$Max \quad U_c = \frac{C^{1-\theta}}{1-\theta} \tag{50}$$

$$Y = AK^{\alpha}H^{1-\alpha} \tag{51}$$

Physical and human capital accumulation process

$$\dot{K} = I_k - \delta K \tag{52}$$

$$\dot{H} = I_H - \delta H \tag{53}$$

Market clearing

$$Y = C + I_k + I_H \tag{54}$$

# Dynamic equilibrium with human capital 2

Current value Hamiltonian

$$J = \frac{C^{1-\theta}}{1-\theta} e^{-\rho t} + v\left[I_k - \delta K\right] + \mu\left[I_H - \delta H\right] + \omega\left[AK^{\alpha} H^{1-\alpha} - C - I_k - I_H\right] \tag{55}$$

$$\frac{\partial J}{\partial C} = C^{-\theta} e^{-\rho t} - \omega = 0 \tag{56}$$

$$\frac{\partial J}{\partial I_k} = v - \omega = 0 \tag{57}$$

$$\frac{\partial J}{\partial I_H} = \mu - \omega = 0 \tag{58}$$

$$\dot{v} = -\frac{\partial J}{\partial K} \tag{59}$$

$$\dot{\mu} = -\frac{\partial J}{\partial H} \tag{60}$$

# Dynamic equilibrium with human capital 3

$$\dot{v} = -\frac{\partial J}{\partial K} = v\delta - \omega\alpha AK^{\alpha-1}H^{1-\alpha} \tag{61}$$

$$\dot{\mu} = -\frac{\partial J}{\partial H} = \mu\delta - \omega\left(1-\alpha\right)AK^{\alpha}H^{-\alpha} \tag{62}$$

From the FOC of consumption and investment

$$C^{-\theta}e^{-\rho t} = \nu \tag{63}$$

Taking log both sides

$$-\theta \ln C - \rho t = \ln \nu \tag{64}$$

$$-\theta\frac{\dot{C}}{C} - \rho = \frac{\dot{\nu}}{\nu} \tag{65}$$

# Dynamic equilibrium with human capital 4

$$g_c = \frac{\dot{C}}{C} = \frac{1}{\theta}\left(\frac{\dot{\nu}}{\nu} + \rho\right) = \frac{1}{\theta}\left(\frac{v\delta - \omega\alpha A K^{\alpha-1} H^{1-\alpha}}{\nu} + \rho\right) = \frac{1}{\theta}\left(\omega\alpha A K^{\alpha-1} H^{1} \right. \tag{66}$$

$$\frac{\dot{\nu}}{\nu} = \frac{v\delta - \omega\alpha A K^{\alpha-1} H^{1-\alpha}}{\nu} = \delta - \alpha A K^{\alpha-1} H^{1-\alpha} \tag{67}$$

$\frac{\dot{\nu}}{\nu} = \frac{\dot{\mu}}{\mu}$ implies

$$\delta - \alpha A K^{\alpha-1} H^{1-\alpha} = \delta - (1-\alpha) A K^{\alpha} H^{-\alpha} \tag{68}$$

$$\frac{K^{\alpha} H^{-\alpha}}{K^{\alpha-1} H^{1-\alpha}} = \frac{\alpha}{(1-\alpha)} \tag{69}$$

$$\frac{K}{\ } = \frac{\alpha}{\ } \tag{70}$$

# Dynamic equilibrium with human capital 5

Thus the ratio of physical to human capital is constant. Putting this value in the production function:

$$Y = AK^{\alpha}H^{1-\alpha} = AK\frac{K^{\alpha}H^{1-\alpha}}{K} = AK\frac{H^{1-\alpha}}{K^{1-\alpha}} = AK\left(\frac{1-\alpha}{\alpha}\right) \tag{71}$$

Thus this model becomes a form of the AK model. The steady state solutions imply $\frac{\dot{Y}}{Y} = \frac{\dot{C}}{C} = \frac{\dot{K}}{K} = \frac{\dot{H}}{H} = \frac{\dot{\mu}}{\mu} = \frac{\dot{\nu}}{\nu}$.

Steady state and the transitional dynamics are solved in terms of $\alpha$,$\beta$,$\delta$,$\sigma$,$\nu$,$\mu$,$\lambda$ and $\omega$.

# Dynamics in the ISLM

Consumption function :

$$C = a + bY - nR \tag{72}$$

Let investment and government spending be as given at $I = \overline{I}$and $G = \overline{G}$ Goods markets does not balance automatically, it take time for adjustment as given by the following equation $(\alpha < 1)$:

$$\frac{\partial y}{\partial t} = \alpha \left( a + by - nR + I + G - y \right) \tag{73}$$

Money market is assumed to balance instantaneously

$$L = ky - hR \tag{74}$$

$$M = \overline{M} \tag{75}$$

# Dynamics in the ISLM

Money market equilibrium implies

$$R = \frac{k}{h}y - \frac{\overline{M}}{M} \tag{76}$$

Putting the money market equilibrium in the goods market gives the economy wide equilibrium process as:

$$\frac{\partial y}{\partial t} = \alpha\left(a + by - \left(\frac{nk}{h}y - \frac{n\overline{M}}{M}\right) + I + G - y\right) \tag{77}$$

By rearrangement

$$\frac{\partial y}{\partial t} + \alpha\left(1 - b + \frac{nk}{h}\right)y = \alpha\left(a + by + \frac{n\overline{M}}{M} + I + G\right) \tag{78}$$

$$\frac{\partial y}{\partial t} + Ay = B \tag{79}$$

where $A = \alpha\left(1 - b + \frac{nk}{h}\right)$ and $B = \alpha\left(a + \frac{n\overline{M}}{M} + I + G\right)$

# Dynamics in the ISLM

the complementary path is given by $y_c = Ce^{-At} = Ce^{-\alpha\left(1-b+\frac{nk}{h}\right)t}$

$$y_t = Ce^{-At} + \frac{B}{A} \tag{80}$$

Definite solution requires getting value of $C$using the initial conditions $y_{t=0} = y_0$ as $C = y_0 - \frac{B}{A}$

$$y_t = \left[y_0 - \frac{B}{A}\right] e^{-At} + \frac{B}{A} = \left[y_0 - \frac{\alpha\left(a + \frac{n\overline{M}}{M} + I + G\right)}{\alpha\left(1 - b + \frac{nk}{h}\right)}\right] e^{-\alpha\left(1-b+\frac{nk}{h}\right)t} + \frac{\alpha}{} \tag{81}$$

Convergence to the steady state requires that $A > 0$. This implies $1 - b + \frac{nk}{h} > 0$ or $\frac{k}{h} > -\frac{1-b}{n}$ .The slope of the LM curve$\left(\frac{k}{h}\right)$ should be greater than the slope of the IS curve$\left(-\frac{1-b}{n}\right)$ .

# Decomposition of ime series

$$Y = T \times C \times S \times I \tag{82}$$

In a simple method the moving average gives $T \times C$ components and is used to isolate the $S \times I$ components. For instance for a 12 monthly moving average

$$\overline{Y}_i = \frac{1}{12} \left( Y_1 + Y_2 + ..... + Y_{12} \right) \tag{83}$$

$$S \times I = \frac{T \times C \times S \times I}{T \times C} = \frac{Y_i}{\overline{Y}_i} = z_t \tag{84}$$

# Decomposition of ime series

$$Month1 : \bar{z}_1 = \frac{1}{5}\left(z_1 + z_{13} + z_{25} + z_{39} + z_{48}\right) \tag{85}$$

$$Month2 : \bar{z}_2 = \frac{1}{5}\left(z_2 + z_{14} + z_{26} + z_{40} + z_{49}\right) \tag{86}$$

$$Month3 : \bar{z}_3 = \frac{1}{5}\left(z_3 + z_{15} + z_{26} + z_{41} + z_{50}\right) \tag{87}$$

.......................................

$$Month11 : \bar{z}_{11} = \frac{1}{5}\left(z_{11} + z_{23} + z_{35} + z_{47} + z_{59}\right) \tag{88}$$

$$Month12 : \bar{z}_{12} = \frac{1}{5}\left(z_{12} + z_{24} + z_{36} + z_{46} + z_{60}\right) \tag{89}$$

Deseasonalisation of data $Y_i^d = \frac{Y_i}{\bar{z}_i}$ and irregular component should be

$$i = \frac{z_t}{\bar{z}_i} \tag{90}$$

# Strategic Analyses

In general students may be able to identify Nash equilibrium in games like:

$$A = \begin{bmatrix} (2,4) & (3,1) \\ (5,3) & (5,5) \end{bmatrix} \tag{91}$$

or be able to solve the duopoly game and its consequence in product and prices in a model with demand and cost functions given by

$$P = 130 - (q_1 + q_2) \tag{92}$$

$$C_i = 10q_i \tag{93}$$

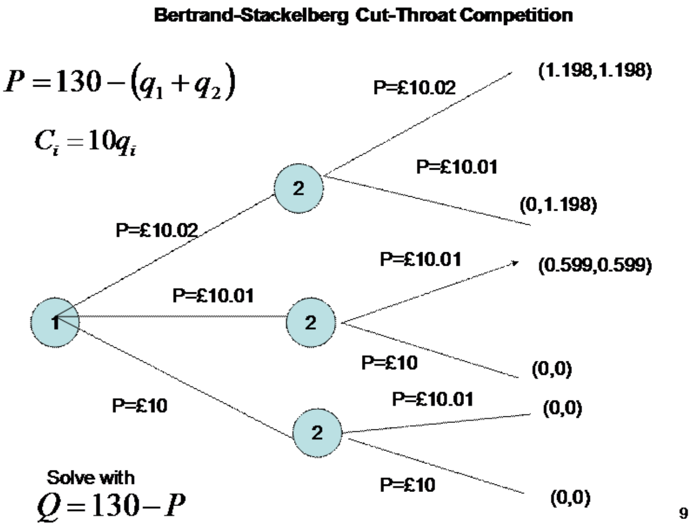
# Strategic Analyses

Most of them face difficulty in putting scenarios for the structures of these markets as:

Table: Solutions under Cartel, Cournot and Cheating

| | $\Pr ice$ | $Total\ Output$ | $Output$ | $Output\ 1$ | $Output\ 2$ | $profit\ 1$ |
|---|---|---|---|---|---|---|
| $Cartel$ | 70 | 60 | 3600 | 30 | 30 | 1800 |
| $Cournot$ | 50 | 80 | 3200 | 40 | 40 | 1600 |
| $Cheating$ | 55 | 85 | 3625 | 45 | 40 | 2025 |

# Cut-Throat Competition



Students may be comfortable with the simple linear regression model of the form:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + e_t \tag{94}$$

Students should be aware of general principles underlying the estimation techniques such as the maximum likelihood

$$lnL(\theta / y) = \ln \left\{ \prod_{i=1}^{T} \frac{1}{\sqrt{2\pi\sigma^2}} \exp \left[ -\frac{1}{2} \frac{(y_i - \alpha - \beta x)^2}{\sigma^2} \right] \right\} \tag{95}$$

or the GMM estimators:

$$0 = g(\theta, Y_t) = \frac{1}{T} \sum_{t}^{T} \left( X_t \left( Y_t - X_t' \beta \right) \right) \tag{96}$$

$$\sum_{t}^{T} X_t Y_t = \left\{ \sum_{t}^{T} X_t X_t' \right\} \widehat{\beta}_T \tag{97}$$

# Time Series

$$Y_t = \varphi_2 X_t + \epsilon_t \tag{99}$$

$$Y_t = X_t + \epsilon_t \ ; \qquad \varphi_2 = 1 \tag{100}$$

$$\epsilon_t \ = Y_t - X_t \tag{101}$$

$$\Delta\epsilon_t \ = \gamma\epsilon_{t-1} \ + u_t \tag{102}$$

$$\Delta\left(Y_t - X_t\right) = \gamma\left(Y_{t-1} - X_{t-1}\right) + u_t \tag{103}$$

$$\Delta Y_t = \Delta X_t + \gamma\left(Y_{t-1} - X_{t-1}\right) + u_t \tag{104}$$

# VAR -VECM

Or generalisation of a VAR model

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + .... + \Pi_p Y_{t-p} + \epsilon_t \tag{105}$$

its ECM form

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + +\Gamma_2 \Delta Y_{t-2} + .... + +\Gamma_p \Delta Y_{t-p-1} + \epsilon_t \tag{106}$$

$\Pi = \Pi_1 + \Pi_2 + ... + \Pi_p - I$ ; $\Gamma_i = -\left(\Pi_{i+1} + \Pi_{i+2} + ..... + \Pi_p\right)$ for $i = 1, ..., p-1$.
deserve attention given their importance in time series analysis.

# Policy Analysis

- The course of economy can be changed using policy instruments that influence the first order conditions of optimisation or the budget or market clearing conditions.
- The impact of policies on economic variables can be studied qualitatively using theoretical derivations for static, comparative static or dynamic analysis.
- Then equilibrium can be computed for scenarios of such changes in order to conduct before after the policy change.
- Econometric models estimate such relations and test them using the most appropriate data but more decentralised dynamic general equilibrium models are required for meaningful policy analysis.
- Decisions taken on the basis of such analysis can have profound impact in the lives of millions of people like those of the expansionary policies taken by governments around the world to mitigate the impacts of current crises.

# Conclusion

- New trends in theoretical and econometric techniques
- greater efficiency and satisfaction of mankind.
- Careful design of curriculum and thoughtful implementation are essential for standards