RELOCE Lecture 3a Regional Growth - the Neo-classical perspective 23/02/10

Aims:

- To introduce students to the theoretical underpinning and construct of the Neo-classical growth model.
- To explore some of the empirical research on the subject.
- To examine the role of technological progress, explore evidence of regional economic convergence and recent developments to the theoretical models.

Outcomes:

- Students should be aware of the methodology underlining the Neo-classical growth model and be able to describe its operation in detail.
- Students should be aware of the scale and scope of research into the Neo-classical growth model in the UK and elsewhere.
- Students should be conversant with recent extensions to the basic model and research into the evidence of regional economic convergence.

Introduction

We have already examined how economists quantify the impact of an EVENT through the use of tools such as multiplier analysis. We now turn to the question of overall growth in the regional economy and the next two lectures look at alternative explanations for growth.

There are two main approaches for explaining regional economic growth, the Neo-classical and the Keynesian. Fundamental differences remain about the underlying causes of regional and local disparities in growth rates. We will therefore be looking at theories, which allow us to examine and explain differences in growth between regions (e.g. why growth is greater in the SE than the NE of England or other regions of other developed countries economies such as the North and South of Italy).

Growth can be defined in a number of ways:
1. Growth in output 2. Growth in output per worker 3. Growth in output per capita

The measures can give quite different readings of a regions performance. For instance, a region may experience low output growth and high per capita growth simultaneously if there is significant out migration of non-workers. But in general there is a high correlation between output growth and per capita growth, but a lower correlation between these two measures and output per worker. Armstrong and Taylor use EU data to demonstrate how growth rates have diverged between 1975 and 96 in most of the major EU countries.

Which is most appropriate? - This depends on the purpose for which the measure is being used.

Output growth is used to indicate growth in productive capacity and its ability to attract capital and labour from other regions - (the South East and the Eastern regions are good examples in the UK)
Growth in output per worker is used to indicate changes in a region's competitiveness (an example in the UK might be Wales which has improved its competitive position).
Growth in output per capita is used to indicate changes in economic welfare
But - past growth attracts in Capital, The capital intensive economy = a higher relative wage rate, attracts in skilled labour thus rising income and economic welfare.
Armstrong and Taylor concentrate on the output growth and competitiveness.

The Neo-classical school emphasises the role of ❶·labour supply, ❷capital stock and ❸technical progress. Drawing on the assumption of efficient market allocation and viewing regional disparities (differences) in productivity as the result of gains from the reallocation of resources towards their pareto-optimal level. Emphasis is on the supply-side characteristics of the growth process - DEMAND ADJUSTS TO SUPPLY

The Keynesian school stresses the role of demand. Particular emphasis is placed on the role of regional exports as the main engine of output growth. Emphasis is on the demand-side characteristics of the growth process - SUPPLY ADJUSTS TO DEMAND. A further extension of the Keynesian model is the principal of cumulative causation. (Once growth disparities occur they tend to become cumulative and self-perpetuating).

One sector neo-classical growth model

This model is based on the production function, there is no technical change and output is determined entirely by capital and labour inputs.

Aggregate production function

$$Y_t = f\left(K_t, L_t\right) \text{ (a)}$$

Where Y = real output
K = capital stock
L = labour force
t = time subscript

Utilising the Cobb-Douglas production function (relates output to factor inputs) and assuming constant returns to scale and perfectly competitive product and factor markets.

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha} \quad \text{(b)}$$

Where A = the parameter translating inputs into outputs & $\alpha + 1 - \alpha = 1$ (constant returns to scale)

In a perfectly competitive economy with flexible factor prices and resources at their full employment levels, growth in output is given as

$$y_t = \alpha k_t + (1-\alpha) l_t \quad \text{(c)}$$

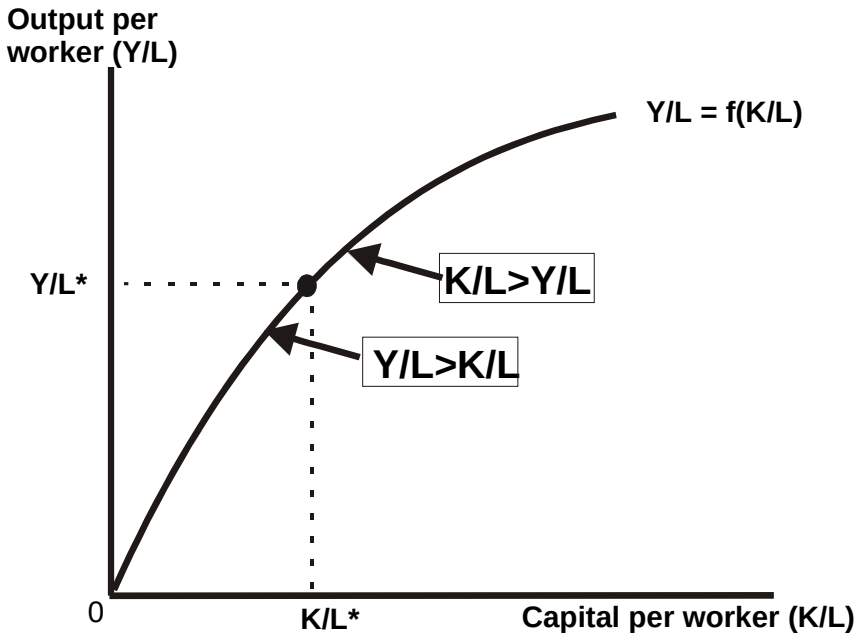
Where y = output growth (per time period)
k = growth of capital stock
l = growth of labour force

These are rates of change of Y, K and L constants α and $1 - \alpha$ are the respective contributions of labour and capital inputs to aggregate output. (Equation (c) is obtained by taking logs of equation (b) and differentiating with respect to time.)

Subtracting the growth in the labour supply (***l***) from both sides of the equation gives rate of growth of output per worker

$$y_t - l_t = \alpha(k_t - l_t) \quad \text{(d)}$$

Output per worker can only increase if capital growth exceeds the growth of the labour supply. Output per worker can increase only if the capital/labour ratio increases - process known as capital deepening. This cannot continue indefinitely in the absence of technical progress since k like l suffers from diminishing marginal returns. (Output per worker increases at a diminishing rate)



Note:
Y = F(K,L) implies Y/L = f(K/L) provided F(K,L) is homogeneous of degree one. A Cobb-Douglas production function with constant returns to scale is such a function and is often used in growth models.

At long-run equilibrium output, capital and labour are all growing at the same rate.

Conclusions:
1. Output grows without limit as supplies of labour and capital increase.
2. Output per worker can increase only if there is capital deepening.
3. When the capital/labour (k/l) ratio reaches its long-run equilibrium level there is no further increase in output per worker.

Inclusion of technical change:

In an attempt to inject more realism into the neo-classical model the effect of technical progress on output growth is introduced. Technical knowledge becomes an additional and separate element in the production function. K and L benefit equally from any technical progress that occurs.

$$Y_t = f\left(A_t, K_t, L_t\right) \quad \text{(f)}$$

A represents technical knowledge, it is independent of capital and labour inputs. It is assumed that technical progress increases smoothly over time (at a constant growth rate). Thus the Cobb-Douglas function can be extended by addition of the extra term.

$$Y_t = Ae^{gt}K^{\alpha}L^{1-\alpha} \quad \text{(g)}$$

In equation (g) g is the constant rate of technical progress per time period t.
The impact of technical progress on output is oversimplified because it ignores the possibility that technical progress is likely to be built into new additions of capital stock as investment takes place and the labour force may acquire new skills, which also improve efficiency. Therefore, both labour and capital are not homogeneous. The inclusion of technical progress shifts the output per worker function upward, resulting in an increase in output per worker at each level of the capital/labour ratio.

Taking logs of equation (g) and differentiating with respect to time gives:

$$y_t = g + \alpha k_t + (1-\alpha) l_t \quad \text{(h)}$$

Where g is the annual rate of technical progress

Therefore if the rate of technical progress was 3% and labour and capital exhibited zero growth output growth would equal 3%.

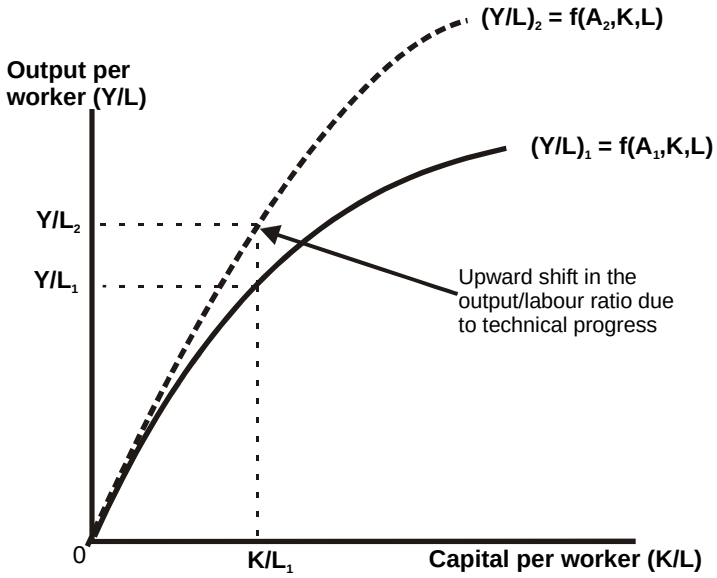
Again taking the growth in the labour supply (***l***) from both sides of equation (h) gives the rate of growth in output per worker

$$y_t - l_t = g + \alpha(k_t - l_t) \quad \text{(i)}$$

Even if capital stock and the labour force grew at the same rate, output per worker will increase providing the rate of technical progress exceeds zero.
In long-run equilibrium it is assumed that output growth and growth of capital stock are equal (y = k) by substituting y for k in (i) the long-run equilibrium growth rate of output per worker becomes:

$$y_t - l_t = \frac{g}{1-\alpha} \quad (j)$$

Thus if **g** = 2% and **α** = 0.5, then output per worker will grow by 4% in long-run equilibrium.



Note:
Y = F(K,L) implies Y/L = f(K/L) provided F(K,L) is homogeneous of degree one. A Cobb-Douglas production function with constant returns to scale is such a function and is often used in growth models.

Converting (*h*) into a regional growth model shows that regional disparities occur for 3 reasons

- Technical progress may vary between regions
- The growth of capital stock may vary between regions
- The growth of the labour force may vary between regions

Regional growth equations can be written as (k) ignoring (t) subscript and substituting (r), which refers to a specific region.

$$y_r = g_r + \alpha k_r + (1-\alpha) l_r \quad \text{(k)}$$

In equation (k) g_r is the rate of technical progress in region r, which can be expected to vary (between regions) in the medium term. As with equation (h) subtracting l_r from both sides produces equation (l)

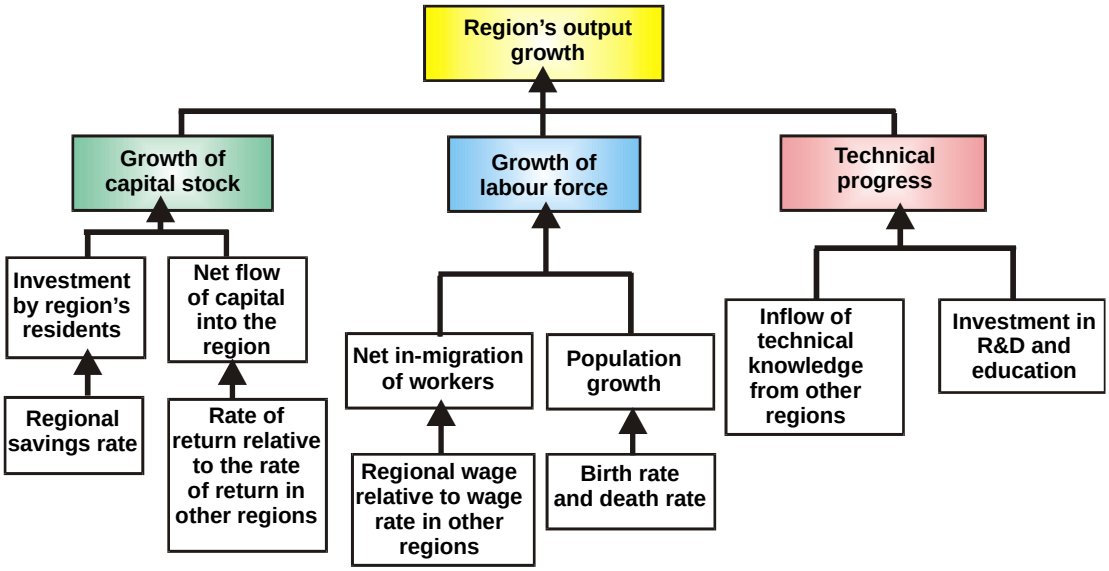
$$y_r - l_r = g_r + \alpha (k_r - l_r) \quad (l)$$

This shows that regional disparities in the growth of output per unit of labour are explained by regional differences in the rate of technical progress and by regional differences in the growth of the capital/labour ratio. (*This assumes that the production functions are the same in both regions*).

The sources of economic growth and factor migration

As we have seen through developing the equations showing the components of economic growth there are three main influences: ❶the growth in labour and ❷capital stock and ❸technical progress. In the Neo-classical model factor migration plays an important part in determining regional disparities. **It is assumed that capital and labour will move to the regions offering the highest rate of return**. Producers search for the most profitable areas to locate their plant and machinery and workers are attracted to high wage areas. There are no impediments to factor migration and perfect knowledge about factor prices in all regions is available. Therefore, disparities occur both because of differences in indigenous growth and through interregional factor migration.

The schematic diagram shows that the growth of the labour force, capital stock and technical progress are dependent on factors internal and external to the region.



Factor supplies and the growth of regional output
Source: Armstrong and Taylor (2000) Regional Economics and Policy

The important question is which regions are likely to grow fastest assuming factors are fully mobile? In the classical model, areas with a high capital/labour ratio will have high wages and low yield on investment (anticipated output growth will be slower). This means that labour and capital are predicted to move in opposite directions.

- Low wage regions attract capital but loose labour (capital/labour ratio expanding).
- High wage regions attract labour but loose capital (capital/labour ratio declining).

Therefore, output per worker (productivity) is predicted to grow faster in low wage regions than high wage regions. However, it is not possible to say with any certainty if output growth is higher or lower

in low wage areas because it will depend on the speed at which factors are flowing (capital in and labour out).

The other variable is technical progress. The expectation is that this would be highly mobile between regions. Evidence suggests that some regions are innovation leaders but the process of diffusion is complex with not all innovations flowing outwards at the same rate. Information on new processes flows more quickly than information about new products. The process of diffusion is thought to be hierarchical in its route - from cities to towns - from main plants to branch plants. (Product development and R&D are often co-located with corporate functions at a company's main plant)

It is anticipated that regions with low technology would gain rapid productivity improvements by exploiting the technical gap between themselves and the high tech areas. However evidence suggests that the technology gap does not necessarily spur productivity improvements. The evidence to support the proposition that low technology regions quickly catch up is not strong. Armstrong and Taylor cite the early work of Borts and Stein, Ghali et al and Hulten and Schwab (see Armstrong and Taylor, 2000, and reading list). More recently Harris and Trainor investigating the rate of technical progress in an attempt to explain regional growth disparities in the UK.

Endogenous growth theory
Armstrong and Taylor argue that whilst the inclusion of technical progress gives an explanation of long-term growth, it does not explain what causes technological progress. Endogenous growth theory seeks to explain the causes of technological progress.

One of the ways entrepreneurs can make a profit is to produce and sell ideas. Economic growth is endogenous because there is a profit incentive in producing new ideas and thus a regions technological frontier is automatically pushed outwards. The basic model of technological growth is amended so that rather than technical progress being separate and increasing at a constant rate it is attached to the workers themselves. Which gives a "knowledge adjusted" workforce. The per capita growth function becomes:

$$y = \alpha k + (1-\alpha)g$$

where y, k and g are the growth rates in per capita output, capital and technological knowledge respectively. If the economy is in long-run equilibrium then output per worker and capital per worker will be growing at the same rate. If this is so then output per worker will also equate to the growth rate of technical knowledge.

Technical knowledge will increase over time and its rate of growth depends on:
The number of workers in the knowledge industry & the existing stock of knowledge

It is suggested that the production of knowledge function suffers from diminishing returns (as does the Cobb Douglas production function). Thus the growth in new ideas is proportional to the rate of growth of people in the knowledge industry. In the long-run the rate of growth in the labour force (and population) determines the rate of growth of technological knowledge. This suggests that if population grows rapidly then so do new ideas and productivity likewise increases.

Catching up with technology leaders
The endogenous growth model only explains the growth in the world economy, to see what the relationship is between lagging and leading regions requires a catch-up model. The technical progress of a region will depend on how much it lags behind the most technologically advanced regions. The model argues that the further away a region's technology is from the most advanced region the faster will be it's technological progress.

$$g_r = \lambda\left(G^* - G_r\right) \quad \lambda > 0$$

where $\mathbf{G}^*$ is the technology level of the advanced region
Underpinning the argument is the fact that it is relatively cheap to copy existing technology but expensive to create completely "new" technology. Providing the socio-economic infrastructure is amenable to market forces then output per worker in lagging region will grow at a faster rate than in the leading regions, implying that in the longer term convergence occurs.

The prediction from this model is that in the long-term there should not be disparities between regional growth rates. However;

- Lagging regions have a lot of catching up to do and;
- The incentive to invest may vary between regions (unstable areas are less likely to attract investment).

Empirical evidence suggests that the process might not be as smooth as the theory predicts. Some regions are innovation leaders, this may be because of deliberate government stimulation, or market forces (often related to migration and preference for location - sunbelt states). Information on new productive processes tend to diffuse more rapidly than information on "new" products, this is because the latter are protected - for instance by patent. Innovation information also travels along well-defined routes from cities to small towns from main plants to branch plants within firms.

Convergence of regional per capita incomes

The neo-classical model predicts that over the long-run disparities in per capita income will disappear, because capital will flow from high to low wage regions and labour in the opposite direction until such time as the returns are equal and there is no incentive to move. Further, poor regions will benefit from technological catch-up.

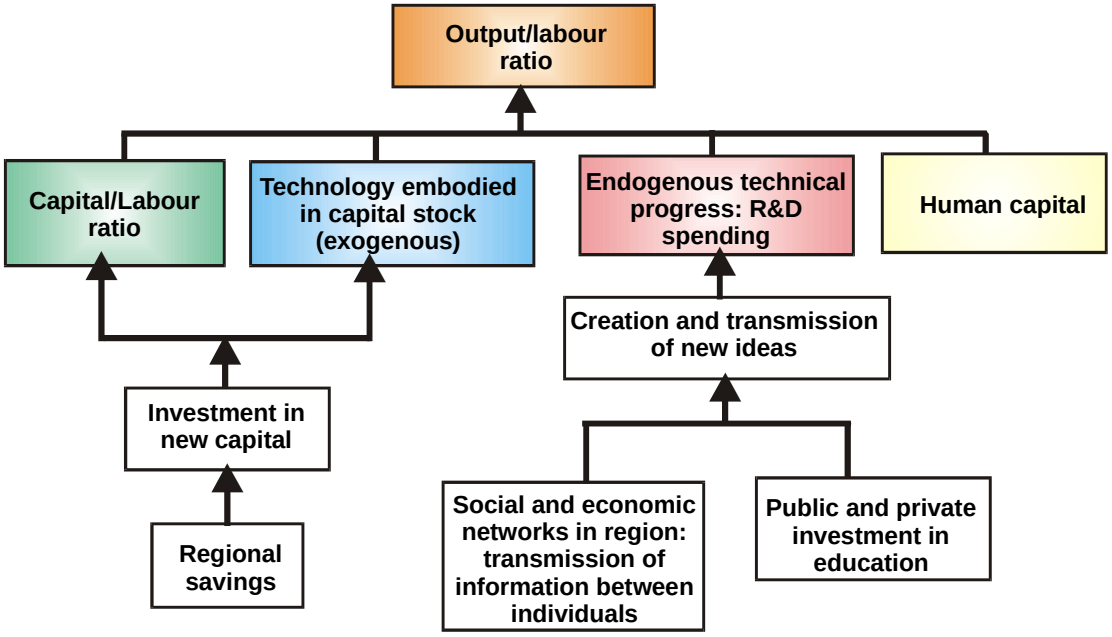
Armstrong and Taylor distinguish between two types of convergence beta and sigma: β (beta) convergence when poor regions grow faster than rich. There is a negative relationship between growth of per capita income and level of per capita income at the start of the period.
σ (sigma) convergence is a measure of per capita income inequality between regions at any given point in time. Convergence occurs when the dispersion of per capita income falls over time.

Empirical evidence (Barro & Sali-i-Martin) suggests that over the long-run beta convergence occurs but that it is very slow, around 2% per annum - they suggest that it is "unimaginable" that East Germany will never gain parity with West Germany in the short-run. (See Table 3.5 Armstrong and Taylor, 2000).

Studies suggest that regional convergence is not uniform across developed countries, a study of European and other leading OECD countries suggest that convergence has been faster in Sweden and the UK than countries such as Italy and Greece. Very recent work looking at China suggests that the rate of regional economic convergence has been extremely rapid since the opening up of China to foreign trade and FDI. A recent study by Rey and Montouri suggests that spillover effects may affect the rate of convergence with neighbouring regions benefiting from the strong growth of a region through the linkages in trade and the labour market. Overall the evidence suggest that the neo-classical model is correct in predicting that convergence in per capita output will occur but that the rate is very slow. However, it is also possible that convergence is the result of technological diffusion and government policy including such aspects as income support.

Extending the neo-classical growth model

The new extension to the neo-classical growth model is based on the notion that the reason disparities in productivity persist in the long run are that capital and labour technology are not completely mobile between regions. Not only does new technology enter the productive system through capital stock but it is also attached to human capital. It is not enough to have technological development embodied in new capital stock what is also required is the ability to absorb and use the new technology. It is thought that a region's institutional environment is crucial to exchange and creation of new ideas. If there is a geographical concentration of highly educated and motivated people then the transfer and ideas and knowledge is much more rapid. It is therefore the institutional environment that drives disparities in regional productivity. Theorists distinguish between **embodied** and **disembodied** technical progress. Embodied technical progress is **exogenous** in that it is already built into the capital good, disembodied technical progress is **endogenous** because it is independent of the capital stock with which it combines to produce output (see Figure 3.5 Armstrong and Taylor , 2000). Typically, knowledge rich regions specialise in creative activities and high-level service activities, knowledge poor regions specialise in routine activities depending heavily on cost competitiveness for their place in world markets.



Determination of labour productivity
Armstrong and Taylor (2000) Regional Economics and Policy

Some serious weaknesses in the neo-classical approach.
Although the neo-classical models give an insight to the significance of the growth factors in a regional economy and the effect of interregional factor mobility it still suffers from some serious weaknesses.

Investors and workers are assumed to be perfectly informed about factor prices in all regions and to respond to regional differentials by migrating to achieve the best rate of return. In reality they are not and there are serious constraints to reacting to factor differentials.

The assumption that interregional movements of L & K will automatically remove factor price differentials is weak. Factor prices are not particularly flexible in practice (especially in the short-run), therefore the adjustment mechanism fails to operate effectively.

There is a serious failure to recognise the importance of demand factors on regional growth. Regions experiencing rapid growth in demand for their output are more attractive locations for investment and draw more K & L from other regions. In addition, it is argued that the growth process is cumulative and this helps to explain why regional growth disparities remain entrenched.

Conclusions
There has been renewed interest in the neo-classical model because of the availability of data (particularly per capita GDP) and its use as the yardstick for measuring convergence and the spur for regional policy initiatives. In addition, the development of endogenous growth theory has gone some way to rectifying the basic weaknesses in the original model. However the new endogenous growth models have not been extensively tested.

Next lectrure demand models of regional growth