



Office for
National Statistics

Public Sector Output and Productivity: Education

Mike Phelps, ONS

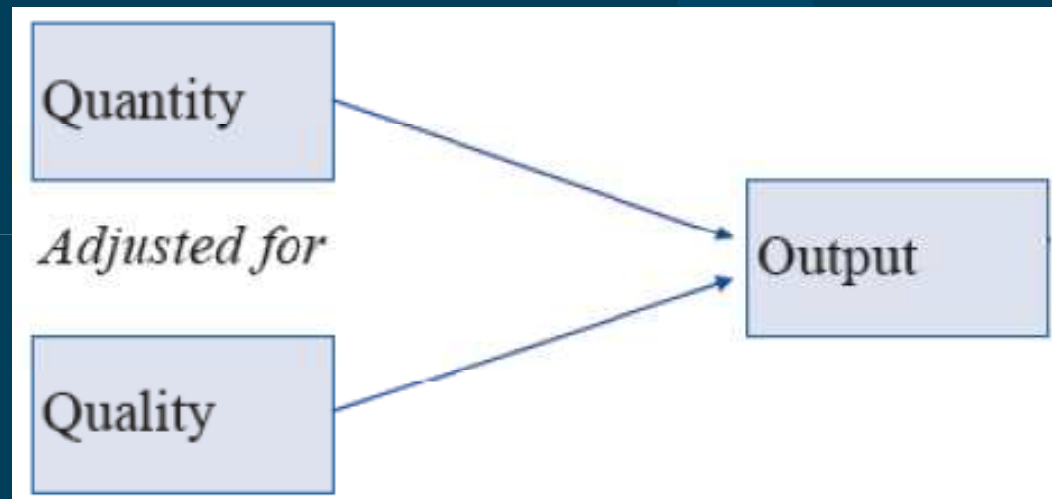
Outline

- Introduction
- Components of education output:
 - quantity
 - quality
- Inputs
- Productivity
- Future development

Introduction

- *Inputs*: What goes in. Labour, procurement etc.
- *Activity*: What gets done. Lessons taught etc
- *Output*: What is produced. Teaching consumed
- *Outcomes*: What is the result. Improved earnings, better citizens etc
- *Productivity*: $\text{Output} / \text{Inputs}$

Output: Components



What exactly is the measure of output?

- The “quantity” measures are activities such as pupils taught.
- These activities are measured in their own natural units, e.g. pupils
- To get them in common units suitable for a measure of aggregate output these underlying measures are multiplied by the (average) cost of each class of activity.

Quantity

- Included in the measure:
- Pupil attendance at government maintained schools
- Government funded full-time equivalent pre-school places in the private, voluntary and independent sector
- Students aged 16-18 in Further Education colleges
- Government procured places on teacher training and health courses

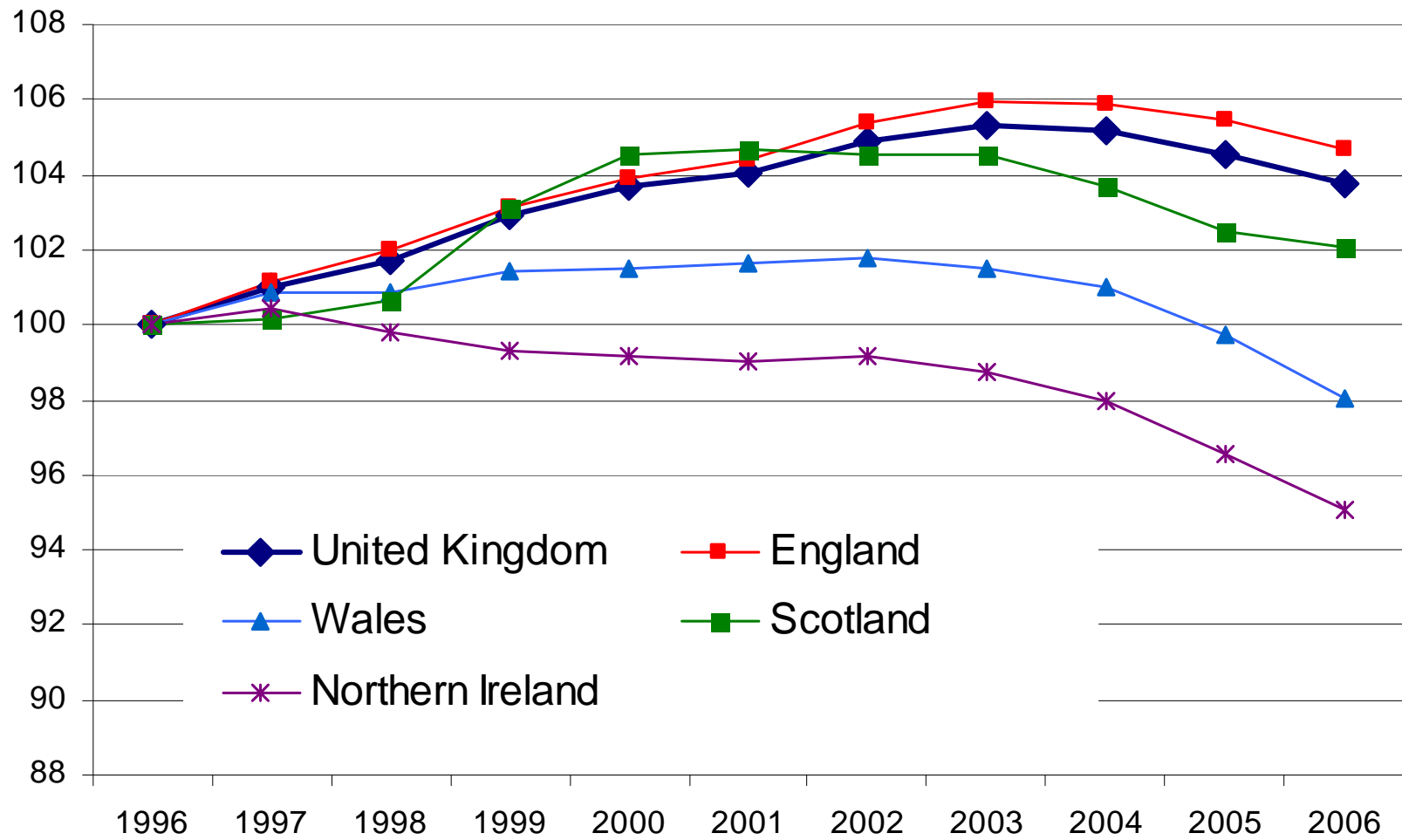
Quantity

- The largest component is pupil attendance.
- Note that it is attendance, not pupil numbers that is measured. Pupils not at school are assumed not to be receiving education services.
- Data comes from the separate parts of the United Kingdom: England, Scotland, Wales and Northern Ireland, from School Censuses or their equivalent.

Determinants of Quantity

- The major factor in pupil attendances, however, is the number of pupils.
- So demographics have a strong effect on the output measure.
- There has also been some increase arising from the expansion of pre-school education: over the decade to school year 2005-06 pre school numbers rose by almost 60 per cent.

Quantity of education in the UK



Incorporating quality

- However pupil attendance clearly only measures part of what an education service provides.
- Parents expect their children to learn skills to enhance their future life prospects.
- Government expects children to be socialised to become better citizens.
- A satisfactory measure of education output ought to take some account of such factors.

Incorporating quality: the problem

- In the market sector high quality varieties can be identified (e.g. luxury hotels) and can be given a higher weight by using the higher price which people are prepared to pay for them.
- In the non-market sector there are no prices to use.

Incorporating quality: the solution?

- The Atkinson Review suggested that what people would be prepared to pay for something would be related to change in final outcomes that an increase in e.g. educational services would provide.
- If this could be estimated then that estimate could be used to quality-adjust the basic quantity estimates.
- The big difficulty arises not from measuring outcomes, but from assessing how much of any change in outcome is attributable to the public service and how much to other factors – the attribution problem.

Possible Quality adjustments

- One possibility is to use labour market outcomes: for example to see what wage premium is earned by people with different qualifications or with different numbers of years schooling.
- There are difficulties with such measures. Labour market returns depend on more than just school level qualifications or attendance and are only observed some years after children leave school.

Quality adjustment

- The approach we have used in the UK is to base quality adjustment directly on the school level qualifications themselves.
- Two methods have been used, both based on the results achieved in the year 11 (aged 15-16) exams, GCSE.
- The multiplicative measure has been incorporated in National Accounts since the late 1990s. The additive measure was first used in our December 2007 productivity article.

Quality-adjusting school output (1)

- Both National Accounts and UKCeMGA adjustment cover children aged 6-18 yrs old
- National Accounts adjusts school output using 'multiplicative-multiplicative model'

- **E.g., $A_t = A_{t-1} E_t Q_t$**

where

A = attainment

E = educational services delivered

Q = quality of educational services delivered

- Solution based on four years' GCSE results
- Q = 0.25% per annum

Algebra for National Accounts model

Calendar year y	Cohort 1	Cohort 2	Cohort 3	Cohort 4
0	A_0			
1	$A_0E_1^1$	A_0		
2	$A_0E_1^2Q^1$	$A_0E_1^1Q^1$	A_0	
3	$A_0E_1^3Q^3$	$A_0E_1^2Q^3$	$A_0E_1^1Q^2$	A_0
4	$A_0E_1^4Q^6$	$A_0E_1^3Q^6$	$A_0E_1^2Q^5$	$A_0E_1^1Q^3$
5	$A_0E_1^5Q^{10}$	$A_0E_1^4Q^{10}$	$A_0E_1^3Q^9$	$A_0E_1^2Q^7$
6	$A_0E_1^6Q^{15}$	$A_0E_1^5Q^{15}$	$A_0E_1^4Q^{14}$	$A_0E_1^3Q^{12}$
7	$A_0E_1^7Q^{21}$	$A_0E_1^6Q^{21}$	$A_0E_1^5Q^{20}$	$A_0E_1^4Q^{18}$
8	$A_0E_1^8Q^{28}$	$A_0E_1^7Q^{28}$	$A_0E_1^6Q^{27}$	$A_0E_1^5Q^{25}$
9	$A_0E_1^9Q^{36}$	$A_0E_1^8Q^{36}$	$A_0E_1^7Q^{35}$	$A_0E_1^6Q^{33}$
10	$A_0E_1^{10}Q^{45}$	$A_0E_1^9Q^{45}$	$A_0E_1^8Q^{44}$	$A_0E_1^7Q^{42}$
11	$A_0E_1^{11}Q^{55}$	$A_0E_1^{10}Q^{55}$	$A_0E_1^9Q^{54}$	$A_0E_1^8Q^{52}$
12		$A_0E_1^{11}Q^{66}$	$A_0E_1^{10}Q^{65}$	$A_0E_1^9Q^{63}$
13			$A_0E_1^{11}Q^{77}$	$A_0E_1^{10}Q^{75}$
14				$A_0E_1^{11}Q^{88}$

et cetera

Quality-adjusting school output (2)

- UKCeMGA adjusts school output using ‘additive-multiplicative model’
- **E.g.**, $A_t = A_{t-1} + E_t Q_t$

where

A = attainment

E = educational services delivered

Q = quality of educational services delivered

- Solution based on 14 years’ GCSE results
- Q = growth in average exam scores each year
- Average = 2.5% per annum – very different to National Accounts adjustment

Algebra for UKCeMGA model

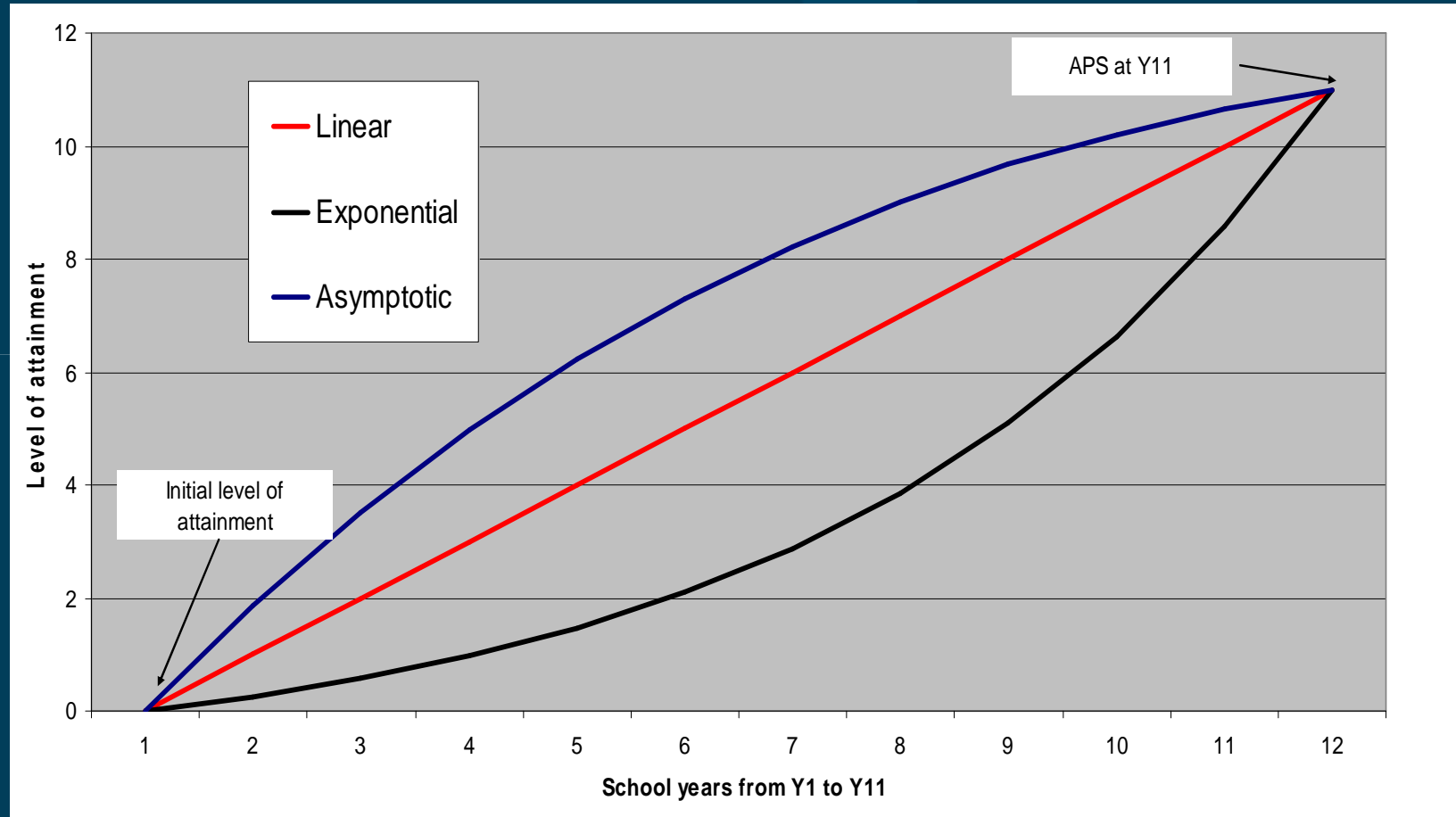
Calendar year y	Cohort 1	Cohort 2	Cohort 3	Cohort 4
0	A_0			
1	A_0+E	A_0		
2	A_0+E+EQ	A_0+EQ	A_0	
3	$A_0+E+EQ+EQ^2$	$A_0+EQ+EQ^2$	A_0+EQ^2	A_0
4	$A_0+E+EQ+EQ^2+EQ^3$	$A_0+EQ+EQ^2+EQ^3$	$A_0+EQ^2+EQ^3$	A_0+EQ^3
5	$A_0+E+EQ+\dots+EQ^4$	$A_0+EQ+\dots+EQ^4$	$A_0+EQ^2+EQ^3+EQ^4$	$A_0+EQ^3+EQ^4$
6	$A_0+E+EQ+\dots+EQ^5$	$A_0+EQ+\dots+EQ^5$	$A_0+EQ^2+\dots+EQ^5$	$A_0+EQ^3+EQ^4+EQ^5$
7	$A_0+E+EQ+\dots+EQ^6$	$A_0+EQ+\dots+EQ^6$	$A_0+EQ^2+\dots+EQ^6$	$A_0+EQ^3+\dots+EQ^6$
8	$A_0+E+EQ+\dots+EQ^7$	$A_0+EQ+\dots+EQ^7$	$A_0+EQ^2+\dots+EQ^7$	$A_0+EQ^3+\dots+EQ^7$
9	$A_0+E+EQ+\dots+EQ^8$	$A_0+EQ+\dots+EQ^8$	$A_0+EQ^2+\dots+EQ^8$	$A_0+EQ^3+\dots+EQ^8$
10	$A_0+E+EQ+\dots+EQ^9$	$A_0+EQ+\dots+EQ^9$	$A_0+EQ^2+\dots+EQ^9$	$A_0+EQ^3+\dots+EQ^9$
11	$A_0+E+EQ+\dots+EQ^{10}$	$A_0+EQ+\dots+EQ^{10}$	$A_0+EQ^2+\dots+EQ^{10}$	$A_0+EQ^3+\dots+EQ^{10}$
12		$A_0+EQ+\dots+EQ^{11}$	$A_0+EQ^2+\dots+EQ^{11}$	$A_0+EQ^3+\dots+EQ^{11}$
13			$A_0+EQ^2+\dots+EQ^{12}$	$A_0+EQ^3+\dots+EQ^{12}$
14				$A_0+EQ^3+\dots+EQ^{13}$

et cetera

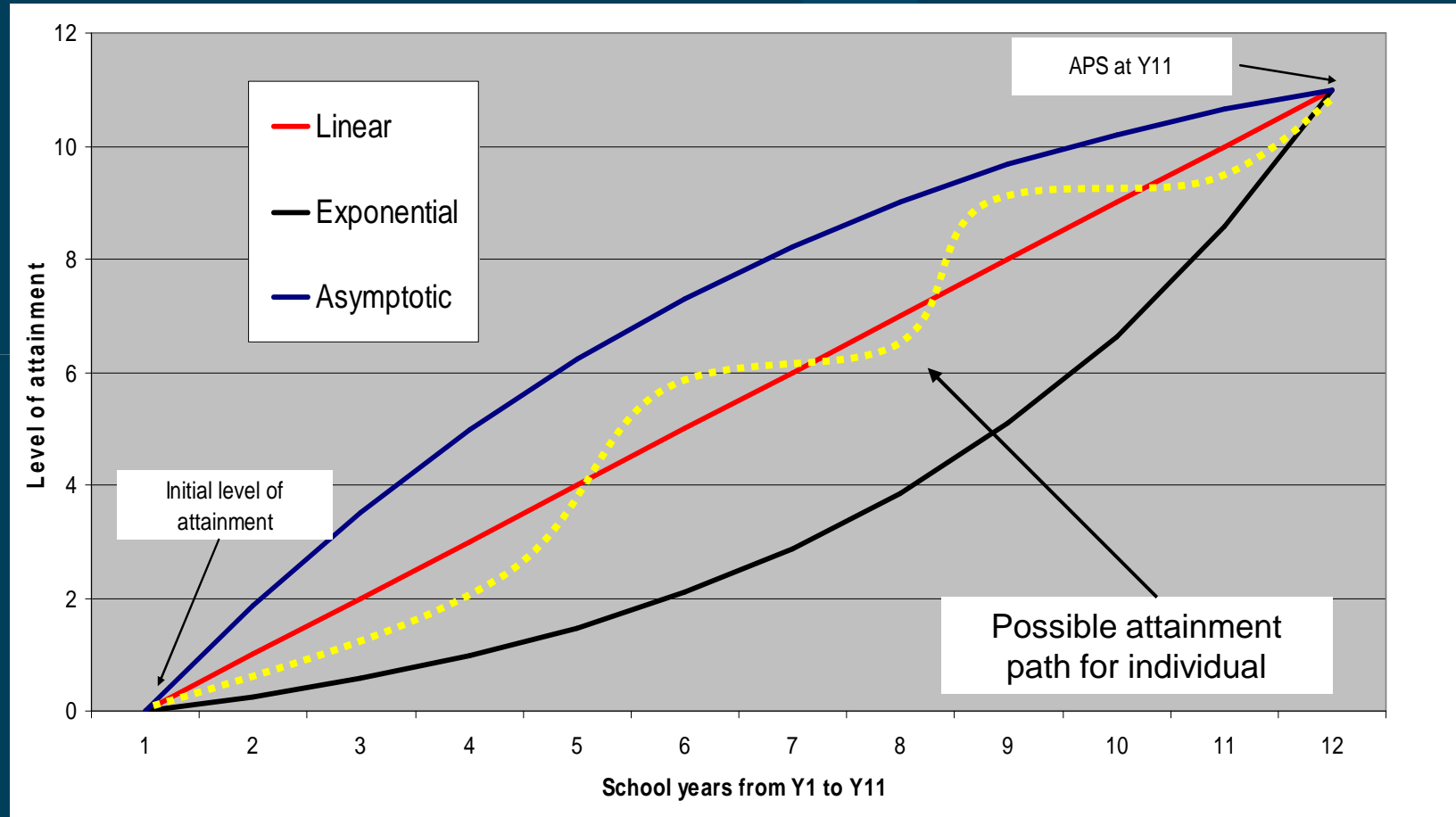
Model comparison

- Both solve for 2 unobservable variables – E and Q (A is pre-determined...but choice is an issue)
- Exponential nature of National Accounts model means that solution for Q (and also E) is low relative to UKCeMGA model
- However, the UKCeMGA model:
 - uses a longer time series to fit E and Q
 - allows Q to vary with exam results (unlike the National Accounts model in which Q is fixed)
 - models attainment more intuitively – **why?**

3 stylized models of attainment growth



3 stylized models of attainment growth



What is 'quality' really measuring

- Inference from model is that Q = educational service quality
- However, Q really covers wide number of socio-economic factors
 - E.g. parental, geographical, educational effects
- UKCeMGA is working with UK central government + devolved administrations (Scotland, Wales, Northern Ireland) to try and weight components of quality
- Health, economic well-being, education, safety and more will be assessed

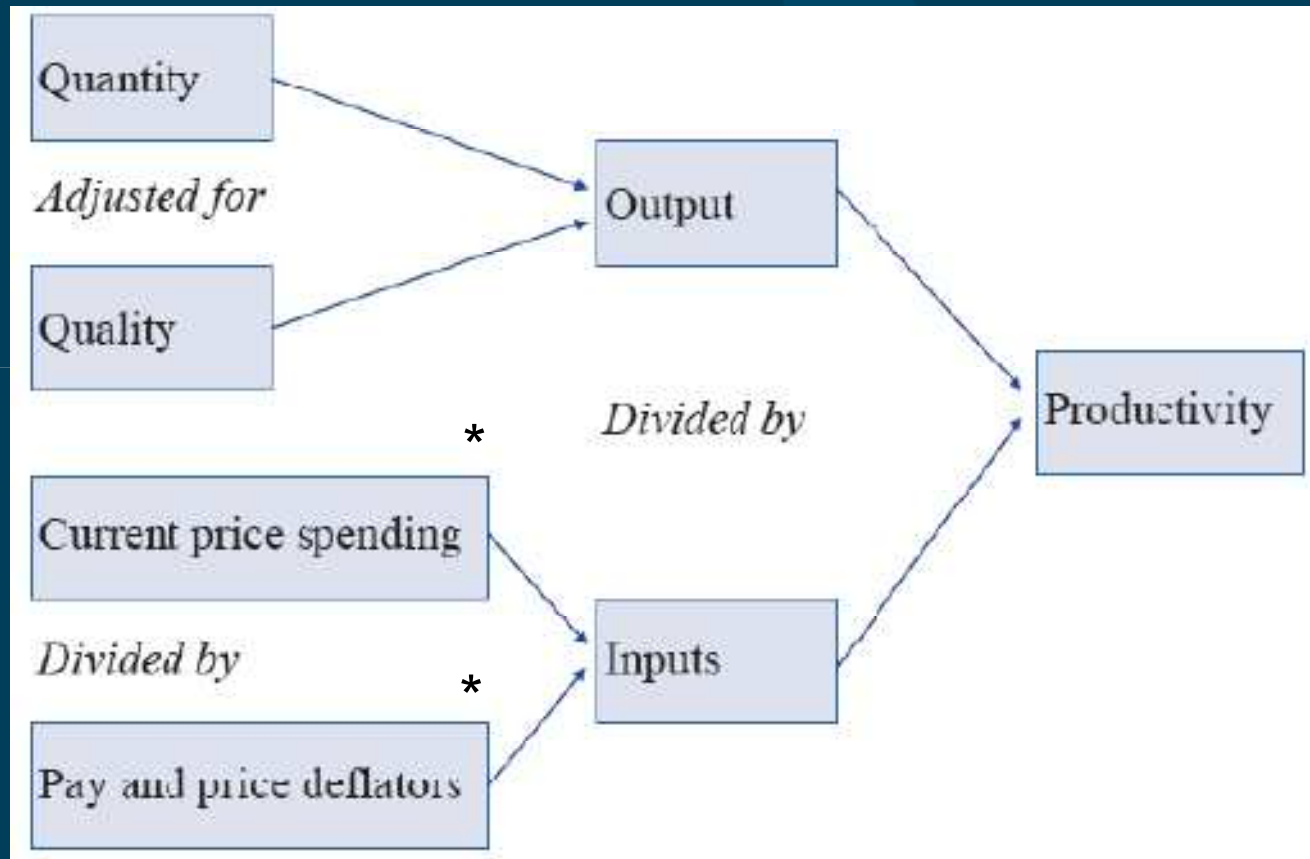
Multi factor or labour productivity?

- UKCeMGA seeks to measure productivity taking account of all inputs not just labour.
- We estimate the volume of inputs of labour – differentiated into different types of labour such as teachers and teachers assistants, intermediate inputs and capital (ideally services, sometimes consumption).
- Volumes of the different inputs are added together using cost weights.

Inputs

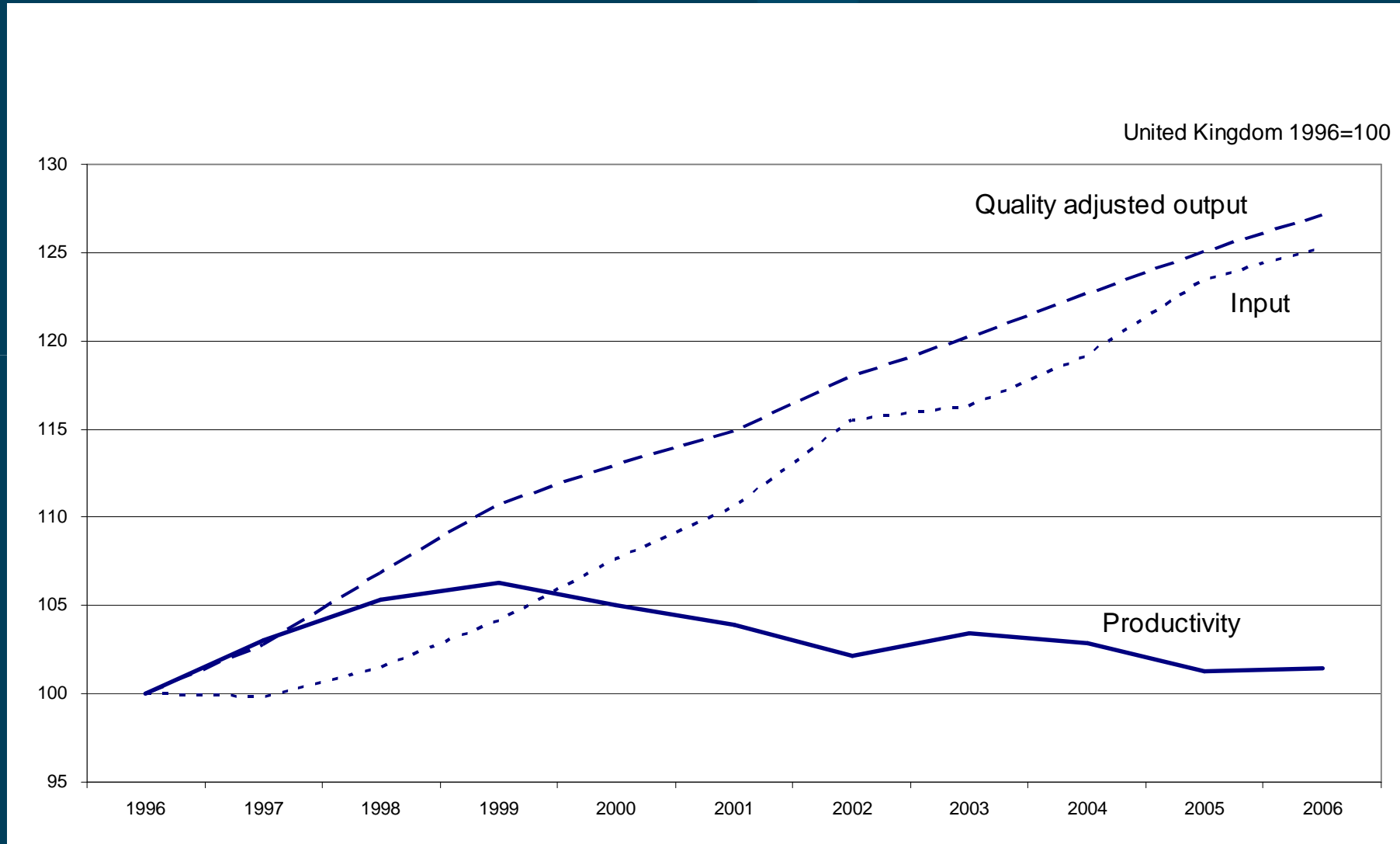
- Inputs raise fewer conceptual difficulties than outputs, because most of them are bought and therefore have market prices.
- In practice, however, there are a number of problems.
- In education most of the input volume measures are derived by deflating expenditure totals by appropriate deflators.
- It is not always easy to get expenditure totals relating to precisely what is spent in schools, rather than e.g. budget allocations from central authorities.

Productivity: Components



* except when direct volume measures are used

Productivity of government funded education (published 2007)



Developments since 2007

- Revised quantity measure to include Further Education for under-19s published in June 2008
- Improved procurement deflators
- New direct measure of education labour based on:
 - teachers' working hours
 - support staff numbers,
 - weighted together using low-level salary/wage data (proxy for skill)

Future developments

- Quantity measure:
 - Inclusion of Further Education for 19+ year olds
 - inclusion of Higher Education (HE)
- Quality measure for:
 - Pre schools pupils
 - Primary school pupils
 - Sixth form students
 - Further Education students
 - HE students
 - Wider outcomes



Mike Phelps

mike.g.phelp@ons.gov.uk

Tel. (44) 1633 456380

www.statistics.gov.uk/ukcemga