LECTURE 5

ECONOMIC GROWTH AND POPULATION GROWTH:

THE SIMULTANIOUS INTER-RELATIONSHIP

Plan of Lecture

A. Introduction: The Stylized Facts

B. Effects of Population Growth on Economic Growth: *Theory*

* ***The Malthusian and Neo-classical Theories***
* ***The Revisionist Theories***

C. Effects of Economic Growth on Population Growth: *Theory*

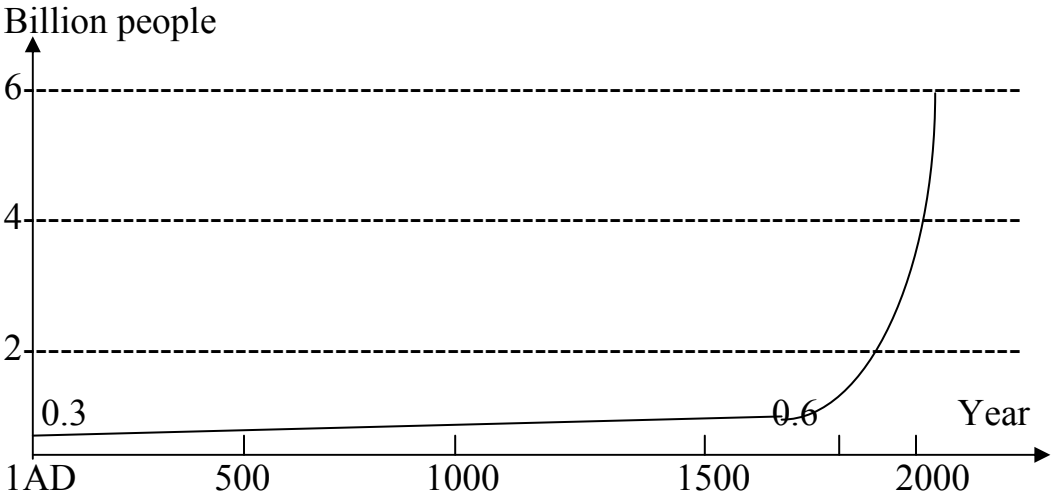
* ***The Transition Theory***
* ***The Transition theory and labour supply***
* ***Determinants of the Demand for Children (Birth rates)***

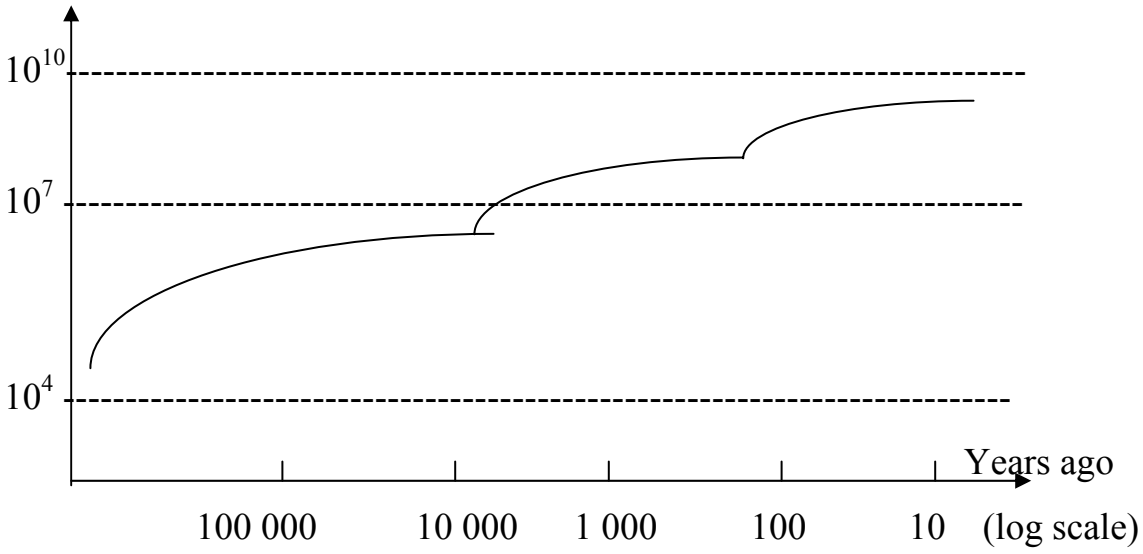
D. Effects of Population Growth on Economic Growth: *The Evidence*

E. Effects of Economic Growth on Population Growth: *The Evidence*

Literature referred to: *see last slide*.

[5.2] Figure 5.1. Two *Non-Conflicting* Pictures of World Population Growth





Two main population growth spurts:

1) Settled agriculture revolution (starting ca 10 000 years ago)

2) Industrial revolution (starting ca 1800)

(Readings: Dimond, 1999; Galor and Weil, 1999)

[5.3] Population Growth and Economic Growth over time

Period	Population growth	Economic growth
1) The Pre-agricultural Era (99 % of human time)	Practically Nil (- 10.000 BC)	Practically Nil. World Pop: <100m)
2) The Settled Agricultural Era (10.000 BC to 1.800 AD)	<0.1 % per Year. World Pop:1.7 billion in 1800	Practically nil per Capita. From 0.2% to 1.4% 1700-1820
3) The Industrial Revolution Era (ca 1820-1970)	Increased from 0.5 % annually to 2.1 % in the 1960s	From 1.0 to 3.0% in the industrializing countries
4) The Post-Industrial Era	Slowed down to 1.3% (1970 -2000). World Pop: 6 billion in 2000	Slow down to 1.7%.

Sources: Kuznets (1966); Galor and Weil (1999); Diamond (1999); Kremer (1993); UN 2000.

N.B. The spurts in economic growth have coincided! What drives what?

[5.3.A] Why stagnant population before 1800 AD?

* Before 8000 BC all humans were **gathers and hunter** and wild plants and small animals do not provide enough **calories** and other nutrients to sustain a growing population.

* Hunting and fishing **techniques** (evidence from archaeological sites) were too primitive to allow large food supplies from such sources (perhaps people were eaten by large animals as frequently as vice versa?).

* Over the 8000 BC to 1800 AC, when **settled agriculture** slowly spread over the world allowing a minuscule growth in population, death rates were almost at par with birth rates. This was the case also in the, at the time, more advanced countries in Europe and certainly in most of the rest.

* Modern medical treatments and germ theory are quite recent phenomena.

[5.4] Population explosion?

The notion that the world's population was on the way to "explode" was widespread in many international and other political fora as late as the mid 1990s. In 1994, a huge UN conference on population was held in Cairo, which revealed strongly conflicting views.

On the one side, there was a group of countries (mainly the rich ones), which took the stand voiced by the then World Bank president, Robert McNamara: "**World population growth is the largest threat to mankind**". The policy recommendations from that quarter were focused on "**family planning**" (often meaning drastic interference in poor families' fertility decisions). Several developing countries had already adopted such policies: India in the 1970s and 1980s (forced sterilisation of women); China (one child only.)

On the other side, representatives from many developing countries, especially Muslim ones, but also the Vatican and several environmentalist groups, **resented all interventions** aimed at holding birth rates down.

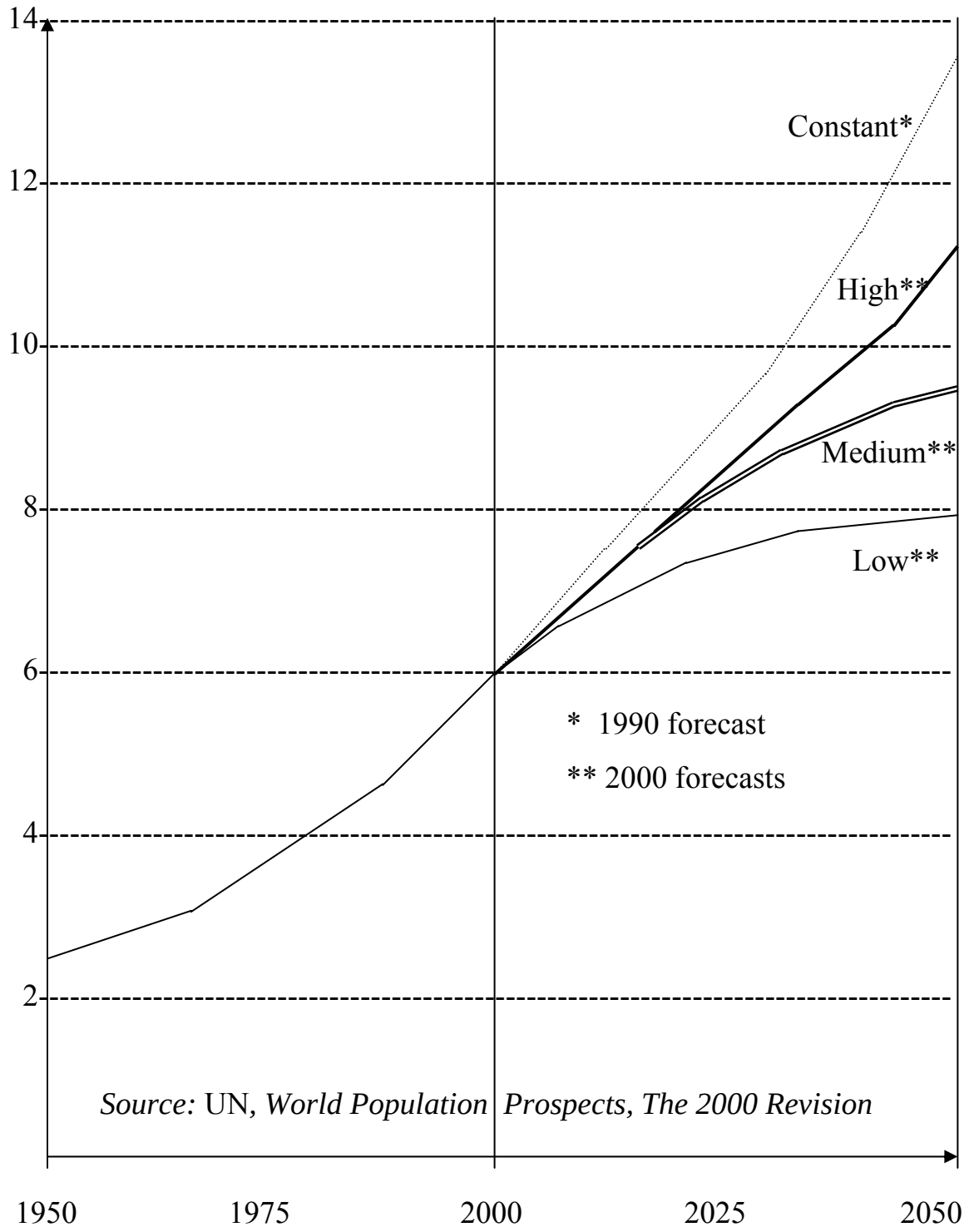
In retro-respect, much of the **conflict** was exaggerated by **faulty statistics**:

a) The world population **prognosis** made by the UN at the time was based on a model that **did not incorporate many relevant variables**.

[5.5]

b) The data on world population growth during the preceding decade (1980s), turned out to be a serious **over-estimates** [5.6]

[5.5] Estimated and projected population of the world by projection variant, 1950-2050 (Billion people)



[5.6] Table 5.1: Changes in population growth 1980-1999 by major regions, revised data from the World Bank

	WDR 1999/00		WDR 2000/01		Difference		% change	
Income group or geographical region	1980-1990	1990-1998	1980-1990	1990-1999	(3)-(1)=	(4)-(2)	(5)/(1)	(6)/(2)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
World	2.9	1.6	1.7	1.4	-1.2	-0.2	-41	-13
Low income	3.4	2.0	2.3	2.0	-1.1	-0.0	-32	0
Middle income	2.8	1.5	1.7	1.2	-1.1	-0.3	-39	-20
High income	1.2	0.7	0.6	0.6	-0.6	-0.1	-50	-14
East Asia & Pacific	2.6	1.5	1.6	1.3	-1.0	-0.2	-38	-13
Europe & C. Asia	1.1	0.2	0.9	0.2	-0.2	-0.0	-18	0
L.America & Carrib.	3.3	1.9	2.0	1.7	-1.3	-0.2	-39	-11
M.East & N.Africa	5.0	2.6	3.1	2.2	-1.9	-0.4	-38	-15
South Asia	3.7	2.1	2.2	1.9	-1.5	-0.2	-41	-10
Sub-Saharan Africa	5.0	3.0	2.9	2.6	-2.1	-0.4	-42	-13

Source: World Development Reports, 1999/00 and 2000/01, end table 3, World Bank

To notice:

a) Enormous **downward revision** for the 1980s; less for 1990s, for the world as a whole and also for all groups of countries;

b) For some individual countries, population is **declining** (European and C. Asian).

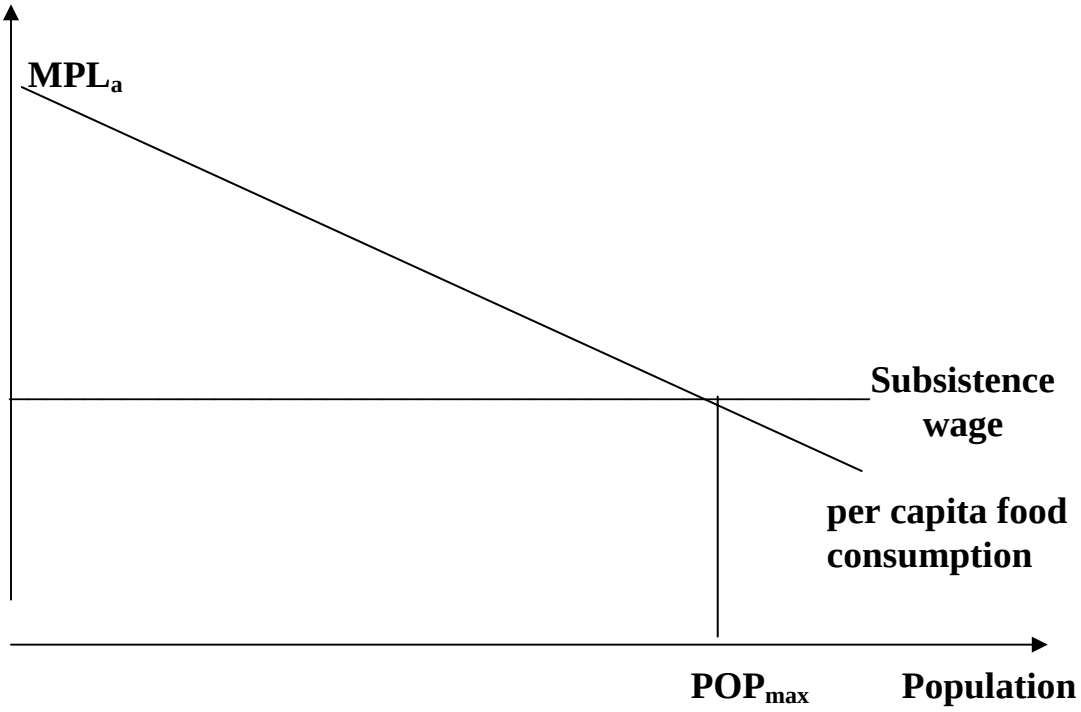
[5.7] Different Theories of Interrelationship between Economic Growth and Population Growth

Even though the "world population explosion" scarce has abated with more **refined prognosis and revised data**, there are still many countries in South Asia and Africa where population growth is 2% or more. In some 20-25 countries, population growth was in fact **higher in the 1990s than in the 1980s** (in the 2.5 -3.5 per cent range). Since these countries are the least developed and poorest, population growth remains an important issue in development economics. And there are several, sometimes conflicting, theories of how economic and population growth are inter-related.

		Economic Growth	
		Exogenous	**Endogenous**
Population Growth	**Exogenous**	Neo-classical Growth Model (in steady state) **[5.9]**	Malthus and Neo-Malthusian[a)] **[5.8]**
	Endogenous	Transition Theory **[5.10]**	Revisionist Theories **[5.11]**

a) To be qualified below [5.8]

[5.8] Malthus' "Doomsday" Model



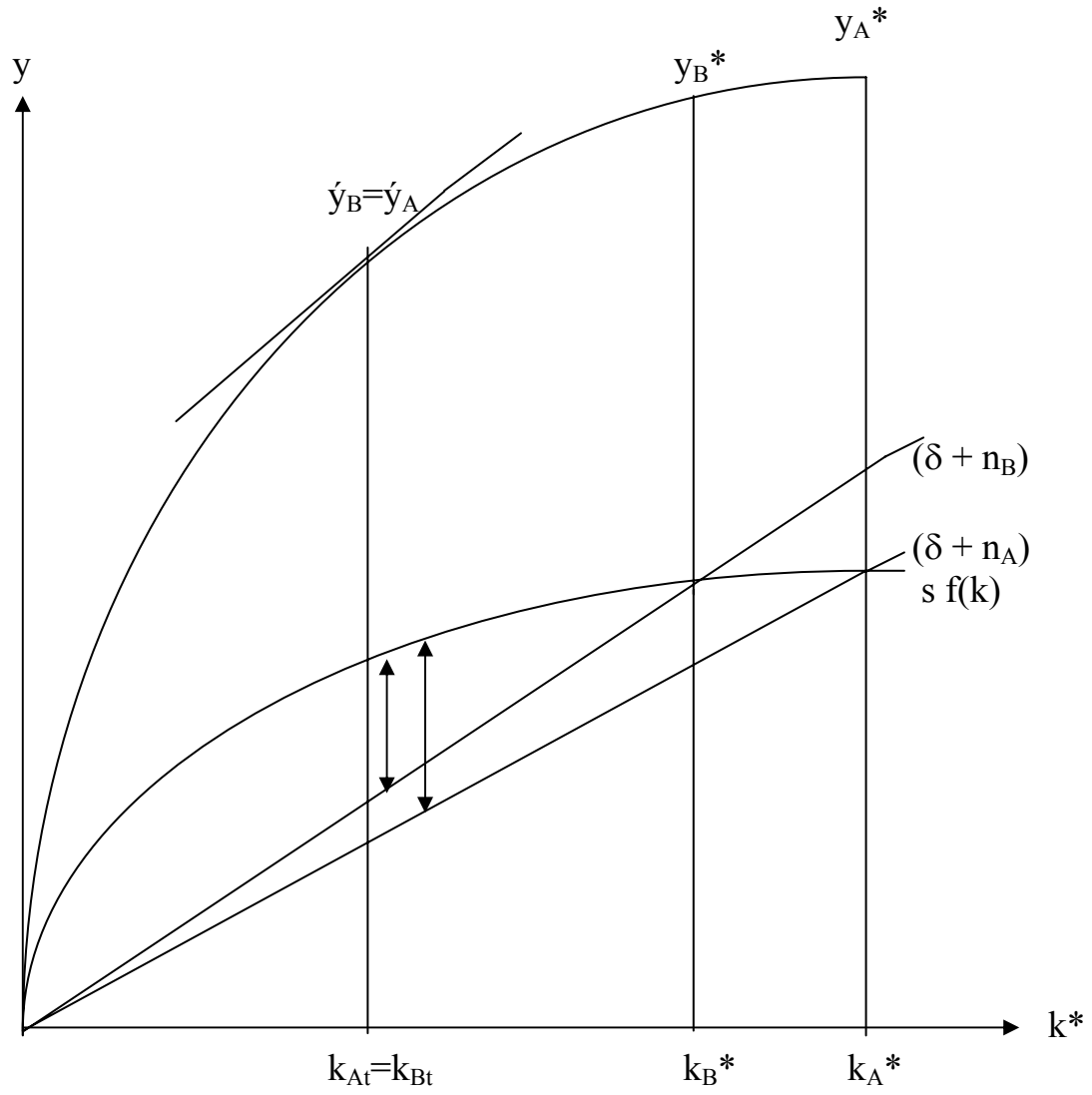
Basic assumptions in 1798 model (later revised by Malthus):

a) Population grows **exponentially (exogenously)**

b) The arable land area and production technologies are given. As the population grow, the marginal product of labour in food production declines and total food production increases at a declining rate. On a per-capita basis, food production and consumption declines until it fall below subsistence level, and population growth stops (people simply die of food shortage)

c) No **technological progress** in agriculture (later revised by Malthus himself)

[5.9] Population Growth Differences Across Countries in the Solow Model



Assumptions:

1) $n_B > n_A$, but 2) $k_{Bt} = k_{At}$, 3) $s_B = s_A$ and 4) $y_B = y_A = f(k)$

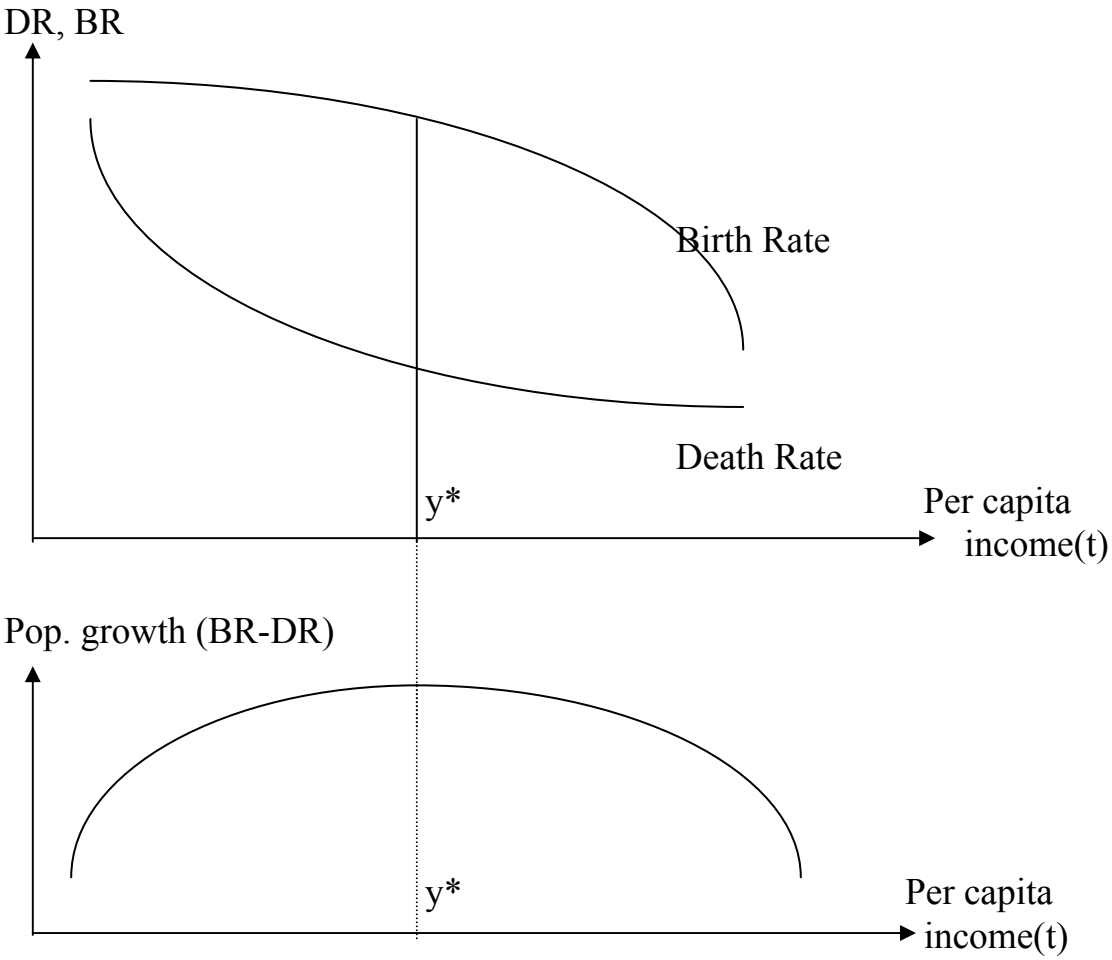
Results:

1) Different population growth rates have no effect on economic growth ***below*** steady state ($\acute{y}_B = \acute{y}_A$), but negative for discrete changes (see OH 3.5)

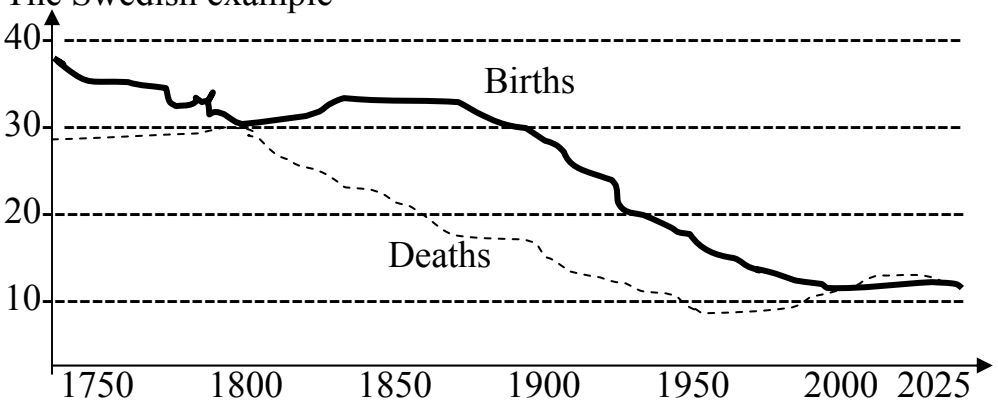
2) ***Different*** steady states income will be accomplished ($y_A^* > y_B^*$)

[5.10] Effects of economic growth on population growth

The Demographic Transition Theory

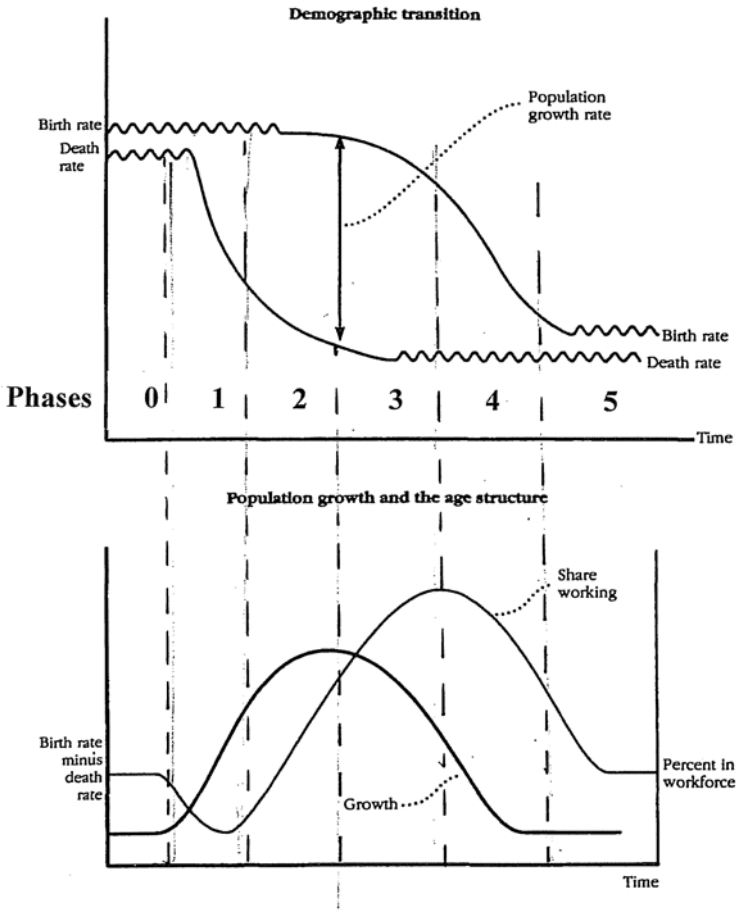


The Swedish example



[5.11.a] Merging the Transition theory with a labour supply model (Bloom & Williamson 1999)

Figure 1. *Demographic Transition and Population Growth*



[5.11.b] Phases in B&W Model

Phase 0. No economic growth and high births and death rates

- No population growth
- No change in share of population at working age

Phase 1. Economic growth is initiated (exogenous ≈ time)

- **Death rates** start to decline rapidly among infants and young children in the wake of higher incomes allowing higher consumption of food and health care (and availability of modern medical technology)
- **Birth rates** not yet affected

Implications:

1) **Population** growth starts to increase from a low initial level as the difference between birth and death rates increases
2) The share of young **children** in the population **increases** as fewer die at an early age and, consequently, the share of people at **working age declines** (the labour force becomes relatively smaller in the population)

[5.11.c] Phases in B&W Model

Phase 2. Continued economic growth (still exogenous)

- The **birth** rate starts to drop slowly
- The **child death rate** decline starts to taper off
- The **death rate** among the **work-age** population declines

Implications:

1) The population growth rate continues to increase, as the decline in the death rate is faster than the incipient decline in the birth rate

2) The share of the working-age population starts to increase because the large share of young children in phase (1) have now joined the labour force .

3) The relative size of the work force in the population also increases because of declining birth rates and due to reduced mortality among adults at work-age in this phase (2). That is, the relative size of the work-force follows the population growth rate with a lag

[5.11.d] Phases in B&W Model

Phase 3. Continued economic growth (still exogenous)

- The **birth rate** starts to fall more rapidly
- The **child death rate** decline peters out
- The **death rate** among the **elderly** starts to drop

Implications:

1) The population growth rate declines as the gap between the birth and overall death rate starts to close

2) The share of the population in the working-age group is still on the increase, but at a declining rate as the relatively small share of young children in the previous phase (2) now reach working age and add little to the work force.

3) At some point, the relative share of the working-age group in the population will cease to increase. The increasingly smaller child cohorts in the previous phase (2), in the wake of declining birth rates, reach working age and add less and less to the labour force. This marks the end of phase 3

[5.11.e] Phases in B&W Model

Phase 4. Continued economic growth (still exogenous)

- The **birth rate** continues to fall, but now at a slower rate
- The **child death** rate has stabilised at a low level
- The **death rate** among **elderly** people continues to fall and they live longer

Implications:

1) Population growth is still declining, but at an increasingly slower pace and finally peters out a low steady state growth rate

2) The share of the working-age people starts to decline, mainly because the mortality among the elderly falls and they become relatively more numerous

[5.11.e] Phases in B&W Model

Phase 5. Continued economic growth (still exogenous)

- Both **birth** and **child death rates** have stabilised at low levels

Implications:

1) Population growth is stabilised at a low level
2) The share of the population of working age continues to decline, but reaches a new level were it is not changing any longer

Phase 6 (*Extension - not in the B&W paper*!)

- The **child birth rate** continues to fall and, eventually, below the replacement level (2.1 child per woman).
- The **death rate** among the **elderly** continues to fall
- The birth rate falls below the death rate..

Implications:

1) Population starts to decline
2) The growing number of elderly people means a declining share of people at working age, as in many OECD countries and soon in China (the curve does not flatten out as in B&W)

[5.11.f] Changes in work-age people in population; Implications for Economic Growth (endogenous now)

Two <u>transitional</u> effects on economic growth:

1) In phases 2 and 3, when the working force is growing relative to the population, the number of hands relative to mouths increases (the dependency ratio declines). This means that, on a **per-capita** basis, economic growth will increase (if everything else is equal).

2) When the labour force is on the increase in the population, the marginal productivity of capital (and return to capital) increases. If savings and investment are mainly out of capital income, savings/investments will increase and so will economic growth (according to most growth models) during these phases

[5.12] The micro-economic foundation behind the links from economic growth to death and birth rate decline

***Death rate*: Higher incomes mean higher effective demand for education, health services and good nutrition**

***Birth rate*:**

1) Higher household income leads directly to lower demand for children:

*** Higher opportunity cost for children**

*** Increased survival of own children with higher economic standards (food, health care) means that fewer children are needed to replace those who die)**

*** Demand for Child Labour in the household falls**

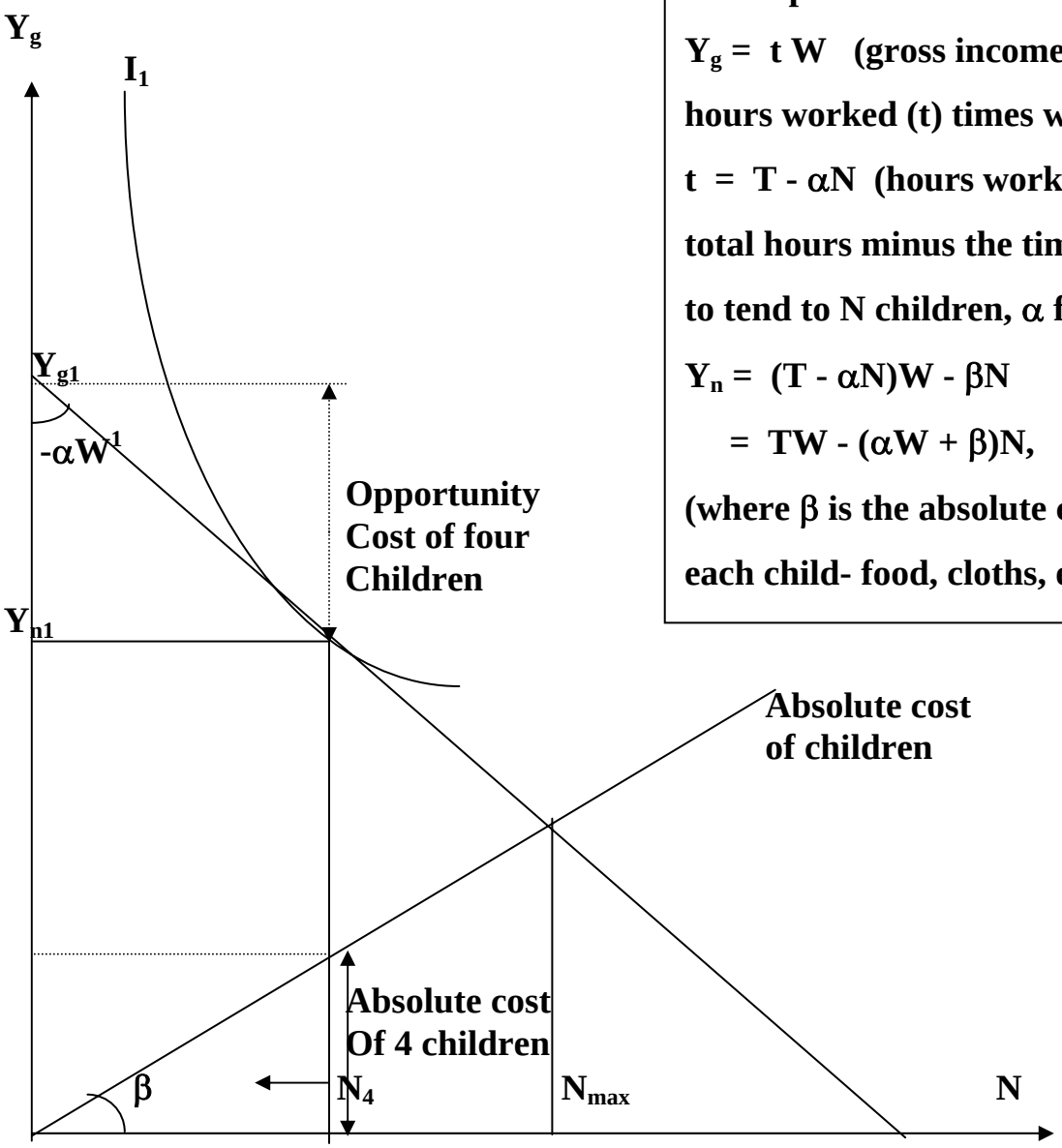
2) Higher income in society at large leads indirectly to lower demand for children:

*** Possibilities for alternative pension schemes**

*** Better information about contraception, which makes more children than wanted less likely**

*** Change of Social Preferences:** *Quality* rather than *quantity*

[5.13a] Figure 5.8a. Earned net income, opportunity cost and desired number of children in a household



Assumptions:

Y_g = t W (gross income is no of hours worked (t) times wage (W)

t = T - αN (hours worked are total hours minus the time it takes to tend to N children, α for each).

Y_n = (T - αN)W - βN

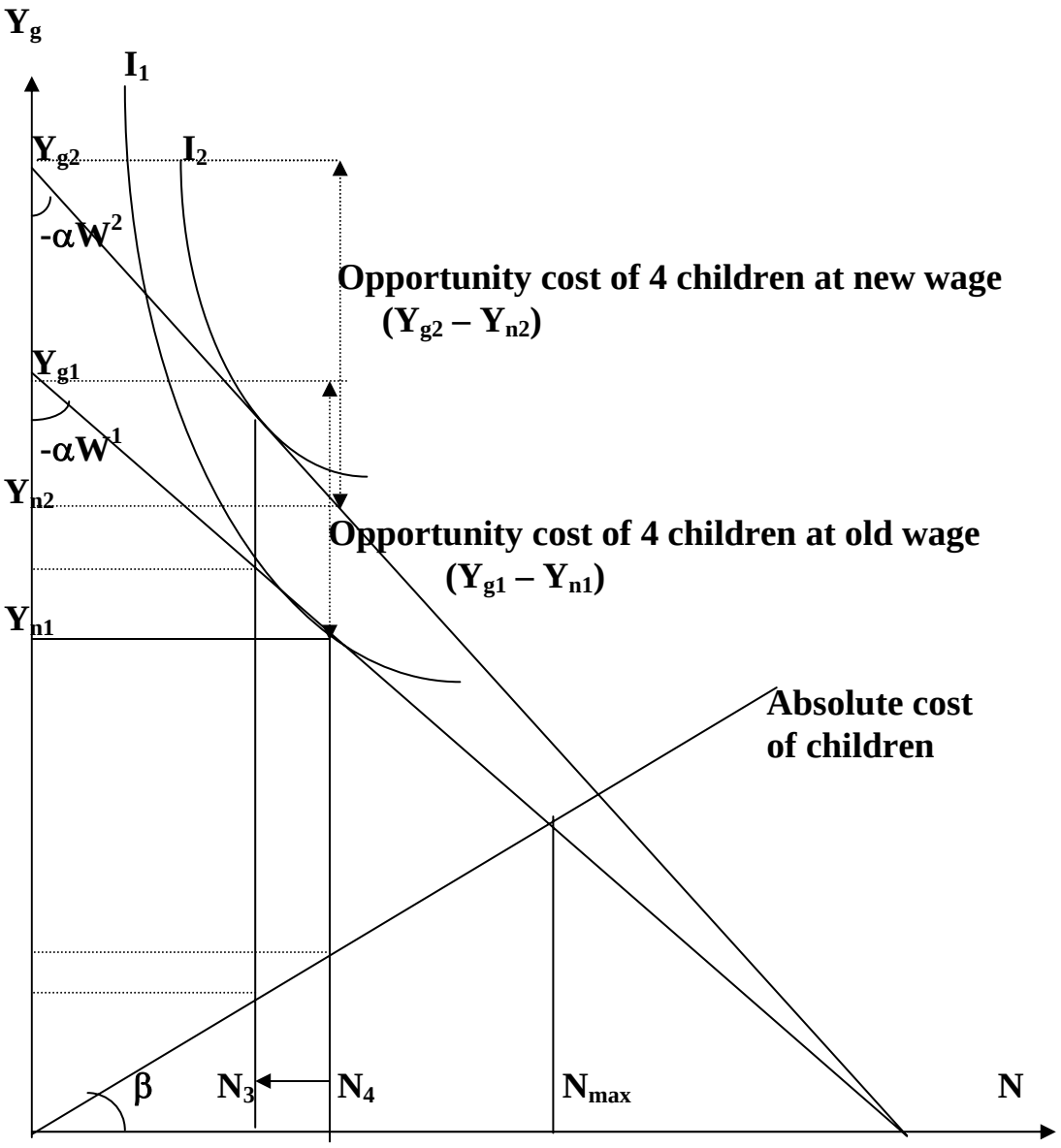
= TW - (αW + β)N,

(where β is the absolute cost of each child- food, cloths, etc)

<u>Initial situation</u>: the wage rate is W^1 and the household could earn a gross income of Y_{g1} if it chooses to have no children. With the preference of having an income also at old age, reflected in the indifference curve I^1, it plans to have 4 children (N_4). The net income is hence (Y_{n1}- β N_4).
Question: What happens if the wage rate is instead W^2?

[5.13b] Figure 5.8.b Earned net income, opportunity cost and desired number of children in a household

Question: What happens if the wage rate is increased to W^2?



New situation: At the wage rate is W^2, the opportunity cost of 4 children increases from $(Y_{g1} - Y_{n1})$ to $(Y_{g2} - Y_{n2})$. That is, the children become more expensive and this may reduce demand. If inter-temporal income preferences are given by I_2, the household will opt for 3 children.
What implicit assumption rests behind such preferences?

[5.14] Number of children also depends on the probability of each child to actually provide support

Define:

ρ = Probability that a **given** child will actually support his/her old parents

$(1 - \rho)$ = Probability that one given child will **not** support his/her old parents (it may die, become disabled, unemployed, run away or just be "rotten")

$(1 - \rho)(1 - \rho)$ = Probability that **none** of two children will support

$(1 - \rho)^n$ = Probability that **none** of n children will support

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$1 - (1 - \rho)^n$ = Probability that at least one of n children will support

	Number of children (n)						
$(1 - \rho)$	1	2	3	4	5	6	7
2/3	0.33	0.55	0.70	0.80	0.86	0.91	0.94
1/2	0.50	0.75	0.83	0.94	0.97	0.98	0.99
1/3	0.67	0.89	0.96	0.99	1.00	1.00	1.00

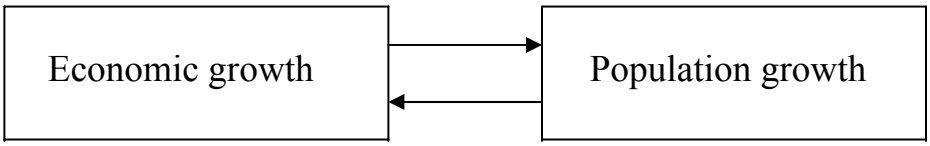
Exercises:

1) How many children are required if the household wants to be 95 per cent sure that at least one child supports when $(1 - \rho = ½)$ and there is a gender bias: i.e. only boys (or only girls) provide support?

2) How will growth in the economy affect parents expected "returns" from their children and hence the number of children planed?

[5.15] Economic and population growth: summary of theories

* Several theories predict that there are causal links between economic growth and population growth in **both directions,** i.e. the labour-supply version of the transition theory



* This theory also predictthat the relationships may look different for countries at **different levels of income**.

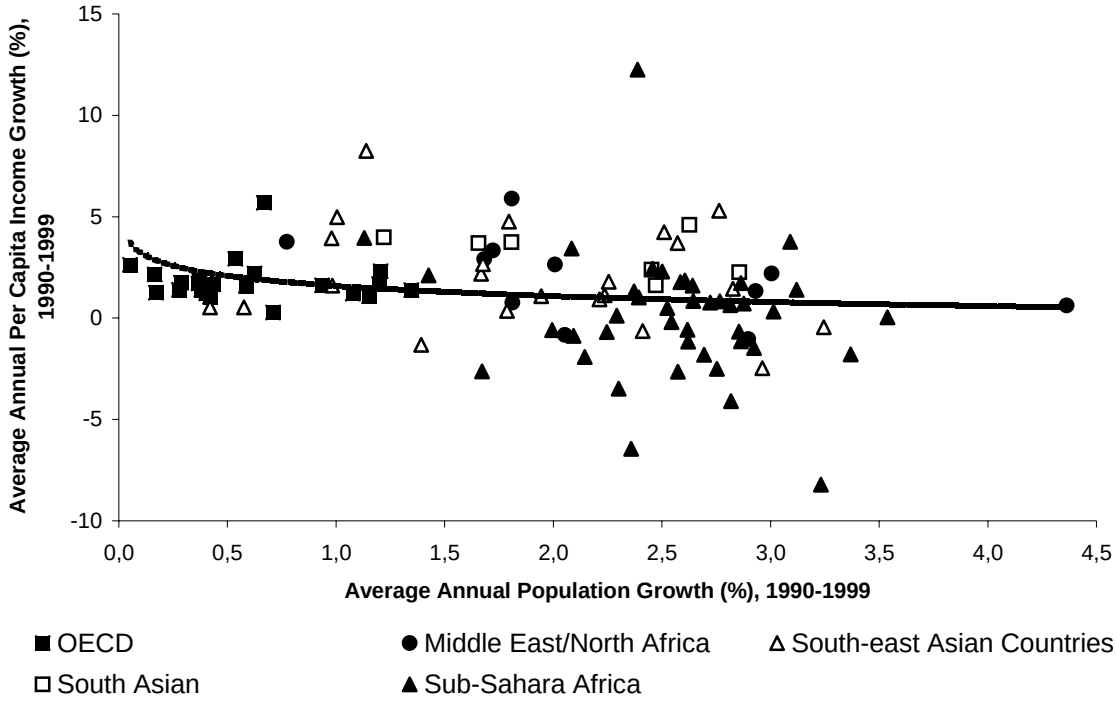
* Some of the effects may be **transitory**, i.e. related to changes in the **rate** of population growth rather than the level.

* Since some other theories predict that population growth is **lowering** economic growth and others that is in **beneficial**, it is an **empirical issue** to find out what theoretical "mechanisms" are the strongest (turn to next)

* Most empirical evidence at hand, are based on **cross-country** (or panel) regressions in which the population growth rate is one of many "explanatory" variables.

[5.16] Economic Growth on Population Growth: Causality?

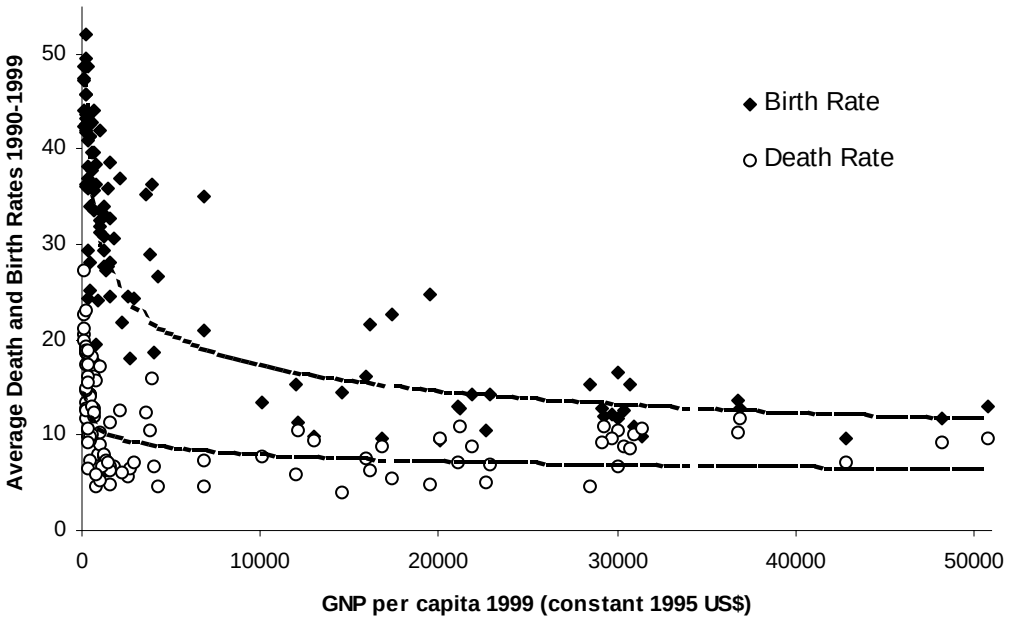
Figure 5.6. Simple Association between Growth of Income (GNP/capita) and Population Growth, 1990-1999



Source: World Development Indicators 2001, World Bank

Recall: Pop-growth = Birth rate - Death rate (+ net migration)

[5.17] Figure 5.7. Simple Association between Birth & Death Rates and Income Level (GNP/capita) across countries



Source: World Development Indicators 2001, World Bank

Comments:

a) Enormous **variation** in both BR and DR in the **poorest countries** (suggesting that for these other factors than income have strong influences)

b) Almost "flat" DR curve above $5-10,000 GNP/capita and not so large inter-country variation

Main empirical problem: establishing causality!

[5.18] Effects of Population Increases on per-capita Income Growth in various Growth Regressions based on Cross-country Observations

1) Barro (1997): Population growth not significant, but negative correlation between fertility and GDP per capita (support for transition theory). Tests with other conditioning variables show income level not to be robust explanation for the **declining birth rate** (fertility): Barro (1997) further finds that (female) **education** is important for bringing **down fertility**. Problems with multicolinearity, though, as income and education levels tend to go hand in hand.

2) Levine and Renelt (1992): Population growth **not significant** and **not robust determinant** of growth (see lecture 4).

3) Sala-i-Martin (1997): Not significant or robust (see lecture 4)

These 3, and many other, cross-country investigations of growth determinants have failed to find that high population growth is hindering economic growth when other variables are controlled, but most studies are flawed in various dimensions (see below).

4) Bloom and Williamson (1999); Brander and Dowrick (1994**):**
B & D probably the most complete and reliable study of the inter-relationship between income and population growth so far. **Several advantages** over most other studies.

[5.19] Brander and Dowrick's model and tests:

Model:

$$\hat{y} = \alpha_0 + \alpha_1 \hat{w}_{it} + \alpha_2 \hat{P}_{it} + \alpha_3[X_{it}] + \mu_{it} + \varepsilon_{it}$$

where y is per capita income, w is the share of the labour force in the population and P is population. The "hats" indicate relative changes. The vector X is a set of conditioning variables (with the investment ratio as the most significant one in subsequent tests). $\mu_{it} + \varepsilon_{it}$ are two components of the error term.

Econometric properties of tests:

a) Distinguish between low- and high-income countries (cf the transition theory) and uses PPP adjusted income data

b) Distinguish between population growth, fertility change, and change in the labor force—the economically active in the population (note that in the poorest countries, population growth may be on the increase while birth rates are falling). Why?

c) Uses a panel and controls for simultaneity and tests alternative econometric models (OLS, Fixed effects and Random effects).

d) Controls for endogeneity (Instrument variables)

[5.20] Table 5.2. Main results as derived by Brander &Dowrick

	Estimation model			
Sample/ variables	**OLS**	**Fixed Effects**	**Random Effects**	**Instrument variables**
Whole sample (107x5 = 535)				
w^	**0.85 (2.7)**	**0.31 (0.9)**	**0.79 (2.7)**	**1.35 (3.2)**
P^	**0.02 (0.1)**	**-0.33 (-1.0)**	**0.02 (0.1)**	**-0.17 (-0.7)**
More developed countries (76x5)				
w^	**0.67 (2.3)**	**-**	**-**	**1.28 (3.1)**
P^	**-0.09 (-0.5)**	**-**	**-**	**-0.27 (-1.2)**
Least developed countries (31x5)				
w^	**1.57 (2.1)**	**1.00 (1.0)**	**1.46 (1.7)**	**-**
...P^	**-0.12 (-0.2)**	**-0.74 (-1.1)**	**-0.22 (-0.5)**	**-**

Notes: Coefficients are in log form and can be interpreted as elasticities; t-statistics in parentheses. Significant coefficients are marked with grey.

[5.21] Brander and Dowrick: Comments on Empirical Results

(1) **Population growth has** no significant effect on economic growth with any of the model specification or group of countries.

(2) An increase in the **share of the work-force (W)** in the population has a significant and positive effect on economic growth with most model specifications for the whole sample (107 countries, 5 five-year periods) and for the higher income countries. Weaker result for the least developed countries. This finding supports the labour-supply hypothesis (the inverse of the dependency-model)

(3) A decline in the **birth rate** is also associated with higher economic growth (in another tests not reported in the above table)

Qualifications:

a) Possible **omitted variable bias** (only 3 conditioning variables and very low R-square adjusted in all tests)

b) No **robustness tests** are carried out

c) **Data** for the not-so-recent 1961-85 period. More recent, and revised data now available (1986-2005).

Last year, a student thesis updated the B&D study and found practically the same results!

[5.22] Summary and Conclusions of Empirical Investigation:

1) Effects of Population Growth on Economic Growth:

Population growth rate has no significant and robust impact on economic growth, which goes contrary to Malthus' theory of natural resource (food) constraints. Solow below steady state? Discretionary changes?

2) Effects of Changes in the Birth Rate on Economic Growth

a) A lowering of the BR induces a **transitional** increase in the share of population at working age, which **enhances economic growth** (and hence supports the dependency theory).

b) High birth rates lower per capita investment in the poorest countries (support for dependence theory); different size of effects in the poorest and other developing countries. That is, more support for **transitional** effects of changes in birth rates, rather than permanent effects of population growth as such.

3) Evidence for Economic Growth to Lower Birth Rates and Population Growth? (the transition theory)

The empirical evidence suggests the economic growth is not the only determinant of birth rates. Education and high child mortality (the replacement effect) also matter.

[5.23] Literature

Recommended readings:

Bloom, D.E and J.G. Williamsson (1999), "Demographic Transitions and Economical Miracles in Emerging Asia, *The World Bank Economic Review* 12 (3): 419-55

Brander, J.A. and S. Dowrick (1994), "The Role of Fertility and Population in Economic Growth", *Journal of Population Economics* 7(1):1-25.

Galor, O. and D.N. Weil (1998), "From Malthusian Stagnation to Modern Growth", *American Economic Review* 89(2): 150-54.

Readings referred to in lecture:

Barro. R.J. (1997), *Determinants of Economic Growth: A Cross-country Empirical Study*, Cambridge: MIT Press.

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Diamond, J. (1999), *Guns, Germs and Steel: The Fate of Human Society*, Norton.

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