Towards a Unified Theory of Economic Growth

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Towards a Unified Theory of Economic Growth

Oded Galor on the transition from Malthusian stagnation to modern economic growth

An interview with introduction by Brian Snowdon

> A complete, consistent, unified theory…would be the ultimate triumph of human reason.
>
> Stephen Hawking (1988)

> It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.
>
> Charles Darwin (1859)

> Deciphering the fundamental determinants of the transition from stagnation to growth and the great divergence has been widely viewed as one of the most significant research challenges facing researchers in the field of growth and development.
>
> Oded Galor (2005a)

Introduction

Oded Galor is one of the world's leading and most imaginative growth theorists. Throughout his career, Professor Galor's numerous publications have focussed on growth-related issues such as labour migration, international trade, income distribution, demography, human capital accumulation, and discrete dynamical systems. Recently his work has emphasised the need for a unified theory of growth that incorporates an evolutionary perspective and can account for the transition from Malthusian stagnation

Oded Galor is Professor of Economics at Brown University, Providence, Rhode Island, USA.
Brian Snowdon is Professor of Economics and International Business at Northumbria University, Newcastle Upon Tyne, UK.

to the modern growth regime.[1] Professor Galor is the author of *Discrete Dynamical Systems* (2007), and is currently working on two new books on economic growth due to be published in 2008–09.[2]

Oded Galor first studied economics at The Hebrew University, Jerusalem, where he graduated with BA (1978) and MA (1980) degrees with distinction. He then went on to gain his M. Phil (1982) and PhD (1984) degrees in Economics at Columbia University. His career as a professional economist began at Brown University where he was appointed as an Assistant Professor in 1984. Since then he has been an Associate Professor (1986–1990) and Professor of Economics at Brown University. He has also been a Visiting Professor of Economics at The Hebrew University of Jerusalem (1987–88 and 1994–95), Université Catholique de Louvain (1994), University of Copenhagen (1997), Universitat Autònoma de Barcelona (1998), and the University of Zurich (2003). He has been a Visiting Fellow at the University of Stockholm, and from 1996 until 2006 was the Chilewich Professor of Economics at The Hebrew University of Jerusalem. Professor Galor serves on the editorial boards of several prestigious journals, including the *Journal of Economic Growth* (Editor), *Journal of Money, Credit and Banking* (Associate Editor) and *Macroeconomic Dynamics* (Associate Editor). Since 1995 Professor Galor has been co-director of the National Bureau of Economic Research group on *Income Distribution and Macroeconomics*, and he is also a Research Fellow at the Centre for Economic Policy Research.

Before discussing with Professor Galor the main ideas developed in his recent quest to produce a unified theory of growth, I briefly survey, as background, the new and exciting literature that attempts to provide a unified account of the 'Great Escape' from 'Malthusian stagnation' to a regime of 'modern economic growth'.

Growth in history: In search of a unified theory

Human history is characterised by a very long period of stagnation in world per capita income, followed by a transition to sustained growth. The modern period of sustained growth dates back two hundred and fifty years to

[1] Details of Professor Galor's career history and publications can be found on his personal webpage, http://www.econ.brown.edu/fac/Oded_Galor/frmain.htlm
[2] See Galor, 2008, 2009.

the Industrial Revolution. However, beginning in the mid-eighteenth century, the world economy also began to witness a 'Great Divergence' of per capita incomes. These extraordinary events pose numerous questions for social scientists. The main puzzles to explain are these:

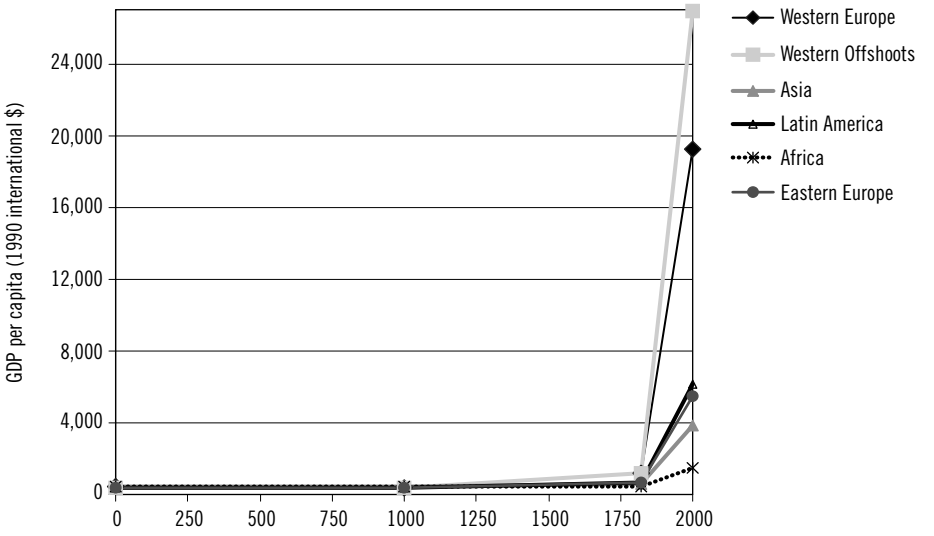
1. Why did no country or region of the world, prior to the eighteenth century (the Malthusian era), experience lasting intensive growth, that is, *sustained* increases in per capita GDP?
2. What led to the first 'Industrial Revolution', and was this 'Revolution' inevitable?
3. Why did the first Industrial Revolution begin in England in the middle of the eighteenth century?
4. What factors can account for the demographic transition, that is, the reversal of the positive relationship between population and per capita income that characterised all of human history until the mid–nineteenth century?
5. What has caused the 'Great Divergence' in living standards across the world during the last 250 years?

It is difficult to imagine that there are any bigger or more difficult questions confronting economists, and scholars searching to provide answers are working at the frontiers of growth theory and empirics. Increasingly, in order to provide plausible answers to such questions, economists have begun to appreciate the value of economic history and the previous research carried out by economic historians. As noted in an earlier article, there has recently emerged a growing synergy between growth theory, economic history and development economics.[3]

Figure 1 illustrates the evolution of regional per capita incomes during the last 2,000 years and the dramatic 'Great Divergence' of the last two hundred and fifty years.[4] Figure 2 captures the experience of sustained growth of per capital incomes in Western Europe and the 'Western Offshoots' (USA, Canada, Australia, and New Zealand) since the last quarter of the nineteenth century. Although major deviations from trend—caused by the Great Depression and the two World Wars of the twentieth

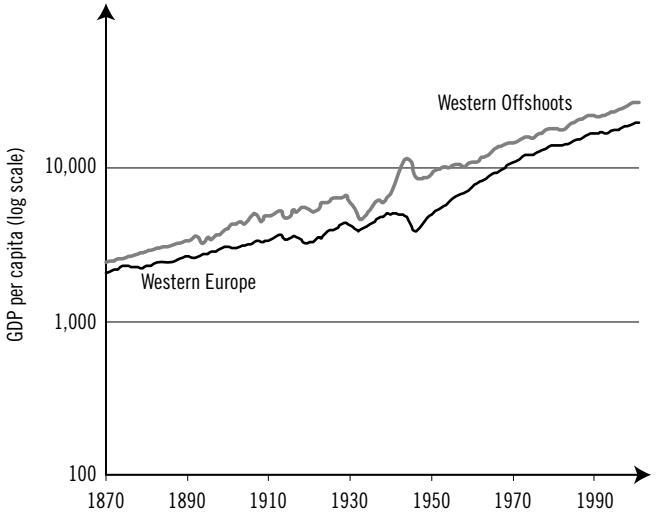
[3] See Snowdon, 2007a.
[4] See Pomeranz, 2000.

Figure 1: The evolution of regional GDP per capita and the 'Great Divergence'



Source: Galor, 2005a

Figure 2: Sustained growth of GDP per capita, 1870–2001: Western Europe and Western Offshoots



Source: Galor, 2005a

century—are visible, the experience of more than one hundred and fifty years of sustained growth of per capita incomes experienced by the now developed economies is historically unprecedented.

While the exogenous and endogenous neoclassical growth models of Robert Solow and Paul Romer may provide plausible explanations of the modern experience of economic growth in *developed* economies, they cannot account for the major growth transition that occurred with the onset of the Industrial Revolution.[5] What is needed is a *unified theory* that can account for the major features of the prolonged Malthusian era as well as the transition to the modern growth regime.[6]

Contours of the world economy: Maddison's data

The most comprehensive set of data going back to 1 AD is provided by Angus Maddison, and Tables 1–6 provide his estimates for GDP and population for the period 1–2001 AD for selected countries and regions of the world.[7] Several important features stand out:

1. Per capita GDP was at subsistence level across the globe until very recently and a significant divergence of living standards has emerged during the last two hundred and fifty years (Table 1).
2. Growth rates of per capita income have accelerated since the Industrial Revolution, but large variations in growth performance across the world's economies characterise the modern era (Table 2).
3. The share of world GDP has shifted dramatically from East to West over the last two thousand years, although that shift is now being reversed (Table 3).
4. Total World population has increased dramatically since the eighteenth century, although world population growth is now slowing. According to the Malthusian model, Asia's large share of world population during the Malthusian era reflects its relative technological success (see Tables 4, 5, and 6).

[5] See Solow, 1956, 1957; Romer, 1986, 1990.
[6] The term 'modern economic growth' was first popularised by Nobel Laureate, Simon Kuznets. See Kuznets, 1966.
[7] The data presented in Tables 1–6 are adapted from Maddison, 2003. See also, Maddison, 2001, 2007.

Table 1: GDP per capita, 1–2001 AD: world, selected countries and regional averages (1990 Geary-Khamis international $)

Country/Region	1	1000	1500	1600	1700	1820	1870	1913	1950	1973	2001
West European average	**450**	**400**	**771**	**890**	**998**	**1,204**	**1,960**	**3,458**	**4,579**	**11,416**	**19,256**
Eastern Europe	**400**	**400**	**496**	**548**	**606**	**683**	**937**	**1,695**	**2,111**	**4,988**	**6,027**
Former USSR	**400**	**400**	**499**	**552**	**610**	**688**	**943**	**1,488**	**2,841**	**6,059**	**4,626**
United States			400	400	527	1,257	2,445	5,301	9,561	16,689	27,948
Other Western offshoots			400	400	408	761	2,245	4,752	7,425	13,399	21,718
Average Western offshoots	**400**	**400**	**400**	**400**	**476**	**1,202**	**2,419**	**5,233**	**9,268**	**16,179**	**26,943**
Mexico			425	454	568	759	674	1,732	2,365	4,845	7,089
Other Latin America			410	431	502	663	683	1,424	2,536	4,426	5,508
Latin American average	**400**	**400**	**416**	**438**	**527**	**692**	**681**	**1,481**	**2,506**	**4,504**	**5,811**
Japan	**400**	**425**	**500**	**520**	**570**	**669**	**737**	**1,387**	**1,921**	**11,434**	**20,683**
China	450	450	600	600	600	600	530	552	439	839	3,583
India	450	450	550	550	550	533	533	673	619	853	1,957
Other Asia	450	450	565	565	565	584	643	882	926	2,049	3,998
Asian average (excluding Japan)	**450**	**450**	**572**	**575**	**571**	**577**	**550**	**658**	**634**	**1,226**	**3,256**
Africa	**430**	**425**	**414**	**422**	**421**	**420**	**500**	**637**	**894**	**1,410**	**1,489**
World	**445**	**436**	**566**	**595**	**615**	**667**	**875**	**1,525**	**2,111**	**4,091**	**6,049**

Table 2: Rates of growth of GDP per capita, 1–2001 AD: world, selected countries and regional averages (annual average % compound growth)

Country/Region	1–1000	1000–1500	1500–1820	1820–1870	1870–1913	1913–1950	1950–1973	1973–2001
Total Western Europe	**–0.01**	**0.13**	**0.14**	**0.98**	**1.33**	**0.76**	**4.05**	**1.88**
Eastern Europe	**0.00**	**0.04**	**0.10**	**0.63**	**1.39**	**0.60**	**3.81**	**0.68**
Former USSR	**0.00**	**0.04**	**0.10**	**0.63**	**1.06**	**1.76**	**3.35**	**–0.96**
United States			0.36	1.34	1.82	1.61	2.45	1.86
Other Western offshoots			0.20	2.19	1.76	1.21	2.60	1.74
Total Western offshoots	**0.00**	**0.00**	**0.34**	**1.41**	**1.81**	**1.56**	**2.45**	**1.84**
Mexico			0.18	–0.24	2.22	0.85	3.17	1.37
Other Latin America			0.15	0.06	1.72	1.57	2.45	0.78
Total Latin American	**0.00**	**0.01**	**0.16**	**–0.03**	**1.82**	**1.43**	**2.58**	**0.91**
Japan	**0.01**	**0.03**	**0.09**	**0.19**	**1.48**	**0.88**	**8.06**	**2.14**
China	0.00	0.06	0.00	–0.25	0.10	–0.62	2.86	5.32
India	0.00	0.04	–0.01	0.00	0.54	–0.22	1.40	3.01
Other Asia	0.00	0.05	0.01	0.19	0.74	0.13	3.51	2.42
Total Asia (excluding Japan)	**0.00**	**0.05**	**0.00**	**–0.10**	**0.42**	**–0.10**	**2.91**	**3.55**
Africa	**0.00**	**–0.01**	**0.00**	**0.35**	**0.57**	**0.92**	**2.00**	**0.19**
World	**0.00**	**0.05**	**0.05**	**0.54**	**1.30**	**0.88**	**2.92**	**1.41**

Table 3: Share of world GDP, 1–2001 AD: world, selected countries and regional averages (% of total)

Country/Region	1	1000	1500	1600	1700	1820	1870	1913	1950	1973	2001
Total Western Europe	**10.8**	**8.7**	**17.8**	**19.8**	**21.9**	**23.0**	**33.0**	**33.0**	**26.2**	**25.6**	**20.3**
Eastern Europe	**1.9**	**2.2**	**2.7**	**2.8**	**3.1**	**3.6**	**4.5**	**4.9**	**3.5**	**3.4**	**2.0**
Former USSR	**1.5**	**2.4**	**3.4**	**3.5**	**4.4**	**5.4**	**7.5**	**8.5**	**9.6**	**9.4**	**3.6**
United States			0.3	0.2	0.1	1.8	8.8	18.9	27.3	22.1	21.4
Other Western offshoots			0.1	0.1	0.1	0.1	1.2	2.4	3.4	3.3	3.2
Total Western offshoots	**0.5**	**0.7**	**0.5**	**0.3**	**0.2**	**1.9**	**10.0**	**21.3**	**30.7**	**25.3**	**24.6**
Mexico			1.3	0.3	0.7	0.7	0.6	0.9	1.3	1.7	1.9
Other Latin America			1.7	0.8	1.0	1.4	1.9	3.4	6.5	6.9	6.4
Total Latin America	**2.2**	**3.9**	**2.9**	**1.1**	**1.7**	**2.2**	**2.5**	**4.4**	**7.8**	**8.7**	**8.3**
Japan	**1.2**	**2.7**	**3.1**	**2.9**	**4.1**	**3.0**	**2.3**	**2.6**	**3.0**	**7.8**	**7.1**
China	26.1	22.7	24.9	29.0	22.3	32.9	17.1	8.8	4.5	4.6	12.3
India	32.9	28.9	24.4	22.4	24.4	16.0	12.1	7.5	4.2	3.1	5.4
Other Asia	16.0	16.0	12.6	11.1	10.9	7.5	6.9	6.0	6.8	8.7	13.2
Total Asia (excluding Japan)	**75.1**	**67.6**	**61.9**	**62.5**	**57.7**	**56.4**	**36.1**	**22.3**	**15.4**	**16.4**	**30.9**
Africa	**6.9**	**11.7**	**7.8**	**7.1**	**6.9**	**4.5**	**4.1**	**2.9**	**3.8**	**3.4**	**3.3**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 4: World population, 1–2001 AD: world, selected countries and regional averages (thousands)

Country/Region	1	1000	1500	1600	1700	1820	1870	1913	1950	1973	2001
Total Western Europe	**24,700**	**25,413**	**57,268**	**73,778**	**81,460**	**133,040**	**187,504**	**260,975**	**304,941**	**358,825**	**392,101**
Eastern Europe	**4,750**	**6,500**	**13,500**	**16,950**	**18,800**	**36,457**	**53,557**	**79,530**	**87,637**	**110,418**	**120,912**
Former USSR	**3,900**	**7,100**	**16,950**	**20,700**	**26,550**	**54,765**	**88,672**	**156,192**	**179,571**	**249,712**	**290,349**
United States	680	1,300	2,000	1,500	1,000	9,981	40,241	97,606	152,271	211,909	285,024
Other Western offshoots	490	660	800	800	750	1,250	5,847	13,795	24,186	38,932	54,815
Total Western offshoots	**1,170**	**1,960**	**2,800**	**2,300**	**1,750**	**11,231**	**46,088**	**111,401**	**176,457**	**250,841**	**339,839**
Mexico	2,200	4,500	7,500	2,500	4,500	6,587	9,219	14,970	28,485	57,463	101,879
Other Latin America	3,400	6,900	10,000	6,100	7,550	15,118	31,180	65,965	137,453	250,756	429,334
Total Latin America	**5,600**	**11,400**	**17,500**	**8,600**	**12,050**	**21,705**	**40,399**	**80,935**	**165,938**	**308,399**	**531,213**
Japan	**3,000**	**7,500**	**15,400**	**18,500**	**27,000**	**31,000**	**34,437**	**51,672**	**83,805**	**108,707**	**126,892**
China	59,600	59,000	103,000	160,000	138,000	381,000	358,000	437,140	546,815	881,940	1,275,392
India	75,000	75,000	110,000	135,000	165,000	209,000	253,000	303,700	359,000	580,000	1,023,590
Other Asia	36,600	41,400	55,400	65,000	71,800	89,400	119,792	184,849	392,827	677,613	1,227,630
Total Asia (excluding Japan)	**171,200**	**175,400**	**268,400**	**360,000**	**374,800**	**679,400**	**730,792**	**925,689**	**1,298,642**	**2,139,553**	**3,526,612**
Africa	**16,500**	**32,300**	**46,610**	**55,320**	**61,080**	**74,236**	**90,466**	**124,697**	**227,333**	**390,034**	**821,088**
World	**230,820**	**267,573**	**438,428**	**556,148**	**603,490**	**1,041,834**	**1,271,915**	**1,791,091**	**2,524,324**	**3,916,489**	**6,149,006**

Table 5: Rates of growth of world population, 1–2001 AD: world, selected countries and regional averages (annual average % compound growth)

Country/Region	1–1000	1000–1500	1500–1820	1820–1870	1870–1913	1913–1950	1950–1973	1973–2001
Total Western Europe	**0.00**	**0.16**	**0.26**	**0.69**	**0.77**	**0.42**	**0.71**	**0.32**
Eastern Europe	**0.03**	**0.15**	**0.31**	**0.77**	**0.92**	**0.26**	**1.01**	**0.32**
Former USSR	**0.06**	**0.17**	**0.37**	**0.97**	**1.33**	**0.38**	**1.44**	**0.54**
United States	0.06	0.09	0.50	2.83	2.08	1.21	1.45	1.06
Other Western offshoots	0.03	0.04	0.14	3.13	2.02	1.53	2.09	1.23
Total Western offshoots	**0.05**	**0.07**	**0.44**	**2.86**	**2.07**	**1.25**	**1.54**	**1.09**
Mexico	0.07	0.10	–0.04	0.67	1.13	1.75	3.11	2.05
Other Latin America	0.07	0.07	0.13	1.46	1.76	2.00	2.65	1.94
Total Latin American	**0.07**	**0.09**	**0.07**	**1.25**	**1.63**	**1.96**	**2.73**	**1.96**
Japan	**0.09**	**0.14**	**0.22**	**0.21**	**0.95**	**1.32**	**1.14**	**0.55**
China	0.00	0.11	0.41	–0.12	0.47	0.61	2.10	1.33
India	0.00	0.08	0.20	0.38	0.43	0.45	2.11	2.05
Other Asia	0.01	0.06	0.15	0.59	1.01	2.06	2.40	2.15
Total Asia (excluding Japan)	**0.00**	**0.09**	**0.29**	**0.15**	**0.55**	**0.92**	**2.19**	**1.80**
Africa	**0.07**	**0.07**	**0.15**	**0.40**	**0.75**	**1.64**	**2.37**	**2.69**
World	**0.01**	**0.10**	**0.27**	**0.40**	**0.80**	**0.93**	**1.93**	**1.62**

Table 6: Share of world population, 1–2001 AD: world, selected countries and regional averages (% of total)

Country/Region	1	1000	1500	1600	1700	1820	1870	1913	1950	1973	2001
Total Western Europe	**10.7**	**9.5**	**13.1**	**13.3**	**13.5**	**12.8**	**14.7**	**14.6**	**12.1**	**9.2**	**6.4**
Eastern Europe	**2.1**	**2.4**	**3.1**	**3.0**	**3.1**	**3.5**	**4.2**	**4.4**	**3.5**	**2.8**	**2.0**
Former USSR	**1.7**	**2.7**	**3.9**	**3.7**	**4.4**	**5.3**	**7.0**	**8.7**	**7.1**	**6.4**	**4.7**
United States	0.3	0.5	0.5	0.3	0.2	1.0	3.2	5.4	6.0	5.4	4.6
Other Western offshoots	0.2	0.2	0.2	0.1	0.1	0.1	0.5	0.8	1.0	1.0	0.9
Total Western offshoots	**0.5**	**0.7**	**0.6**	**0.4**	**0.3**	**1.1**	**3.6**	**6.2**	**7.0**	**6.4**	**5.5**
Mexico			1.7	0.4	0.7	0.6	0.7	0.8	1.1	1.5	1.7
Other Latin America			2.3	1.1	1.3	1.5	2.5	3.7	5.4	6.4	7.0
Total Latin America	**2.4**	**4.3**	**4.0**	**1.5**	**2.0**	**2.1**	**3.2**	**4.5**	**6.6**	**7.9**	**8.6**
Japan	**1.3**	**2.8**	**3.5**	**3.3**	**4.5**	**3.0**	**2.7**	**2.9**	**3.3**	**2.8**	**2.1**
China	25.8	22.1	23.5	28.8	22.9	36.6	28.1	24.4	21.7	22.5	20.7
India	32.5	28.0	25.1	24.3	27.3	20.1	19.9	17.0	14.2	14.8	16.6
Other Asia	15.9	15.5	12.6	11.7	11.9	8.6	9.4	10.3	15.6	17.3	20.0
Total Asia (excluding Japan)	**74.2**	**65.6**	**61.2**	**64.7**	**62.1**	**65.2**	**57.5**	**51.7**	**51.4**	**54.6**	**57.4**
Africa	**7.1**	**12.1**	**10.6**	**9.9**	**10.1**	**7.1**	**7.1**	**7.0**	**9.0**	**10.0**	**13.4**
World	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

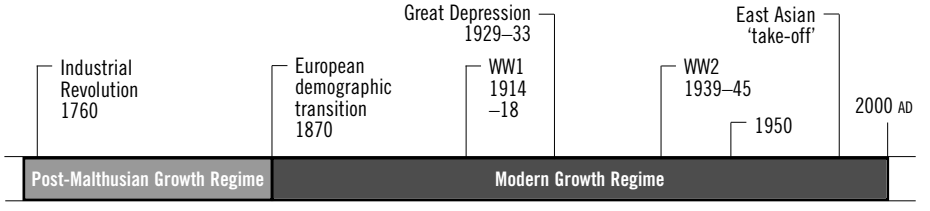
A history of the world economy in three simple images

Since it is extremely difficult to comprehend the full span of human economic history it will be helpful to imagine that we can represent the time span of 1 million BC–2000 AD in terms of a 100.2 metre soccer field, where each metre represents 10,000 years. Figure 3 illustrates this image and shows that for most of human history, prior to the Neolithic (agricultural) Revolution, hunter-gatherer societies were the only game in town as far as economic organisation is concerned. Figure 4 shows that during the final metre of our soccer field of history (8000 BC–2000 AD), the 'Malthusian Growth Regime' dominates human history until the onset of the Industrial Revolution. In the Malthusian regime, technological progress results in a larger, but not richer population. Only in the final 2.5 centimetres of human history (Figure 5), do we see the demographic transition and

Figure 3: One million years of human economic history represented by a 100.2 metre soccer field

Figure 4: The final metre of human economic history: 8000 BC–2000 AD

Figure 5: The final 2.5 centimetres of human economic history: 1750–2000



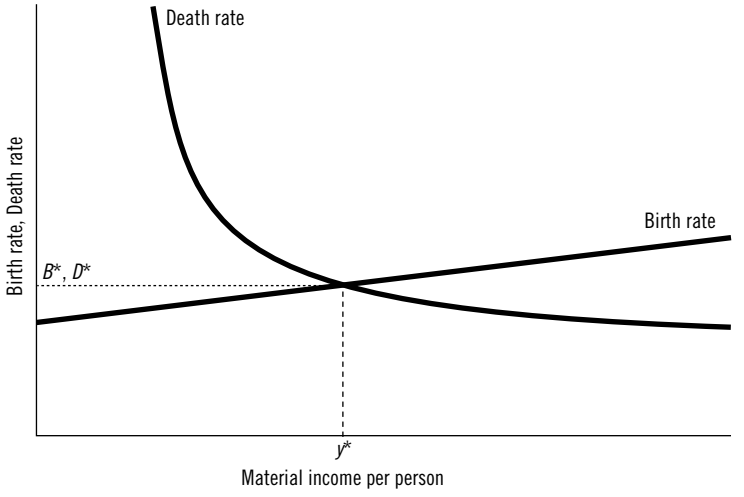
emergence of the modern growth regime, with sustained increases in per capital income for an increasing number of countries.

Anyone born in the developed economies during the second half of the twentieth century should be extremely grateful that they have lived in the last few centimetres of our soccer field because had they been born earlier in history, to borrow the words of Thomas Hobbes, their life would almost certainly have been 'solitary, poor, nasty, brutish and short'.[8]

The Malthusian model

As we have just seen, world economic history has been dominated by Malthusian dynamics. The classical growth model, developed by Thomas Robert Malthus in 1798, accounts brilliantly for the vast bulk of human material experience prior to the Industrial Revolution.[9] The model has two basic assumptions, illustrated in Figure 6.[10] First, the birth rate (B) is positively related to income. Second, the death rate (D) is negatively related to income. In such a world, technological progress will raise total GDP and hence material living standards in the short run. However, once

Figure 6: Long-run equilibrium in the Malthusian model

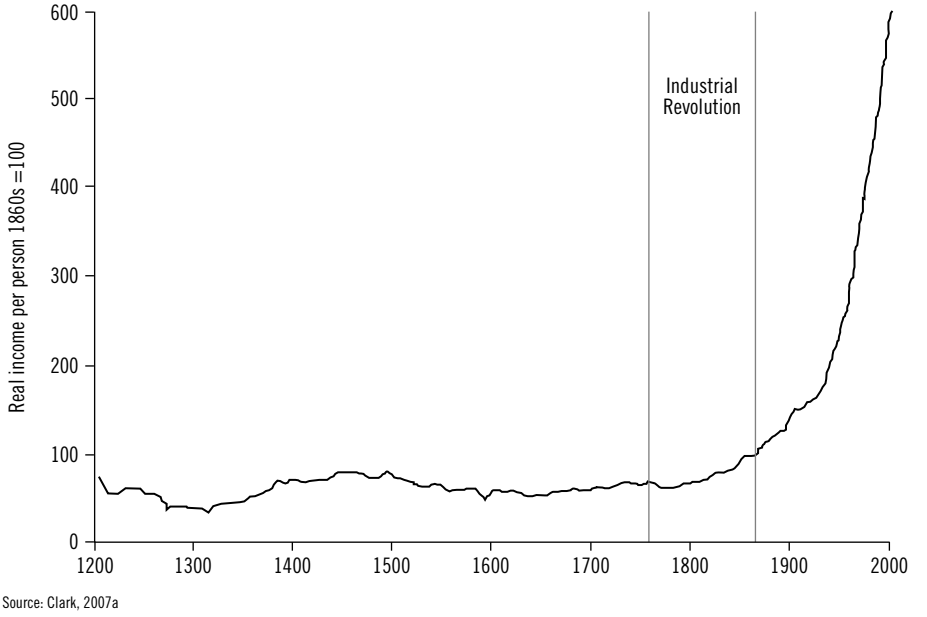


[8] Hobbes, 1651.
[9] See Ashraf and Galor, 2008a.
[10] See Clark and Hamilton, 2006; Clark, 2007a; Crafts and Mills, 2007.

the Malthusian population dynamics kick in, the impact of technological progress on total GDP is offset by population growth as $B > D$. In the Malthusian world, living standards (material income per person) will vary inversely with population. As a result, a long-run Malthusian equilibrium is established where $B^* = D^*$, with income per capita at, or close to, subsistence level (y^*). There is 'extensive growth' (total GDP increases), but no 'intensive growth' (GDP per capita is constant in the long run).

However, as Gregory Clark's data clearly illustrate (Figure 7), something dramatic happened during the nineteenth century in England.[11] For the first time in human history, and counter to the predictions of Karl Marx and Friedrich Engels that the real wages of workers would fail to rise because of the exploitative nature of the capitalist system,[12] technological progress was leading to a sustained improvement in real income per capita.

Figure 7: Real income per capita in England: 1260s–2000s



Source: Clark, 2007a

[11] See Clark, 2005.

[12] Marx and Engels, 1848. It is interesting to note that Karl Marx never used the word 'capitalism' in either the *Communist Manifesto* or *Capital* (1867, Vol. 1). It was the late nineteenth-century Marxists who developed the use of the word capitalism 'as a term of opprobrium for the economic system they wished to overthrow' (Rosenberg and Birdzell, 1986).

Promethean growth had finally been unleashed. Unlike previous historical experience, these gains were not offset by population growth, and, as Clark demonstrates, 'the biggest beneficiary of the Industrial Revolution has so far been the unskilled'.

Towards a unified theory of long-run growth and development

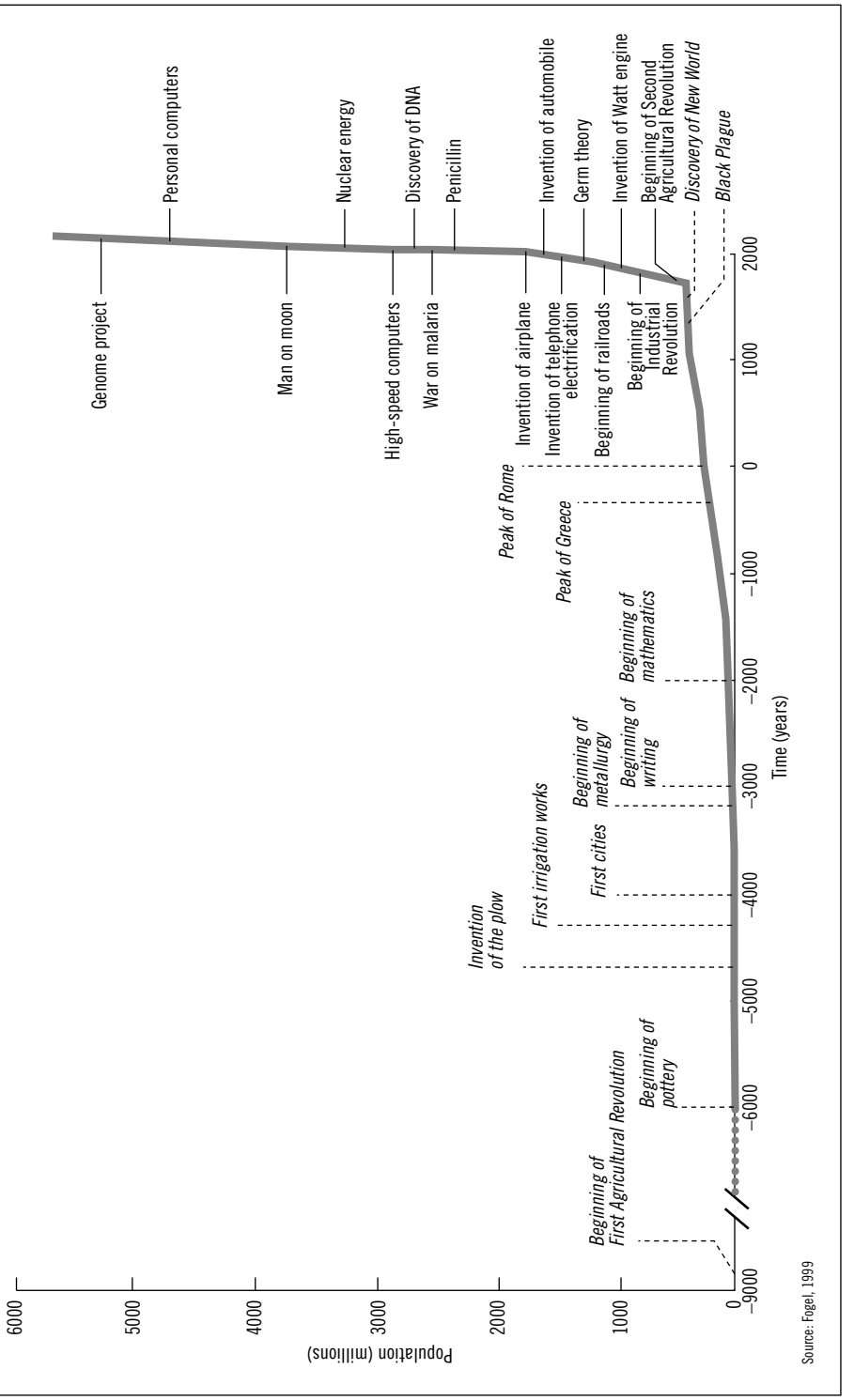
Can economists and economic historians account for this transition from Malthusian stagnation to sustained progress in material living standards? In the contemporary economics/economic history literature, several plausible 'stories' that attempt to explain the main features of the evolution of world living standards have emerged.[13]

The population and ideas story

Michael Kremer, building on the work of Paul Romer, constructs a model where technological progress is driven by new ideas, and the number of ideas depends on the size of the population.[14] Therefore, during the Malthusian era, while improvements in living standards are negligible, technological progress causes the size of the population to increase, which further stimulates technological progress through the creation of more ideas (see Figure 8). Kremer's model predicts that, historically, the growth rate of population will be proportional to its level, at least prior to the worldwide spread of the demographic transition in the latter part of the twentieth century. Charles Jones adds to this story a key requirement that in order for technological progress to win the race against Malthusian diminishing returns, not only does there need to be increasing returns to accumulable factors, there also needs to develop 'innovation-promoting institutions' as emphasised by Douglass North.[15]

[13] Prominent here has been the research of scholars such as: Daron Acemoglu, Gregory Clark, Richard Easterlin, Oded Galor, Martin Goodfriend, Avner Grief, Gary Hansen, Simon Johnson, Charles Jones, Eric Jones, Michael Kremer, David Landes, Robert Lucas, Angus Maddison, John McDermott, Omer Moav, Joel Mokyr, Douglass North, Stephen Parente, Kenneth Pomeranz, Edward Prescott, James Robinson, and David Weil.
[14] Kremer, 1993; Romer, 1990.
[15] See Jones, 2001; North, 1990.

Figure 8: The relationship between population and ideas



The Malthus to Solow story

The Malthus to Solow story combines the Gary Hansen–Edward Prescott theory of economic development with the Stephen Parente–Edward Prescott model of relative efficiencies to produce a unified theory of the evolution of international per capita GDP levels.[16] The Hansen–Prescott model combines the classical growth theories of Malthus and Ricardo with the neoclassical growth theory developed by Robert Solow.[17] The classical model provides a coherent account of the growth experiences in the era prior to the first Industrial Revolution, while the Solow model accounts for the pattern of growth experienced post-1900 in Western Europe, the US and other Western Offshoots. Initially, in the Hansen–Prescott model, all economies are dominated by a land intensive, low productivity 'Malthus technology' with low knowledge input. As shown in equation (1), total output (Y_{Mt}) is determined by A_{Mt}, representing Total Factor Productivity (TFP), K_{Mt}, the capital input, L_{Mt}, the labour input, and N_{Mt}, the land (natural resource) input. The parameters Φ and β are the capital and labour shares in total output.

$$\text{Malthus Technology} \quad Y_{Mt} = A_{Mt} K_{Mt}^{\Phi} L_{Mt}^{\beta} N_{Mt}^{1-\Phi-\beta} \tag{1}$$

Eventually, as land becomes less important as a factor of production, driven by the profit motive, the importance of knowledge in the production process grows. The economy gradually transforms into one dominated by the more productive 'Solow technology' shown in equation (2). In Solow's world, technology grows exogenously at a constant geometric rate.[18]

$$\text{Solow Technology} \quad Y_{St} = A_{St} K_{St}^{\Phi} L_{St}^{1-\Phi} \tag{2}$$

The Parente–Prescott model contributes to an explanation of the 'Great Divergence' in living standards that emerged in the twentieth century by providing a *theory of relative efficiencies* to explain the evolution and divergence of international per capita incomes. The basic idea is captured

[16] Hansen and Prescott, 2002; Parente and Prescott, 2005.
[17] Malthus, 1798; Ricardo, 1817; Solow, 1956.
[18] An earlier model developed by Goodfriend and McDermott (1995) emphasises the transition from household to market production driven by the increasing returns to specialisation made possible by a growing population.

in the Parente–Prescott '*modern growth production function*' given in equation (3).

$$\text{Parente–Prescott Technology} \quad Y_{Pt} = E_P A_{Pt} K_{Pt}^{\Phi} N_{Pt}^{1-\Phi} \tag{3}$$

Note that in this model, TFP has two elements: a *technology component* (A_{Pt}) that is 'common across countries', and an *efficiency component* (E_P) that varies widely across countries due to differences in institutional structures, incentives, and choice of economic policies. The value of E_P will have a value in the range 0–1, where $E_P < 1$ implies that a country is operating inside its production possibility frontier, and $E_P = 1$, implies that a country is operating on its production possibility frontier. Parente and Prescott argue that poor developing countries have tremendous potential for rapid catch-up with the developed economies providing they adopt policies which remove the '*barriers*' to efficient production, thereby dramatically increasing E_P. This is a necessary condition for catching up. The existing *economic* barriers to progress have been put in place 'to protect the interests of industry groups vested in the current production process'.[19]

The institutions and property rights story

Nobel Laureate Douglass North and Barry Weingast highlight the positive impact that the establishment of more secure property rights, following the 'Glorious Revolution' of 1688, had on innovation and entrepreneurship in Britain prior to the Industrial Revolution. Daron Acemoglu, Simon Johnson and James Robinson, building on this idea, trace the rise of the colonial 'Atlantic trader' economies after 1500 and link their subsequent growth success to the influence of the commercial bourgeoisie who demanded and obtained changes in institutions that led to greater protection of property rights and provided a foundation for the Industrial Revolution to take place in Britain.[20] In his more recent work, North argues that economic change is largely 'a deliberate process shaped by the perception of the actors about the consequences of their actions'.[21]

[19] See also, Parente and Prescott, 2000. Acemoglu and Robinson (2006) develop a model where political barriers rather than economic barriers prevent progress. Parente and Prescott argue that membership of a free trade club is the most effective way of promoting an increase in efficiency.
[20] North and Weingast, 1989; North, 1990; Acemoglu, Johnson and Robinson, 2005a.
[21] North, 2005.

Therefore, culture and human learning play a key role in determining the economic performance of nations over time. In a non-ergodic world of uncertainty, the way in which various societies structure human interaction (their institutional structures) 'appear to be the key to understanding why some societies are capable of sustained economic and political development'.[22]

The biogeography story

Ola Olsson and Douglas Hibbs, building on the work of Jared Diamond develop a model of long-run development based on biogeography.[23] In this model, the transition from a world dominated by hunting and gathering to one dominated by organised agriculture (the 'Neolithic Revolution') represents a 'crucial event in history' that makes possible the (endogenous) acceleration of technological progress that eventually leads to the first 'Industrial Revolution'. The initial diversity of biogeographical endowments, with respect to the number of plants and animals suitable for domestication in a continent, is determined by the size and major axis of that continent.[24] Biogeographical diversity plays a major role in the timing of the transition to sedentary forms of agriculture, which in turn allows the emergence of urban populations and a non-food producing class of chiefs, priests, craftsmen, bureaucrats and warriors. As Ernest Gellner observes, in this world, dominated by kings, priests and warriors, the qualitative division of labour is between 'those who fight, pray and work'.[25] Nevertheless, these new classes initiated 'an explosion of new knowledge' in mathematics, science, astronomy, construction and organisation allowing further technological progress and population growth. Ultimately, endogenous technological progress leads to an Industrial Revolution. The Olsson–Hibbs model provides a direct link from initial biogeographical conditions to current living standards without having to link geography indirectly to development via institutions, as in the political economy models of Acemoglu, Johnson and Robinson.[26]

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[22] North, Wallis and Weingast, 2006. Greif (2006) also regards institutions as the most important of the fundamental determinants of economic performance. See also Clark's (2007b) review of Greif.
[23] Olsson and Hibbs, 2005; Diamond, 1997. On the neglected importance of geography on economic development, see also, Landes, 1998; Bloom and Sachs, 1998.
[24] As in Diamond (1997), a major east–west axis, as in Eurasia, is advantageous as this facilitates the diffusion of animals, plants and ideas.
[25] Gellner, 1988.
[26] Acemoglu, Johnson and Robinson, 2001, 2002.

The 'Gifts of Athena' story

Joel Mokyr surveys the history of technological change and traces the intellectual roots of the Industrial Revolution to important changes in the method and culture involved with the creation and dissemination of new knowledge.[27] 'The Scientific method that evolved in seventeenth-century Western Europe meant that observation and experience were placed in the public domain' and scientific knowledge became a public good. 'Open science' and verification, rewarded by fame and recognition became part of what Mokyr calls the 'Industrial Enlightenment'. The notion that economic progress was possible dominated this new enlightenment and this influenced the economy in two important ways. First, the Baconian belief that human progress was desirable created an intellectual climate supportive of innovation and new technological developments. As Mokyr notes, 'knowledge creates opportunities, but it does not guarantee action'. The wave of 'macroinventions' and 'microinventions' (the 'wave of gadgets') that characterised the Industrial Revolution would not have been possible without these intellectual roots. Second, the enlightenment facilitated institutional change that lowered tolerance of rent-seeking activities and predation by the state.[28] More than anything else, Enlightenment thinking gave support to new ideas and innovations and as a result the momentum of technological progress was 'preserved rather than dissipated'.[29]

The 'survival of the richest' story?

In his recent highly controversial book *A Farewell to Alms*, Gregory Clark rejects the institutional and external shock approaches to explaining the Industrial Revolution and instead provides an explanation of human history based on Darwinian natural selection.[30] As Clark notes… 'The Darwinian struggle that shaped human nature did not end with the Neolithic Revolution but continued right up to 1800'. According to Clark, in England, during the six hundred year period prior to the Industrial Revolution, the richest families had twice as many surviving children as

[27] Mokyr 2002, 2005a, 2005b. See also Snowdon, 2007a.
[28] The growth-retarding impact of rent-seeking is emphasised by Eric Jones (1988) who notes that…'Economic history may be thought of as a struggle between a propensity for growth and one for rent-seeking, that is, for someone improving his or her position, or a group bettering its position, at the expense of general welfare…Whenever conditions permitted, that is when rent-seeking was somehow curbed, growth manifested itself'.
[29] See Mokyr, 2007.
[30] Clark, 2007a. For critiques, see Goldstone, 2007, and Kuznicki, 2007.

the poorest.[31] Because this was the Malthusian era of stagnation in per capita incomes, 'the superabundant children of the rich had to, on average, move down the social hierarchy'. As a result of this downward social mobility, the 'survival of the richest' demographic mechanism propagated and embedded within the English population the bourgeois virtues of thrift, hard work, education and patience. As a result of this biological spread of Calvanist culture throughout the population, England's advantage 'lay in the rapid cultural, and potentially also genetic, diffusion of the values of the economically successful throughout society in the years 1200–1800'.[32] In line with the arguments of David Landes, the neo-Weberian hypothesis put forward by Clark implies that 'the Europeans, particularly the English, had a culture that was more conducive to growth than was the case in China'.[33]

The natural selection, evolution, and human capital story

Oded Galor and David Weil divide human history into three growth regimes, namely, a 'Malthusian Regime', a 'Post-Mathusian Regime', and a 'Modern Growth Regime'.[34] The first two regimes are separated by an acceleration of technological progress while the latter two are separated by a demographic transition, driven by the micro fundamentals of utility-maximising fertility behaviour. Building on this framework, Oded Galor and Omer Moav highlight the long-run consequences of the constant interplay between Darwinian and Malthusian forces.[35]

The Galor–Moav model contains four essential ingredients, namely: (i) a Malthusian element that explains the struggle for existence and persistence of low per capita incomes over most of human history; (ii) a Darwinian evolutionary element, that highlights the slowly changing genetic composition of the population over thousands of years; (iii) an element relating the evolution of human species to human capital accumulation and

[31] See Clark and Hamilton, 2006.
[32] Clark, 2007a, p. 271.
[33] See Landes, 1998, 2006. Deepak Lal's (1999) cultural explanation of the economic rise of the West suggests that the 'classical liberal package was conducive to intensive growth', and the 'midwife in delivering the package that led to Promethean growth in the West was the Christian church'. The individualism inadvertently promoted by the Roman Catholic Church created the 'instrumental rationality responsible for the scientific and industrial revolutions that generated Promethean growth'.
[34] Galor and Weil, 1999, 2000. Richard Easterlin (1996) divides world history into three 'economic epochs', namely (i) a pre-historic epoch dominated by hunting and gathering; (ii) an epoch of settled agriculture 8000 BC–1750 AD; and (iii) an epoch of modern economic growth.
[35] Galor and Moav, 2001, 2002.

technological progress; and finally, (iv) the Galor–Moav model links the inevitable acceleration of technological progress to the onset of a demographic transition during the second phase of the Industrial Revolution. In the Galor–Moav model, the struggle for survival during the epoch of Malthusian stagnation gradually leads to an evolutionary improvement in the *quality* of human capital, which in turn stimulates an increase in the rate of technological progress, an increase in the demand for human capital, a demographic transition, and sustained economic growth.

These are just some of the recent stories that provide the foundation stones of a unified account of the evolution of world income over the very long run. As Joel Mokyr has recently commented:[36]

> The issue of the emergence of Modern Economic Growth in the Nineteenth century West has once again resumed its rightful place at the centre of attention of large groups of scholars, coming from economics, history, and the other social sciences.

In the interview that follows, I discuss with Professor Galor his innovative approach to explaining some of the most profound and difficult questions in human history, and the progress that is being made in building a coherent unified theory of long-run growth.

INTERVIEW[37]

Background information

What first attracted you to study economics?

I was born in Israel in the midst of a geo-political conflict and vast regional inequalities and I was eager to get a better understanding of the world in which I live. My passion towards mathematics and philosophy and my interest in contemporary socio-political issues naturally led me into the branches of economics that integrate my passions and interests.

[36] Mokyr, 2007.
[37] I interviewed Professor Galor in his office in the Department of Economics, Brown University, Rhode Island, USA, on 29th May, 2007.

Were there any specific individuals who influenced you?

As Newton said, 'If I have seen further, it is by standing on the shoulders of giants.' My attempt to develop a unified theory of economic growth was influenced primarily by researchers from other scientific disciplines whose attempt to develop unified theories had a profound effect on the way that we understand the world.

Do you mean people like Isaac Newton, Charles Darwin and Albert Einstein?

Precisely.

Your models tend to be very mathematical. Presumably you have always had a strong mathematics background?

Indeed. I have been fascinated by various fields of mathematics, and along the course of my education I developed significant expertise in dynamical systems.[38] Nevertheless, although my research tends to be rigorous mathematically, my extensive use of mathematical modelling is designed to subject the theory to proper logical scrutiny, without presenting a barrier to most readers. I tend to present my ideas and their foundations in a fashion that is excisable to the non-mathematical reader.

In your recent research you have been concentrating on issues related to very long-run growth and development. What is it about this area that fascinates you?

During the two decades that I have spent studying the process of development, I have become increasingly convinced that contemporary variations in economic development have deep roots in the distant past. I was determined to find coherent answers to the fundamental questions…Why are some countries poor while others are rich? What is the source of the dramatic increase in inequality across countries in the past two centuries? Are there lessons that can be learned from the growth experiences of the developed economies in order to alleviate the poverty in the less developed countries?

[38] See Galor, 2007.

The inconsistency of exogenous and endogenous growth models with some of the most fundamental features of the process of development, has led me to a search for a unified theory that would unveil the underlying micro-foundations of the growth process in its entirety, capturing the epoch of Malthusian stagnation that characterized most of human history, the contemporary era of modern economic growth, and the underlying driving forces that triggered the recent transition between these regimes and led to the divergence in income per capita across countries.[39]

Economic history

In recent years there has been a revival of interest in economic history amongst many economists, including yourself and people like Daron Acemoglu.[40] *Even Robert Lucas and Edward Prescott are writing about the Industrial Revolution.*[41] *Why do you think this has happened?*

Clearly, our understanding of the contemporary world is limited and incomplete in the absence of a historical perspective. However, the renewed interest in the interaction between economic development and economic history could be attributed to the increasing frustration with the failure of the a-historical branch of growth theory to capture some of the most fundamental aspects of the growth process.

Is history in general something that has always attracted your interest?

Absolutely. I have been intrigued by the evolution of humans and societies since pre-history, and I devoted a significant portion of my time to read about our evolution from the emergence of early humans to the present.

[39] See Pomeranz, 2000.
[40] For example, Galor and Weil, 1999, 2000; Galor, 2005a; Acemoglu and Robinson, 2006. See Snowdon, 2007b, for an interview with Daron Acemoglu.
[41] Lucas, 2002; Parente and Prescott, 2005.

Unified growth models

The exogenous and endogenous growth models of Robert Solow and Paul Romer were really developed to try and explain the growth process in the developed world.[42] *For example, Solow was particularly interested in explaining the growth experience of the US in his 1957 paper. The work of Malthus effectively describes the world before 1800.*[43] *Why do we need a model that can explain both the modern and Malthusian growth regimes, as well as providing an explanation of the evolution of an economy between these regimes?*

There are several fundamental reasons for the quest for a unified theory of economic growth. First, a comprehensive understanding of the hurdles faced by less developed economies in reaching a state of sustained economic growth would be futile unless the factors that prompted the transition of the currently developed economies into a state of sustained economic growth could be identified and their implications modified to account for the differences in the growth structure of less developed economies in an interdependent world. However, as you stated, neither exogenous and endogenous growth models nor Malthusian models generate insights about the forces that permitted economies to shift from Malthusian stagnation to a state of sustained economic growth.

Second, imposing the constraint that a single theory should account for the entire intricate process of development and its prime causes in the last thousands of years is a discipline that enhances the viability of growth theory. The evolution of theories in older scientific disciplines suggests that theories that are founded on the basis of a subset of the existing observations and their driving forces may be attractive in the short run, but non-robust and eventually non-durable in the long run. The attempts to develop unified theories in physics have been based on the conviction that all physical phenomena should be governed by some underlying unity. Similarly, the entire process of development and its fundamental forces ought to be captured by a unified growth theory.

Third, a unified theory of economic growth reveals the fundamental micro-foundations that are consistent with the process of economic development

[42] Solow, 1956; Romer, 1986, 1990. See also Snowdon and Vane (2005) for a survey of the Solow and Romer models as well as interviews with both economists.
[43] Malthus, 1798.

over the entire course of human history, rather than with the past decades only. Similarly to the advancements that were made possible by the establishment of micro-foundations to models of macroeconomics, it will improve not only the predictions of growth theory but its policy implications.

What do you consider to be the strengths of the Solow and Romer growth models?

These models have been instrumental in advancing our understanding of the role of factor accumulation and technological progress in the process of development in the modern era and in sustaining economic growth in the long run. Nevertheless, it is important to acknowledge that they are inconsistent with the qualitative aspects of the growth process over most of human existence. In particular, in contrast to these models, during the Malthusian epoch capital accumulation and technological progress had a negligible effect on the long-run level of income and its growth rate, and they were counterbalanced almost entirely by an increase in the size of the population.

People such as Nobel Laureate Douglass North regard long-run growth and change as the key issue in economic history.[44] *With your unified growth model are you trying to produce a general theory of economic history?*

I suppose so. My unified growth theory provides a general theory of the evolution of economies over the entire course of human history. But, in fact, it is even more ambitious than that. It goes beyond economic history and examines the interaction of economic and human history. As you know, some of my recent research has examined the interaction between long-run economic development and human evolution.[45] It demonstrates that in contrast to the viewpoint advanced in the influential work by Jared Diamond, the evolution of the composition of human traits in the process of development is a significant force in the transition from stagnation to growth and in the understanding of comparative development.[46]

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[44] Douglass North was awarded the Nobel Prize in 1993 (jointly with Robert Fogel) for 'having renewed research in economic history by applying economic theory and quantitative methods in order to explain economic and institutional change'. See North, 1990, 1994, 2005; Fogel, 1994. North (2005) writes… 'Understanding the process of economic change would enable us to account for the diverse performance of economies, past and present….A real understanding of how economies grow unlocks the door to greater human well-being and to a reduction in misery and abject poverty'.

[45] Galor and Moav, 2001, 2002, 2005; Galor and Michalopoulos, 2006; Ashraf and Galor, 2008b.

[46] Diamond, 1997.

Growth regimes

In your unified growth models you distinguish between three growth regimes, namely, the 'Malthusian regime', the 'post-Malthusian regime', and the 'modern growth regime'.[47] *In general terms, before we look in more detail later, what are the main characteristics of each of these regimes?*

The Malthusian regime captures the early stages of economic development that lasted up until the middle of the eighteenth century for modern developed economies, and until the beginning of the twentieth century for today's developing countries. The Malthusian regime describes a world in a low-level equilibrium in terms of income per capita. Technological progress takes place, but very slowly. The growth of total output resulting from technological progress is matched by population growth so that per capita income fluctuates around a low stable level, with no significant progress in average living standards over a long period of time. The post-Malthusian regime marks the initial take-off from the Malthusian regime. This is an era when technological progress accelerates and consequently we observe the beginning of economic growth in per capita income terms even though population growth is still positively linked to rising incomes. The modern growth regime is triggered by a rise in the demand for human capital and a demographic transition. This is the era of rapid technological progress, sustained economic growth and rising per capita incomes. Unlike the previous two regimes, population growth is no longer counterbalancing the growth of income per capita.

Are there any countries in the world today that are still trapped in a Malthusian growth regime?

Many less developed economies are still faced by the main element of the Malthusian trap. Namely, their population growth has an adverse effect on their development process. Nevertheless, it is difficult to determine in the short run, whether technological progress in these economies or an increase in their available resources per capita (due to foreign aid, the discovery of natural resources, or increased mortality) would ultimately result

[47] Galor and Weil, 1999, 2000; Galor, 2005a.

in a faster rate of population growth that would offset significantly their output growth.

Where would you locate China in terms of your regimes? Given China's remarkable economic growth during the last twenty-five years, can we say that China has entered the modern growth regime?

China has indeed crossed the threshold of the modern growth regime. It is experiencing rapid technological progress, human capital formation, and sustained output growth without any significant offsetting effects of population growth.

The Malthusian growth regime

The Malthusian regime dominates just about all of human history until we come to the Industrial Revolution. Malthus's famous book was published in 1798. Somewhat ironically this was just about the time that the Malthusian regime was beginning to come to an end in Western Europe. So Malthus's theory is a pretty good description of human history before 1800, but not after the publication of his book.[48] *When you are researching into this area are you conscious of this irony, that Malthus was writing down his growth model right at the time you identify as the beginning of the breakpoint between the Malthusian and post-Malthusian regimes?*

Indeed, this irony was one of the catalysts in my quest for a unified theory of economic growth. It made me realize that unless I will construct my theory on solid micro-foundations that capture diverse economic regimes, the theory is unlikely to survive a major shift in the economic paradigm, and the irony about the Malthusian theory may repeat itself.

From your Darwinian-evolutionary perspective, to what extent was an Industrial Revolution, and a consequent breakout of the Malthusian regime, inevitable?[49]

According to my unified growth theories the transition from stagnation to growth is an inevitable outcome of the process of development. During

[48] For a recent discussion of Malthusian theory, see Galor, 2005a; Clark, 2007a; Ashraf and Galor, 2008a.
[49] Galor and Moav, 2001, 2002. See also Kremer, 1993; Jones, 2001, 2005; and Snowdon, 2002, for an interview with Charles Jones on this issue.

the Malthusian epoch technological progress permitted an increase in the size of the population, while population size affected the rate of technological progress. The size of the population determined the supply of, and demands for, ideas. It also influenced the diffusion of ideas, the degree of specialisation in the production process that stimulated 'learning by doing',[50] and the level of international trade that further fostered technological progress. At the same time, the rate of technological progress and its effect on the resource constraint, enabled population growth.

This inherent Malthusian positive feedback between the level of technology and the size of the population brought about a gradual acceleration in the pace of technological progress. Rapid technological progress, inevitably, raised the demand for human capital in the production process, in order to cope with the rapidly changing economic environment. The rise in the demand for human capital in the second phase of industrialization induced the formation of human capital, and led to a substitution, by parents, between the quality and quantity of children, triggering the onset of the demographic transition.[51] It brought about significant technological advancements along with a reduction in fertility rates and population growth, enabling economies to convert a larger share of the fruits of factor accumulation and technological progress into growth of income per capita, which paved the way for the emergence of sustained economic growth.

Similarly, the evolutionary growth theory that I have advanced suggests that the transition from stagnation to growth is an inevitable outcome of the effect of the process of development in the Malthusian epoch on the selection of traits that are complementary to the growth process, such as higher valuation for child quality, entrepreneurial spirit, and longer life expectancy.[52] Hence the transition is brought about by a gradual change in the composition of the population, and its effect on technological progress and human capital formation. It is interesting to note that the non-evolutionary perspective suggests that the adverse effect of limited resources on population growth in the Malthusian era delays the process of development, while the evolutionary theory suggests that the Malthusian constraint generates the necessary evolutionary pressure for the ultimate take-off.

[50] See Arrow, 1962.
[51] For an excellent discussion of the demographic transition, see Lee, 2003.
[52] See Galor and Moav 2002, 2005; Galor and Michalopoulos, 2006.

Even if an Industrial Revolution was inevitable, we still need to explain why it happened in Britain rather than China, which had a much larger population.[53] *In a recent interview that I conducted with Joel Mokyr, he argued that much more important than population size was the intellectual climate that pervaded Western Europe and Britain during the seventeenth and eighteenth centuries.*[54] *Douglass North emphasises the role of institutions and the political impact of the Glorious Revolution in 1688.*[55] *Is there anything in your research which can lead us to an answer to the question…Why was Britain first?*

Unified growth theory is a Meta theory, a skeleton on which one can hang different elements that have generated variations in the performance across countries, such as England's earlier industrialization in comparison to China. The theory suggests that the timing of the take-off is determined by the effect of the size of the population as well as its composition (namely education, entrepreneurial spirit, and even intellectual spirit), on technological progress and its effect on the demand for, and the formation of, human capital. But clearly, in order to account for comparative development, we have to open these two theoretical black boxes and fill them with the cultural, institutional, demographic, and policy factors that determine the intensity of each of these effects in individual countries or regions.

Indeed, in the absence of variations in these additional important dimensions, one may expect the first Industrial Revolution to take place in China. But once we allow for different institutions, policies, and cultural attitudes towards technological progress and education, then countries with large populations may nevertheless lag behind if they do not have the complementary forces that can stimulate technological progress, the demand for human capital, human capital formation, and fertility decline.

For instance, once a technologically driven demand for human capital emerged in the second phase of industrialization, the prevalence of human capital promoting institutions, such as public education, determined the extensiveness of human capital formation, the timing of the demographic transition, and the pace of the transition from stagnation to growth. Hence

[53] Maddison's (2001) data indicate that the population of China in 1000 and 1700CE was 59 million and 138 million respectively, whereas the UK's population was 2 million and 8.5 million respectively. See also Maddison, 2007.
[54] See Snowdon, 2007a; Mokyr, 2005a, 2005b. See also Landes, 2006.
[55] See North and Weingast, 1989.

variations in the presence of human capital promoting institutions across the globe may have contributed to the European dominance in the transition from agriculture to industry.[56] Similarly, geographical variations may underline the earlier European take-off. Societies that were geographically vulnerable to cultural diffusion were characterized by diminished cultural assimilation, higher cultural diversity and lower accumulation of society-specific human capital. While reduced cultural assimilation diminished their performance in the technological paradigm that characterised the agricultural stage of development, their greater cultural diversity fostered their ability to adapt to a new technological paradigm, accelerating their industrialisation and take-off to a state of sustained economic growth.[57]

I was struck when reading your papers that you make frequent use of the 'take-off' concept. When I was a student, back in the late 1960s, discussion of Walt Rostow's work was all the rage in economic history.[58] *Rostow's idea of various stages in the growth process, from primitive society, to pre-conditions for take-off, to the take-off, to the drive to maturity, and finally to the age of high mass consumption, at least stylistically remind me of your growth regimes. Were you influenced by Rostow's work?*

Although I do not think that I was influenced directly by Rostow, it appears that I have constructed my unified growth theory around stages of development that has some parallels to the ones that he had in mind.

The post-Malthusian growth regime

How does an economy finally break out of the low-level Malthusian equilibrium?

As I pointed out earlier, the post-Malthusian regime marks the initial take-off from the Malthusian regime. The reinforcing interaction between population and technology during the Malthusian epoch changed the size and the composition of the population sufficiently so as to support a faster pace of technological progress and generated the transition to the post-Malthusian Regime. The growth rates of output per capita increased

[56] See Galor, Moav and Vollrath, 2006.
[57] See Ashraf and Galor, 2007.
[58] See Rostow, 1956, 1960.

significantly, and although the positive Malthusian effect of income per capita on population growth was still maintained, the sizable increase in population growth only offset some of the potential gains in income per capita. The acceleration in the rate of technological progress increased the industrial demand for human capital in the second phase of industrialization, and induced significant investment in human capital and the onset of the demographic transition.

To develop a single structure that can encompass all these features must have been a huge theoretical challenge. What were the main complications that you faced?

Indeed, the establishment of a unified growth theory has been a great intellectual challenge. It required major methodological innovations in the construction of dynamical systems that could capture the complexity which characterized the evolution of economies from a Malthusian epoch to a state of sustained economic growth.

Most economic historians view the Industrial Revolution as a gradual process that could not plausibly be viewed as the outcome of a major shock that shifted economies from the basin of attraction of the Malthusian equilibrium into the basin of attraction of the Modern Growth Regime. Hence, the simplest methodology for the generation of a phase transition, namely, a major shock in an environment characterized by multiple locally stable equilibria, appears inappropriate for generating the observed take-off from stagnation to growth.

An alternative methodology for the observed phase transition was rather difficult to establish since a unified growth theory in which economies take off gradually from an epoch of a stable Malthusian stagnation would require a *gradual* escape from an absorbing (stable) equilibrium, which in itself sounds a bit of a contradiction *[laughter]*. Ultimately, however, it has become apparent to me that this phase transition would be captured by a single dynamical system, if the set of steady-state equilibria and their stability would be altered qualitatively in the process of development due to latent state variables that evolve behind the scene and ultimately change the qualitative structure of the dynamical system allowing the economy to escape from the absorbing Malthusian equilibrium and gravitate towards a sustained growth regime. The long era of Malthusian stagnation of output per capita masked the dynamism behind the scene that ultimately generates

a take-off and escape from the Malthusian equilibrium. For example, during the 1–1750 period, world population quadrupled even though income per capita remained rather stable.

So when you constructed your model you did it in such a way that it contained a latent state variable that would ultimately bring about the change that we observe.

Yes, but I also needed to ensure that during the take-off the positive relationship between population and income per capita would remain for some time, but then the model would generate, endogenously, a demand for human capital and a demographic transition. This is when I began to review the different theories of the demographic transition.

The demographic transition

With respect to explaining the demographic transition and falling birth rates, researchers have emphasised, for example, falling infant mortality, the rising opportunity cost of women's time,[59] *the decline in the pensions motive for having children, and the reduction in family income generated from child labour due to public policies. What is your overall assessment of existing explanations of the demographic transition, and why have you focussed on an explanation that emphasises the demand for human capital?*

A natural starting point was Gary Becker's theory.[60] Becker argues that the rise in the level of income induced a fertility decline because of two related reasons. First, the positive income effect on fertility that was brought about by the rise in income was dominated by the negative substitution effect that was triggered by the increase in the opportunity cost of raising children through forgone earning in labour force participation. Second, the income elasticity with respect to child quality is greater than that with respect to child quantity, and a rise in income therefore led to a decline in fertility along with a rise in the investment in each child.

When I reviewed the historical evidence, however, it became evident that the Beckerian theory appears inconsistent with the evidence. In the context of the relatively homogeneous region of Western Europe, the

[59] Galor and Weil, 1996; Galor, 2005b.
[60] See Becker, 1981.

timing of the demographic transition was not negatively related to the level of income per capita, as the Beckerian theory would imply. The demographic transition occurred simultaneously in a set of countries whose income gap is in a ratio of 3:1 around 1870. For example, the demographic transition occurs in the 1870s in England where income per capita was around $3,200 per year, in Germany where it was $1,800 per year, and also in Finland where income per capita was only $1,100 per year.[61] More generally, based on evidence on the relationship between income and fertility within and across economies, it does not appear plausible that the rise in the level of income per capita is the driving force behind the demographic transition.

What about the influence of declining infant mortality?

The decline in infant and child mortality rates that preceded the decline in fertility rates in many countries in the world was among the factors that affected the level of fertility. Nevertheless, historical evidence does not indicate that the decline in mortality rates accounts for the *reversal* of the positive historical trend between income and fertility. The decline in fertility during the demographic transition in Western Europe occurred in a period in which the pace of mortality decline remained stable for nearly a century and it appears that it was triggered by a universal force that changed its course during this period.[62]

Ultimately, it became apparent that the dominating universal force that triggered the decline in fertility was the acceleration in the rates of technological progress in the post-Malthusian regime and its inevitable effect on the rise in the demand for human capital.[63] The increase in the rate of technological progress brought about an increase in the industrial demand for human capital in the second phase of industrialization which, along the lines of the Beckerian theory, induced a substitution by parents of quantity of children for quality of children and the onset of the demographic transition.

[61] See Maddison, 2003.
[62] See also, Doepke, 2004.
[63] See Galor, 2005b.

Trade and the demographic transition

You have an interesting paper, co-authored with Andrew Mountford, that links the patterns of specialisation and trade with the emergence of the 'Great Divergence' and the failure of the demographic transition to spread to countries like India until late in the twentieth century.[64] *Specialisation helped to raise living standards in Britain, whereas it led to population growth in India. Can you explain the thinking behind this argument?*

The argument of that paper is that if trade opens up between advanced and less advanced economies, say Britain and India, at a time when Britain is more technologically advanced than India, then specialisation will imply that Britain produces industrial skill-intensive goods, whereas India will specialise in the production of primary goods which are much less skill intensive. The demand for human capital in Britain will increase, leading to an earlier demographic transition. In India we should expect the demand for human capital to decline leading to a delay in the demographic transition. This would prolong the post-Malthusian regime in India and shorten it in Britain. It is important to note that while both Britain and India gain from trade, the composition of their gains is different. Much of the gain to India is in the form of population growth with a smaller part coming in the form of rising income per capita. In Britain most of the gains come in the form of rising income per capita.

Where does this leave David Ricardo's famous theory of comparative advantage which is popularly invoked by economists to demonstrate the mutual gains from specialisation and trade in terms of its impact on living standards?[65] *Is the different outcome from your theory due to dynamic effects dominating static effects from specialisation and trade?*

Ricardo's influential theory of comparative advantage suggests that if trade patterns follow the patterns of comparative advantage, trade is mutually beneficial and each of the trading parties will generate a gain in aggregate income. However, the Ricardian theory does not consider the possibility that population may be affected by the patterns of specialisation. Once

[64] Galor and Mountford, 2006, 2008.
[65] Ricardo, 1817. See also, Irwin, 1996.

you permit population to be endogenous we ought to reinterpret the famous argument about gains from trade. The gains from trade are in the context of *total* output. Even if the terms of trade effect equalises the gains from trade in terms of total output for the two trading economies, this does not imply that there will be similar gains in output per capita. Total output is the product of output per capita and population and there are two dimensions in which total output can be enlarged: population and output per capita. In the case of India the gains were relatively larger in the population dimension, whereas in the case of Britain it was mainly in the output per capita dimension.

Daron Acemoglu, Simon Johnson and James Robinson argue that the expansion of Atlantic trade had beneficial effects on the British economy because it led to a change in the political power structure in favour of an emerging entrepreneurial class.[66] *This story complements their emphasis on the importance of institutions as the key determinant of economic success.*[67] *Does their trade story complement yours?*

My research has focused on the identification of the underlining economic forces that brought about the transition from stagnation to growth and the divergence in economic performance across countries. In particular, I have attributed the transition to a state of sustained economic growth to the rise in the demand for human capital and a decline in population growth. Their research, in contrast, abstracts from the transition from stagnation to growth and attributes contemporary differences in income per capita to the role of institutions. I view the indirect political economy mechanism complementary to my attempt to identify the direct economic forces that were generated by international trade and their consequences.

Perhaps this would be a good point for you to comment more broadly about your view of the role of institutions in the process of development, particularly in the light of unified growth theory.

As I explained earlier, the Malthusian epoch is governed by economic forces that will inevitably generate industrialisation and a transition to sustained economic growth. The rapidity of this process may be influenced

[66] Acemoglu, Johnson and Robinson, 2005a.
[67] Acemoglu, Johnson and Robinson, 2005b.

by different factors including institutions. But institutions, by themselves, do not trigger a take-off from stagnation to sustained economic growth. They simply affect the speed of this transition. Institutions can be viewed as the oil that lubricates the wheels of a train that is already in motion. The presence or absence of oil may affect the speed of the train, but it does not trigger its initial motion.

Das Human-Kapital

In your 'Das Human-Kapital' paper, co-authored with Omer Moav, you argue that capitalists consciously brought about a transformation of society because of their positive attitude towards the promotion of mass education.[68] *As technological progress accelerated, the complementarity of physical capital and human capital in the production process generated incentives for capitalists to support investment in human capital. Contrary to conventional Marxist thinking, capitalists, by actively supporting educational reforms, ultimately undermined the class structure. Claudia Goldin has also emphasised the importance of human capital in establishing US economic supremacy during the twenty-first century.*[69] *As Goldin's paper shows, Europe lagged well behind the US in the promotion of mass education.*[70] *Since both European countries and the US were capitalist economic systems, do you have any thoughts on why Europe lagged behind?*

Variations in the provision of public education over this period among equally developed economies could be partly attributed to non-economic objectives such as social and national cohesion, military efficiency, enlightenment, moral conformity, sociopolitical stability as well as religious reasons. But perhaps the earlier onset of mass education in the US could be linked to the adverse effect of European income inequality and the concentration of land ownership on human capital formation.[71] As the industrial demand for human capital emerged, differential human capital formation occurred across countries. Even though individuals with credit constraints could not finance this growth-promoting human capital formation, a conflict of interests between capitalists and the landed aristocracy

[68] Galor and Moav, 2006.
[69] Goldin, 2001.
[70] See also the interview with Claudia Goldin in Snowdon, 2007c.
[71] Galor and Zeira, 1993; Galor, Moav, and Vollrath, 2006.

affected the implementation of institutions that promote human capital formation, such as public education.

So prior to industrialisation, the main conflict of interest in society was between the elite, largely the landed aristocracy, and labour.

Indeed. Prior to industrialisation, the main conflict of interest in society was between the landed aristocracy and labour. The production process that occurred at this time implied that a larger output share to workers would result in a smaller share to the landed aristocracy. Industrialisation, however, shifted the conflict of interest in society from a conflict between the elite and the masses to a conflict between the landed aristocracy and the emerging capitalist elite. The capitalist elite tended to support education reforms so as to complement their capital in the production process. The landed aristocracy, on the other hand, objected to public education because human capital was more complementary to the industrial production process than the agricultural one. They feared that educated workers would depart from the agricultural sector and would bring about a decline in the rental rate. In places where land inequality was more pronounced and the landed aristocracy was therefore more powerful, one should expect to observe less human capital formation. In this respect the more egalitarian nature of the US society in that period may have led to the earlier promotion of mass education.

Since you mention inequality, it is worth recalling that some economists have argued that inequality can promote economic growth. For example, fifty years ago, Nicholas Kaldor, developed a model of economic growth where inequality is good for growth because it concentrated income in the hands of the capitalist investing class.[72] *What is your view on the relationship between inequality and growth?*

I think that the replacement of physical capital accumulation by human capital accumulation as the main engine of economic growth changed the effect of inequality on the process of development.[73] In the early stages of industrialisation, when physical capital accumulation was the prime engine of economic growth, inequality enhanced the process of development.

[72] Kaldor, 1957.
[73] See Galor and Moav, 2004.

It diverted resources towards capitalists whose marginal propensity to save is higher and it increased the rate of investment and capital accumulation. However, in the later stages of the transition to modern growth, once human capital emerged as the prime engine of economic growth, equality alleviated the adverse effect of credit constraints on human capital formation and stimulated the growth process. Finally, it appears plausible that at more advanced stages of economic development the impact of inequality on growth becomes more ambiguous. Credit constraints become less binding and their effect on efficient investment in human capital and investment projects is less pronounced, while the economic incentives that are generated by inequality remain in place.

During the last twenty years or so, Robert Fogel has emphasised the importance for economic growth of what he calls the 'technophysical evolution' of the human population.[74] *Until very recently in human history the vast majority of people were physically incapable of sustaining productive work for extended periods because of poor diet, health and general physical strength and stature. Does this neglected aspect of growth analysis play any part of your unified growth story?*

Certainly. When I refer to human capital in my unified theory of growth, I am interpreting human capital very broadly to include education and health. The rise in the demand for human capital and the emergence of human capital formation over the period of industrialisation can be viewed in the context of education as well as human health that allowed labour to be much more productive.

The modern growth regime

In the modern growth regime we have growth driven by technological progress and the demographic transition is more or less completed. Since technological progress depends on new ideas, this is where your story must connect with Paul Romer's work on endogenous technological change.[75]

Romer's research as well as the work of Philippe Aghion and Peter Howitt, and Gene Grossman and Elhanan Helpman is instrumental for the understanding

[74] Fogel 1994, 1999, 2004.
[75] Romer, 1990.

of the role of ideas in promoting technological progress and sustaining economic growth.[76] Unified growth theory employs a similar underlying structure that generates technological progress and sustained economic growth.

In William Baumol's recent work he has stressed the importance of innovation and of the crucial role of entrepreneurship in fostering and sustaining economic growth.[77] Where does the entrepreneur fit in with your explanation of long-run growth?

In unified growth theory technological progress in the modern growth regime is governed by human capital formation. This flexible theoretical black box can be adjusted to the growth experience of individual countries, by incorporating the elements that are unique to these economies. In particular, the effect of human capital on technological progress will be stronger in a society in which intellectual property rights that are optimally protected and the class of entrepreneurs is significant.[78]

One worrying feature of the modern growth regime that has emerged in recent years is the problem of demographic ageing. In a sense we now have the reverse of Malthus in that in many countries a major concern is that the fertility rate has fallen below the replacement rate. In many developed countries population is forecast to fall, in some cases like Japan, quite dramatically.[79] This problem is also affecting countries of the former Soviet Union and China. Can this phenomenon fit into your long-run story of growth?

Unified growth theory can generate a long-run equilibrium with declining, stable, or rising population growth. You should note, however, that a declining population growth will induce a substitution of quality for quantity of children and the decline in fertility therefore will be associated with an increase in investment in human capital for each individual. As a result, the productive capacity of individuals will rise from generation to generation and may permit the support of the proportionately larger ageing population.

[76] Grossman and Helpman, 1994; Aghion and Howitt, 1998.
[77] See Baumol, 2002; Baumol, Litan and Schramm, 2007.
[78] See Galor and Michalopoulos, 2006.
[79] See, United Nations, 2007.

Another issue that is currently a central focus of discussion relates to the relationship between growth and the environment and the problem of global warming. In Britain last year we saw the publication of the Stern Report which caused a huge, and ongoing, public debate on this issue.[80] *If every country in the world eventually joins the modern growth regime, can the world as a whole sustain growth on such a global scale into the distant future, or will we have to completely rethink the way we live? Are you confident that technology can solve the problems caused by global warming, assuming that it is caused by human activity?*

Indeed, if population growth in the world will keep on growing, as it did during the twentieth century, then we will face a major demographic catastrophe. However, I am not concerned about this possibility. I think before we will reach a catastrophe, resource constraints will raise the cost of raising children sufficiently so as to assure that population growth will come to a halt. Similarly, if technological progress will not permit us to control global warming, its adverse effects will generate an economic slowdown to a rate of economic growth that can be sustained by the environment.

Economic growth comes in for a lot of criticism for the costs it imposes on society, particularly from environmentalists. Ben Friedman's recent book, The Moral Consequences of Economic Growth, *provides a spirited defence of economic growth in terms of the many beneficial, and often neglected, effects that growth has on society.*[81] *Friedman argues that when economic growth increases material living standards, for a majority of the population, it also tends to promote social and political progress. Do you share Friedman's vision on this aspect of economic growth?*

I entirely share this viewpoint. I think that economic growth alleviates poverty, increases social mobility, generates the income that allows people to fulfil their potential, and promotes freedom.

[80] Stern, 2006a, 2006b, 2008; Stern *et al.*, 2007; Carter *et al.*, 2006.
[81] Friedman, 2005. See also the interview with Ben Friedman in Snowdon, 2008a.

Culture, religion and economic growth

There has been a recent revival of interest in the influence of culture and religion and on the economic performance of nations.[82] *I note that in a recent paper you have also entered this debate.*[83] *What are the basic ideas in that paper and how does it relate to unified growth theory?*

This research argues that variations in the interplay between cultural assimilation and cultural diffusion have played a significant role in giving rise to differential patterns of economic development across the globe. At the start of the second millennium CE, civilisations of Asia were arguably well ahead of European societies in both wealth and knowledge. By the twelfth century, China employed water-driven machinery to make textiles and coke-based smelting to produce iron. These technologies, however, would not appear in Europe for more than five hundred years. Yet, during the process of the Industrial Revolution, the technological leaders of the pre-industrial era were leapfrogged by European economies that accelerated into the modern age of sustained economic growth. What can explain the delayed emergence of sustained growth in China and other leading agricultural societies?

In contrast to the cultural and institutional hypotheses, which posit a hierarchy of cultural and institutional attributes in terms of their conduciveness to innovation and their ability in fostering industrialisation, the theory suggests that the desirable degree of the relative prevalence of cultural assimilation versus cultural diffusion varies according to the stage of development. Enhanced cultural assimilation is optimal within a given stage of development, but is detrimental for the transition between technological regimes. Hence, while cultural traits themselves do not necessarily have a differential effect on the process of development, it is the variation in the relative strengths of the forces of cultural assimilation and cultural diffusion, determining the diversity of these traits, which is instrumental for comparative economic development.

It is argued that productivity is enhanced by diversity-driven accumulation of general human capital but reduced by inefficiencies in the intergenerational transmission of society-specific human capital that is

[82] See Porter, 2000; Guiso *et al.*, 2003, 2006; Barro and McCleary, 2006.
[83] Ashraf and Galor, 2007.

associated with diminished assimilation. Thus, societies that were geographically less vulnerable to cultural diffusion benefited from enhanced assimilation, lower cultural diversity and greater accumulation of society-specific human capital, flourishing in the technological paradigm that characterised the agricultural stage of development. This greater cultural rigidity, however, diminished the ability of these societies to adapt to a new technological paradigm, delaying their industrialisation and take-off to a state of sustained economic growth.

Geography *v.* institutions

Another important debate in the growth literature has been that between those who stress the importance of institutions in the growth process, such as Douglass North, Daron Acemoglu, Bill Easterly, and Dani Rodrik, and those who believe that economists have on the whole neglected the importance of geographical factors, such as David Landes, Jared Diamond, and Jeffrey Sachs.[84] *You have already mentioned the influence of geography with respect to its impact on cultural diffusion, but what are your general thoughts on the importance of geography with respect to its influence on the prosperity of nations? Have economists perhaps neglected the importance of geography?*

I would enlarge the context of this debate and frame it in the context of the comparative role of geography, human capital, and institutions in the process of development. Clearly, variations in geographical factors preceded those in human capital and institutions. Geographical factors affected the genetic make up of the population, human capital formation, and presumably the evolution of institutions over time.

The influential thesis of Jarred Diamond suggests that contemporary variations in economic development could be traced to bio-geographical factors that led to regional variations in the timing of the Neolithic Revolution. He argues that the Neolithic Revolution conferred a developmental head-start to societies that experienced an earlier transition from primitive hunting and gathering techniques to the more technologically advanced agricultural mode of production. According to this hypothesis,

[84] Bloom and Sachs, 1998; Diamond, 1997; Landes, 1998; Rodrik, 2003, 2007; Sachs, 2003; Acemoglu, Johnson and Robinson, 2005b; Easterly and Levine, 2003; Easterly, Ritzen, and Woolcock, 2006. See also the interviews with Acemoglu, Easterly, Rodrik and Sachs in Snowdon, 2007b.

the favorable bio-geographic endowments that contributed to the emergence of agriculture gave some societies the early advantage of operating a superior production technology and generating resource surpluses, which enabled the establishment of a non-food-producing class whose members were crucial for the development of written language and science, and for the formation of cities, technology-based military powers and nation states. The early dominance of these societies subsequently persisted throughout history, being further sustained by geopolitical and historical processes such as colonization.

While geographical conditions may have a direct effect on the performance of societies today via the disease environment and the feasibility of extensive trade, it appears to me plausible that geographical factors had primarily an indirect effect through human capital formation and institutions. As I emphasized earlier, my viewpoint is that the role of human capital dominates the role of institutions in the process of development. While the formation of human capital was a critical force in triggering the transition from stagnation to growth, institutions affected only the pace of this transition.

Prospects for global convergence

During the last two hundred years we have witnessed global divergence.[85] *There are many views about the current path of world inequality held by economists such as Xavier Sala-i-Martin, Branco Milanovic, and Francois Bourguignon.*[86] *Do you think the world will witness global convergence in the twenty-first century?*[87]

I think that the twenty-first century will witness convergence between middle-income countries and rich economies, but the gap between these economies and the very poor ones is unlikely to be narrowed. Unfortunately, there is no hierarchy of institutions. Their effectiveness is state dependent. We cannot just drop on poor economies institutions that are suitable for the most developed ones and expect dramatic changes to occur. If we share the hypothesis advanced by unified growth theory that human capital formation is a key factor in the transition from stagnation to

[85] See Pritchett, 1997; Maddison, 2001.
[86] Bourguignon and Morrisson, 2002; Milanovic, 2006; Sala-i-Martin, 2006. See also Balcerowicz and Fischer (2006) and the interview with Xavier Sala-i-Martin in Snowdon, 2007b.
[87] Galor, 1996.

growth, it would still be difficult to orchestrate a sustained simultaneous move whereby both the demand and supply of human capital will be present leading to a virtuous circle of development and technological progress. The process of development is a gradual one and convergence is particularly difficult for less developed economies in an interdependent world.

Earlier this year I interviewed Francois Bourguignon, Chief Economist at the World Bank. In response to one of my questions he said… 'When I first arrived at the World Bank from academia I believed that the problem of development was primarily an economic one requiring economic policy solutions. More and more, with experience, I am becoming convinced that the problem of development is political, and many of the political problems in developing countries are rooted in the issue of inequality'.[88] *It follows that even if economists know what policies are conducive to growth, there are powerful political barriers to the adoption of these growth-enhancing policies.*[89] *Would you agree with this assessment?*

Political factors are undoubtedly very important and should be considered in the design of economic policy for less developed economies. However, unless we understand the economic forces that would enable less developed economies to follow the path of the developed world towards sustained economic growth, one cannot design the proper policy that will circumvent these political barriers.

The 'Industrial Revolution' *v.* 'Neolithic Revolution'

Do you think that the Industrial Revolution represents the most important event in human history?

I would argue that the 'Neolithic Revolution' was at least as important for contemporary economic outcomes. As I discussed earlier, Jared Diamond convincingly argues that variations in the timing of the Neolithic Revolution has a significant effect on comparative development. Moreover, my recent research about human evolution and economic development and the biological origins of the Industrial Revolution suggests that the Neolithic Revolution is a point in human history that has

[88] Snowdon, 2008b.
[89] See Acemoglu and Robinson, 2006.

had a long-lasting effect on the composition of the human population and therefore on contemporary stages of development. The Agricultural Revolution and the establishment of individual, rather than tribal, property rights expedited the process of natural selection and increased the representation in the population of individuals, whose characteristics were complementary to the growth process. This evolutionary process accelerated the transition from stagnation to sustained economic growth.

Interestingly, I am in the midst of empirical research about the effect of the Neolithic Revolution on life expectancy today.[90] In the past few years I have been advancing a theory about the evolution of life expectancy. I argue that the rise in population density, the domestication of animals, and the increase in work effort in the course of the Neolithic Revolution increased the exposure and the vulnerability of humans to environmental hazards, such as infectious diseases. This rise in the mortality risk generated an evolutionary advantage to individuals who were genetically predisposed towards higher somatic investment. It increased their representation in the population, and led to the observed increase in life expectancy in the post-Neolithic period.

More recently I started to examine this theory empirically. I find that a significant portion of contemporary variations in life expectancy across countries can be traced to the time elapsed since the ancestors of the population of each country today experienced the Neolithic Revolution. In particular, regressing current life expectancy on the timing of the Neolithic Revolution, ten thousand years ago in some places, one thousand years ago in other places, while accounting for income, education, health expenditure per person, and geographical characteristics, every one thousand years of earlier transition to the Neolithic period contributes about 1.5 years to life expectancy today.

These findings, as well as those that support the Diamond hypothesis imply that the Neolithic Revolution was indeed a very important event in human history and probably affected the composition of human populations and human capital formation in a very dramatic way. Ultimately this fed back into the process of industrialisation and the transition into sustained economic growth.

[90] Galor and Moav, 2005, 2007. See also, Comin, Easterly and Gong, 2006.

Current research

In addition to the research you have just outlined, what else are you currently working on?

I am engaged in a major research project, a very exciting one, with my exceptional doctoral student, Quamrul Ashraf.[91] This research attempts to identify long-run historical forces that have influenced current development. It examines the role of human genetic diversity within a society as an important determinant of its economic development. Contrary to the uni-causal hypothesis of Diamond, this research establishes that, while the timing of the transition to agriculture is indeed an important determinant of economic development, the composition of human populations with respect to their overall genetic diversity has been an equally significant factor in this regard.

In the first stage of this research, the study examines the hypothesized effect of human genetic diversity within societies on their population densities in the years 1 CE, 1000 CE and 1500 CE.

Why is population density so important?

The examination of comparative economic development in the pre-colonial era, when societies were in their agricultural stage of development, requires the interpretation of outcomes from a Malthusian steady-state point of view. This implies that the relevant outcome variable for comparative development is population density as opposed to income per capita since, given the natural productivity of land with respect to agriculture, any surplus generated by total factor productivity is channeled into population growth while income per capita remains stable in the long run.

The empirical analysis shows that human genetic variables and the timing of the Neolithic Revolution each explain slightly over twenty per cent of the variation in population density. The empirical analysis therefore confirms the importance of the Neolithic Revolution for comparative development, but Diamond's conjecture that genetic variables do not play a role in comparative development is rejected.

[91] Ashraf and Galor, 2008b.

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