

The Role of Population in Economic Growth

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E. Wesley F. Peterson¹

Abstract

The relationship between population growth and economic growth is controversial. This article draws on historical data to chart the links between population growth, growth in per capita output, and overall economic growth over the past 200 years. Low population growth in high-income countries is likely to create social and economic problems while high population growth in low-income countries may slow their development. International migration could help to adjust these imbalances but is opposed by many. Drawing on economic analyses of inequality, it appears that lower population growth and limited migration may contribute to increased national and global economic inequality.

Keywords

economic growth, population growth, economic inequality, productivity, migration

Introduction

The relationship between population growth and growth of economic output has been studied extensively (Heady & Hodge, 2009). Many analysts believe that economic growth in high-income countries is likely to be relatively slow in coming years in part because population growth in these countries is predicted to slow considerably (Baker, Delong, & Krugman, 2005). Others argue that population growth has been and will continue to be problematic as more people inevitably use more of the finite resources available on earth, thereby reducing long-term potential growth (Linden, 2017). Population growth affects many phenomena such as the age structure of a country's population, international migration, economic inequality, and the size of a country's work force. These factors both affect and are affected by overall economic growth. The purpose of this article is to use long-term historical data and a review of both theoretical and empirical work on the relationship among growth of population, total output and per capita output to assess the implications of their evolution for economic inequality, international migration policies, and general economic growth.

In his important book on inequality, Thomas Piketty (2014) observes that economic growth “... always includes a purely demographic component and a purely economic component, and only the latter allows for an improvement in the standard of living” (p. 72). Economic growth is measured by changes in a country's Gross Domestic Product (GDP) which can be decomposed into its population and economic elements by writing it as population times per capita GDP. Expressed as percentage changes, economic growth is equal to population growth plus growth in per capita GDP. GDP is

a measure of economic output and is also an indicator of national income which can be defined as total output net of capital depreciation plus net income from sources outside the country (Piketty, 2014, p. 45). Piketty (2014, p. 73) points to evidence that average annual world economic growth between 1700 and 2012 was 1.6% made up of equal parts population growth and per capita output growth of 0.8% each. While these growth rates may appear to be very small, they can lead to impressive increases over long periods of time. Population growth at an average annual rate of 0.8% over the period 1700 to 2015 resulted in a 12-fold increase in world population from about 600 million in 1700 to over 7.3 billion in 2015 (Maddison, 2001 and World Bank, 2017).

Piketty (2014) develops a number of economic relationships to describe the workings of a capitalist economic system and traces the implications of these relationships for changes in economic inequality. The relationship between economic growth and the rate of return to capital is of central importance in his analysis. He argues that when the rate of return to capital is greater than the economic growth rate ($r > g$ in his notation), the likely result will be concentration in the ownership of capital leading to increasing inequality. In a later article, Piketty (2015) clarifies this result noting that other factors as well as economic policies contribute importantly to the evolution of economic inequality, suggesting

¹University of Nebraska–Lincoln, USA

Corresponding Author:

E. Wesley F. Peterson, Department of Agricultural Economics, University of Nebraska–Lincoln, 207b Filley Hall, Lincoln, NE 68583-0922, USA.
Email: epeterson1@unl.edu



that large gaps between r and g will tend to amplify the effects of these other factors. This qualification does not diminish the importance of economic growth in Piketty's analysis of the causes and consequences of rising inequality. He argues that economic growth is likely to be relatively slow in the future, less than the rate of return on capital, in part because its demographic component is expected to grow very little. Baker et al. (2005) agree noting that slowing population growth in the United States is part of the reason that future U.S. economic growth will be lower than it was for most of the 20th century. Population growth is falling in many parts of the world and once the demographic transition is completed in sub-Saharan Africa and other areas of robust population growth, world population growth will probably return to historic levels of less than 1% per year. Average annual growth in per capita output has also been fairly modest over the past 200 years accelerating during periods when very poor countries begin to catch up with more highly developed economies or when rapid productivity growth is achieved as was the case in many countries during the 20th century. The danger of slow economic growth in Piketty's view is that the resulting concentration of capital will help to bring back the patrimonial capitalism of the 19th century when one's fortune was more effectively made by marrying an heir to great wealth than by working to develop one's talents in the service of a productive career.

Piketty's explanation of the importance of economic growth is not the only possible account, of course. Economic growth is important for raising living standards around the world and the role of population growth in the evolution of living standards is a significant policy issue (see Heady & Hodge, 2009). In addition to the potential effects of population growth on economic inequality, population and economic growth have significant impacts on such controversial topics as international migration and global resource use. In the following sections of the article, the relationships between population and economic growth are analyzed to assess the implications of their likely evolution for growing inequality around the world and for population and migration policies. There is an extensive literature on these relationships but little consensus on the actual effects of population on economic growth (Heady & Hodge, 2009). Some authors offer theoretical arguments and empirical evidence to show that robust population growth enhances economic growth while others find evidence to support the opposite conclusion. Still others find that the effects vary with the level of a country's development, the source or nature of the population growth, or other factors that lead to nonuniform impacts. Heady and Hodge (2009) point to wide variation in empirical analyses of the link between population growth and growth in per capita income due to different methods, control variables, and other factors. In the next section, statistical evidence on the long-term evolution of population, per capita output, and the total economic product for various regions and selected countries is laid out. This is followed by a review of the

theoretical and empirical analyses of the role of population in economic growth and a discussion of the impacts of productivity increases and international migration on economic growth. The final section summarizes the evidence on the effects of population growth on economic growth and examines the predictions that long-term economic growth will be low as countries around the world complete the demographic transition and the potential for high economic growth from low-income countries catching up with countries with more advanced technological capabilities is exhausted.

Statistical Evidence on the Growth of Population, Per Capita Output, and GDP

Angus Maddison compiled an extraordinary set of data on population, per capita GDP, and GDP for virtually all countries in the world from 1 to 2008 of the Common Era (World Economics, 2016 and Maddison, 2001). After his death in 2010, researchers at the Groningen Growth and Development Center launched an initiative known as the "Maddison Project" which seeks to maintain, refine, and update Maddison's original data set (The Maddison Project, 2013). Clearly, there were no government agencies collecting data on the national accounts of countries that may not even have existed in year one of the Common Era, or in 1700 or 1820 for that matter. As a result, the estimates recorded in the data sets may be somewhat less reliable than would be the case for more recent statistics. They are, however, consistent with the historical record and calculated in a uniform manner making them reasonable estimates of long-term economic trends. The World Bank (2017) publishes an online database with a great many socio-economic variables, including population and real GDP, from 1960 to the present for most countries and world regions. Both statistical sources are used in computing the estimated growth rates reported in this article. Data on productivity are from the U.S. Bureau of Labor Statistics (2016) and the Organization for Economic Cooperation and Development (OECD; 2016, 2017). Population and migration projections are from the U.S. Census Bureau (2017). Average annual compound growth rates are calculated using the formula: $V = Ae^{rt}$ where V is the final value, A the initial value, r the rate of growth, t the number of years, and e is the exponential. For example, total world population in 1960 was 3.04 billion rising to 7.35 billion in 2015, a period of 55 years. Setting A at 3.04 billion, V at 7.35 billion, and t at 55 and solving the formula for r gives an estimate of average annual compound population growth over this period of 1.61%. All the GDP estimates reported in this study have been adjusted to remove the effects of inflation. Data collected by Maddison (World Economics, 2016) are in 1990 U.S. dollars while those of the World Bank (2017) are in 2010 U.S. dollars.

Regional groupings in the following tables reflect the classifications used by Maddison and the World Bank. In general, high-income countries include the members of the

Table 1. Average Annual Growth Rates of Population, Per Capita GDP, and GDP, World Regions, 1820 to 1913, 1913 to 2010, and 1820-2010.

Region	1820-1913		1913-2010		1820-2010	
	Population	per capita GDP	Population	per capita GDP	Population	per capita GDP
Western Europe	0.73	0.94	0.47	1.85	0.60	1.40
Eastern Europe	0.84	0.60	0.42	1.79	0.62	1.21
Former USSR	1.13	0.49	0.66	1.70	0.87	1.11
Western offshoots ^a	2.47	1.50	1.29	1.79	1.84	1.64
Latin America	1.43	0.97	2.05	1.52	1.75	1.25
Asia	0.34	0.17	1.48	2.28	0.93	1.25
Africa	0.26	0.67	2.17	0.83	1.38	0.75
World	0.58	0.83	1.38	1.67	0.99	1.26

Source. World Economics (2016) and U.S. Census Bureau (2016) for population; The Maddison Project (2013) for per capita GDP growth; and author's calculations.

Note. The dates 1820, 1913, and 2010 were chosen because there is more complete country and regional information for those dates in the Maddison data set. USSR = Union of Soviet Socialist Republics.

^aWestern offshoots are the United States, Canada, Australia, and New Zealand.

OECD (Europe, North America, Japan, Korea, Australia, New Zealand, Israel, and Chile) along with such countries as Kuwait, Saudi Arabia, Uruguay, and a number of smaller island economies. These countries have annual per capita incomes of \$12,476 and above according to World Bank data. All other countries are considered to be low- and middle-income countries. Geographic regions vary somewhat across the tables according to whether the data are from the Maddison project (World Economics, 2016) or the World Bank (2017). The Maddison data include one group, the “western offshoots” (United States, Canada, Australia, and New Zealand) not found in the World Bank data. The precise make-up of geographic regions and other country classifications used by the World Bank can be found at <https://data-helpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>

Average annual compound growth rates for population, real GDP, and real per capita GDP in various regions and countries from 1820 to 2010 are shown in Tables 1 and 2. Average annual world population growth over this period was about 1% but has varied considerably across regions and over time. Europe and the countries formerly included in the Soviet Union had relatively slow population growth overall with levels that were lower in the 20th century than in the 19th. One reason for slower population growth in Europe was the substantial emigration to Latin America and the “western offshoots” where high population growth rates were recorded between 1820 and 1913. While European population growth rates slowed during the period 1913 to 2010, they accelerated somewhat in Africa, Asia, and Latin America. Note that a constant annual population growth rate of 1% means that population doubles every 69.3 years. World population in 1820 was just over a billion people compared with about 6.9 billion in 2010 (World Economics, 2016 and World Bank, 2017). The results reported in Table 1 can shed

light on the timing of the demographic transition in various parts of the world. The demographic transition consists of an initial phase during which both crude birth and mortality rates are high and population growth is slow. As societies modernize, mortality rates fall while birth rates remain high leading to high population growth rates. Eventually, birth rates begin to decline resulting in a return to lower population growth as the transition is completed. This process appears to have run its course in Europe by the beginning of the 20th century and somewhat later in the western offshoots, while many countries in Africa, Asia, and Latin America have yet to complete it.

Average annual growth of per capita GDP also increased during the period 1913 to 2010 which, when combined with generally higher population growth rates, led to significant overall economic growth, over 3% per year for the world as a whole. The more recent acceleration of economic growth in China and other emerging economies can be seen in Tables 3 and 4 covering the period 1960 to 2015. Economic growth in the high-income countries of Western Europe and North America over this period has been a little less than the world average while growth in Asia has been well above the global average over the past 55 years. Population growth has slowed everywhere except sub-Saharan Africa but still accounted for almost half of world economic growth over the period 1990-2015. The emerging Asian economies are catching up with the high-income countries, registering significant growth in per capita GDP with population growth contributing relatively little to overall economic growth. In China, for example, average annual population growth between 1990 and 2015 was only 0.76%, perhaps as a result of that country's former policy of limiting families to one child, while average annual per capita GDP growth was 8.72% for an overall economic growth rate of 9.48% per year. Similar results are found for India

Table 2. Average Annual Growth of Population, Real Per Capita GDP, and Real GDP (Percent), Selected Countries, 1820 to 1913 and 1913 to 2010.

Country	Population 1820-1913	Per capita GDP 1820-1913	GDP 1820-1913	Population 1913-2010	Per capita GDP 1913-2010	GDP 1913-2010
France	0.30	1.21	1.51	0.47	1.87	2.34
Germany	1.03	1.31	2.34	0.24	1.79	2.03
Italy	0.66	0.45	1.11	0.48	2.15	2.63
Norway	0.99	1.20	2.19	0.71	2.51	3.22
United Kingdom	0.82	0.93	1.75	0.33	1.62	1.95
Former USSR ^a	1.13	0.77	1.89	1.36	0.47	1.83
Canada	2.43	1.71	4.14	1.51	1.78	3.29
United States	2.45	1.46	3.91	1.19	1.80	2.99
Mexico	0.88	1.09	1.97	2.13	1.54	3.67
Japan	0.55	0.78	1.33	0.94	2.85	3.79
Korea	0.13	0.40	0.53	1.59	3.92	5.51
India	0.40	0.25	0.65	1.44	1.66	3.10
China	0.15	-0.01	0.14	1.15	2.76	3.91
Indonesia	1.14	0.54	1.68	1.59	1.74	3.33
Iran	0.56	0.57	1.13	1.97	1.92	3.89
Jordan	0.51	0.57	1.08	2.98	1.78	4.76
Iraq	0.42	0.57	0.99	2.48	0.49	2.97
Brazil	1.78	0.18	1.96	2.19	2.20	4.39
Argentina	2.86	1.40	4.30	1.74	1.02	2.76
Ghana	0.60	1.34	1.94	2.55	0.93	3.48
Morocco	0.69	0.54	1.23	1.89	1.79	3.68
Egypt	1.14	0.69	1.83	1.97	1.60	3.57
South Africa	1.48	0.82	2.30	2.18	1.19	3.37
World	0.54	0.83	1.37	1.40	1.67	3.07

Source. Author's calculation based on data from World Economics (2016) and The Maddison Project (2013).

Note. USSR = Union of Soviet Socialist Republics.

^aCountries formerly included in the USSR.

Table 3. Average Annual Growth of Population, Real GDP, and Real Per Capita GDP (Percent), Regions, EU, and United States, 1960 to 2015, and 1990 to 2015.

Region	Population 1960-2015	Per capita GDP 1960-2015	GDP 1960-2015	Population 1990-2015	Per capita GDP 1990-2015	GDP 1990-2015
World	1.61	1.85	3.46	1.32	1.42	2.74
Low and middle income	1.81	2.77	4.58	1.46	3.04	4.50
High-income countries	0.81	2.28	3.09	0.68	1.37	2.05
East Asia, Pacific	1.49	5.45	6.94	0.95	7.05	8.00
South Asia	2.03	2.97	5.00	1.73	4.25	5.98
Middle East and North Africa	2.48 ^a	1.53 ^a	4.01 ^a	2.03	1.82	3.85
Latin America	1.85	1.79	3.64	1.40	1.53	2.93
Sub-Sahara Africa	2.69	0.78	3.47	2.71	1.10	3.81
North America	1.07	1.99	3.06	1.01	1.38	2.39
EU	0.40	2.26	2.66	0.26	1.38	1.64
United States	1.03	2.01	3.04	0.98	1.40	2.38

Source. Author's calculations based on data from World Bank (2017).

Note. EU = European Union.

^a1970 to 2015.

and Indonesia although population growth in these countries has been much higher than in China (Table 4).

It is also interesting to note the more recent acceleration of per capita economic growth in developing countries. For

Table 4. Average Annual Growth of Population, Real Per Capita GDP, Real GDP (Percent), Selected Countries, 1960-2015.

Country	Population 1960-2015	Per capita GDP 1960-2015	GDP 1960-2015	Population 1990-2015	Per capita GDP 1990-2015	GDP 1990-2015
France	0.65	2.10	2.75	0.53	0.95	1.48
Austria	0.37	2.35	2.72	0.44	1.38	1.82
Italy	0.35	2.06	2.41	0.28	0.36	0.64
Norway	0.67	2.46	3.13	0.85	1.59	2.44
United Kingdom	0.39	1.97	2.36	0.52	1.49	2.01
Turkey	1.91	2.43	4.34	1.51	2.30	3.81
Canada	1.27	1.89	3.16	1.02	1.26	2.28
United States	1.03	2.01	3.04	0.98	1.40	2.38
Mexico	2.18	1.72	3.90	1.58	1.10	2.68
Australia	1.53	1.89	3.42	1.33	1.70	3.03
Japan	0.58	3.04	3.62	0.11	0.77	0.88
Korea	1.28	5.68	6.96	0.66	4.18	4.84
India	1.95	3.16	5.11	1.64	4.69	6.33
China	1.31	6.41	7.72	0.76	8.72	9.48
Indonesia	1.96	3.44	5.40	1.40	3.37	4.77
Iran	2.33	1.56	3.89	1.37	1.94	3.31
Brazil	1.91	2.16	4.07	1.29	1.38	2.67
Argentina	1.35	1.32	2.67	1.13	2.68	3.81
Honduras	2.54	1.39	3.93	2.00	1.71	3.71
Algeria	2.32	1.21	3.53	1.71	1.20	2.91
Nigeria	2.53	1.23	3.76	2.58	2.48	5.06
Kenya	3.16	1.36	4.52	2.71	0.80	3.51
South Africa	2.09	0.98	3.07	1.79	0.71	2.50
World	1.61	1.85	3.46	1.32	1.42	2.74

Source. Author's calculations based on World Bank (2017) data.

the decade of the 1990s, annual growth in per capita output in these countries averaged 1.37% compared with a rate of 4.15% for the period 2000-2015 (Table 5). These results are undoubtedly influenced by the exceptional economic performance in China and other large emerging economies although economic growth also picked up in many low-income countries. Population growth slowed slightly between these two periods in all regions except Sub-Saharan Africa where negative growth in per capita GDP during the 1990s shifted to a much higher rate of 2.29% for the period 2000 to 2015 and an overall economic growth rate for this period of almost 5%. Per capita GDP growth increased substantially in Asia and somewhat less in Latin America between these two periods. The 1990s were a particularly difficult period for Russia where population declines and low growth of per capita GDP combined to generate negative average annual economic growth. Life expectancy at birth in Russia fell from 69.5 years in 1988 to 64.5 years in 1994 only returning to its previous high in 2011 after which it seems to have stabilized at 70.4 years. For comparison, life expectancy at birth in Japan in 2015 was 83.6 years and in the United States it was 78.9 years (World Bank, 2017). Although population continued to decline in Russia after 2000, per capita output rebounded significantly leading to overall annual average economic growth of 3.53%. High-income countries, in contrast,

registered slower growth after 2000 than in the preceding decade. The effects of the Great Recession of 2008-2009 appear to be reflected in the lower per capita growth rates for the period 2000-2015 in the United States, Japan, and most European countries (Table 5).

Piketty (2014), Milanovic (2016), and Atkinson (2014), among others, have noted that economic inequality declined during much of the 20th century only to begin rising after 1975. In explaining these trends, Piketty (2014) points to the 30 years after World War II (*“les Trente Glorieuses,”* p. 11) as a period of exceptionally high economic growth. Average annual population, GDP, and per capita GDP growth rates are shown for selected countries for the period 1945 to 1975 in Table 6. World economic growth over this period at 3.79% was higher than the average rates for the past 200 years (2.25%) or for the period 1913 to 2010 (3.05%). France, Spain, Italy, the Soviet Union, Turkey, Japan, South Korea, Mexico, and Brazil were able to realize very rapid growth between 1945 and 1975. In the case of France, Italy, the Soviet Union, and Japan, much of this growth was driven by rebuilding after the destruction of the war years. In many Western European countries, population growth rates were low but higher growth in per capita output led to substantial overall economic growth during this period. These higher growth rates meant that Piketty's inequality, $r > g$, was

Table 5. Average Annual Percentage Growth of Population, Real Per Capita GDP, and Real GDP (2010 US\$), World Regions and Selected Countries, 1990 to 2000 and 2000 to 2015.

Region/country	Population 1990-2000	Per capita GDP 1990-2000	Real GDP 1990-2000	Population 2000-2015	Per capita GDP 2000-2015	Real GDP 2000-2015
Low-income	1.64	1.37	3.01	1.34	4.15	5.49
High-income	0.70	1.90	2.67	0.66	0.98	1.64
World	1.46	1.29	2.75	1.22	1.51	2.73
East Asia/Pacific	1.64	1.91	3.55	0.72	3.65	4.37
South Asia	2.02	2.86	4.88	1.53	5.00	6.53
Middle East/North Africa	2.14	1.08	3.22	1.97	2.13	4.10
Latin America	1.65	1.42	3.07	1.23	1.60	2.83
Sub-Sahara Africa	2.72	-0.67	2.05	2.70	2.29	4.99
North America	1.22	2.11	3.33	0.88	0.89	1.77
United States	1.20	2.18	3.38	0.86	0.90	1.76
EU	0.21	2.02	2.23	0.29	0.95	1.24
China	1.11	8.82	9.93	0.55	8.62	9.17
Brazil	1.60	0.95	2.55	1.11	1.64	2.75
India	1.90	3.54	5.44	1.46	5.47	6.93
Russia	-0.68	0.28	-0.40	-0.14	3.67	3.53
South Africa	2.29	-0.49	1.80	1.49	1.47	2.96
Japan	0.24	0.88	1.12	0.01	0.71	0.72
Germany	0.37	1.59	1.96	-0.01	1.11	1.10
France	0.33	1.75	2.08	0.63	0.45	1.08
United Kingdom	0.34	2.06	2.40	0.65	1.10	1.75
Norway	0.69	2.87	3.56	0.96	0.63	1.59
South Korea	0.89	5.44	6.33	0.54	3.32	3.86

Source. Author's calculations using World Bank (2017) data.

Note. EU = European Union.

reversed contributing to a reduction of the concentration of capital and declining levels of inequality. Piketty (2014) estimates the “pure” rate of return to capital, defined as the observed rate of return minus an estimate of the costs of managing investment portfolios, to have been 4% to 5% in the 19th century declining to 3% to 4% today with substantial variation from country to country. In many of the countries shown in Table 6, economic growth rates were substantially higher than these estimates of the rate of return on capital and in several cases, high population growth contributed significantly to overall economic growth.

A striking feature of the estimates in the Tables is that, with the exception of the immediate postwar period, economic growth in the United States has been slightly more rapid than in most Western European countries both in the 19th and early 20th centuries when it was catching up to the more advanced European economies and in more recent years. From 1960 to 2015, for example, the U.S. economy grew at an annual rate of 3.04% compared with 2.66% for the European Union (EU). If the United States and EU are both set at 100 in 1960, these growth rates mean that the United States would end up in 2015 at 532 compared with 432 for the EU, an advantage of about 23%. Note, however, that the reason for this difference is not that the United States had greater growth in per capita output but rather that U.S.

population growth was higher. In fact, per capita GDP growth in the EU outpaced that of the United States where economic growth would have averaged 2.41% instead of 3.04% if the U.S. population had increased at the same rate as that of the EU. Does this mean that countries with higher population growth rates will benefit from greater overall economic growth potentially mitigating the effects on inequality that concern Piketty? This question is the subject of the next section.

The Relationship Between Economic Growth and Population Growth

If population growth and per capita GDP growth are completely independent, higher population growth rates would clearly lead to higher economic growth rates. It would still be true that, as noted by Piketty (2014), only the growth in per capita GDP would give rise to improvements in economic well-being. On the other hand, if population growth affects per capita output growth, higher population growth rates would contribute to either higher or lower overall economic growth depending on the nature of its effects on per capita GDP. For the world as a whole, over the period 1990 to 2015, the correlation between population growth and real per capita GDP growth, based on World Bank (2017) data, was

Table 6. Average Annual Growth of Population, Real Per Capita GDP, and Real GDP, Selected Countries, 1945 to 1975.

Country	Population growth (%)	Real per capita GDP growth (%)	Real GDP growth (%)
France	1.02	5.39	6.41
Germany	0.54	3.27	3.81
Hungary	0.51	4.05	4.56
Italy	0.69	5.74	6.43
Norway	0.87	3.75	4.62
Switzerland	1.24	2.66	3.90
Spain	0.94	4.60	5.54
United Kingdom	0.45	1.73	2.18
Former USSR	1.27	3.88	5.15
Canada	2.09	2.32	4.41
United States	1.43	1.10	2.53
Australia	2.08	2.15	4.23
Japan	1.27	7.11	8.38
South Korea	2.26	5.11	7.37
Mexico	3.13	2.94	6.07
Brazil	2.86	3.68	6.54
China	1.81	2.13	3.94
India	1.30	1.00	2.30
Turkey	2.56	4.12	6.68
Egypt ^a	1.85	1.49	3.34
Nigeria ^a	2.35	1.81	4.16
South Africa ^a	2.14	1.74	3.88
World ^a	1.59	2.20	3.79

Source. Author's calculations based on World Economics (2016), The Maddison Project (2013), and United Nations (2016).

Note. USSR = Union of Soviet Socialist Republics.

^a1950 to 1975.

−0.1849 suggesting that these two variables were uncorrelated during that period. Simple correlation, of course, tells us very little about the actual relationship between these variables. It turns out that economists have developed theoretical arguments supporting both the idea that population growth slows growth in per capita output and the opposite idea that population growth stimulates greater economic growth. Thomas Malthus (1993) developed one of the earliest and best known theories showing that population growth has a negative effect on well-being. He believed that population has a tendency to grow more rapidly than food supplies so that population reductions through various types of misery are always required to keep the number of people at a level consistent with the amount of food available. The implication of Malthus's model is that average incomes will always be driven down by population growth to a level that is just adequate for the population's subsistence.

A major purpose of Malthus's essay was to argue against the English Poor Laws. He suggested that trying to increase the well-being of the poor was an exercise in futility as higher incomes would lead to population increases that would drive incomes back down to the subsistence level. This understanding represented an accurate image of the past but missed the boat entirely for the future. From 1000 to 1820, average

annual population growth in England was about 0.29% while per capita GDP growth averaged 0.12% for an overall average annual economic growth rate of 0.41% according to data from World Economics (2016). With the Industrial Revolution, however, both income and population growth began to increase as did the supplies of food. Growth in global agricultural output has been faster than world population growth over the past two centuries (Peterson, 2009) and real per capita GDP in England has increased more than 11-fold since 1820 (The Maddison Project, 2013). The fact that technological innovations have allowed incomes to rise well above the subsistence levels familiar to Malthus does not mean, however, that the question of how population growth affects growth in per capita output is resolved. It is still possible that growth in output would have been greater if population growth rates had been somewhat lower. In fact, population growth in the United Kingdom between 1820 and 2010 was moderately higher at 0.57% than was the case for the previous 820 years while annual growth in per capita GDP was substantially more rapid at 1.28% after 1820 (World Economics, 2016 and The Maddison Project, 2013).

Malthusian perspectives on the effects of population growth on social and economic well-being were revived by Paul Ehrlich (1968) and others in the latter part of the 20th

century when population growth rates reached very high levels, primarily in low-income countries. The concern of these writers was that world population would reach a level that would overwhelm the capacity of the earth and its resources to generate the food and other goods needed for human life. Many felt that both population growth and economic growth needed to be scaled back or eliminated entirely to avoid an existential crisis. Other authors argued that fears about population growth were overblown suggesting that population growth would stimulate technological innovations that would allow food production to keep up with the growing population (Boserup, 1965) or that larger populations would result in more brains that could be applied to solving any resource problems that might arise (Simon, 1981). In 1980, Julian Simon and Ehrlich made a famous bet on the future prices of five mineral commodities over the following 10 years with Ehrlich predicting rising prices as the world population exploded while Simon forecast the opposite as clever humans found ways to overcome resource constraints. Simon won the bet as the commodity prices fell substantially while the world added 800 million people to its population (Sabin, 2014). As population growth rates have begun to fall in recent years, the possibility that food and natural resources will be exhausted by a larger population seems to be less of a preoccupation than the more likely danger that continued use of the earth's resources at current rates will lead to climate change and other environmental problems.

The neoclassical growth model pioneered by Solow (1956) also provides a theoretical explanation for a negative relationship between population growth and growth in per capita output. Models of this nature are often referred to as "exogenous" growth models because the two variables that drive economic growth, savings (which lead to increases in the capital stock) and population (which determines the amount of labor available), are introduced exogenously. In these models, rapid population growth leads to smaller amounts of capital per worker slowing economic growth (Bucci, 2015). In addition, it is generally assumed that increasing population combined with relatively static growth in the capital stock gives rise to diminishing returns. Note that most theoretical economic growth models do not actually use population as a factor in economic output. Instead, the size of the labor force (number of workers often adjusted for the average hours worked by each worker) is the variable that is combined with capital to generate GDP. In most cases, however, the population growth rate appears to be taken as a measure of labor force growth although more sophisticated models also take account of labor quality and the structure of the labor force. For example, Mankiw, Romer, and Weil (1990) add human capital accumulation which enhances the quality of the labor force to Solow's model and find that empirical evidence is consistent with the theoretical result that higher population growth rates lead to lower steady-state economic growth while higher savings rates have the opposite effect.

Early empirical applications of the neoclassical growth model found that after accounting for the effects of labor and capital in economic growth, there remained a large residual thought to be associated with technological progress (Shackleton, 2013). Endogenous growth models were developed to provide a better explanation of this residual by including representations of research and development and altering some of the assumptions about diminishing returns to capital as labor supply increases (Todaro & Smith, 2012). An interesting result from early efforts to model endogenous growth is that these models often suggest that there is a positive relationship between population growth and per capita economic growth in contrast to the predictions of the neoclassical growth models. Such an outcome is consistent with arguments advanced by Simon (1990) who suggested that greater population growth would result in a larger "stock of useful knowledge" (p. 168) which would, in turn, foster greater per capita economic growth. Jones (1999) identifies three types of endogenous growth models noting that early versions resulted in the prediction that population growth would generate increased per capita GDP growth claiming, in contrast to Simon, that this result is at odds with the empirical evidence. The other types of endogenous growth models described by Jones also predicted a positive relationship between population and per capita economic growth although there have been several representations that allow for a negative correlation between these variables (see Strulik, 2005 and Prettnner & Prskawetz, 2010). Most of these authors believe that empirical evidence does not support the idea that population growth is positively correlated with per capita output growth (Strulik, 2005).

Empirical work on the effects of population growth on economic growth in particular countries has generated contradictory results. Sethy and Sahoo (2015) and Tumwebaze and Ijjo (2015) find that population growth has a positive impact on per capita economic growth in India and the Eastern and Southern Africa region. In contrast, Yao, Kinugasa, and Hamori (2013) and Banerjee (2012) conclude that there is a negative relationship between population and per capita GDP growth in China and Australia. Huang and Xie (2013) find that current population growth has a negative effect on economic growth while lagged population growth has a positive effect so that there is no long-term relationship between these variables. Such contradictory findings have led several analysts to consider the possibility that the impact of population growth on per capita output growth may not be uniform but, rather, varies with particular circumstances. For example, Becker et al. (1999) suggest that population growth in low-income, agricultural societies slows growth in per capita income due to diminishing returns to the growing labor force making more intensive use of a fixed resource base while a growing population in high-income, urban economies may give rise to greater income growth as a result of increasing returns from greater specialization and growth in investments in human capital. Bucci (2015) points to

positive effects of population growth on productivity due to greater specialization but suggests that larger populations give rise to more complex production processes that offset these effects. Kelley and Schmidt (2001) and Mierau and Turnovsky (2014) argue that population growth stemming from declining mortality rates stimulates economic growth while population growth resulting from fertility increases will tend to slow it. The reason for these contrasting effects is that declines in mortality provide incentives for people to save more which stimulates growth while increases in fertility have a negative impact on aggregate savings (Mierau & Turnovsky, 2014). In a meta-analysis of studies of economic growth and population growth, Heady and Hodge (2009) found that declining population growth rates in high-income countries slow economic growth while high population growth rates in low-income countries lower their economic growth.

Several analysts have investigated the relationship between population and per capita output growth by taking advantage of the natural experiment provided by the post-World War II baby boom in the United States, Canada, Australia, and much of Western Europe. Baby booms are characterized by relatively short periods of increased fertility which can lead to greater population growth. In the United States, the U.S. Census Bureau counts the baby boom as lasting from July 1, 1946 to July 1, 1964 (Colby & Ortman, 2014). During this period, the average annual U.S. population growth rate was 1.70% which is higher than the average of 1.29% for the 20th century as a whole. Per capita GDP growth for these years was 1.82%, about the same as the average annual growth rate of 1.87% for the period 1946 to 2010 (The Maddison Project, 2013). Yoo (1994) develops three models to examine the impact of this increase in population growth on U.S. economic growth. He finds that the large increase in the number of children slowed growth as resources were transferred from more productive activities to education and health care for this large cohort. Once the baby boom generation moved from the dependency stage to the more productive phase of active workers and savers, standards of living improved and even when the baby boomers exit the labor force, his models suggest that the decline in savings will have little impact on economic well-being. Bloom and Canning (2004) also show that there are positive impacts on economic growth as baby boom cohorts join the labor force and save for retirement. Many of these authors emphasize the importance of age structure for economic development. High population growth rates mean that the average age of a population will be young and there will be high dependency rates. Forty-three percent of the population in sub-Saharan Africa, where population is growing 2.7% per year, is under the age of 15 while only 3% is over 65. In Japan, where population growth is negative, 13% of the population is under age 15 with 26% over 65 (World Bank, 2017). As dependents, the large number of children in sub-Saharan Africa will slow growth but once they enter the

labor force, these countries can expect to reap a “demographic dividend” that will enhance economic growth. This dividend could be diminished if countries in sub-Saharan Africa do not complete the demographic transition to lower population growth rates in coming years.

There appears to be some agreement in the literature that population growth and growth in per capita output are not independent and the most likely nature of the relationship between them seems to be that it depends very much on the particular circumstances, notably the age structure of the population, in the various countries and regions. The aging population in countries like Japan means that a relatively smaller cohort of working age people will be called upon to support growing numbers of retirees slowing economic growth unless there is a substantial rise in productivity and per capita output. A different type of dependency problem exists in many African countries where relatively small working-age populations are required to support the very large number of children who have important educational and health needs. In the future, these children will enter the labor force and economic growth should increase. Trajectories of population growth do not tend to include large and dramatic turning points so it is unlikely that the population trends in various parts of the world can be significantly altered in the short run by policy changes. As a result, the effect of population growth on per capita economic growth will probably remain highly country specific although population policies may have some longer-term effects on population growth and age structure.

Productivity, Migration, and Economic Growth

While the effects of population growth on per capita economic growth may be quite variable, productivity growth is unequivocally related to the “economic component” of growth that Piketty points to as the source of improvements in the standard of living. As noted earlier, the services of capital and labor do not explain economic growth in its entirety. The part not explained by these inputs, the “Solow residual,” is often referred to as multifactor productivity (MFP). It is a measure of the effects of technological change, increases in efficiency, and other economic effects that may influence output such as increasing returns to scale or changes in the allocation of resources (Bureau of Labor Statistics, 2016). To measure MFP, it is necessary to determine the value of total output (GDP) and the contribution of the combined inputs, capital and labor, with MFP calculated as the amount of output that can be obtained from a unit of the combined inputs (OECD, 2016, pp. 101-102). MFP and per capita economic growth are distinct concepts but may be correlated, in part, perhaps, because the same variable (GDP) is in the numerator of both. Piketty (2014) sometimes treats per capita economic growth and productivity growth as interchangeable. Shackleton (2013) estimates that average

Table 7. Real Average Annual Per Capita GDP Growth and Correlation Coefficients Between Real Per Capita GDP Growth and Multifactor Productivity Growth, Selected OECD Members, 1990-2015.

	Per capita GDP growth (%)	Correlation coefficient
Australia	1.69	0.5845
Austria	1.37	0.3302
Belgium	1.24	0.1078
Canada	1.27	0.7977
Denmark	1.19	0.7251
Finland	1.20	0.8468
France	1.02	0.7612
Germany	1.34	0.9121
Ireland	4.08	0.7781
Italy	0.38	0.6647
Japan	0.87	0.9190
Korea	4.18	0.6896
Netherlands	1.47	0.7167
New Zealand	1.48	0.5821
Portugal	1.10	0.7604
Spain	1.22	-0.0648
Sweden	1.54	0.8445
Switzerland	0.67	0.8267
United Kingdom	1.45	0.7993
United States	1.41	0.4038

Source. Author's calculations based on World Bank (2017) data for real per capita GDP growth and OECD data at <http://www.oecd.org/std/productivity-stats/> for multifactor productivity growth.

Note. OECD = Organization for Economic Cooperation and Development.

annual growth in U.S. MFP over the period 1870 to 2010 was between 1.6% and 1.8% which is about the same as average annual growth of per capita GDP over that period (1.8%) based on the Maddison Project (2013) data. Correlation coefficients for per capita GDP and MFP growth for the period 1990 to 2014 based on OECD (2017) data for the OECD countries for which data are available are shown in Table 7. The correlation is quite strong in Germany and Japan but there is no apparent correlation in Belgium and Spain. Overall, these results suggest that per capita GDP growth is not a perfect proxy for MFP growth in these countries in recent years.

The evolution of MFP over time follows the business cycle closely (OECD, 2016). During the recession of 2008-2009, both MFP and per capita GDP growth rates were negative in all but a few OECD countries (OECD, 2017). The OECD (2016) suggests that MFP typically increases when the economy is expanding but declines when it is contracting. Comin (2006) argues that over the long term, productivity growth is driven by technological innovation making the factors that influence innovation such as patent policies or spending on research critically important for economic growth in the future. Gordon (2016) argues that economic

growth between 1870 and 1970 reflected a revolutionary change in the way human beings live and work as a result of a set of transformative inventions such as electricity generation and the internal combustion engine. He feels that more recent advances in information technology and communications will not have the same kind of effects as these earlier innovations and predicts that future economic growth will be lower than it was during the special century of revolutionary inventions. Shackleton (2013) is somewhat more optimistic noting that the full effects of technological innovations often are only seen many years after their introduction so that recent advances in information and communications technologies may yet translate into increased economic growth. Although growth in per capita GDP in the high-income countries did appear to slow down after 2000, it increased in many low- and middle-income countries (see Table 5).

There appears to be some agreement among economists not only that productivity growth has slowed since 2000 in high-income countries but also that there is little prospect for a reversal of this trend. Irwin (2016) and Baker et al. (2005) point to falling labor forces as the baby boom generation retires and workers choose to work fewer hours coupled with lower per capita output growth as causes of slower GDP growth. Gordon (2016) notes the same types of demographic changes as these authors and argues that stagnation in educational attainment, inequality, and government debt will largely offset the effects of any potential technological innovations. He predicts that average annual per capita GDP growth in the United States will be only 0.8% over the period 2015 to 2040, far lower than the average growth rate of 2.11% (Gordon's estimate) achieved between 1920 and 2014. One factor that might help to offset the forces giving rise to predictions of slow economic growth is international migration. The U.S. Census Bureau (2017) estimates that crude birth and mortality rates in the EU are about equal at 10 per thousand people suggesting that the natural rate of population growth is zero. With net migration at two per thousand people, the EU did realize a positive population growth rate of 0.2%. In contrast, deaths in Japan outnumbered births and with virtually no net migration, the country had a negative population growth rate of -0.2% in 2016. For the United States, the 2016 population growth is estimated at 0.8% made up of equal parts natural increase (crude birth rate of 12 per thousand and crude mortality rate of 8 per thousand) and net migration (4 per thousand). The U.S. Census Bureau (2017) predicts that natural population increases in the United States will continue to decline while net migration remains fairly constant. By 2040, the Census Bureau estimates that annual population growth will fall to 0.5% based on a natural increase of 0.1% (crude birth rate of 11 per thousand and crude mortality rate of 10 per thousand) coupled with an increase of 0.4% (four per thousand) due to immigration.

In recent years, there has been a fairly steady flow of migrants primarily from low- and moderate-income

Table 8. Net Migration (2012) and Foreign-Born Population (Total and Percent, 2015), World Regions and Selected Countries.

Regions/countries	Net migration (000) 2012	Total foreign-born Population (000), 2015	Foreign-born population as % of total population, 2015
World	0.0	243,700.2	3.3
Low- and moderate-income countries	-15,350.7	103,218.3	1.7
High-income countries	15,359.6	140,482.0	11.2
East Asia/Pacific	-1,457.5	25,565.3	1.1
South Asia	-6,280.8	14,103.7	0.8
Middle East/North Africa	-213.0	40,278.5	8.4
Latin America	-2,081.9	9,234.0	1.5
Sub-Saharan Africa	-1,689.0	18,994.0	2.0
North America	6,183.8	54,488.7	15.2
Europe/Central Asia	5,547.4	81,539.4	10.1
China	-1,800.0	4,159.4	0.3
India	-2,598.2	5,241.0	0.4
Pakistan	-1,081.9	3,629.0	1.9
Syria	-4,030.0	875.2	4.7
Turkey	2,000.0	2,964.9	3.8
Saudi Arabia	850.0	10,185.9	32.3
Brazil	15.9	713.6	0.3
Russia	1,117.9	11,643.3	8.1
South Africa	600.0	3,142.5	5.8
Japan	350.0	2,043.9	1.6
Germany	1,250.0	12,005.7	14.9
France	331.6	7,784.4	12.1
United Kingdom	900.0	8,543.1	13.2
Norway	235.7	741.8	14.2
United States	5,007.9	46,627.1	14.5

Source. Net Migration from World Bank (2017); foreign-born population, United Nations (2017).

countries to high-income countries as shown in Table 8. In 2012, about 15 million people emigrated from low- and moderate-income countries while high-income countries received about an equal number. There is some migration among the low- and moderate-income countries but the main flows are to Europe and North America as well as such regional magnets as South Africa. According to United Nations (2017) data, 3.3% of the world population lives in countries that are not the countries in which they were born (Table 8). Many small island states such as the Cayman Islands (39.6% foreign-born) or the Falklands (54.1%) have large proportions of foreign-born residents as do countries with limited land areas such as Singapore (45.4%) and Liechtenstein (61.1%). The Persian Gulf states are classified as high-income countries by the World Bank and have unusually large foreign-born populations. Foreign-born residents make up 51.1% of the population of Bahrain, 73.6% of the population of Kuwait, 88.4% in the United Arab Emirates, and 32.3% in Saudi Arabia. Connor (2016) suggests that economic growth in these countries and the availability of short-term work visas have attracted large numbers of migrants with the number of foreign-born residents growing by 61% between 2005 and 2015.

Despite the fact that foreign-born residents make up a little more than 10% of the populations in all high-income countries, the flow of migrants into these countries does not appear to be great enough to significantly raise population growth rates. Slowing population growth in high-income countries not only means lower economic growth rates but also an increased burden on the working population to support the growing numbers of retirees. Immigration increases the working age population thereby easing the burden of supporting a large elderly population. In line with some of the arguments sketched earlier, higher population growth may be beneficial in high-income countries where there is currently a tendency for population growth rates to decline. In contrast, many populous low-income countries, particularly in sub-Saharan Africa, would probably be better off with lower population growth (Becker et al., 1999). International migration could play a positive role in adjusting these imbalances. In 2016, population growth in Somalia was estimated to be 2.0% with the high natural rate of increase (2.7%) reduced by a net migration rate of seven per thousand (U.S. Census Bureau, 2017). For all of sub-Saharan Africa, net migration had a much smaller impact, reducing the population growth rate from its natural level of 2.5% to 2.4% in 2016. Likewise, The U.S. Census Bureau (2017) estimated that population

growth in the least-developed countries in 2016 was only reduced from 2.3% to 2.2% by emigration. Hanson and McIntosh (2016) argue that there will be little change in the impact of emigration from Africa, predicting that it will siphon off only a small proportion of the estimated population increase between 2010 and 2050.

These observations suggest that there could be benefits in both high- and low-income countries of more open borders to allow increased migration. Branko Milanovic (2016, p. 143) argues that realizing the full benefits of globalization requires the free movement of goods, services, technology, and ideas as well as the exchange of such productive inputs as labor and capital. He notes that much progress has been made in freeing up the movement of goods, services, and capital but the international movement of labor remains restricted. The free movement of workers within countries has long been one of the strengths of market economies. When substantial deposits of petroleum became accessible in North Dakota (USA), economic activity picked up greatly attracting large numbers of workers from less prosperous parts of the United States and easing the labor shortages that had arisen with the onset of the oil boom (Healy, 2016). Similar benefits to both receiving and sending nations would become available if there were fewer barriers to the global movement of labor resources. Milanovic (2016, p. 132) notes that global inequality is much greater than the inequality found within nations due primarily to the large "citizenship premium" received by those born in high-income countries. He argues that rapid increases in average incomes in poor countries combined with greater migration could reduce the citizenship premium and the level of global inequality but recognizes that allowing greater international migration is controversial and likely to be resisted strongly by many in high-income countries. Immigration was a prime motivation for those in the United Kingdom voting to sever ties with the EU as well as a stimulus for the nativist political movements that have sprung up in Europe and for the election of Donald Trump in the United States.

Conclusion

Most of the work reviewed in this article supports the idea that population growth is an important factor in overall economic growth and may even contribute to increased growth in per capita output in some cases. In low-income countries, rapid population growth is likely to be detrimental in the short and medium term because it leads to large numbers of dependent children. In the longer run, there is likely to be a demographic dividend in these countries as these young people become productive adults. It has also been argued that population growth induced by high levels of fertility, as is often the case in low-income countries, can reduce general well-being in contrast to growth resulting from declines in mortality rates generally believed to have more benign impacts on savings and economic

growth. In high-income countries, population growth is low and in some cases negative giving rise to age structures with a high proportion of elderly people in the population. The burden of supporting a large number of retired people could be eased if population growth were higher in these countries but it does not appear likely that fertility rates will increase in the future or that mortality rates will fall much below current levels. As a result, the natural population growth rate is likely to be very low. The U.S. Census Bureau (2017) predicts that annual natural population growth in high-income countries will be -0.3% by 2050. Increased migration from low- to high-income countries could offset these low and negative natural population growth rates while alleviating some of the pressures of high population growth in low-income countries. Although not directly affected by migration, an additional advantage of higher population growth in high-income countries is that it reduces the effects of inherited wealth on economic inequality (Piketty, 2014, p. 83). Higher population growth is generally associated with larger families and large families will have to divide inheritances among more children. Inherited wealth is an important part of the concentration of capital which, Piketty (2014) shows, contributes to greater economic inequality.

There are still many who take exception to conclusions such as these, arguing that the world is currently overpopulated putting unsustainable strains on resources and the environment. The president of "Negative Population Growth, Inc." argues that policies to reduce the world's population are crucial in realizing a human population that can be sustained indefinitely (Mann, 2015). Most of those who believe the world is overpopulated focus on the potential exhaustion of vital resources such as farmland, water, and raw materials. The implicit assumption in these analyses is that future technological innovations will be unable to overcome resource scarcities created by the needs of the growing population without causing environmental damage. In the case of natural resources, it is expected that technological innovations will be directed toward creating substitutes as the resources become scarce and their prices rise. In other words, rising prices for petroleum and other natural resources are likely to stimulate innovations that will solve many of the problems generated by the increasing scarcity that will lead to the rising prices. In the case of fossil fuels, many would agree that increasing the costs associated with their use either as a result of scarcities or through taxation or other price-enhancing policies would have significant benefits in reducing the greenhouse gas emissions that contribute to climate change. There may be limits to the ability of market forces and technology to overcome potential resource constraints or to protect such environmental goods as clean air and water but it would be wrong to think that human ingenuity is completely impotent when it comes to creating a sustainable environmental future without severe population reductions. This is good as dramatic reductions in the size of the global

population are highly unlikely short of widespread nuclear conflict or unusually deadly disease outbreaks.

Recent technological innovations in food and agricultural production offer an encouraging example. Conservation practices such as no-till farming which can reduce soil erosion and chemical runoff, precision farming which allows more exact applications of chemical fertilizers and pesticides reducing the quantities required, and other environmentally benign management practices have been widely adopted around the world without significant sacrifices in total food production or farm incomes (Derpsch, Friedrich, Kassam, & Hongwen, 2010; Thakur, Kassam, Stoop, & Uphoff, 2016; U.S. Department of Agriculture, 2016). Even such widely decried technological innovations as those created by genetic engineering can give rise to crop varieties that require fewer chemical inputs and reduce the impact of agriculture on the environment (Hamilton, 2009). It is almost certain that world population will reach 10 billion over the next 50 years and as these people will have higher incomes on average than is the case today, food demand is expected to increase dramatically. Meeting this increased demand without causing irreversible damage to the environment may be challenging but the rapid adoption of more sustainable agricultural practices currently under way suggests that this is not an insurmountable task.

Mann (2015) also calls for greater limitations on immigration which is seen as part of the unsustainable population growth in high-income countries. The main argument against immigration raised in these countries is that immigrants accept lower wages than native-born workers who are displaced by the influx of new workers (Frum, 2015). This popular understanding of the impact of immigration is bolstered by academic work done by George Borjas who argues that immigration into the United States depresses wages of low-skilled workers although it does contribute to increases in GDP (Borjas, 2013). Other analysts find that immigration generally has positive effects on income growth and productivity with limited displacement of low-skilled workers (Boubtane, Coulibaly, & Rault, 2013; Mason 2014; Peri, 2012). The positive effects of immigration in high-income countries are greater if the immigrants are highly-skilled (Chojnicki & Ragot, 2016; Kerr, Kerr, Ozden, & Parsons, 2016) but even immigrants with limited skills are often able to make significant economic contributions. The positive economic impacts of migration may not be sufficiently compelling to counter the political opposition these human movements engender, however. The arrival of large numbers of immigrants can upset traditional social systems leading to cultural conflict as well as economic anxieties. While the world economy could plausibly benefit from more open borders, the prevalence of anti-immigration political movements in Europe and other high-income countries makes it unlikely that the global movement of people will be as free as the global movement of goods, services, and capital any time soon.

Given the likely evolution of the global population and the fairly low expectations that many have for per capita growth in output, Piketty's worry that the rate of return to capital will be higher than the economic growth rate leading to increasing concentration of wealth and greater inequality seems warranted. This problem would be less severe if the rate of return to capital were to decline to levels below the current 3% to 4% suggested by Piketty. One would expect this return to decline as greater amounts of capital are amassed which may account in part for Piketty's estimate that current returns are lower than those of the 19th and early 20th century. Baker et al. (2005) argue that returns to capital are related to the state of the economy so that low economic growth will lead to lower returns to capital. If this is correct, the problem posed by Piketty's inequality may be at least partially self-correcting. In any case, economic growth will remain important in the 21st century for at least two reasons. First, if Piketty's analysis is correct, slow economic growth may continue to be a factor in rising inequalities in the distribution of income and wealth. Second, economic growth in low-income countries is crucial for raising living standards and reducing global disparities between the more prosperous industrialized countries and those in which poverty and low standards of living are still rife (Milanovic, 2016). Because population growth plays an important role in overall economic growth, the evolution of world population will continue to be a major global concern.

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Author Biography

E. Wesley F. Peterson is a professor of agricultural economics at the University of Nebraska-Lincoln. His teaching and research interests include international trade, public policy, economic development, and ethics.