Can Economic Growth Be Sustained? A Post-Malthusian Perspective

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Can economic growth be sustained? Is technical change the engine of economic growth? These issues have generated intense controversy since at least the early years of the industrial revolution. They emerged with even greater intensity during the last half of the twentieth century. During the late 1990s, a spurt of growth in output and productivity led the business press, and some economists, to proclaim that the economy had entered a new era in which the old rules that had governed cyclical and secular growth no longer obtained (Stiroh 1999). During the twenty-first century the United States and the other advanced industrial countries will be confronted by a new challenge: to make the service sector the driver of economic growth.

In the classical model of Malthus and Ricardo, growth is constrained by an inelastic supply of natural resources. In the neoclassical model, economic growth is constrained by the rate of growth of the labor force (Solow 1956; Prescott 1988). In both models the constraints on growth were released by exogenous technical change. In the new growth economics, the constraints are released by endogenous technical change driven by the accumulation of knowledge and human capital (Romer 1986, 1990, 1994; Lucas 1988, 1993). In this article I argue that future economic growth in economically advanced countries such as the United States will be constrained by low service-sector productivity.

Limits to growth

Economists and technologists have typically taken an optimistic view of the possibilities of sustainable growth. Ecologists and many natural scientists have often taken a less sanguine view. Environmentalists have replaced economists as the dismal scientists. The trauma of the Great Depression and the fear of post–World War II economic instability directed economists to
explore the conditions and economic policies that could lead to "steady-state" sustainable economic growth (Harrod 1939; Domar 1946; Solow 1956). Productivity growth, resulting from technical change, was identified as a fundamental source of economic growth. Concerns about the constraints imposed by natural resource scarcity receded.

Beginning in the 1970s, economists' optimism about economic growth was challenged by the coincidence of a global energy crisis and the slowing of economic growth in the developed industrial economies. The Ricardo-Malthus concern with the adequacy of the natural resource base to sustain economic growth was supplemented by the emergence of intense concern about environmental degradation. These concerns were highlighted for the general public by the press coverage given to the book *Limits to Growth* sponsored by the Club of Rome.4

The three main elements in these new concerns were:
— an anticipated scarcity of food, raw materials, and energy under conditions of burgeoning population growth;
— rising demand for environmental assimilation of residuals—the spillovers into the environment of pollutants arising as byproducts from commodity production, energy production, and transportation; and
— growth in consumer demand for environmental amenities—for the direct consumption of environmental services associated with rapid growth in per capita income and high income elasticity of demand for environmental services such as freedom from pollution and congestion.

During the 1980s fears about the adequacy of material and energy resources abated. But concern about the implications of environmental changes that were occurring at the global level intensified. These included the possibility that increases in the concentration of carbon dioxide (CO₂) and other "greenhouse" gases in the atmosphere were leading to deleterious climate change and that human encroachment on the environment was leading to irreparable loss of biodiversity (Turner et al. 1990; Stern, Young, and Druckman 1992).

There has also emerged since the 1970s a renewed concern about the "social limits to growth." In the 1920s the German historian Oswald Spengler (1926, 1928) argued that Western "culture" had lost its dynamism and was becoming a static "civilization." More recently Yale historian Paul Kennedy (1988) theorized that strategic "overreach"—an imbalance between strategic commitment and economic capacity—had been the major source of the decline of empires in the past and had become a source of excessive burden on economic growth in the United States and the Soviet Union since the middle of the twentieth century. It would have been considered highly audacious, however, even in 1986, to predict the imminent collapse of the Soviet empire.

Among its critics technical change came to be regarded as part of the problem confronting both the modern world and the countries that are still
poor. The view became pervasive in both popular and elite culture that modern technology—reflected in the cataclysm of war, the degradation of the environment, and the psychological cost of rapid social change—was dangerous to the modern world and the future of humankind (Lawless 1977; Wagar 1982). In a much more sophisticated exploration of the social limits to growth, Fred Hirsch (1976) has argued that the good things of life are restricted not only by the physical limits imposed by natural and human resources but also by the inherent scarcity of positional goods that limit the capacity to expand consumption without deterioration in quality.

**Productivity growth**

In this section I present the results of a two-sector economic growth simulation constructed in the spirit of the Ricardo-Malthus classical model. Natural resources, however, play no role in the model. The model is exceptionally simple when compared to the complexity of the world we live in. Yet even in its simplicity it has features that are recognizably similar to our world. The lesson of the simulation is that continued slow growth in productivity in the service sector of the US economy will result in a dampening of economic growth for the entire economy. An implication of the model is that slow growth in labor productivity and in per capita income may be unavoidable even in the absence of resource constraints.5

This stylized model economy is composed of two sectors: the automobile sector and the education sector (see Table 1). In the automobile sector technical change generates a rate of growth in labor productivity (output per worker) of 3 percent per year. In the education sector there is no technical change. Labor productivity, the student-teacher ratio, remains unchanged. The names that I have given the two sectors are not important. I could have labeled one sector "professional sports"—the numbers of players on baseball and football teams have not changed in my memory. I could have labeled the other sector "everything else"—all those progressive goods and service production activities that have experienced technical change and productivity growth. I could have labeled one sector the service sector and the other the material goods-producing sector.

Table 1 presents two submodels. In Model I all of the gains in productivity are realized in the form of an increase in automobile (or material) consumption. None of the labor released by gains in labor productivity in the automobile sector is transferred to the education (or service) sector. It is used to produce more automobiles (or material goods). In Model II, I assume that all of the labor released by productivity in the automobile sector is transferred to the education (or service) sector. The two models can be viewed as extreme limiting cases of the same underlying model.6

In Model I population and labor force remain unchanged: the economy has already achieved zero population growth. Note that the number of work-
### TABLE 1 Hypothetical growth paths for a two-sector economy

<table>
<thead>
<tr>
<th>Year (No.)</th>
<th>Automobile sector</th>
<th>Education sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Labor productivity (index)</td>
<td>Wage rate ($/hr)</td>
</tr>
<tr>
<td>$t_0$</td>
<td>100</td>
<td>1.00</td>
</tr>
<tr>
<td>$t_{10}$</td>
<td>100</td>
<td>1.35</td>
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<tr>
<td>$t_{20}$</td>
<td>100</td>
<td>1.81</td>
</tr>
<tr>
<td>$t_{30}$</td>
<td>100</td>
<td>2.43</td>
</tr>
</tbody>
</table>

**Model I: No reallocation of labor**

**Model II: Full reallocation of labor**

NOTE: Assumption specifies productivity growth of 3.0 percent per year in the automobile sector and 0.0 percent in the education sector.

**SOURCE:** Author's calculations.

**Input productivity growth rate:**
- Automobile sector: 3.0 percent per year
- Education sector: 0.0 percent per year

**Output price:**
- Automobile sector: $1.00 per unit
- Education sector: $1.00 per unit

**Wage rate:**
- Automobile sector: $1.00 per hour
- Education sector: $1.00 per hour
ers in each sector remains 100 (or an index of 100) over the entire 30 years in which I let the simulation run. With labor productivity rising at 3 percent per year and the number of workers unchanged, both labor productivity and automobile production rise from an index of 100 to 243. I also assume that workers have a contract with the automobile industry that specifies that wages will increase at the same rate as labor productivity. This assumption is consistent with the overall experience in the US economy for most of the post–World War II period (see Figure 1). Thus wage rates rise to $2.43 per hour. If we had started with wages at $10.00 per hour they would have risen to $24.30 per hour. Note also that the price of automobiles remains unchanged. Because of the rise in labor productivity it was possible to hold automobile prices unchanged while increasing workers’ wage rates.

Now let us examine what happens in the education sector. Labor productivity does not rise at all, but teachers’ wages rise at the same rate as in the automobile sector. If teachers’ wages do not rise they will walk across

FIGURE 1  Real income, productivity, and compensation in the US economy 1947–2000

the street and take jobs in the automobile sector. But if productivity does not rise and wages do, the cost of schooling (or tuition) must also rise. In the economy of Model I students (or taxpayers) are paying a lot more for education but are not consuming more education. Baumol (1967) has referred to this tendency for wages to rise in labor-intensive sectors that are not able to achieve productivity growth as the service-sector cost disease.

The world of Model I may not look exactly like the world we live in. But most of us would agree that it has been easier to achieve productivity growth in the automobile sector than in the education sector. And most would also agree, even without looking at the numbers, that the cost of education has risen several times as fast as the cost of automobiles.

In Model II we take a modest step toward making our simulation more realistic. It is quite possible, even before we have two cars in every garage, that the demand for automobiles—or the material components of consumption—might begin to fall off. People begin to resist what Easterlin has termed “the triumph of material wants over humanity” (1996: 154). In more technical language, the marginal utility of material goods consumption falls and the income elasticity of demand for automobiles (or material consumption) declines as incomes rise. People prefer to consume more education or other forms of “cultural consumption” (such as baseball games or symphony concerts).7

It may be a bit extreme but Model II holds automobile consumption unchanged. As productivity growth releases workers from automobile production, they will be transferred to the education sector. This resembles the structural transformation that can be documented in the American economy over the last 130 years (see Table 2; Figures 2 and 3). Consumption of agricultural commodities in the United States no longer rises as income rises. Employment in agriculture has declined from almost 50 percent of total employment in 1870 to less than 2 percent in the late 1990s. Employment in manufacturing, mining, and construction has declined from over 30 percent of total employment in 1950 to some 23 percent. Employment in the service sector (including government) accounted for over 75 percent of the labor force in the late 1990s. Even before the burst of the “new economy” growth bubble, it was clear that employment in the sectors producing material goods—agriculture and manufacturing—would fall to the range of 10 percent of the labor force in the United States within the next several decades. The recent declaration of a global “war on terrorism” will accelerate the transfer of labor from the goods-producing to the service sector in the form of domestic and international security services. An effect could be a further dampening of service-sector productivity growth.

In our model economy, employment in the automobile sector has declined from 100 workers to 41 (or from 100,000 to 41,000) over the 30-year period. If the productivity growth that has been set in motion continues its course, the time will come, in the not too distant future, when only
TABLE 2 Percent distribution of GNP by major industrial sector, in current prices, selected years 1947–97

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<tr>
<td>Declining shares</td>
<td></td>
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<tr>
<td>Agriculture, forestry, and fishing</td>
<td>8.8</td>
<td>4.1</td>
<td>3.0</td>
<td>2.8</td>
<td>2.0</td>
<td>1.6</td>
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<td>Mining</td>
<td>2.9</td>
<td>2.5</td>
<td>1.8</td>
<td>2.7</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>28.1</td>
<td>28.6</td>
<td>26.9</td>
<td>23.6</td>
<td>18.4</td>
<td>17.0</td>
</tr>
<tr>
<td>Total</td>
<td>39.8</td>
<td>35.2</td>
<td>31.7</td>
<td>29.1</td>
<td>22.2</td>
<td>20.1</td>
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<td>Stable shares</td>
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<td></td>
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<tr>
<td>Transportation and utilities</td>
<td>8.9</td>
<td>9.1</td>
<td>8.6</td>
<td>9.1</td>
<td>8.7</td>
<td>8.3</td>
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<tr>
<td>Construction</td>
<td>3.9</td>
<td>4.8</td>
<td>5.1</td>
<td>4.8</td>
<td>4.4</td>
<td>4.1</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>7.1</td>
<td>6.9</td>
<td>6.7</td>
<td>7.0</td>
<td>6.5</td>
<td>6.9</td>
</tr>
<tr>
<td>Retail trade</td>
<td>11.7</td>
<td>9.9</td>
<td>9.8</td>
<td>9.6</td>
<td>9.3</td>
<td>8.8</td>
</tr>
<tr>
<td>Total</td>
<td>31.6</td>
<td>30.7</td>
<td>30.2</td>
<td>30.5</td>
<td>28.9</td>
<td>28.1</td>
</tr>
<tr>
<td>Rising shares</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Finance, insurance, and real estate</td>
<td>10.1</td>
<td>13.8</td>
<td>14.2</td>
<td>14.4</td>
<td>17.7</td>
<td>19.4</td>
</tr>
<tr>
<td>Other services</td>
<td>8.6</td>
<td>9.7</td>
<td>11.5</td>
<td>13.0</td>
<td>18.9</td>
<td>20.4</td>
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<tr>
<td>Government</td>
<td>8.6</td>
<td>10.2</td>
<td>12.6</td>
<td>12.5</td>
<td>12.2</td>
<td>12.7</td>
</tr>
<tr>
<td>Total</td>
<td>27.3</td>
<td>33.7</td>
<td>38.3</td>
<td>39.9</td>
<td>48.8</td>
<td>52.5</td>
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<tr>
<td>Overall total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>


one worker will be left in the automobile sector. Note also that in each decade the 3 percent annual decline in the labor force releases fewer workers to be transferred to the education sector (3 percent of 100 workers is 3 workers, 3 percent of 67 workers is only 2 workers, and 3 percent of 33 workers is only 1 worker).

As the number of workers released by productivity growth in the automobile sector declines, the rate of growth of output in the education sector slows down. But the cost per unit of output in the education sector continues to rise as before. As the number of workers who can be transferred from the automobile sector declines, and the share of workers in the total economy employed in the education sector rises, the growth of the total economy grinds to a halt. Workers and consumers have higher levels of consumption than at the beginning—either in the form of more automobiles (as in Model I) or in the form of more education (as in Model II) or, under some cases intermediate between I and II, more of both. But eventually growth stops. We have backed into a no-growth economy—not because of the nineteenth-century Malthus–Ricardo resource constraints or the late-twentieth-century environmental constraints—but because of fail-
ure to achieve productivity growth in at least some service-sector industries for the products of which demand is price-inelastic.

**Perspective**

It appears from the simulation that if even one essential sector does not achieve productivity growth, it will eventually cause the entire economy to grind to a halt—and the larger the share of the economy that does not achieve productivity growth, the more rapidly the economy will approach a zero-growth "steady state." This state will be achieved at an income level...
was the result of a dramatic rise in the rate of growth of investment and in
substantially lower than the common high per capita income/low steady-
state growth that Lucas (2000) recently suggested the world would con-
verge to by the closing decades of the twenty-first century.

The “new economy” growth acceleration that began in the mid-1990s
was the result of a dramatic rise in the rate of growth of investment and in
technical change in the information technology (IT) industries. The IT indus-
tries accounted for less than 5 percent of gross national product (GNP), but
they accounted for almost half of productivity growth in the US economy dur-
ing 1995–99. A rate of growth in labor productivity in the 4 percent per year
range is unlikely to survive an anticipated slowdown in the maturing IT indus-
tries (Jorgenson 2001). The more serious constraint on growth in labor pro-
ductivity will, however, occur as a result of the continuing decline in the share

SOURCES: See Figure 2.
of output accounted for by the goods-producing sectors and the difficulty of enhancing the rate of productivity growth throughout the service sector.\textsuperscript{8}

The classical economists were mistaken when they assumed productivity growth was not possible in the agricultural sector. It is also a mistake to assume that productivity growth is not possible in the service sector. Use of computers is, after some delay, contributing to productivity growth in the financial services sector. Television has made it possible for more people to watch World Series baseball or the Metropolitan Opera. Real costs in technology-intensive transmission of television signals have declined. But the costs of labor-intensive programming have risen. Similarly the costs of computers and of computing have declined dramatically. But the cost of the more labor-intensive software development has risen and accounts for an increase in cost share in the information sectors. The drivers of trucks that deliver consumer goods to households employ substantial information technology—but it still requires one driver to load and unload the packages and to drive the truck (Gordon 2000).

It would be possible to make the model more sophisticated, and less intelligible, by introducing more-realistic assumptions. One could, for example, relax the assumption of early convergence toward zero population growth in the United States. The effect would be to dampen the decline in material consumption as a share of GNP and in the rate of regression toward the low level of productivity in the service sector. One could also construct a model with more sectors and introduce wider substitution in consumption among the products of the several sectors. And one could appeal to the scale economies and technological spillovers that have been emphasized in endogenous growth theory and to the effects of an open rather than a closed economy model in order to relax some of the service-sector productivity constraints (Ruttan 1998).

The allocation of greater resources to the statistical agencies of the federal government would undoubtedly repair possible underestimation of productivity growth in some service sectors. But it would take some very "creative" growth accounting to avoid a conclusion that if there are significant sectors in which productivity growth is not feasible or is severely constrained, the effect would be some combination of increasing costs and declining quality that would sharply limit the possibilities of long-term economic growth.

A clear implication is that the rate of growth in the US economy will regress toward the rate of growth in its least-productive sectors. This implies that in the early decades of this century the rate of economic growth in the United States and in other high-income countries will regress toward the low rate that will be achieved in an expanding service sector.
Notes

This article draws on material from Ruttan (2001). I am indebted to Hamid Mohtadi and Steven Polasky for comments on earlier drafts.


2 For a review of both the neoclassical and the new growth economics literature from a development economics perspective see Ruttan (1998).


5 The standard neoclassical model avoids the Ricardian constraints by including only labor and capital in its aggregate production function. But, as Solow has noted, if land and other resource constraints were included the neoclassical model “would become more Ricardian” (Solow 1956: 67).

6 The inspiration for the two models in Table 1 is the Baumol service-sector “cost disease” model (1967); Baumol, Batey-Blackman, and Wolff (1989): 124–126.

7 For the emergence of “postmaterialist” or “postmodernist” styles of consumption in the high-income countries see Inglehart (1990, 1997).

8 Estimates of industry contributions to US aggregate total factor productivity growth during 1958–96 by Jorgenson and Stiroh (2000) indicate negative contributions from the service sector and zero or negative contributions from 12 non-service-sector industries.

References


