How Fast Can We Grow?

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Nearly thirty years ago, Arthur Okun posed the question, "How much output can the economy produce under conditions of full employment?" He offered a "simple and direct" answer that now, with the benefit of hindsight, seems outmoded and inadequate. In subsequent years, the very phrases "full employment" and "potential GNP" have been called into question.

Yet, despite this skepticism about Okun's answer, the question he posed will not go away. Some quantitative concept of full capacity is needed to produce a long-term plan for the federal budget and the monetary growth targets. Similarly, some measure of the potential growth rate underlies any policy target for growth of monetary aggregates aimed at zero inflation, let alone a world where policy attempts to balance maximum economic growth with the risks of inflation.

The concept of potential output is also behind the myriad of private economic decisions made every day. Investment, production, pricing, and employment decisions will face entirely different risks and rewards in the 1990s than they did in the 1950s and 1960s, when real GNP grew at a 4 percent average annual rate.

Despite the difficulty of producing a precise answer, Okun's question must be answered explicitly or implicitly because it is an important question. This paper follows Okun's transparently simple, clearly incomplete approach. Its thesis is that a minor modification of Okun's original approach, based on major demographic changes, can account for the experience of the last thirty-five years and provide as reliable an idea of what to expect in the 1990s as a more complex, complete approach. It will be introduced by a brief review of the components involved in the process of economic growth.

I. Economic Growth Accounting

The pace of economic activity depends on the quantity and quality of the inputs to production, the state of technical knowledge about combining inputs, the efficiency with which the productive inputs are allocated, and the degree of utilization of productive inputs. Each of these factors is difficult to quantify, let alone to understand, predict, or control. Consequently, numerous approaches are possible in analyzing the process of economic growth. This section simply presents the history of several components of economic growth.

The point of departure is a simple accounting identity:

(1) O≡(O/H) · (H/E) · (E/LF) · (LF/Pop) · Pop.

Output can be viewed as the product of (1) output per hour (O/H), the average product of labor, or "productivity"; (2) average hours per employee (H/E); (3) employment as a percent of the labor force, (E/LF), (or 1 minus the unemployment rate); (4) the percentage of the working-age population in the labor force, (LF/Pop), and (5) the working-age population (Pop), defined as those 16 years and older. This identity can also be written in more familiar terms as:

(2) Output ≡ "Productivity" · Hours · Employment Rate · Participation Rate · Population.

Table 1 presents the behavior of these five components of output over various historical periods. Over the last forty years, real GNP has increased at a 3.4 percent annual rate; virtually all of that increase can be traced to two factors, growth in the working-age (16+) population and growth in the average product of labor ("productivity"). A secular rise in the participation rate has added only a few tenths of a percentage point to growth, virtually offset by a secular decline in the average number of hours employees work. Changes in the degree of utilization of the labor force, although the most important factor in yearly variations in economic activity, play little role over long periods of time.

The table confirms that in each of the last four decades the proximate sources of economic growth have been population growth and productivity growth. The relative importance of these two factors, however, has varied considerably. In the 1950s, productivity growth equaled roughly two-thirds of economic growth, population growth only a little over a quarter. In contrast, in the 1970s, population growth was two-thirds as large as economic growth, while productivity growth was only about two-fifths as large. Economic growth in the 1980s was the slowest of the four decades, slightly below the 1970s. The primary source of the recent slowing in growth has been a slowdown in the growth of the working-age population, after its extremely rapid growth in the

Table 1
Sources of Economic Growth
Percent

	Annual Rate of Growth					
Time Period (1)	Output (O) (2)	Productivity (O/H) (3)	Hours (H/E) (4)	Employment Rate (E/LF) (5)	Participation Rate (LF/Pop) (6)	Population (Pop) (7)
1950–89	3.4	1.9	−.3	0	.2	1.4
1950–69	4.0	2.6	−.2	.1	0	1.3
1970–89	2.7	1.2	−.4	−.1	.3	1.6
1950–59	4.0	2.6	−.1	.1	0	1.1
1960–69	4.1	2.5	−.3	.2	.1	1.5
1970–79	2.8	1.2	−.5	−.2	.4	1.9
1980–89	2.6	1.1	−.3	.1	.3	1.2

O: Real GNP; O/H: Output per hour, nonfarm business sector; H/E: Average weekly hours per worker, 16 and over, total private; E/LF: Ratio of the number of persons employed to the total labor force, both 16 and over, including resident armed forces; LF/Pop: Ratio of the number of persons in the total labor force to the total population, both age 16 and over, including armed forces; Pop: total population age 16 and over, including armed forces overseas.

Note: Details of the identity do not add up because of rounding and the use of disparate data sources.

Source: U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, and U.S. Bureau of the Census.

1970s when the baby boom generation swelled its ranks.

As discussed in greater detail below, it is extremely difficult to explain the slowdown in productivity growth and even more difficult to make a reliable estimate of how rapidly productivity will grow in the 1990s. In contrast, the growth of the population of 16 years or more is relatively easy to anticipate because the new entrants have already been born and mortality rates are fairly predictable. Hence differences among the various projections of the working-age population mainly reflect different assumptions about public policy with respect to legal and illegal immigration.

Population

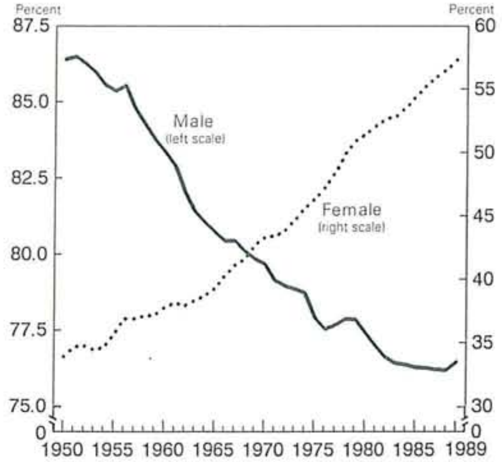
The dominant demographic event of the postwar period has, of course, been the "baby boom," commonly defined as those born from 1946 to 1964. This group swelled the ranks of the working-age population from 1962 to 1980, raising its growth rate from less than 1 percent in the early 1950s to nearly 2 percent throughout the 1970s. The "birth dearth" which followed the baby boom has produced a sharp deceleration in growth of the working-age population as well as the widely publicized scarcity of entry-level workers. This trend will start to reverse in the 1990s as the children of the baby boomers, the "echo," begin to enter the labor force. Nevertheless, even with this infusion of new workers, the proportion of young persons in the working-age population will be smaller at the end of the decade than it was at the beginning. Moreover, growth in the working-age population will average only 0.8 percent throughout the decade. In light of the importance of population growth to long-term economic growth, it is essential to stress that 0.8 percent growth will be the slowest rate of increase in any decade since the 1940s, far below the 1.9 percent rate experienced in the 1970s. For example, even if all the other components of economic growth listed in equation 1 were to grow at the same average rate as over the last twenty years, economic growth would average less than 2 percent in the 1990s, solely because of the slower growth of the working-age population.

Participation Rates

After remaining virtually constant in the 1950s and 1960s, the participation rate, the percentage of the working-age population who were employed or seeking employment, has been rising since about 1970. This increase is due entirely to females, as the participation rate of males has been declining steadily (Figure 1). Combined with the baby boomers' attaining working age, the rise in female participation has kept the labor force growing about one-third more rapidly than population over the last two decades (Figure 2).

Figure 1

Labor Force Participation Rates of Males and Females Age 16 and Over



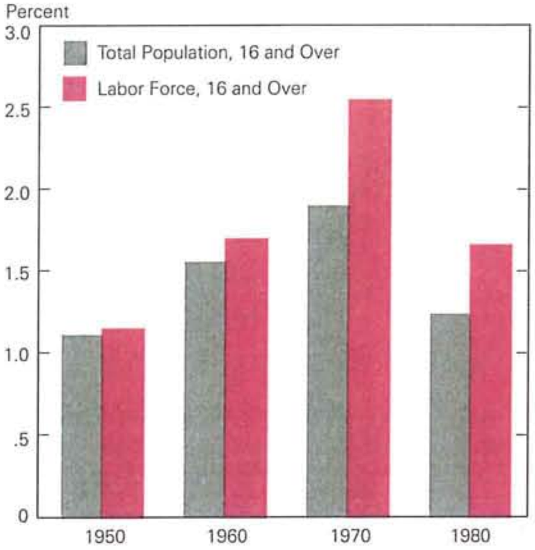
Source: U.S. Bureau of Labor Statistics.

Even though the female participation rate may appear to be increasing at an increasing rate, the rise in female participation rates seems likely to slow in the 1990s. First, a participation rate obviously cannot exceed some number less than 100 percent! More seriously, the total participation rate for females has been boosted by an increase in the proportion of females in the high participation age cohorts, as the baby boomers became prime age workers. Within the younger age cohorts, female participation rates have already started to level off. Moreover, in these age groups, the female participation rate now stands near to that of males. Traditionally, childbearing and disproportionate child care responsibilities of females have kept their labor force participation rates below those of males in the same age cohorts.

Although male participation rates in all age co-

Figure 2

Labor Force and Population Growth Rates



Source: U.S. Bureau of the Census and U.S. Bureau of Labor Statistics.

horts have declined, the sharpest drops have been in the early retirement (55 to 64) and "normal" retirement (65 and over) age groups. The labor force participation of early retirement workers, those between 55 and 64, has been the subject of intensive research. (See Munnell 1991.) The early retirement decision is an extremely complex one, reflecting the interests and expectations of both workers and employers as well as the interactions among Social Security, private pensions, and personal savings for retirement.

To the extent that the trend to "early retirement" reflects workers' preferences to enjoy more leisure as their financial resources increase, that trend seems likely to continue as economic resources increase. However, part of the historical decline in participation reflects the increasing generosity of both public and private pensions. It seems highly unlikely that Social Security benefits will grow as rapidly in the near future as they did in the past. Moreover, it also seems unlikely that employers will be as eager to encourage early retirement as much in the future as they did when the baby boom was offering a ready supply of new workers. In contrast, the population slowdown may actually encourage employers to offer premiums in order to retain their older workers. These tendencies will be reinforced by increases in life expectancy, which increase the need to accumulate savings for retirement. Even though the exact mechanism and magnitude are subject to great uncertainty, it seems likely that the trend toward early retirement will slow as the generosity of both public and private pensions relative to the rewards from continuing employment rises more slowly than it has in the past.

Table 2 compares changes in participation rates over the past twelve years with the changes the U.S. Bureau of Labor Statistics (BLS) projects will occur over the next twelve years. Generally speaking, the predictions are consistent with the trends just described—smaller increases in female participation rates and smaller declines (or even increases) in the participation rates of males. The only exceptions to these general trends are the larger increases in participation rates of females aged 16 to 19 and 55 to 64. The latter increase can be rationalized on the basis of the reduced incentives to retire that also motivate the projected increase in the participation rates of older males. The projected acceleration of the increase in the female teenagers' participation rates is more puzzling. After years of decreasing, the differential between participation rates of male and female teenagers has nearly disappeared (Figure 3). To the extent that the decrease in the differential represents the elimination of sex discrimination or the establishment of identical preferences toward employment, this source of the increase in female participation may now be nearly exhausted. Recently participation rates for teenage females have grown more slowly; their

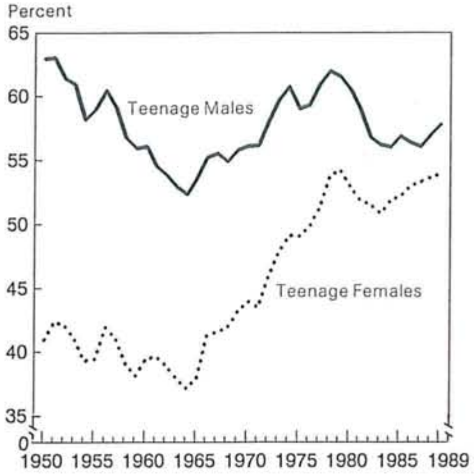
Table 2
Changes in Labor Force Participation Rates
Percentage Points

	Male		Female	
Age	Actual 1976–88	B.L.S. Projected 1988–2000	Actual 1976–88	B.L.S. Projected 1988–2000
Total	−1.3	−.3	9.3	6.0
16–19	−2.4	2.1	3.8	6.0
20–24	−.1	1.5	7.7	5.2
25–34	−.9	−.2	15.4	9.7
35–44	−.9	−.2	17.4	9.7
45–54	−.7	−.4	14.0	7.5
55–64	−7.3	1.1	2.5	5.5
65+	−3.7	−1.8	−.3	−.3

Source: Fullerton 1989, Table 4, p. 8.

Figure 3

Participation Rates of Male and Female Teenagers (Ages 16-19)



Source: U.S. Bureau of Labor Statistics.

1989 rate was no higher than their 1979 rate. It seems quite possible that their participation rate, like those of other female cohorts under age 55, will increase more slowly in the future than it has in the past, not more rapidly as BLS projections indicate.

A second puzzle in the BLS projection is the magnitude of the increase in the participation rate of males between ages 20 and 24. As shown in Figure 4, more than 87 percent of this group participated in the civilian labor force in the 1950s and early 1960s. The proportion fell sharply in the mid 1960s, but rebounded somewhat in the 1970s and 1980s, averaging about 85 percent. The BLS projects that in the 1990s the participation rate for this age-sex cohort will revert to its highest level since the early 1960s. The equation appearing on Figure 4 suggests that, even after taking account of changes in the size of the armed forces and the unemployment rate, the participation rate of males 20 to 24 has exhibited a downward trend. This result appears for both levels and changes and whether the equation is fit to the past 10, 20, 30, or 40 years. Like the projected participation rate of female teenagers, the BLS projection of the participation of 20- to 24-year-old males seems more likely to be too high than too low.

Figure 4

Labor Force Participation Rate of Males Aged 20 to 24, from 1950 to 1989, and the BLS Projected Rate for 2000

PRM2024 = 17.25 + 0.86 PRM2024(-1) - 0.24 AF% - 0.16 UR - .07t

Δ PRM2024 = 5.72 - 0.24 AF% - 0.20 UR - 0.05t

Note: Projection taken from the U.S. Bureau of Labor Statistics, 1990, Table A-1, p. 106.
Source: U.S. Bureau of Labor Statistics and author's calculations.

To get some idea of the importance of these uncertainties, one can calculate how the BLS projections would change under the assumptions that (1) the participation rate of female teenagers will rise as much in the 1990s as it did in the 1980s and (2) the participation rate of males aged 20 to 24 will remain unchanged. Under these assumptions the labor force would grow only 2¼ percentage points less than under the BLS projections, so that the (rounded) annual rate of growth of the labor force would remain unchanged. This calculation and experiments with more extreme assumptions suggest that the BLS participation rate projections, while subject to some uncertainties, are fairly robust with regard to reasonable projections of changes in participation rates over the rest of this century.

Hours

Aggregate data on average hours each employee works are not highly reliable. The available data, as given in Table 1, show a secular decline of about −0.3 percent per year in average hours as well as an inverse correlation with the unemployment rate. Although some indications can be seen that the decline in hours has leveled off in the 1980s, it may be safer to assume the downtrend will continue, perhaps at a slower rate.

Productivity

The average rate of growth of labor productivity is, as we have seen, a major component of long-term economic growth and the dominant determinant of per capita output or "the standard of living." Measured labor productivity growth is extremely volatile. It is highly cyclical and subject to measurement errors. This greatly limits our ability to understand secular changes in productivity, let alone predict them.

Conceptually, the productivity of labor depends in the long run on the quantity and quality of the other productive inputs (capital) and the state of technical knowledge about how inputs can be most effectively combined into outputs. Most economists believe that these factors change gradually over time, apart from cyclical variations, so "that productivity growth is not readily responsive to attempts to change its magnitude, and that nontransient changes may only come about rather slowly." (Baumol, Blackman and Wolff 1989, p. 14.) If this view is correct, it would seem to follow that the trend rate of productivity growth in the near future will resemble its growth in the past. Based on this line of reasoning, one should not expect labor productivity in the 1990s to differ much from the 1.2 percent annual rate over

Table 3
Okun's Law with and without Demographic Modifications

	Dependent Variable: Δ UR									
Time Period	C	Q%	$\dot{Q}$	$\dot{Q}_{-1}$	$\dot{Q}_{-2}$	$\dot{Pop}$	ΔTeen	$\bar{R}^2$	S.E.R.	D.W.
1. 1947:II to 1960:IV	.30 (*)	−.30 (*)						*	*	*
2. 1948:II to 1990:III	.25 (.03)	−.30 (.02)						.53	.31	1.60
3. 1955:II to 1990:III	.22 (.08)		−.06 (.01)	−.04 (.01)	−.02 (.01)	.09 (.05)	.58 (.29)	.69	.22	1.83
4. 1955 to 1989	1.29 (.13)		−.42 (.03)					.81	.47	1.94
5. 1955 to 1989	.88 (.35)		−.43 (.03)	−.06 (.03)		.41 (.21)	.70 (.30)	.85	.41	2.65
6. 1955 to 1983	.81 (.45)		−.43 (.04)	−.07 (.03)		.49 (.29)	.85 (.38)	.84	.43	2.67
	Dependent Variable: Log ER									
	C	Log Q	Log (Q/Pop)	Log Teen	t			$\bar{R}^2$	S.E.R.	D.W.
7. 1955 to 1989	2.683 (.320)	.270 (.046)			−.009 (.001)			.64	.01	.43
8. 1955 to 1989	3.872 (.088)		.287 (.036)		−.0048 (.0005)			.75	.008	.54
9. 1955 to 1989	3.683 (.040)		.431 (.019)	−.073 (.006)	−.0068 (.0003)			.96	.0035	1.73

Notes: * Equation was taken directly from the original text, in which these statistics were not reported. The figures in parentheses are the standard errors of the coefficients.

ΔUR is the change in the civilian unemployment rate; Q% is the percentage change in real GNP; $\dot{Q}$ is the percent change in real GNP at an annual rate; $\dot{Q}_{-i}$ is a i period lag in $\dot{Q}$; $\dot{Pop}$ is the percent change in the working-age population at an annual rate; ΔTeen is the change in the percentage of teenagers in the working-age population; S.E.R. is the standard error of the regression; D.W. is the Durbin-Watson statistic.

Log ER is the log of the civilian employment rate; log Q is the log of real GNP; log (Q/Pop) is the log of the ratio of real GNP to the working-age population, or real GNP per capita; log Teen is the log of the number of teenagers in the working-age population; t is a linear time trend.

Source: U.S. Bureau of Economic Analysis, U.S. Bureau of the Census, author's calculations, and Okun, 1962, p. 135.

the past twenty years. An optimist could appeal to Baumol, Blackman and Wolff's estimate (p. 2) that average labor productivity growth has been a bit more than 1½ percent per year since the beginning of the nineteenth century.

II. *A Modified Okun's Law*

Arthur Okun (1962, p. 132) raised the question, "How much output can the economy produce under conditions of full employment?" nearly thirty years ago. His "simple and direct" answer to the question now appears clearly inadequate. Simple, direct answers are seldom complete and true. Nevertheless, this article will argue that a minor modification of Okun's original approach can both account for historical experience and retain its simplicity. A direct though incomplete approach, like Okun's original insight, can often yield as valuable insights as a more complex, complete approach.

Okun used three different methods to address the question: one based on changes in output, one based on output levels and an assumed trend of output growth, and a third based on output levels without assuming a trend. The first, based on changes, simply regressed changes in the unemployment rate (UR) on percentage changes in real GNP (Q%). Okun's original result is reported in line 1 of Table 3; the second line reports the original version updated to the present.

According to the updated estimate, the unemployment rate will rise by 0.25 percentage point, rather than Okun's original estimate of 0.3 point, from one quarter to the next if real GNP is unchanged. The implicit secular gains in productivity and the labor force (and hence "potential GNP") are smaller over the longer period than they were in the 1950s. Nevertheless, like Okun's original equation, the updated equation also implies that each additional 1 percent (not at an annual rate) of real GNP would reduce unemployment by 0.3 percentage point, or "at any point in time, taking previous quarters as given, 1 percentage point more in the unemployment rate means 3.3 percent less [real] GNP." (Okun 1962, p. 136.)

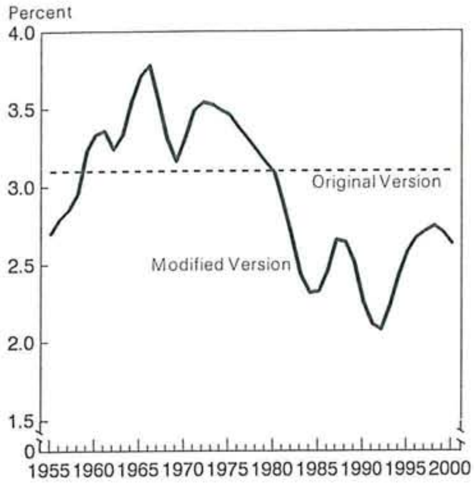
Okun's bivariate relationship between output and unemployment is clearly oversimplified. Faster growth in the working-age population, as when the baby boom entered the labor force, implies more unemployment for any given output. In addition, young workers typically experience relatively high rates of unemployment due to shifts into and out of school and relatively frequent shifts from their first employer or occupation. Historical changes in the growth of the population 16 and over and in the percentage of teenagers in the working-age population have been substantial. Finally, the simultaneous relationship does not allow employment to adjust gradually to changes in output due, for example, to the costs of hiring and firing or "labor hoarding."

Some quantitative concept of full capacity is required to produce a long-term plan for both monetary and fiscal policy.

Line 3 in the table shows a modified Okun's law that allows for lags and demographic factors. Lines 4 and 5 show the original and modified versions of Okun's Law fit to annual data. Equation 6, which first appeared in McNees (1984, p. 21), shows that the equation's coefficients have held fairly stable and are not simply picking up the unemployment-output relationship in the late 1980s that puzzled analysts who ignored demographic changes. Under the assumption that the unemployment rate will not change when the economy grows at its potential rate, this equation gives an estimate of the rate of growth of potential GNP. Specifically, the equation can be solved for a rate of real GNP growth that holds the unemployment rate unchanged. Unlike the original version which yields a constant rate of growth of potential GNP, the potential growth rate depends on the growth and composition of the working-age population. Figure 5 compares this estimate of the potential growth rate with the constant growth rate, 3.1 percent, implied by Okun's original formulation. The differences between the two highlight the role played by demographic factors. The modified equation implies a higher growth of potential GNP when population growth is rapid and when the proportion of teenagers is rising—the rise in teenagers by itself tends to raise the unemployment rate so that somewhat faster real growth is required to stabilize the rate. Both of these factors were at play in the 1960s to the mid 1970s when the baby boom entered the labor force. Since that time, population growth has slowed and the proportion of teenagers has fallen, lowering

Figure 5

Potential GNP Growth



Note: The solid line is a potential GNP estimate with demographic modifications and is represented as a three-year moving average. The dotted line is a constant potential GNP growth estimate, which is implied by using Okun's original formulation, without demographic adjustments.
Source: Author's calculations and Okun, 1962.

estimated potential growth to only about 2 percent in 1990–91. The entry of the "echo" group, the children of the baby boom, along with a slight increase in population growth, is projected to increase the potential growth rate to 2½ percent by the mid 1990s.

Okun also estimated potential GNP with a model based on levels of output and unemployment. His model assumed "a constant elasticity in the relevant range" between the ratio of actual (Q) to potential output (Q^*) and the employment rate ER (= 100 − UR), or

$$(ER/ER^*) = (Q/Q^*)^a.$$

The model also assumed that potential output grows at a constant rate (r) so that starting from Q_o^* at any time (t),

$$Q_t^* = Q_o^* e^{rt}.$$

Solved for ER_t, these equations imply:

$$\log ER_t = \log (ER^*/Q_o^{*a}) + a \log Q_t - art.$$

Line 7 in Table 3 shows this second version of Okun's Law fit to annual data. The coefficient of log Q, .27, is the estimated "output elasticity of the employment rate" (which compares to Okun's original estimate of from .35 to .40), the potential growth rate is 3.3 (= .009/.270) percent, and the intercept yields an estimate of the level of Q_o^* for any assumed ER^*.

Modifying this original formulation to allow the potential growth rate to vary with the growth of the working-age population, the equation above becomes

$$Q_t^* = Q_o^* \text{ Pop } e^{rt}$$

where r is the assumed constant growth rate of output per member of the working-age population. Thus, the estimated equation becomes

$$\log ER = \log (ER^*/Q_o^{a*}) + a \log (Q/Pop) - art.$$

Line 8 in Table 3 gives the results of Okun's Law modified to allow for changes in the working-age population.

The estimated output elasticity of the employment rate remains at .29 and the constant rate of growth of potential output per working population is 1.7 (= .0048/.287).

If further allowance is made for differences between teenagers and experienced workers, the equation becomes

$$Q_t^* = Q_o^* \text{ Teen}^b \text{ Pop } e^{rt}.$$

Thus, r becomes the assumed constant rate of growth of potential output per working-age population *adjusted* for its teenage composition, so that

$$\log ER = \log (ER^*/Q_o^{*a}) + a \log (Q/Pop)$$
$$- ab \log Teen - art.$$

Line 9 in the table presents Okun's Law modified for both population growth and the composition of the working-age population. The coefficient of log (Q/Pop), .43, becomes the output elasticity of the employment rate adjusted for its age composition, 1.6 is the rate of growth of potential output per adjusted population, and .17 is the estimated adjustment factor for teenagers' role in the labor force.

The demographic modifications of the original specification change the results in several ways: (1) the fit is improved—the standard error of the regression drops from .0100 to .0035; (2) serial correlation is virtually eliminated—the Durbin Watson statistic

Table 4
Stability Tests of Modified Okun's Law

First Period	Constant	a	r	b
1955–89	3.68	.43	1.6	.17
	(2.68)	(.27)	(3.3)	(n.a.)
1955–71	3.74	.41	1.5	.19
	(2.15)	(.35)	(3.5)	(n.a.)
1972–89	3.35	.47	1.1	.002
	(.68)	(.54)	(2.6)	(n.a.)

a = elasticity of the ratio of actual to potential output with respect to the ratio of the actual to the potential employment rate.
r = rate of growth of potential output per member of the working-age population (or constant rate of growth of potential output in original model).
b = exponent of teenagers as a percent of working-age population.
Estimates based on original model appear in parentheses, (n.a.) = not available.

rises from .43 to 1.73; and most importantly, (3) the estimated coefficients are more stable. Table 4 gives the estimated coefficients for the entire sample period 1955–89 and its first and second halves separately.

The estimated elasticity between the ratio of actual to potential output and the employment rate (a) is fairly stable in the modified model, as the model assumed; the estimated growth rate of potential output per member of the working-age population (r) is somewhat more stable than the estimated rate of growth of potential output in the original equation. Unfortunately, the estimated adjustment for teenagers is not stable across periods.

Okun's third method was to regress the level of the unemployment rate on alternative estimates of the percentage gap between potential and actual real GNP,

$$U = a + b\ GAP = a + b\ [((Q^* - Q)/Q^*) \cdot 100].$$

Unlike the two versions of Okun's Law already described, this version requires an estimate of not just the potential growth rate but also the level of potential GNP. To implement it, one must assume a "full" employment or "natural" unemployment rate or, equivalently, select some base year in which actual output is assumed to have been equal to potential.

Much of the skepticism regarding measures of potential GNP stems from Okun's choice of a 4 percent unemployment rate as "the target rate of labor utilization." Okun acknowledged that this particular rate had little analytical or empirical justification and subsequent experience certainly confirms his caution on this score. Measuring the concept of "full capacity," "full" employment, or the "natural" unemployment rate remains one of the most contentious and controversial issues in empirical macroeconomics. Its resolution depends on a more complete model of the inflation process, a task beyond the scope of this article.

Nevertheless, some concept of capacity is implicit in most economic reasoning. Rather than abandon the attempt to measure that concept, it seems preferable to adopt a measurement strategy that highlights the imprecision of the estimate. While a precise estimate of full capacity is difficult, a reasonable estimate of the *range* of possibilities is not. (And although reasonable estimates may change and have changed over decades, they seem unlikely to change very rapidly.)

For example, as shown in Figure 6, labor compensation growth declined steadily from the early 1980s to 1987, a period when the unemployment rate remained consistently above 6 percent, and then rose fairly steadily from 1987 to mid 1990, a period when

Figure 6

Unemployment Rate and Labor Compensation Growth

Note: The unemployment rate is the percent of all civilian workers unemployed and labor compensation growth is the percent change from a year earlier in the employment cost index for compensation of all civilian nonfarm workers.
Source: U.S. Bureau of Labor Statistics

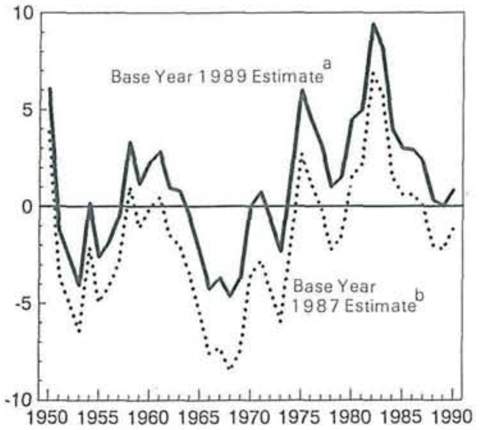
the unemployment rate remained near 5¼ percent. Even acknowledging that this simple bivariate relationship omits some relevant information (such as trend productivity growth) and could disguise complex leads and lags, it would seem difficult to argue that the economy could have operated at much less than 5¼ percent unemployment without increasing inflationary pressure or to describe an economy with much more than 6 percent unemployment as producing beyond its full capacity.

Figure 7 presents estimates of the historical gap between actual and potential GNP based on the potential group rate implied by equation 5 on Table 3 and two alternative assumptions about the level of potential GNP—that the economy operated at full capacity in 1987 (when the unemployment rate averaged 6.2 percent) or in 1989 (when it averaged 5.3 percent). The assumption that actual and potential GNP were equal in 1989 produces a higher correlation with the unemployment rate than the assumption that they were equal in 1987. Its standard error is about one-third smaller, whether the equation is fit to the past thirty-five years or the past fifteen years.

Ideally, we would like to be able to measure and predict changes in the natural rate of unemployment. Unfortunately, as Milton Friedman stressed when he introduced the concept, the natural rate is inherently difficult to measure. Without a reliable measure, the most we can do is assume that changes will be gradual and be mindful that changes can occur over long periods of time.

Figure 7

Gap between Actual and Potential GNP



[a]Assumes the economy operated at full capacity in 1989 when the unemployment rate averaged 5.3%.
[b]Assumes the economy operated at full capacity in 1987 when the unemployment rate averaged 6.2%.

Source: Author's calculations.

III. Alternative Estimates of Potential Growth

This paper started with a simple accounting identity, describing the components of long-term growth, and developed a simple approach relating output to labor. It thus implicitly assumes that labor is a suitable proxy for all productive inputs. Clearly, aggregate output is more completely described by a production function that relates output to the quantity and quality of *all* productive inputs. Practically, economists have not reached a consensus on the mathematical form of the aggregate production function, or on how to measure the quantity, let alone the quality of productive inputs. When productivity, which cannot be directly observed, is measured as a residual, or "a measure of our ignorance," a production function approach loses its virtue as a technological "law" and becomes yet another accounting identity. While a production function approach provides a more complete, balanced accounting of the sources of historical growth, it is much less useful in a forecasting context. In contrast to the modified Okun's Law approach developed here, which requires only projections of population and its composition, a production function approach is conditional on projections of all inputs to production as well as their "productivity" residual. Thus, while the production function approach is more complete than the simple, direct Okun approach, it does not necessarily provide a more reliable estimate. The Appendix contrasts the estimate of potential output developed here with an estimate developed with a more complex, indirect approach.

IV. Summary and Conclusion

Quarterly and even annual movements in economic activity are dominated by the phase of the business cycle. For many purposes, it is useful to have a measure of economic activity that abstracts from the cycle. A generation ago, Arthur Okun provided a simple, direct method to estimate "potential GNP." Because Okun's method is incomplete and because his estimates were based on what now appears to be an unreasonable definition of "full capacity," his approach has fallen into disuse. It is as if we had decided that since we cannot measure full capacity precisely, we will ignore it. This decision is unfortunate because all economic analysis involves the concept of productive capacity.

The argument advanced here is that Okun's simple, direct approach can be modified easily to take account of important changes that have occurred since he wrote. Specifically, the simple bivariate relationship between output and unemployment needs to take account of the large demographic swings associated with the advent of the baby boom. Population growth is an indisputable element of economic growth. Moreover, unemployment is influenced by the composition of the working-age population. Teenagers, in particular, experience distinctly more unemployment than more experienced workers. Such compositional changes also affect the output-unemployment relationship.

A minor modification of Okun's original approach can both account for historical experience and retain its simplicity.

Concretely, once these demographic changes are taken into account, one can estimate how the potential growth rate varies over time. The estimates developed here suggest potential GNP, defined as the growth rate that would hold unemployment unchanged, grew nearly 4 percent in the mid 1960s when population was growing rapidly and the rising share of teenage workers was putting upward pressure on the unemployment rate. Recently, with population growth slowing and the proportion of teenagers declining, estimated potential growth has fallen to about 2 percent. This approach explains how the unemployment rate stabilized from 1988 to mid 1990, during a period of "sluggish" real growth. By the mid 1990s, a partial reversal of these factors will generate a 2½ to 2¾ percent potential growth rate.

A full explanation of potential output would ascribe an important role to capital formation and technical change. Until these factors are incorporated into the estimates of potential output, they remain tentative and imprecise. Our ability to measure and anticipate demographic changes, at least over the next sixteen years, vastly exceeds our understanding of productivity growth and the role of capital formation. For this reason, attempts to project potential GNP inevitably must rely disproportionately on the relatively more reliable information. For example, it is already clear that the next major issue will be the early retirement and retirement behavior of the baby boom generation. This will be a critical element in potential growth in the twenty-first century. (For an intriguing start, see Cutler et al. 1990.)

Appendix: An Alternative Approach to Estimating Potential GNP

by Kim Gilbo

Many published estimates of potential GNP are based on extrapolations or simple versions of Okun's Law (Holloway 1989; Clark 1983). A more complete, though more complex method for estimating potential GNP is the aggregate production function approach. This approach will be illustrated by describing the procedures used by Data Resources, Inc. (DRI) to estimate and project potential output.

The DRI equation assumes that potential output depends on three productive inputs—labor, capital, and energy. The equation assumes constant returns to scale and estimates the weights, or output elasticities, of the inputs by their shares in total costs (.62 for labor, .33 for capital, and .05 for energy).

All inputs are measured at their "full employment" utilization level. The labor force also depends on the size and composition of the population, the wage rate, and the unemployment rate. Capital inputs depend on the capacity utilization rate in the manufacturing sector, and energy inputs include demand in all sectors of the economy. DRI also stresses the role of research and development (R & D) spending and technological change.

Economic growth clearly does depend on all these as well as several other factors (for example, the educational attainment and experience of the labor force and the stock of public capital). However, aggregate production functions in general present a number of empirical problems.

Productivity cannot be observed directly; it must be inferred from the residual of the DRI equation. This reduces the aggregate production function approach to a residual similar to the accounting identity employed in this article. Also, while the concept of a production function is a cornerstone of microeconomic theory, aggregate production in general, and an aggregate capital stock in particular, are much more difficult to measure. Further, while the future course of technical change will be an important factor in determining potential GNP growth, it is not apparent that its past behavior can be represented by a time trend and even more unclear how its future can be measured by an extrapolation of its past trend. Also, some recent research (Romer 1986) suggests the possibility of increasing returns to scale.

All of the above criticisms are not peculiar to the DRI equation, but can be applied to the whole aggregate production function approach, illustrating further how difficult it is to explain the economic growth process.

Nevertheless, the production function approach yields estimates similar to those of the modified Okun's law developed in this article.

Decade	DRI	Modified Okun
1960s	3.3	3.5
1970s	3.3	3.3
1980s	2.5	2.4
1990s	2.3	2.5

Assuming no change in the capacity of the economy (with an average capacity utilization rate of 81.3 percent and an unemployment rate of 5.9 percent), DRI predicts the largest decline in potential growth will be in the near future, with a recovery as we approach the year 2000.

The explanation for this decreased growth comes from DRI's projections of labor and capital. Labor force growth will decline as a result of the smaller number of births over the last two decades. This will result in two factors that will actually help to offset this decline by increasing labor productivity: a rising average age, which will foster a higher level of experience, and a rising capital-labor ratio. DRI projects that, in combination with positive incentives from fiscal and monetary policy changes, shorter-lived capital investments will result in annual increases in the capital stock of 3.5 percent between 1989 and 2005. Overall, the shrinking of the labor force should hinder potential GNP growth only in the near future.

DRI's equation still cannot account exactly for all aspects of the capacity of the economy, and in making projections, DRI must project not only the labor force but the future capital stock, energy demand, research and development expenditures, and technological change, all of which may be more difficult to assess in the longer term. DRI's equation, like the direct, Okun approach, has some limitations based on the assumptions made, but it has come one step closer to a "complete," indirect estimate of potential GNP.

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