The Trend Growth Rate of Employment: Past, Present, and Future

By Todd E. Clark and Taisuke Nakata

Over the course of the recovery from the 2001 recession, many forecasters have revised downward their expectations for job growth in the United States. The often disappointing pace of employment growth has been attributed to various forces, such as the high health-care costs faced by employers, structural changes causing some industries to decline, outsourcing of jobs from the United States to other countries, and strong productivity growth.[1] Many of these explanations imply the sluggish pace of job gains to be the result of weakness in aggregate demand and labor demand. However, some observers have suggested that broad demographic changes affecting labor supply—such as the aging of the population—could account for part of the sluggishness of job growth.

The labor supply explanation of disappointing job growth implies that forecasters' usual rule of thumb for benchmark, or trend, job growth may now be too optimistic. The benchmark is an estimate of the number of jobs the economy must add per month to absorb typical increases in labor supply due to population growth and trend changes in labor force participation. Thus, the benchmark corresponds to an estimate of trend or sustainable employment growth. Common rule-of-thumb estimates put

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the trend rate of increase at 150,000 jobs per month. But if demographic changes have slowed the growth of labor supply, the trend rate of job growth may have fallen below the historical benchmark.

A change in trend would have important implications for fiscal and monetary policy. For fiscal policy, slower trend growth in employment will tend to result in slower long-term growth in tax revenues, with potentially important effects on government programs such as Social Security. For monetary policy, assessments of the state of labor markets and the overall economy compared to sustainable trends often figure prominently in monetary policy decisions. If trend job growth were to slow, actual growth in jobs that appears weak by historical standards could exceed the new trend rate. The course of monetary policy could differ substantially if job growth were correctly realized to be above trend rather than incorrectly assessed to be at or below trend. Therefore, accurate assessments of potentially changing trends are important to effective monetary policy.

This article examines employment and labor force indicators for evidence of a slowing of trend employment growth in the United States. The first section of the article analyzes historical movements in employment, population, and labor force participation for evidence of changes in trend growth rates. The second section combines information from available forecasts of population, labor force participation, and other indicators to project the trend rate of employment growth over the next ten years. The article concludes that declines in the growth rates of population and labor force participation have caused the trend growth rate of employment to slow. Over the next ten years, a reasonable baseline projection for trend job growth is 1.1 percent per year, or about 120,000 jobs per month.

I. HISTORICAL EVIDENCE OF CHANGES IN TREND GROWTH

To assess demographics-related changes in employment trends, economists often rely on an identity relating employment to population, the labor force participation rate, and the unemployment rate.[2] The identity allows changes in employment growth to be decomposed into contributions from growth in population, labor force participation,

and unemployment. Long-term demographic shifts can lead to significant changes in the trend growth rates of each of these three variables and, in turn, employment. Such demographic shifts primarily affect employment through their impact on labor supply. However, long-term changes in demand-side factors could also affect the trend growth rate of employment through, for example, labor force participation and unemployment rates.

Over the course of this article, trends will be measured in various ways, all intended to reflect the same concept. In general, trend growth corresponds to long-term growth—the component of growth not due to the business cycle or temporary disturbances. Accordingly, one common approach is to compute the trend as average growth over a long period of time. Another common estimation approach is to use statistical techniques that attempt to separate trend from cyclical movements. These first two approaches are commonly used in historical analysis.

Another way to remove the influence of the business cycle is to estimate trend growth from the so-called full employment levels of employment, population, labor force participation, and the employment rate. Full employment is the conceptual, but not directly observed, level of employment that would prevail if the economy were expanding at its sustainable, trend rate, with the unemployment rate at its sustainable or natural level and steady inflation.[3] Using full employment levels removes the influence of the business cycle on employment and the other variables of interest. Thus, growth rates based on full employment levels correspond to trend growth rates. The approach of estimating trends based on full employment levels is especially useful for projecting future trends, as the second section of the article does.

Using some of these different approaches to estimating trend growth, this section first examines historical employment data for evidence of changes in trend growth. Then, after explaining the identity relating employment to population, labor force participation, and the unemployment rate, the section assesses potential sources of the changes.

Changes in trend employment growth

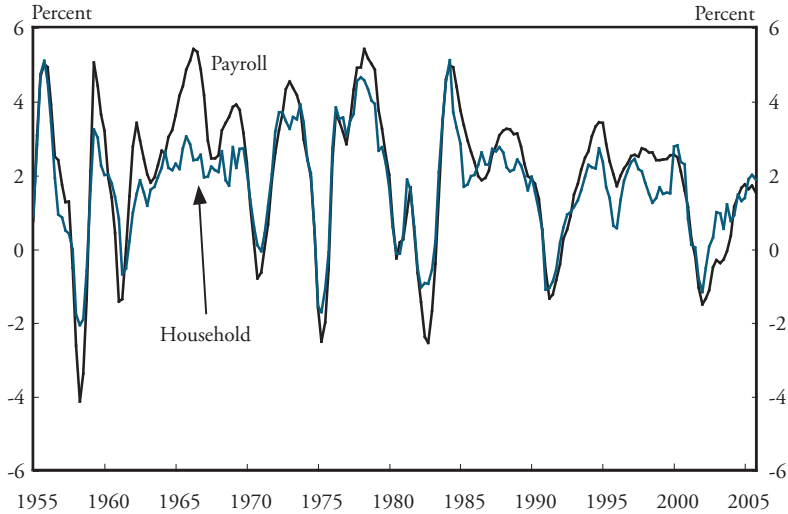
Simple charts of employment growth suggest the trend rate may have slowed sometime in the early to mid-1980s (Chart 1). Employment appears to have grown at a slower rate during the past 20 or so years than in the prior 30 years.[4] Both of the available measures of aggregate employment, the so-called payroll measure based on a survey of employers and the measure based on a survey of households, share this pattern.[5] According to the payroll measure, employment grew an average of 1.6 percent per year 1985-2005, down from 2.2 percent per year 1955-84. Average growth in the household measure of employment slowed from 1.9 percent for 1955-84 to 1.4 percent for 1985-2005. The average growth rates of the past 20 years correspond to current payroll employment gains of about 180,000 per month and household employment gains of about 169,000 per month.

Although useful as basic indicators, average growth rates for 1955-84 and 1985-2005 could yield estimates of trends that are influenced by the business cycle.[6] Employment growth generally rises during expansions and slows during recessions. Thus, differences in business cycle conditions across the years of 1955, 1984, 1985, and 2005 could affect the trend estimates. For example, in 1955 the economy was only two years from a recession, but in 1985, the economy was still six years from a recession. Differences in business cycle positions in 1955 and 1985 could impact trend estimates based on average growth rates for 1955-84 and 1985-2004.

One simple approach to insulating trend estimates from business cycle influences is to define trends as growth rates from one business cycle peak to another (Kahn). By ensuring similar economic conditions at the beginning and end of each of the trend periods, growth rates based solely on peak periods put trend estimates on an apples-to-apples basis. In light of the simple evidence of a potential trend shift in the early to mid-1980s, a natural comparison is the growth of employment from the NBER-defined business cycle peak of 1957:Q3 to the peak of 1981:Q3 against growth from the 1981:Q3 peak to the 2001:Q1 peak or to 2005:Q4.[7] Compared to the peak-to-peak estimate for 1981-2001, a trend estimate based on the 1981-2005 period has the advantage of incorporating more recent data and, therefore, perhaps of

Chart 1

EMPLOYMENT GROWTH:
PAYROLL AND HOUSEHOLD MEASURES



Notes: Data are four-quarter rates of change.
Source: Bureau of Labor Statistics and authors' calculations

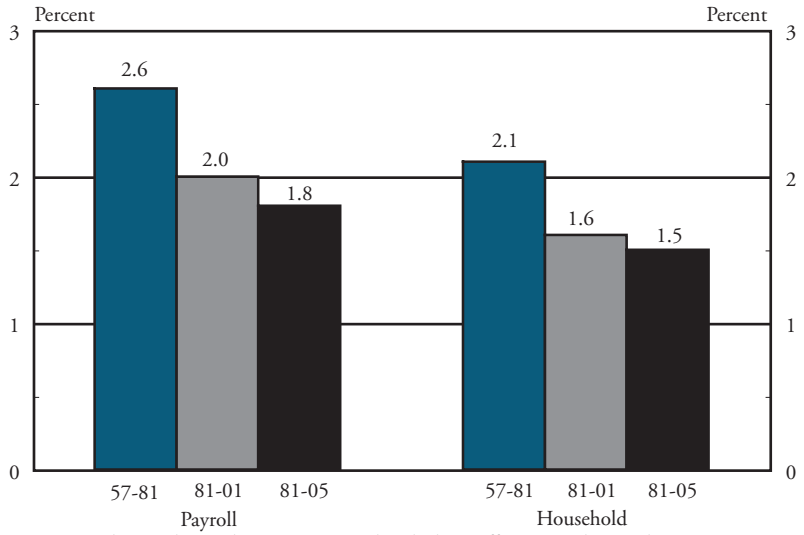
better reflecting current trends. But to the extent the economy today is far from its business cycle peak and may yet experience strong employment growth, the trend estimate for 1981-2005 may slightly understate the true trend growth rate.

Peak-to-peak growth rates of employment provide further evidence of a slowing of trend employment growth (Chart 2).[8] By these estimates, the trend growth rate of payroll employment slowed from 2.6 percent over 1957-81 to 2.0 percent over 1981-2001 and 1.8 percent over 1981-2005. The peak-to-peak growth rate of household employment fell from 2.1 percent for 1957-81 to 1.6 percent for 1981-2001 and 1.5 percent for 1981-2005.

Another approach to insulating trend growth estimates from the influences of the business cycle is to use statistical methods that separate trend and cycle components. One common method, developed by Hodrick and Prescott, allows the trend growth rate to vary gradually over time. This analysis follows Shimer (2005) in using the Hodrick

Chart 2

EMPLOYMENT TRENDS ESTIMATED FROM PEAK-TO-PEAK GROWTH RATES



Notes: The trend growth rate is estimated with the coefficient on the trend in a regression of the log of employment (multiplied by 400) on a constant and time trend. The sample ranges are based on NBER-determined peaks in the business cycle: 1957:Q3 to 1981:Q3, 1981:Q3 to 2001:Q1, and 1981:Q3 to 2005:Q4.

Sources: Bureau of Labor Statistics, NBER, and authors' calculations

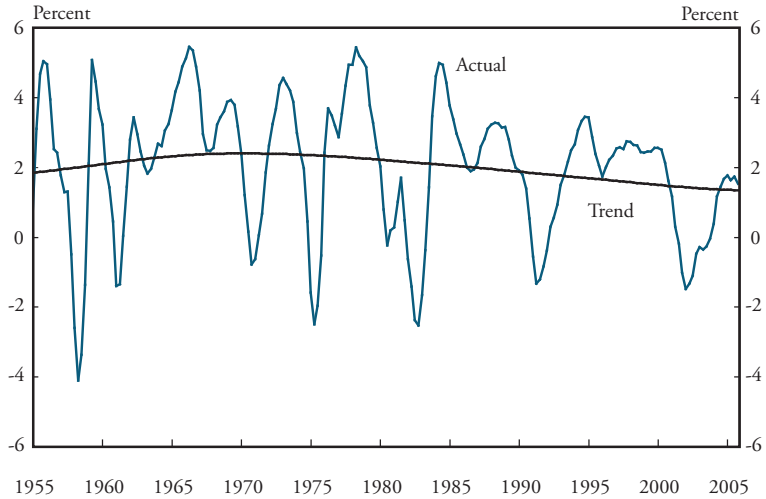
and Prescott approach, with a high degree of smoothing, to estimate labor market trends.[9] The resulting trend estimate corresponds to a smooth curve through the history of quarterly growth rates.

The statistical estimates of trend growth confirm a deceleration in the trend (Charts 3 and 4).[10] For both measures of employment, trend growth drifted up from 1955 through the early or mid-1970s and has since drifted down. Based on the statistical estimates for payrolls, trend growth was 1.8 percent in 1955, 2.3 percent in 1975, 2 percent in 1985, 1.6 percent in 1995, and 1.3 percent in 2005. The trend growth rate for household employment shows a similar pattern, declining from 2 percent in 1975 to 1.3 percent in 2005.

Put together, the alternative approaches to estimating trends all indicate the trend growth rate of employment has slowed. For example, all of the estimates indicate trend growth is lower in 2005 than it was in 1975.

Chart 3

TREND EMPLOYMENT GROWTH: PAYROLL

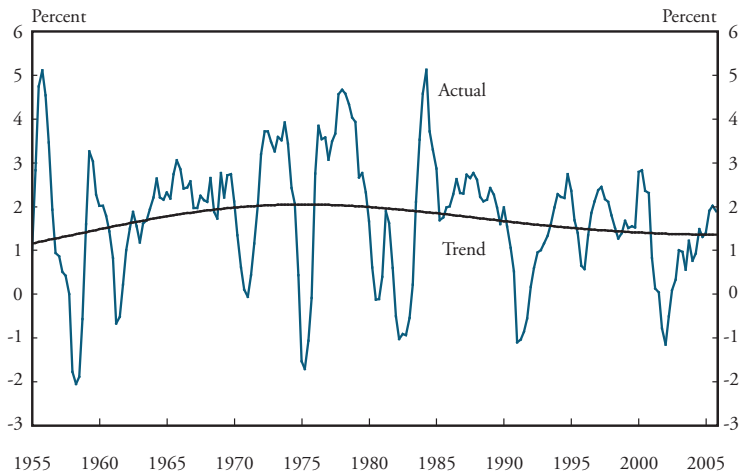


Notes: Actual growth rates are four-quarter rates of change. The trend is estimated with the Hodrick and Prescott filter, using a smoothing parameter of 800,000. The trend estimates are based on quarterly growth rates starting in 1948 and extended from 2006 through 2015 with forecasts formed from AR(4) models fit to 1984-2005 data.

Sources: Bureau of Labor Statistics and authors' calculations

Chart 4

TREND EMPLOYMENT GROWTH: HOUSEHOLD



Notes: Actual growth rates are four-quarter rates of change. The trend is estimated with the Hodrick and Prescott filter, using a smoothing parameter of 800,000. The trend estimates are based on quarterly growth rates starting in 1948 and extended from 2006 through 2015 with forecasts formed from AR(4) models fit to 1984-2005 data.

Sources: Bureau of Labor Statistics and authors' calculations

The employment identity

The sources of the slower trend growth of employment can be assessed with a simple identity that relates employment to population, the labor force participation rate, and the employment rate:

employment = population x labor force participation rate x employment rate.

In this identity, employment is defined as the household measure, because the other variables in the identity are measured from the household survey. The first determinant is the working-age (age 16 and above), civilian noninstitutional population. For simplicity, the remainder of the article uses just the term *population* to refer to the working-age population. The next determinant, the labor force participation rate, is the percentage of the population that is in the labor force, counted as either employed or unemployed in the household survey. Finally, the employment rate is the percentage of the labor force that is employed, which is just 1 minus the unemployment rate. An employment rate of 95 percent, for example, corresponds to an unemployment rate of 5 percent. The same basic identity also applies to payroll employment, but with an additional term reflecting the share of payroll employment in household employment. The broader household measure includes several groups, such as self-employed workers and farm workers, excluded from the payroll count.

The identity implies a similar relationship among the growth rates of employment, population, labor force participation, and the employment rate. The growth rate of household employment equals the sum of the growth rates of population, the labor force participation rate, and the employment rate. The growth rate of payroll employment equals the sum of the same components, plus the growth rate of the share of household employment accounted for by payroll employment. All other things equal, faster population growth implies faster employment growth. Similarly, larger increases in the labor force participation or employment rates imply faster employment growth.

Over long periods of time, the growth rates of population, labor force participation, and the employment rate determine the trend rate of increase in employment. Long-term changes in demographics

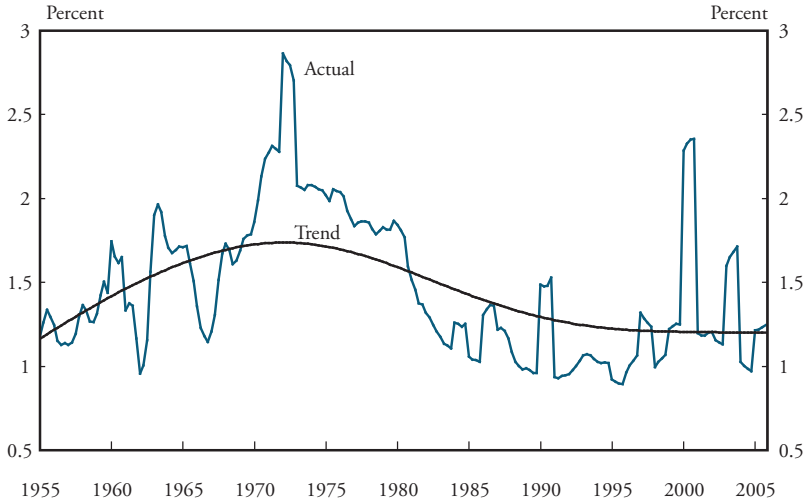
can significantly influence trends in each of these determinants and, in turn, employment. For example, a fall in the fertility rate will lower the population growth rate, making fewer adults available for the labor force. If more and more women opt to work outside the home, pushing the overall labor force participation rate higher, the labor force will grow more rapidly than the population. As a final example, a fall in the share of young workers in the population tends to raise the employment rate, because young workers have relatively weak attachments to the labor force and high unemployment rates (Shimer 1998). All other things equal, the associated rise in the employment rate boosts the pool of workers and, in turn, employment. To some degree, long-term changes in demand-related factors could also affect trends in variables such as the employment rate and, in turn, employment. For example, a shift toward temporary work that makes firms quicker to hire when demand picks up could lower the natural rate and, in turn, permanently boost the employment rate (Otoo).

What might account for the slowdown in trend employment growth?

Simple charts suggest the slower employment growth of the last 20 or so years can be attributed to a fall in population growth and less rapid increases in labor force participation (Charts 5 and 6). Like employment, the working-age population appears to have grown at a slower rate during the past 20 years than in the prior 30 years.[11] Population growth slowed from an average of 1.6 percent per year 1955-84 to 1.2 percent per year 1985-2005.[12] The labor force participation rate increased much less 1985-2005 (1.2 percentage points) than 1955-84 (5.1 percentage points). Average growth in the participation rate slowed from 0.3 percentage point in 1955-84 to 0.1 percentage point in 1985-2005. In contrast, across the 1955-84 and 1985-2005 periods, long-term movements in the employment rate appear to have slightly offset the downward pressures from population and labor force participation. A decline in the employment rate slowed average employment growth by 0.1 percentage point in 1955-84, but a rise in the employment rate raised employment growth 0.1 percentage point in 1985-2005.

Chart 5

POPULATION GROWTH: ACTUAL AND TREND

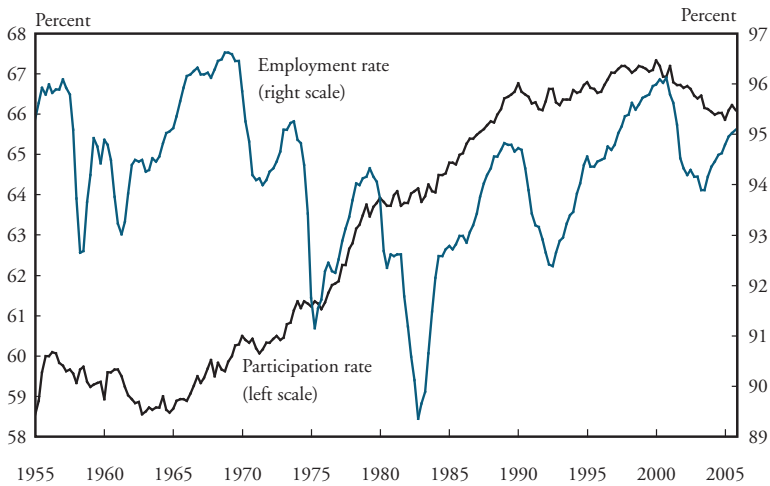


Notes: Actual growth rates are four-quarter rates of change. The trend is estimated with the Hodrick and Prescott filter, using a smoothing parameter of 800,000. The trend estimates are based on quarterly growth rates starting in 1948 and extended from 2006 through 2015 with forecasts formed from AR(4) models fit to 1984-2005 data.

Sources: Bureau of Labor Statistics and authors' calculations

Chart 6

LABOR FORCE PARTICIPATION AND EMPLOYMENT RATES



Notes: The employment rate is 1 less the unemployment rate. Data are quarterly averages of monthly figures.

Sources: Bureau of Labor Statistics and authors' calculations

But as is the case with employment, a simple comparison between average growth rates for 1955-84 and 1985-2005 could yield estimates of trend changes that are influenced by the business cycle. The business cycle has been widely shown to affect the unemployment rate, as changes in aggregate demand lead to changes in employment. The business cycle also affects labor force participation. For example, as recessions reduce the availability of jobs and slow growth in wages, some workers will leave the labor force. Some are so-called "discouraged" workers; others may be retirees or even prime-age workers with other sources of income.

In the case of population growth, however, the business cycle has relatively little effect. Estimated over the past 50 years, the correlation between GDP growth and population growth is nearly zero.[13] Despite the absence of a measurable impact on population, the business cycle likely has some impact on immigration, one of the components of population growth. Strong expansions in the United States that increase job opportunities and wages will tend to draw more immigrants (primarily illegal, because legal immigration is almost always near its allowed maximum). To this point, though, cyclical fluctuations in immigration have not been large enough to generate noticeable cyclical movements in population. In any event, statistical methods that attempt to separate the trend and cyclical components of population growth should accurately capture the trend.

The statistical estimates of trend growth rates confirm that a falloff in population growth and, to a lesser extent, a decline in the growth contribution of labor force participation account for the deceleration of employment. According to trend estimates based on business cycle peaks, population growth slowed from 1.8 percent for 1957-81 to 1.1 percent for 1981-2001 and 1.2 percent for 1981-2005 (Table 1). According to statistical estimates, trend growth in population drifted up from 1.2 percent in 1955 to 1.7 percent in 1975 and down to 1.2 percent in 2005 (Chart 5). Based on either approach to trend estimation, the decline in trend population growth accounts for most of the falloff in trend employment growth. For example, in the peak-to-peak estimates, trend population growth fell 0.6 percentage point from 1957-81 to 1981-2005, while trend growth in payrolls dropped 0.8 percentage point.

Table 1

PEAK-TO-PEAK ESTIMATES OF TREND GROWTH IN POPULATION, LABOR FORCE PARTICIPATION, AND THE EMPLOYMENT RATE

	1957-81	1981-2001	1981-2005
Population	1.8	1.1	1.2
Labor force participation	.3	.3	.2
Employment rate	-.1	.2	.2
Addenda			
Household employment	2.1	1.6	1.5
Payroll employment	2.6	2.0	1.8

Notes: The employment rate is defined as 1 minus the unemployment rate. Trend growth is measured as the coefficient on the trend in a regression of the log of each variable (multiplied by 400) on a constant and time trend. The sample ranges are based on NBER-determined peaks in the business cycle: 1957:Q3 to 1981:Q3, 1981:Q3 to 2001:Q1, and 1981:Q3 to 2005:Q4. Rounding errors may cause the trend rate for household employment to differ slightly from the sum of trends for population, participation, and the employment rate.

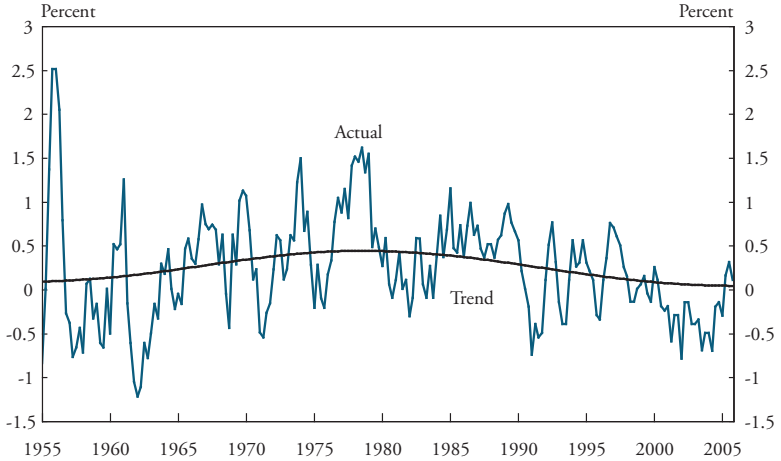
Sources: Bureau of Labor Statistics, NBER, and authors' calculations

A smaller portion of the falloff in trend employment growth can be attributed to changes in labor force participation. However, the importance of participation rate movements depends in part on the trend estimation method. According to the peak-to-peak estimates, trend growth in labor force participation was little changed, at 0.3 percent in 1957-81 and 1981-2001 and 0.2 percent in 1981-2005 (Table 1). But the statistical estimates show trend growth in participation rising from 0.1 percentage point in 1955 to 0.4 percentage point in 1975 and 1985 and then falling to nearly 0 in 2005 (Chart 7).

As in the simple average growth rates, the peak-to-peak and statistical estimates of trend growth rates indicate movements in the employment rate have slightly mitigated the downward pressures from population and labor force participation. In the peak-to-peak estimates, trend growth in the employment rate rose from -0.1 percentage point in 1957-81 to 0.2 percentage point in 1981-2001 and 1981-2005 (Table 1). The statistical estimates follow the same pattern, with trend growth drifting up from -0.1 percentage point in 1955 and 1975 to 0.1 percentage point in 2005 (Chart 8).

Chart 7

TREND GROWTH IN THE LABOR FORCE PARTICIPATION RATE

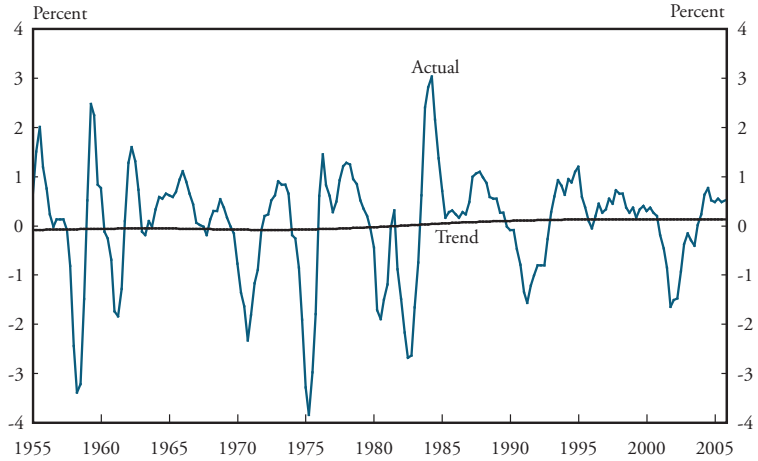


Notes: Actual growth rates are four-quarter rates of change. The trend is estimated with the Hodrick and Prescott filter, using a smoothing parameter of 800,000. The trend estimates are based on quarterly growth rates starting in 1948 and extended from 2006 through 2015 with forecasts formed from AR(4) models fit to 1984-2005 data.

Sources: Bureau of Labor Statistics and authors' calculations

Chart 8

TREND GROWTH IN THE EMPLOYMENT RATE



Notes: The employment rate is 1 less the unemployment rate. Actual growth rates are four-quarter rates of change. The trend is estimated with the Hodrick and Prescott filter, using a smoothing parameter of 800,000. The trend estimates are based on quarterly growth rates starting in 1948 and extended from 2006 through 2015 with forecasts formed from AR(4) models fit to 1984-2005 data.

Sources: Bureau of Labor Statistics and authors' calculations

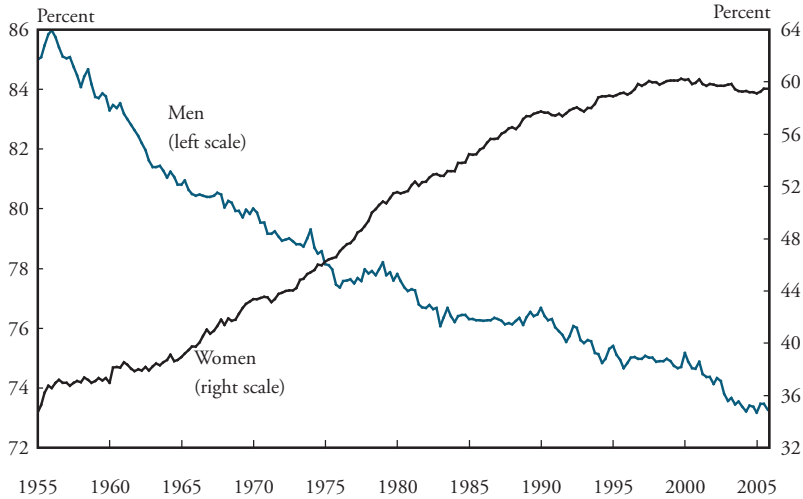
What has caused population and labor force participation to decelerate?

The deceleration of population and labor force participation that underlie the slowing of trend employment growth reflect various demographic and socioeconomic changes.[14] The falloff in population growth stems chiefly from fluctuations in fertility associated with the baby boom. The fertility rate soared during the baby boom (1946-64), subsequently causing growth in the working-age population to surge. More recently, a lower fertility rate (the so-called "baby bust") has restrained growth in the working-age population. The downward pressures on population growth associated with the reduction in the fertility rate have dominated the effects of changes in mortality and immigration, the other two determinants of population change. Reflecting factors such as advances in medical technology, mortality rates have steadily declined over time. Thus, declining mortality has boosted population growth but played little role in changes in population growth over the postwar period. As detailed in the appendix, rising immigration (reflecting factors such as an increased willingness of the United States to allow immigration and the greater desirability of jobs in this country) has also been an important source of population growth.

The slowing of growth in the labor force participation rate can be attributed primarily to a deceleration in the participation rate of women. Over the last several decades, a number of factors have led women to devote more time to paid work (Bradbury and Katz; Hotchkiss 2005). These factors include increased education, rising wages, changes in household structures and technologies, and legal and social movements promoting equal opportunities in the workplace. Accordingly, the participation rate of women has risen dramatically, from 35.6 percent in 1955 to 59.2 percent in 2005. However, over time, the pace of increase in women's participation has slowed (Chart 9). The participation rate of women increased much more from 1955 to 1981 (from 35.6 percent to 52.1 percent) than it did from 1981 to 2005 (from 52.1 percent to 59.2 percent). Although many have speculated that the deceleration of the participation rate of women is tied to factors such as the incomes of spouses and more women deciding to stay home with children, the deceleration has proved hard to explain (Bradbury and Katz). In contrast, the participation rate of men has

Chart 9

LABOR FORCE PARTICIPATION RATES OF MEN AND WOMEN



Notes: Data are quarterly averages of monthly figures.

Source: Bureau of Labor Statistics and authors' calculations

drifted down at a steady rate over the past five decades (Chart 9), reflecting such factors as an upward trend in early retirement (Costa; CBO 2004). As a result, the slowing of growth in the participation rate of women associated with many different demographic and socioeconomic factors largely accounts for the deceleration of overall labor force participation.

II. FORECASTING THE TREND GROWTH RATE FOR 2005 TO 2015

Just as demographic and socioeconomic changes have slowed the trend growth rate of employment sometime in the past 20 to 30 years, they might also restrain trend growth in the years ahead. Indeed, forecasts from sources such as the Bureau of Labor Statistics (Su), Council of Economic Advisers, and Macroeconomic Advisers put average payroll growth over the next 5-10 years at between 1.0 and 1.3

percent.[15] By comparison, this article's estimates of trend growth over the past 20 or so years range from 1.3 to 2.0 percent, depending on the measure and time period.

By themselves, the few available forecasts of employment growth over the next decade raise a number of questions. First, is the projected slowing of average or trend employment growth a reasonable forecast? Second, as good as any single prediction may be, is it possible to develop a forecast that may be more accurate? Many studies have shown averages of forecasts to generally be more accurate than any single forecast (Clemen; Timmermann). Accordingly, a forecast that combines information from a range of available forecasts may be more accurate than any of the individual forecasts of trend employment growth. Finally, any forecast is subject to considerable uncertainty. The true rate of trend growth may be well above or below the forecast. In light of the inherent uncertainty, what is a reasonable confidence interval for the forecast of trend employment growth?

This section analyzes and combines information from various forecasts of population, labor force participation, and the employment rate to develop a forecast of the growth trend of employment for 2005 to 2015. The forecast includes a point estimate and an approximate 70 percent confidence interval. According to this analysis, slower population growth and, to a lesser extent, declining labor force participation are likely to pull trend employment growth down from the prevailing level of the last 20-30 years. Over the next ten years, a reasonable baseline projection for annual payroll job growth is 1.1 percent, or about 120,000 jobs per month. The estimated forecast confidence interval for trend (payroll) employment growth is 0.8 to 1.3 percent, or 85,000 to 150,000 jobs per month.

The section begins with an explanation of the methodology used to forecast trend growth and proceeds with estimation of trends in population, labor force participation, and the employment rate. The estimated trends in these variables are then combined to derive a forecast of trend employment growth. The section concludes with a discussion of policy implications.

Trend forecast methodology

One approach to forecasting trend employment growth from 2005 to 2015 would be to project employment directly. Such an approach, however, would ignore much of the currently available information on demographic forces that are likely to affect growth in the labor force over the next decade. For example, the current age structure of the population implies important changes in labor force participation over the next 10 years. A more accurate forecast of trend employment growth can probably be obtained by first forecasting population, labor force participation, and the employment rate, and then adding up their growth rates, using the identity described in the last section. Thus, this section relies on the forecast-by-component approach.

Developing accurate projections of trend growth of employment and its determinants requires some care in separating trend and cyclical influences. To isolate trends in labor force participation and the employment rate, the following analysis develops forecasts of growth in the full employment levels of each variable.[16] As noted in the first section, full employment levels remove the influences of the business cycle. Thus, conceptually, growth rates based on full employment levels correspond to long-term growth rates that average out the effects of the business cycle. The distinction between actual and full employment levels is especially important for the 2005 levels of the labor force participation and employment rates. At this point in the recovery from the 2001 recession, it is not clear whether the participation and employment rates are at or below trend (the analysis elaborates). Looking ahead to 2015, however, forecasts of the participation and employment rates generally represent full employment rates. Because business cycle influences are very difficult to project 10 years into the future, long-term forecasts usually correspond to estimates of trend or full employment levels. In the case of population growth, because the influences of the business cycle are small, forecasts of trend growth in population can be based on just forecasts of actual growth.

For each variable, point forecasts and confidence intervals are developed by combining information from various sources, including recent trends and forecasts from sources such as the Bureau of Labor Statistics (Toosi, hereafter referred to as the BLS forecast), Congressional Budget Office (2006, and unpublished detail provided by the CBO), Report of the Trustees of the Social Security Administration (U.S. Social Security Administration, hereafter referred to as SSA Trustees Report), and Macroeconomic Advisers. In all cases, the point forecast is estimated as an average of the available forecasts.

Calculating confidence intervals for the growth forecasts of employment and most of its determinants involves some significant complications. In the cases of labor force participation and the employment rate, the available forecasts are for the 2005 and 2015 levels of these variables, rather than the growth rates from 2005 to 2015. As a result, it is most natural to specify confidence intervals for the 2005 and 2015 levels, and then derive the implied confidence intervals for the growth rates. However, the statistically appropriate confidence interval around the growth rate forecast is a complex function of the intervals around the 2005 and 2015 levels. Moreover, in the case of the participation rate, the confidence intervals are asymmetric—that is, not centered at the point estimate (for reasons made clear below). Finally, the appropriate confidence interval for the trend employment growth forecast is a complex function of the intervals for growth in population, labor force participation, and the employment rate.[17]

The statistical simulation method of Lebow and Rudd provides a simple way of estimating confidence intervals that appropriately account for these complications. The simulation method is used to estimate the confidence intervals for trend growth in the labor force participation rate and the employment rate from underlying intervals around projections of the participation and employment rates in 2005 and 2015. In the case of population, however, the confidence interval is formulated directly, without simulation, because the available forecasts are for population growth rather than population levels. Finally, statistical simulation is used to estimate the confidence interval for the trend employment growth forecast as a function of the intervals for the components of employment growth.

The intervals, largely subjective, are intended to approximate 70 percent confidence intervals. In most cases, the confidence intervals are broadly consistent with 70 percent intervals implied by historical errors in the available long-term forecasts and select other statistical evidence of forecast uncertainty (for each variable, detail is provided below in footnotes). In particular, over the past 30 years, the Bureau of Labor Statistics (BLS) has regularly published 10-year ahead forecasts of population growth and labor force participation. The BLS has also regularly published evaluations of the forecasts' accuracy. The size of such historical forecast errors provides some guidance on the likely uncertainty in forecasts for 2005-15. Nonetheless, as is the case in the Lebow and Rudd and Shapiro and Wilcox studies of bias in CPI inflation, the intervals reflect a significant amount of judgment.

Forecasts of population, labor force participation, and the employment rate

Using the methodology described above, this section develops baseline forecasts and confidence intervals for the 2005-15 trend growth rates of population, labor force participation, and the employment rate.

Population growth. Over the next ten years, the size of the working-age population will be determined by three factors: the current (2005) population size, mortality, and immigration.[18] Fertility will affect the total population size but not the size of the working-age population. Of these factors, the current population size is known. The mortality rate can be forecast reasonably accurately, in part because of its stability over periods such as a decade (Mulder). Immigration is the largest source of variability in population growth over a decade and, in turn, the largest source of forecast uncertainty (Fullerton 2003; Mulder).

Various factors (detailed in the appendix) contribute to making immigration difficult to forecast. Unpredictable changes in immigration law can significantly affect immigration. Congress is currently considering alternative proposals for reforming immigration law. However, the diversity of views toward immigration in the United States makes predicting the timing and form of any reforms difficult. Illegal immigration, an important component of total immigration, further

complicates forecasting total immigration. Illegal immigration depends on hard-to-predict variables such as economic and social conditions in other countries and the effectiveness of the enforcement efforts of the Department of Homeland Security. Finally, imprecision in annual estimates of immigration (especially illegal) makes it difficult to accurately assess recent trends and the implications for future immigration.[19]

Reflecting these difficulties, some of the projections of immigration over the next 10 years differ considerably.[20] In the most recent Census Bureau population projections (U.S. Census Bureau 2004), immigration is assumed to average about 800,000 persons per year from 2005 to 2015.[21] In contrast, the recommendations of a panel of technical advisors to the Social Security Administration imply annual average immigration of about 1.3 million persons per year over the next decade (Technical Panel on Assumptions and Methods, hereafter referred to as SSA Technical Panel). These very different projections reflect alternative interpretations of the late 1990s surge in immigration, to a level of at least 1.3 million per year. The Census Bureau attributes the high immigration of the late 1990s to transitory effects of the Immigration and Reform Control Act of 1986.[22] The SSA Technical Panel attributes more of the late 1990s rise in immigration to permanent factors. The baseline projection in the SSA Trustees Report takes a middle ground, putting average annual immigration from 2005 to 2015 at about 1 million.[23]

But because the reported forecasts of population reflect relatively modest differences in immigration assumptions, the forecasts are very similar. In fact, the available forecasts of population growth over the next ten years are all identical, at 1.0 percent per year (Table 2).[24] For example, both the Census Bureau (U.S. Census Bureau 2004) and SSA Trustees Report put average population growth at 1.0 percent, even though the SSA Trustees Report projection assumes 200,000 more immigrants per year than does the Census Bureau. Incorporating the even stronger immigration projection of the SSA Technical Advisers implies stronger population growth, roughly 1.1 percent per year.

For the purposes of forecasting trend employment growth, this article takes the consensus or average population growth rate of 1.0 percent as the baseline trend estimate. The trend forecast confidence interval is estimated by combining alternative immigration assumptions from the Census Bureau, SSA Trustees Report, and SSA Technical Panel

Table 2

AVAILABLE FORECASTS OF POPULATION GROWTH, LABOR FORCE PARTICIPATION, AND THE EMPLOYMENT RATE

	Average population growth, 2005-15	Labor force participation rate (trend or full employment), 2005	Labor force participation rate (trend or full employment), 2015	Unemployment rate (trend or natural), 2005	Unemployment rate (trend or natural), 2015
CBO	1.0	66.5	65.4	5.2	5.2
BLS[a]	1.0	66.0	65.6	5.4	5.0
SSA Trustees Report	1.0		65.4		5.5
Macro-economic Advisers[a]	1.0			5.3	5.3
Statistical trend[b]		66.5		4.9	
Himmelberg and McConnell[c]		66.1			
U.S. Census Bureau	1.0				
United Nations	1.0				
Blue Chip[d]					4.9
Council of Economic Advisers[e]					5.0
Survey of Professional Forecasters				5.0	
Average[f]	1.0	66.3	65.5	5.2	5.2

Notes: (a) For BLS and Macroeconomic Advisers, the forecasts use 2014 instead of 2015. (b) The statistical trends are estimates based on the Hodrick and Prescott filter, with a smoothing parameter of 51,200 (a setting in line with the one used by Orphanides and Williams to estimate trend unemployment). The trend estimates are based on a data sample starting in 1948 and extended from 2006 through 2015 with forecasts formed from AR(4) models fit to 1984-2005 data. (c) The Himmelberg and McConnell estimate is for 2004 rather than 2005. (d) The natural rate figure for Blue Chip is a consensus forecast of the average unemployment rate for 2012-2016. (e) The natural rate figure for the CEA is a forecast of the unemployment rate in 2011. (f) The average is a simple average of the available forecasts.

Sources: Congressional Budget Office (2006, and unpublished detail provided by the CBO), Toosi and Su (BLS figures), U.S. Social Security Administration, Macroeconomic Advisers, Himmelberg and McConnell, U.S. Census Bureau (2004), United Nations, Blue Chip Economic Indicators, Council of Economic Advisers, Survey of Professional Forecasters, and authors' calculations

with baseline immigration and population numbers from CBO. The CBO forecast is based on the SSA Trustees Report projection, updated to reflect newly available population data for 2005. Accordingly, the CBO's population forecast incorporates the SSA's middle-ground assumption on immigration, of about 1 million persons per year. In calculating the population growth confidence interval, a reasonable range for immigration is taken to be 800,000 to 1.4 million per year.[25] The lower bound of 800,000 corresponds to the immigration assumption of the Census Bureau. The upper bound of 1.4 million draws on the immigration recommendation of the SSA Technical Panel and the high-immigration scenario considered in the SSA Trustees Report.[26] This range of immigration assumptions implies a population growth forecast range of 0.9 to 1.1 percent per year (Table 3).[27]

Labor force participation. Most analyses of the labor force participation rate (LFPR) focus on the rates of particular demographic groups, such as men and women of age 25 to 54. The overall participation rate equals a population-weighted average of the participation rates of demographic groups (the weight on each group's participation rate is the group's share in the population). Consequently, changes in the overall participation rate over time can be decomposed into two components, one reflecting changes in the population weights of demographic groups and the other reflecting changes in the participation rates of demographic groups:[28]

$$\textit{change in overall LFPR} = \sum_{\textit{group } i} (\textit{group i's initial LFPR}) \times (\textit{change in group i's population share})$$

$$+ \sum_{\textit{group } i} (\textit{group i's end period population share}) \times (\textit{change in group i's LFPR}).$$

Over a ten-year horizon, difficulties in forecasting changes in the participation rates of key demographic groups create the largest uncertainties in forecasts of the overall participation rate.[29] Although participation rates for some important groups have followed clear historical trends, rates for others have not. For example, the participation rate of prime-age (ages 25 to 54) men has trended down steadily over the postwar period. In contrast, the participation rate of men of age 55

Table 3

POINT FORECASTS AND RANGES FOR 2005-15 TREND EMPLOYMENT GROWTH AND ITS DETERMINANTS

	Point forecast (percent)	Forecast confidence interval (percent)
Population growth	1.0	.9 to 1.1
Labor force participation rate (trend or full employment), 2005	66.3	66.0 to 67.3
Labor force participation rate (trend or full employment), 2015	65.5	64.3 to 66.7
Growth in participation rate	-.2	-.3 to .0
Unemployment rate (trend or natural), 2005	5.2	4.7 to 5.7
Unemployment rate (trend or natural), 2015	5.2	4.4 to 6.0
Growth in employment rate	.0	-.1 to .1
Differential between household and payroll growth	.3	.0 to .4
Growth in household employment	.8	.6 to 1.0
Growth in payroll employment	1.1	.8 to 1.3

Note: The growth rates in the table correspond to average annual percent changes.

Sources: Congressional Budget Office (2006, and unpublished detail provided by the CBO), Toosi and Su (BLS figures), U.S. Social Security Administration, Macroeconomic Advisers, Himmelberg and McConnell, U.S. Census Bureau (2004), United Nations, Blue Chip Economic Indicators, Council of Economic Advisers, Survey of Professional Forecasters, and authors' calculations

and above declined steadily until 1985, but has since trended upward (Johnson; Quinn). Even for some demographic groups with clear historical trends in participation, it is difficult to distinguish trend and business cycle contributions in recent declines of participation (Ferguson). Some observers have suggested the level of labor force participation in 2005 is at about trend, or the full employment level, while others argue current participation is well below the full employment level because of a cyclically soft demand for labor. The trend-cycle

decomposition problem is especially acute for the participation rate of women, in light of the deceleration of women's participation over the last 20 or so years (Bradbury).

In contrast, changes in population weights are a relatively small source of uncertainty in forecasts of changes in the overall labor force participation rate. Current population shares are of course known. Looking ahead to 2015, immigration makes the population level difficult to forecast, but immigration has more effect on the overall population level than on population shares.[30] As a result, the population shares of demographic groups in 2015, and the changes in shares from 2005 to 2015, can be predicted with some precision. Over the next ten years, the population shares of prime-age men and women will fall, while the shares of men and women age 55 and above will rise. Because the participation rates of older men and women are lower than their prime-age counterparts, the population aging will tend to push down the overall participation rate. For example, if the participation rates of male and female workers in the age groups of 16-24, 25-54, and 55 and up remained at their 2005 levels, the overall participation rate would fall about 1.7 percentage points from 2005 to 2015.[31]

The available forecasts of the full employment rates of overall labor force participation in 2005 and 2015 are generally similar (Table 2). For 2005, the BLS estimates the full employment rate of labor force participation to be 66.0 percent. The CBO estimates the full employment rate of participation to be 66.5 percent.[32] For 2015, the CBO projects that, under current tax rates, the full employment participation rate will fall to 65.4 percent.[33] The BLS predicts an overall participation rate of 65.6 percent in 2014.

The similarities in overall participation rates mask some sizable, but offsetting, differences in projections for the participation rates of demographic groups. For example, in the case of the 2015 participation rate of women of age 55-64, the CBO projection (about 57.8 percent) considerably exceeds the SSA Trustee Report forecast (52.8 percent). But for men of age 16-24, the SSA's projected participation rate (roughly 68 percent) is higher than the CBO's (65.6 percent).

The baseline estimates of full employment participation in 2005 and 2015 are simple averages of the available estimates in each year: 66.3 percent in 2005 and 65.5 percent in 2015 (Table 2).[34]

Confidence intervals for the 2005 and 2015 forecasts of full employment participation are based on recent movements in participation rates and various scenarios for participation rates implied by the analysis of sources such as Bradbury, CBO, and SSA Trustees Report. For 2005, some have suggested the full employment rate of labor force participation to be as high as it was prior to the 2001 recession—as high as 67.3 percent, the peak rate of participation reached in 2000. Alternatively, according to BLS estimates and other less formal assessments, the full employment rate of participation could be 66.0 percent, the actual rate for the year.

Confidence intervals for full employment participation in 2015 combine the intervals for 2005 participation with different estimates of the effects of population aging on participation. As noted above, a rough estimate (obtained by assuming the participation rates of major demographic groups remain at their 2005 levels) of the population aging effect is 1.7 percent. An upper bound for the 2015 participation rate is obtained by subtracting a very conservative population-aging effect of 0.6 percentage point (roughly one-third of the baseline estimate) from the 2005 upper bound of 67.3 percent. The resulting upper bound of 66.7 percent could prove accurate if, for example, the participation rate of workers aged 16-24 moved toward its levels of 2000 and the participation rate of prime-age women resumed an upward trajectory. The lower bound of 64.3 percent is obtained by taking the full employment level in 2005 to be equal to the actual rate of 66.0 percent and subtracting the baseline population-aging contribution of 1.7 percentage points.[35] Reflecting the greater uncertainty in forecasts for 2015 compared to estimates for 2005, the forecast range for full employment participation in 2015 is wider than the range for 2005.

These full employment levels yield a baseline estimate of trend growth in participation equal to -0.2 percent per year, with an approximate confidence interval of -0.3 to 0.0 percent (Table 3). The confidence interval for the growth rate, calculated with the statistical methods of Lebow and Rudd, reflects the confidence intervals around the forecasts of the participation rate levels in 2005 and 2015.[36] The growth rate range is asymmetric: The gap between the upper end of the range and the baseline estimate is larger than the gap between the lower end and the baseline. The asymmetry in the growth rate interval reflects

asymmetries in the confidence intervals for the trend participation rate estimates for 2005 and 2015. The growth rate interval's upper bound of 0 percent implies that, although there is some chance of an increase in the trend rate of participation, the chances are not high.

Employment rate. The natural or full employment rate of unemployment is affected by a wide array of factors. As noted in the first section, demographics are key determinants of the natural rate. The structural factors that determine how long workers take to find jobs also affect the natural rate. For instance, long-term changes in the economy that destroy jobs in old industries and create jobs in new ones can produce mismatches between the skills workers have and the skills needed for the new jobs. The mismatches can extend the time required for workers losing old jobs to find new ones, raising the natural unemployment rate. Similarly, a higher level of unemployment benefits will lead some workers to be more selective about job offers, extending their unemployment spell and thereby increasing the overall unemployment rate. Finally, structural forces that affect the willingness of firms to hire can also impact the natural rate. For instance, increased availability of temporary workers may make firms quicker to hire in response to a pickup in demand, lowering the natural rate of unemployment (Otoo).

Estimates of the natural rate are widely known to be imprecise (Staiger, Stock, and Watson; Orphanides and Williams). Estimates are inherently imprecise in part because the true natural rate can never be observed. In addition, many of the likely determinants of the natural rate are difficult to quantify, making it hard to estimate their contributions to the natural rate. Even for determinants that can be measured, their relationships to the natural rate may not be precisely estimated.

Nonetheless, most available estimates of the natural rate of unemployment are similar (Table 2). For example, CBO estimates the natural rate to be 5.2 percent, at present and in 2015. Macroeconomic Advisers puts the natural rate at 5.3 percent from 2005 through 2014. The BLS projects a natural rate of 5.4 percent in 2004 and 5.0 percent in 2014 (U.S. Bureau of Labor Statistics 2005(a)). The SSA Trustees Report assumes an unemployment rate of 5.5 percent in 2015, implying a natural rate of the same value.

The baseline estimates of the natural rate of unemployment in 2005 and 2015 are simple averages of the available estimates in each year: 5.2 percent in 2005 and 2015 (Table 2).

Confidence intervals for the 2005 and 2015 forecasts of the natural rate are drawn from historical fluctuations in estimates of the natural rate and recent fluctuations in actual unemployment. Although most estimates of the natural rate are now close to 5.2 percent, in the recent past, conventional estimates of the natural rate were sometimes higher. For example, in the early 1990s, the natural rate was commonly estimated to be about 6 percent (Weiner). More recently, though, actual unemployment has dipped well below 5 percent. During the last expansion, in which unemployment surprisingly dipped below 4 percent, some observers suggested the natural rate could be less than 5 percent. In light of such evidence, the confidence interval for the 2005 estimate of the natural rate is set at 4.7 to 5.7 percent.[37] The interval for 2015 should be somewhat wider, to reflect the greater uncertainty in long-term forecasts. The 2015 forecast interval is set at 4.4 to 6.0 percent.[38]

The baseline estimate and ranges for the natural rate in 2005 and 2015 yield a baseline estimate of trend growth in the employment rate (recall that the employment rate is 1 less the unemployment rate) equal to 0 percent per year. The forecast confidence interval (statistically simulated) is -0.1 to 0.1 percent (Table 3).[39] The range implies that, although long-term changes in the employment rate could add to or subtract from trend employment growth, the impact should be small.

A forecast of trend growth in employment

The projected rates of trend growth in population, labor force participation, and the employment rate can be combined to estimate the trend growth rate of employment from 2005 to 2015. The baseline estimate of trend growth in the household measure of employment is just the sum of the baseline trends of growth in population (1.0 percent), labor force participation (-0.2 percent), and the employment rate (0 percent): 0.8 percent per year (Table 3). The approximate 70 percent confidence interval for the household employment growth forecast is a

statistically simulated function of the confidence intervals for the forecasts of growth in population, participation, and the employment rate. The estimated confidence interval is 0.6 to 1.0 percent per year.

Forecasting the trend growth rate of payroll employment involves combining the projection of household employment with a projected differential between trend growth in household and payroll employment. As noted in the article's first section, growth in payrolls has often exceeded growth in household employment. The available forecasts that include both household and payroll employment continue the pattern. In BLS forecasts for 2004 to 2014, annual growth in payrolls outstrips growth in the household measure by 0.3 percentage point (Su). In the Macroeconomic Advisers forecast for 2005 to 2014, payroll growth exceeds household growth by about ¼ percentage point per year. The first section's estimates of recent statistical trends put the differential between 0 (the smooth trend estimates for 2005) and 0.3 percentage point (the peak-peak estimates for 1981-2001). At times in the past, however, the differential in trend estimates has been 0.5 percent or larger. In light of this evidence, the point estimate of the differential between trend growth in household and payroll employment is set at 0.3 percentage point (an average of the differentials in the BLS and Macroeconomic Adviser forecasts), with a confidence interval of 0 to 0.4 percentage point.

Combining the projected household-payroll differential with the forecast for household employment yields a baseline estimate of 2005-15 trend growth in payrolls equal to 1.1 percent. The approximate 70 percent confidence interval (statistically simulated) for the trend forecast is 0.8 to 1.3 percent.[40] At the current size of payrolls, trend growth of 1.1 percent corresponds to average monthly job gains of about 120,000. The 0.8 to 1.3 percent range for trend growth in payrolls corresponds to average monthly job gains between 85,000 and 150,000. The baseline estimate implies the common, benchmark, rule of thumb for job gains—150,000 jobs per month—is too high. The rule of thumb falls at the top end of a reasonable range of estimates of trend job gains.

Policy implications

The slower trend growth of employment over the next decade has a range of important implications for fiscal and monetary policy. Without an offsetting change in productivity growth, slower trend growth in employment implies slower long-run growth of GDP and aggregate income. The trend deceleration of employment and income will likely reduce growth in tax revenues. Slower growth in tax revenues could create difficulties in funding some government programs. For example, many economists have projected that the demographic factors likely to slow trend employment growth in the years ahead will eventually have dramatic effects on the financial health of the Medicare and Social Security systems.

In the case of monetary policy, the Federal Reserve Open Market Committee has made clear that assessments of the state of labor markets and the overall economy compared to sustainable trends play an important role in policy decisions. As a result, accurate estimates of trends are crucial to effective monetary policy. If trend job growth were overestimated, actual growth in jobs thought to be below trend could in fact exceed trend. In turn, operating with an overestimate of trend growth, policymakers might ease policy when, given the true rate of trend growth, they should hold policy steady or tighten. Extended over a period of time, the stimulative monetary policy associated with such a mistake could cause inflation to rise above its desired level. Along these lines, some economists have suggested that the broad failure of economists to detect the trend productivity slowdown of the early 1970s and the associated slowdown in trend GDP growth can explain much of the rise in inflation over the 1970s (Orphanides). Fortunately, however, in current circumstances, policymakers are well aware of the likelihood of a slowing of trend growth in employment. Forecasts from such sources as the BLS, CBO, and Council of Economic Advisers all anticipate slower average employment growth in the years ahead than in the years past.

III. CONCLUSION

Although some of the sluggish pace of job gains following the 2001 recession is likely due to demand-side forces, long-term changes in demographics and socioeconomic factors have likely slowed the trend growth rate of employment. Most importantly, long-term population growth has fallen, as declining fertility has dominated increasing immigration. Various factors have caused a deceleration in labor force participation that has modestly detracted from trend growth in the workforce. These forces slowed the trend growth rate of employment over the past 20 or so years compared to the prior 30 years. Looking ahead, they can be expected to cause the trend growth rate of the next 10 years to edge down further. This article estimates the trend growth rate of payroll employment from 2005 to 2015 at 1.1 percent per year, or about 120,000 jobs per month. By comparison, common rule-of-thumb estimates put the trend rate of increase at 150,000 jobs per month. Of course, forecasts of trends are very uncertain. An approximate 70 percent confidence interval around the baseline estimate of trend growth implies monthly job gains between 85,000 and 150,000 jobs per month. So although the point estimate implies the historical rule of thumb to be too high, a reasonable confidence interval includes the common benchmark.

APPENDIX

This appendix details the rising importance of immigration in population growth and the sources of difficulties in forecasting immigration.

Immigration's contribution to population growth

Over time, immigration has accounted for an increasingly large share of total population growth. Using data from decennial censuses, Table 4 shows the growth of total population, the growth in the foreign-born population, and the estimated contribution of immigration, based on the foreign-born population.[41] From 1970 to 1980, immigration contributed approximately 2.1 percentage points to the total population growth of 11.4 percent. From 1990 to 2000, immigration contributed 4.5 percentage points to the total population growth of 13.0 percent. As a result, the change in the foreign-born population has accounted for a larger share of the change in the total population (Chart 10). During the 1990s, the change in foreign-born population accounted for more than ⅓ of the change in total population, compared to only ⅕ to ¼ of the change in total population in the 1970s and 1980s.

Census Bureau estimates of the components of population change since 2000 suggest immigration's importance has continued to increase this decade. According to the latest estimate, published in December 2005, immigration accounted for more than 40 percent of population growth from April 2000 to July 2005 (U.S. Census Bureau 2005). However, there is some disagreement among demographers as to whether immigration's importance has in fact risen further this decade.

Difficulties in forecasting immigration

Three factors make immigration difficult to forecast accurately. The first two, the most important, are the unpredictability of changes in immigration law and unpredictability of illegal immigration. The third is the imprecision of annual immigration data.

Table 4

ESTIMATES OF THE HISTORICAL CONTRIBUTIONS OF IMMIGRATION TO TOTAL POPULATION GROWTH

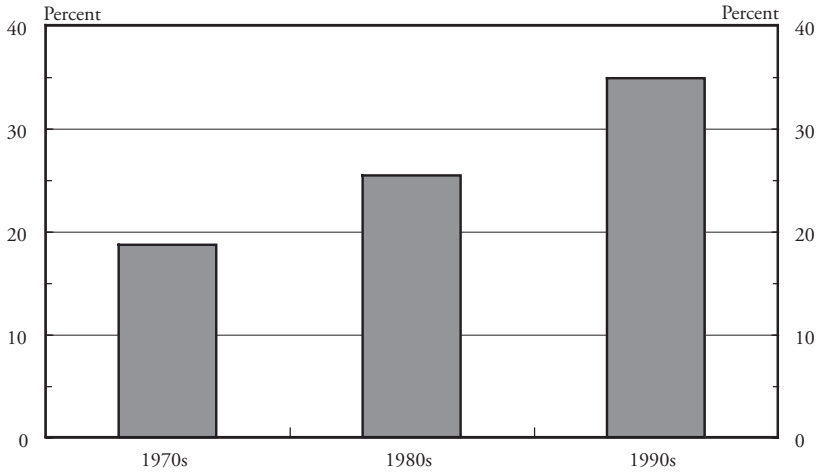
	Percent change in total population	Percent change in foreign-born population	Approximate contribution of immigration to population growth (percentage points)
1970-80	11.4	44.6	2.1
1980-90	9.9	40.4	2.4
1990-2000	13.0	57.4	4.5

Note: The approximate contribution of immigration to population growth is estimated as the change in the foreign-born population divided by the base year total population level.

Sources: Census Bureau figures reported in the 2002 *U.S. Statistical Abstract* and authors' calculations

Chart 10

THE CHANGE IN THE FOREIGN BORN POPULATION AS A SHARE OF THE CHANGE IN THE TOTAL POPULATION



Sources: Census Bureau figures reported in the 2002 *U.S. Statistical Abstract* and authors' calculations

Immigration law. The laws governing immigration are subject to important, difficult-to-predict changes. For example, the numerical caps on admission of legal immigrants have changed many times in the past. As the U.S. economy boomed in the late 1990s, the caps on temporary workers (workers on H1-B visas) were temporarily raised to much higher levels. Such changes are difficult to predict far in advance. At present, Congress is considering reform proposals that could significantly affect future immigration. However, as noted in the article's text, the outcomes of the reform discussions cannot be reliably predicted.

Illegal immigration. Illegal immigration is a large part of total immigration.[42] Conventional estimates put annual illegal immigration during the 1990s between 350,000 to 550,000 persons per year, or about 30 to 40 percent of total immigration (Costanzo and others; Warren). Some studies estimate that, since 2000, the share of illegal immigration in total immigration has been even higher, at 50 percent or more (Passel; Passel and Suro).

The considerable unpredictability of illegal immigration makes total immigration difficult to forecast. As noted in the text, illegal immigration depends on hard-to-predict variables such as economic and social conditions in other countries and the effectiveness of the enforcement efforts of the Department of Homeland Security.

Imprecision in annual data. Problems with the reliability of annual data make assessing immigration trends and accurately projecting future immigration difficult (Mulder and others). Changes in the foreign-born population can be decomposed into three components: legal immigrants (so-called "green card" holders), illegal immigrants, and legal nonimmigrants (students and workers allowed to live in the United States temporarily).[43] Estimating the net flow of legal immigrants is complicated because some new legal immigrants become legal immigrants by adjusting their status from legal nonimmigrants. Many of those obtaining legal permanent residence have already lived in the United States for a long time. There is of course no official record-keeping on the entry and exit of illegal immigrants. Finally, legal changes make projecting the net flow of legal nonimmigrants difficult.[44]

ENDNOTES

[1]The initial weakness of job growth led many to describe much of the recovery as "jobless." Schreft and Singh review demand-related explanations for the "jobless" recoveries that followed the 1990-91 and 2001 recessions.

[2]Perry is a seminal reference on using such an approach to estimate trend employment growth.

[3]At a moment in time, it is possible that the pace of economic growth could be above or below trend, while the level of activity at that moment in time is at its full employment level. In a steady state equilibrium, however, full employment would be accompanied by trend growth.

[4]Although the data are suggestive of a shift in average growth, formal statistical tests (the tests of Andrews and Bai and Perron) fail to identify a statistically significant break. However, in limited data samples, such tests are known to sometimes have difficulty in correctly identifying whether breaks have occurred.

[5]The modestly lower average growth of household employment compared to payrolls reflects some of the important conceptual differences between the measures. For example, the measures differ importantly in their definitions of employment (U.S. Bureau of Labor Statistics 2005(b)). The payroll survey counts jobs; the household survey counts workers. As a result, for an individual holding two jobs, the payroll survey records two positions, while the household survey records just one. Factors such as an upward trend in multiple job holding would contribute to faster growth in payrolls than household employment. The payroll measure is generally considered to be a more reliable indicator of employment, because it is based on a larger survey.

[6]Assessing changes in trends from simple charts is further complicated by the clear reduction in the volatility of employment growth that began around 1984 – a change in volatility associated with the "great moderation" documented by (among others) Blanchard and Simon, Kim and Nelson, McConnell and Perez-Quiros, and Stock and Watson (2002). In Chart 1, what appears to be a reduction in trend growth in the early to mid-1980s might be more reflective of a fall in the cyclical volatility of growth than a true decline in trend growth.

[7]Using a peak date of 1980:Q1 yields results very similar to the reported results based on the 1981:Q3 peak.

[8]The peak-to-peak growth rates are estimated by regressing log employment on a constant and time trend. The time trend estimate is generally thought to be more efficient than a simple average growth rate. Filardo applies the same approach to estimating trend growth in productivity.

[9]Estimates from alternative statistical models of trends are qualitatively similar to those reported from the Hodrick and Prescott (with high smoothing) approach. In particular, trend estimates based on the Rotemberg approach are very similar to those reported. Trend estimates based on an autoregressive model with time-varying intercept are also qualitatively similar, if the amount of time variation in the intercept is fixed at the level estimated for the labor force. However, if the amount of time variation in the intercept is estimated by maximum likelihood or the method of Stock and Watson (1998), the resulting trend estimate shows very little change over time.

[10]In line with the suggestions of Perron and Wada and Shimer (2005), the smoothing parameter of the Hodrick-Prescott filter is set very high, to 800,000. In light of the difficulty of accurately estimating trends at the beginning of samples, the trend estimates are based on raw data starting in 1948. Following the Mise, Kim, and Newbold methodology for reducing potential imprecision in the end-of-sample estimates, the data samples from which the trends are estimated are padded with forecasts of employment growth for 2006-2015. The forecasts are formed from AR(4) models fit to data from 1984 to 2005. Using AR models fit to 1948-2005 data yields qualitatively similar results. Nonetheless, the uncertainty around estimates of trends at the end of a data remains considerable.

[11]The periodic spikes in the population growth rate reflect revisions to population levels that sometimes follow decennial censuses. When such revisions occur, past data are not revised to reflect the new higher levels of population. Trend estimates based on a population series that smoothes out these population adjustments are very similar to those reported.

[12]Applying the Bai and Perron tests for structural breaks identifies two significant changes in average population growth, in 1968 and 1980.

[13]In particular, in 1955-2005 data, the correlation between GDP and population growth (four-quarter rates) is essentially zero. The correlation between cyclical components in GDP and population estimated with the usual Hodrick-Prescott filter is also essentially zero.

[14]Although changes in the growth trend in the employment rate have not exerted much influence on trend employment growth, the natural rate of unemployment generally trended up through the mid-1980s and then trended down. Demographics such as the rising and then declining share of young workers played a key role in the natural rate trends (see, for example, Shimer (1998) and Katz and Krueger). Some have suggested a rising incarceration rate has contributed to the trend reduction in unemployment since the mid-1980s (Katz and Krueger). Rising incarceration could also have slightly boosted the trend rate of labor force participation.

[15]The BLS projects average payroll growth of 1.3 percent per year from 2004 to 2014 (Su). The Council of Economic Advisers forecasts average payroll growth of 1.2 percent from 2005 to 2011. Macroeconomic Advisers forecasts average payroll growth of 1.0 percent from 2005 to 2014. Hotchkiss (2004) estimates the current trend growth rate of employment to be a bit lower, at a rate corresponding to about 98,000 jobs per month.

[16]An alternative approach would be to use just historical data and time series models for population, labor force participation, and unemployment to forecast long-term average growth. However, such a simple and purely statistical approach would make it difficult to incorporate the currently available information on demographic forces that are likely to affect growth over the next decade.

[17]As noted by Shapiro and Wilcox in the context of estimation of bias in CPI inflation (an estimate also based on summing estimates of more detailed components), the confidence interval for trend employment growth cannot be calculated by simply summing the intervals for population, labor force participation, and the employment rate. The confidence interval is determined by the standard deviation of the forecast error. The standard deviation of some variable $z = x + y$

is always smaller than the sum of the standard deviations of x and y (even though the variance of z equals the sum of the variances of x and y, if the covariance between x and y is 0).

[18]Following the conventions of Census Bureau projections, population in this article refers to the "resident population" of the 50 states and the District of Columbia. Immigration refers to net international migration, defined as the number of people moving into the 50 states and District of Columbia less the number who moved out. Immigrants from Guam, Puerto Rico, and the U.S. Virgin Islands, who are U.S. citizens, are not distinguished from immigrants from elsewhere in the world.

[19]Annual immigration can be estimated two ways. The Census Bureau decomposes net international migration into subcategories such as legal immigrants, net temporary nonimmigrants, and emigrants, and estimates each component using various sources of administrative records and surveys (sources include the BLS's Current Population Survey, U.S. Citizenship and Immigration Services, and Office of Refugee Settlement). Immigration estimates obtained from this approach can differ from estimates based on counts of the foreign-born population provided in decennial censuses. Some other sources estimate annual immigration from survey information. Data from the Current Population Survey and American Community Survey on nativity and year of entry into the United States can be used to estimate the number of new arrivals to the United States and the change in the foreign-born population over a given period. Of course, the surveys cover not the entire population but samples, creating the potential for sampling error. In addition, the number of new arrivals represents only one of the components of net immigration. Overall, the available estimates of annual immigration are more indicative of broad trends than the level of net immigration in a particular year.

[20]Assessing recent trends in immigration and the implications for future immigration has been further complicated by the slowdown in immigration that followed the September 2001 terrorist attacks. Some of the slowdown is attributable to increased enforcement efforts by the Department of Homeland Security, and therefore likely permanent. But how much is uncertain.

[21]This Census Bureau forecast is the so-called middle series projection. Census Bureau data on actual 2004 immigration, published in August 2005, put immigration well above the level incorporated in the projection, which was published in March 2004. The Bureau estimates actual 2004 immigration of about 1.2 million, compared to the projection of 950,000.

[22]The Act gave permanent resident status to many illegal immigrants already in the United States. Over time, these new permanent residents were able to bring relatives to the United States as legal immigrants (Hollmann, Mulder, and Kallan).

[23]Similarly, projections from the United Nations put annual immigration from 2005 to 2015 at about 1.1 million persons per year (United Nations).

[24]Some of the forecasts, such as those from BLS and Macroeconomic Advisers, are simply Census Bureau projections, with slight adjustments for updated data on actual population in 2004 and 2005.

[25]In calculating the population growth rates associated with each immigration assumption, immigration of working-age persons was assumed to be about 80 percent of total immigration, in line with recent patterns.

[26]The upper bound is also meant to reflect other evidence that suggests annual immigration of 1.5 million persons per year. For example, Lee, Miller, and Anderson forecast annual immigration of roughly 1 million persons per year over the next decade, with a 95 percent confidence interval of 800,000 to roughly 1.5 million.

[27]In light of historical errors in BLS forecasts of population growth (based on Census Bureau forecasts), this range could be too tight. In BLS forecasts of average population growth roughly ten years ahead (reported in Fullerton 1982, 1988, 1992, 1997, 2003), the root mean square error was about 0.35, implying a 70 percent confidence interval with width of about 0.7 percentage point. However, errors in forecasts for more recent periods have been considerably smaller, in part because forecasts of immigration have improved (Mulder). The 0.9 to 1.1 percent range used in this article is in line with the low-high range considered in the SSA Trustees Report.

[28]Under an alternative decomposition, the participation rate in the first term would be the rate in the end period rather than the initial period, and the population weight in the second term would be the initial share rather than the end period share. Using available projections of 2015 participation rates with this decomposition yields broadly comparable aging effects.

[29]Most participation rate forecasts (for example, the BLS, CBO, and SSA Trustee Report forecasts) use cohort analysis in projecting the participation rates of demographic groups. For example, the fact that participation of women aged 25 to 54 is higher today than it was historically suggests that, in the future, participation of women aged 55 to 64 will be higher than it was historically. Incorporating such cohort effects is generally thought to improve forecast accuracy.

[30]Because the age-gender distribution of new immigrants will likely differ somewhat from the age-gender distribution for current residents, immigration will have some impact on overall population shares in 2015. However, the size of the new immigrant population compared to the existing population (the stock) will be small (even though immigration is a large component of total population growth, the flow). Thus, the effect of immigration on total population shares will be small.

[31]The 2005 population weights used in this calculation are taken from the CBO's population projections.

[32]Other, less formal analysis also puts the full employment rate at about the actual 2005 rate of 66.0 percent (Koropeckyj; Moskow).

[33]This CBO figure for 2015 does not incorporate the CBO's estimate of the effects of tax changes on labor force participation rates. The CBO projects that the expiration of various tax provisions in 2010-11 will lower the overall participation rate by 0.4 percentage point.

[34]The BLS forecast used in the 2015 average is actually for 2014. However, if a BLS forecast for 2015 were available and used, it would likely be sufficiently similar to the 2014 estimate as to have little effect on the average forecast. Moreover, actual participation in 2005 (66.0 percent) came in well below the SSA Trustees Report's forecast (66.6 percent), likely put together (the report was published in March 2005) before any 2005 data were available. Therefore, it could be

argued that the SSA forecast for 2015 used in forming the baseline estimate is too high. However, a crude adjustment of lowering the SSA forecast for 2015 by 0.6 percentage point has little effect on the reported results for the trend growth of labor force participation and employment.

[35]The 2.4 percentage point spread reflected in the 2015 confidence interval is somewhat smaller than historical errors in BLS forecasts of labor force participation rates imply it should be. In BLS forecasts of participation roughly ten years ahead (reported in Fullerton 1982, 1988, 1992, 1997, 2003), the root mean square error was about 1.7, implying a 70 percent confidence interval with width of about 3.4 percentage points. The smaller, subjective interval used in this article could be justified by improvements in forecast methods.

[36]The baseline estimate and range for the growth rate are calculated using simulations of distributions for the participation rates in 2005 and 2015. The baseline estimate corresponds to the median of the simulated distribution of the growth rate. In these simulations, the full employment participation rates in 2005 and 2015 are assumed to have a correlation of about 0.5. The correlation means that having a trend participation rate in 2005 above the baseline estimate would tend to be associated with a trend participation rate in 2015 above the baseline forecast.

[37]The width of the 2005 natural rate confidence interval is broadly consistent with Orphanides and Williams' results on uncertainty in contemporaneous estimates of the natural rate. Orphanides and Williams estimate the difference between real time and retrospective natural rate estimates to be between 0.5 and 0.75 percentage point. A root mean square error of 0.5 percentage point implies a 70 percent confidence interval spanning about 1.0 percentage points.

[38]The 1.6 percentage point spread in the confidence interval for the 2015 natural rate appears to be consistent with the size of historical errors in long-term forecasts of the natural rate from Blue Chip (using Blue Chip's long-horizon unemployment rate forecasts as natural rates) and the CBO (using Kozicki's data on the CBO's real-time estimates of the natural rate).

[39]The baseline estimate and range for the growth rate are calculated using simulations of distributions for the natural unemployment rates in 2005 and 2015. The baseline estimate corresponds to the median of the simulated distribution of the growth rate. In these simulations, the natural rates in 2005 and 2015 are assumed to have a correlation of about 0.5. The correlation means that having a natural rate in 2005 above the baseline estimate would tend to be associated with a natural rate in 2015 above the baseline forecast.

[40]The 0.5 percentage point spread reflected in the employment growth forecast is broadly in line with historical errors in BLS forecasts of employment. In BLS forecasts of employment (usually a measure somewhat broader than payroll employment) roughly ten years ahead, the root mean square error was about 0.35, implying a 70 percent confidence interval with width of about 0.7 percentage point. The smaller, subjective interval used in this article could be justified by improvements in forecast methods.

[41]The change in the foreign-born population between two periods equals the number of newly arrived immigrants less departures and (beginning-of-period) deaths of foreign-born U.S. residents. Net international migration equals newly arrived immigrants less emigrants who were foreign-born U.S. residents. Thus,

net migration during a specified period is the sum of change in the foreign-born population and deaths of those foreign-born counted at the beginning of the period.

[42]Estimates of the number of illegal aliens are usually derived by subtracting the (estimated) number of legal aliens from the total foreign-born population.

[43]Legal immigrants are those granted legal permanent residence. Legal nonimmigrants consist mostly of students and temporary workers, and their dependents, and they are allowed to live in the United States for specified periods of time for specific purposes associated with the types of visas they have. Illegal immigrants come to the United States by crossing the border illegally, or legal nonimmigrants may become illegal immigrants if they stay in the United States after their visas expire.

[44]Until 2000, the Census Bureau assumed a constant migration flow in this category in estimating annual net migration. However, a change in immigration law increasing the number of specialty workers granted H-1B visas during 1998-2003 forced the Census Bureau to change this assumption (Mulder). To improve estimates of net migration in the face of a rising number of foreign students in the United States, the Census Bureau is considering separate estimation of foreign students to be incorporated in the population estimates (Mulder).

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