

Skills-Based Employment Projections:
Replacement Index

by

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Introduction

For each job requirement, the replacement index is the proportion of total openings due to net replacements rather than growth. The index scale ranges from 0 to 100. As the value of the index increases, the proportion of openings that are replacements, not new jobs, also increases.

For example, production and processing knowledge is concentrated in manufacturing-related occupations. In a manufacturing downturn, openings for hires will largely reflect the need to replace workers who have separated, i.e., to fill vacant jobs, as opposed to demand driven by business expansion, i.e., to fill newly created jobs. In this scenario, the replacement index for production and processing will approach 100.

In contrast, therapy and counseling is a critical knowledge for many occupations in the growing healthcare industry. Hiring demand for workers with this knowledge area reflects the need for workers to fill new jobs, as well as to replace incumbents who have separated. Consequently, the replacement index for therapy and counseling is likely to be low.

A comparison of the two-year and ten-year replacement index yields a sense of the relative impact of business cycle and structural change on the demand for specific knowledge areas, skills, and work activities. Some industries are more cyclically sensitive than others, e.g., machinery manufacturing, and skills most concentrated in these industries will manifest a cyclical pattern not unlike the industries. By extension, other industries have been heavily impacted by structural change, e.g., air transportation,

and the mix of skills most germane to jobs in these firms will readily reflect the effect in the long-term horizon.

Calculating the Replacement Index

Total annual projected openings are derived from two component measures, openings due to growth and openings due to replacements. The former captures hiring activity motivated by business growth. As demand for an industry's goods or services fluctuates over time, employers respond by augmenting or contracting payroll employment. In the instance of an industry in an expansionary mode, some portion of the hiring of new workers is in response to the greater demand for goods or services. While the exact trigger point at which employers engage in sustained hiring is unclear, the general phenomenon of growth-driven demand for new workers is captured as a portion of total annual openings.

The second component of total annual openings is replacements, hiring activity motivated by the separation of incumbent workers from their job. The reason for a separation may be voluntary (promotion, career change, and retirement) or involuntary (illness and layoff). The importance of this measure is the recognition that demand for workers is stimulated, in part, by churning in the labor market as workers move from one occupation to another, or permanently withdraw from the labor force. One cautionary note, openings due to replacements does not encompass workers who change employers, but remain in the same occupation.

The replacement index represents the proportion of total annual openings due to replacements. For example, an index score of 75 for the two-year horizon, is interpreted

as seventy-five percent of the total annual openings in the next two years are projected to be due to replacements. Thus, approximately seventy-five percent of the hiring activity for this knowledge, skill, or work activity will likely reflect the departure of current incumbents. An increase in workforce capacity, i.e., new jobs, will account for only twenty-five percent of the hiring.

Several methodological issues are embedded in the construction of this index. The index, as mentioned, is calculated for specific job requirements: knowledge areas (e.g., economics and accounting, English language, and sales and marketing); skills (e.g., critical thinking and reading comprehension); and, work activities (e.g., documenting information and handling and moving objects). However, the unit of analysis in the estimation of this index is the occupations that comprise a job requirement. The Skills-Based Projections software links an occupation to a set of job requirements if the latter meets the default (or user-defined) criteria for importance and performance level for that occupation. Replacement openings are summed across all occupations that meet the criteria for each knowledge, skill, or work activity.

A second methodological issue concerns the distinction between total and net measures of replacements. The count of total replacements reflects the demand for labor due to the separation of an incumbent in an occupation. The reason for separation can be as varied as promotion and illness. Total replacements reflects the gross outflow of workers from an occupation, without regard to the inflow of entrants.

Net replacements, on the other hand, takes into consideration both the outflow and inflow of workers for an occupation. In an instance where employment in an occupation declines, net replacements is less than separations. Thus, entrants are fewer in number

than those who have separated. When employment increases, the assumption is that net replacements is equal to separations and the additional hiring is motivated by openings due to growth. States implement the net measure of replacements in the occupational employment projections and, therefore, the Skills-Based Projections application uses the same approach by default.

Finally, as mentioned, total annual openings has two components, projected openings due to net replacements and those due to growth. Replacements assume either a zero or positive value. A zero value corresponds to the extreme situation when all current incumbents in an occupation are displaced and there is no hiring into the occupation. This occurs when the sole employer of a specific occupation ceases operation, for example, the town's only bakery closes and its bakers are separated from employment. Admittedly, this situation is more likely in a local labor market than at the state or national level. In a more typical pattern of labor market behavior, openings due to net replacements is a positive value. The number of entrants to an occupation exceeds the number of incumbent separations from the occupation.

Similarly, the projected number of total annual openings due to growth also assumes either a zero or positive value. In an occupation with a projected employment decline, the calculation of total openings is derived solely from replacements; thus, the growth component of openings is zero. The assumption, in this circumstance, is that the projected employment decline is due only to the replacement phenomenon. The number of individuals separating from an occupation, whether voluntarily or involuntarily, exceeds the number of new hires. When employers are adding workers to build capacity,

in contrast, projected total openings in an occupation reflects growth-driven demand, as well as replacement needs, i.e, both are positive values.

In the Skills-Based Projections application, the calculation of the replacement index for the knowledge areas, skills and work activities is based on the total annual openings and openings due to replacements estimated for those occupations that meet the default (or user-defined) criteria for importance or performance level. Moreover, the index uses only the net replacement estimate, as is the case in the state occupational employment projections. Finally, a knowledge, skill or work activity with a replacement index approximating 100 is interpreted as projected demand driven entirely by replacement needs. At the other extreme, an index score near 1 indicates projected demand stimulated almost entirely by new jobs or growth.

Analysis of Replacement Rates

The US Bureau of Labor Statistics (BLS) compiles two files of replacement rates for use by states in the estimation of occupational employment projections. These rates reflect national data on the occupational movement of incumbents and new hires by age cohort. The utilization of these data in state occupational projections assumes a similar pattern of labor market behavior for demographic groups in a state and the nation.

The first BLS replacement file covers years one through five (referred to as short-term) and the second, years six through ten (referred to as long-term). In the estimation of two-year occupational projections, states implement a two-fifths share of the short-term replacement rate, thereby estimating a two-year horizon. In the ten-year projections, the replacement rates from both files are added together for a specific occupation and

represent a cumulative ten-year rate. In Fall 2003, BLS developed two replacement rate files covering projected years one to five and six to ten for states to implement in the 2002-2004 and 2002-2012 horizons.

The median value of replacement rates is similar in the short-term (years 1 to 5) and long-term (years 6 to 10) files, .1071 and .1177 (see Table 1). However, the standard deviation and skewness are markedly different. The former is almost twice as large in the short-term file (.05378 and .0317) and the latter, approximately three times larger (.2.978 and .9118). Moreover, the kurtosis is substantially higher in the short-term file, 16.5719 and 2.9182.

The short-term file not only has a higher concentration of values around the median, but also the upper bound (maximum value) of the distribution is .5372, compared to .2923 in the long-term file. These descriptive statistics suggest different distributional properties of values in the two replacement rate files that could indicate significant differences between projections horizons in the separation and entrant behavior in some occupations.

One question, though, is whether the variations reflect the impact of a small number of outliers or a more pervasive difference in the short-term and long-term replacement rates. The latter scenario, then, would suggest a systematic difference in the projected impact of the business cycle (short term) and structural change (long term) on the separation/entrant behavior of incumbents across occupations. A scattergram highlights a small number of outlier occupations with relatively high replacement rates in the short-term file, between .4 and .6, and moderate rates in the long-term file, between .1 and .2 (see Scattergram 1).

The exclusion of the most grievous outliers in the short-term file (four of 765 cases) diminishes considerably the dispersion of replacement rates. A comparison of short-term files, with and without the four outliers, shows a decrease in the standard deviation, .054 to .046, and the skewness, 2.98 to 1.56 (see Table 2). Indeed, the distribution of replacement rates in the adjusted short-term file more closely approximates the long-term file.

Given the similarity in the replacement rates in the two- and ten-year projections, an observed difference in the replacement index (the number of projected net replacements as a proportion of total annual projected openings) between these two time horizons is due to a variation in the growth-driven component of total openings. Therefore, a difference in this index across time does not reflect a time-dependent divergence in separation/entrant behavior across occupations; rather, it reveals the distinct impact of the business cycle and structural change on the relative contribution of replacement- and growth-driven demand on projected hiring.

To investigate this issue more closely, we compare the replacement index, as calculated in the Skills-Based Projections application, for a two-year (2002-2004) and ten-year (2002-2012) projection period using Illinois statewide occupational projections data. The percentage of total annual openings due to net replacement openings varies between these two time periods for some occupations, but not for others. Scattergram 2 plots short-term and long-term replacement indices for all occupations.

The plot depicts two distinct linear patterns. Most obvious, nearly sixty percent of all occupations (441 of 765 cases) show a maximum of 100 on the short-term index (x axis) and values that range downward from 100 on the long-term index (y axis) (see

Scattergram 2). In the two-year horizon (short term), total annual projected openings in these occupations is due only to replacement needs. In the 10-year horizon (long term), demand due to growth is a more prominent component, i.e., the display of intermediate values in the long-term index. As mentioned, the underlying replacement rates between these two horizons show a comparable distribution; therefore, the contrast in the demand components between these two time periods can be attributed to differences in projected total openings. Ultimately, the differences can be traced to the pattern of projected industry employment, a primary input to the occupational projections.

In the Illinois data, those occupations with the greatest difference between the short-term and long-term replacement indexes are heavily concentrated in construction and entertainment/media; the two-year demand for these occupations is exclusively replacements whereas the 10-year demand is mostly growth. The projection for these industry sectors is a cyclical downturn (two year) followed by a return to positive trend growth in the extended time period (ten year). These industry forecasts, then, manifest themselves in the occupational projections. The projected industry downturn produces an occupational demand that reflects only replacements whereas the projected return to trend growth will generate an occupational demand motivated by both growth-driven and replacement-driven hiring. The impetus for growth-driven hiring is the creation of new jobs.

The second linear pattern in Scattergram 2 may be slightly less obvious, but, nevertheless, persists in the Illinois data. There exists a general concentration of values at a forty-five degree angle extending from the point of origin on the graph. Thus, as values increase along the short-term index (x axis) there is a commensurate increase in the long-

term index (y axis). More specifically, the relative composition of total openings between replacements and growth is similar across these occupations for the two projection horizons. Occupations that are weighted toward more growth-oriented hiring (creation of new jobs) in the short-term demonstrate a comparable dynamic in the long-term.

Occupations related to education and healthcare industries cluster among cases with similar short-term and long-term replacement indexes, i.e., vary by only ten percent. In fact, these industries are growth sectors in both sets of Illinois projections and, consequently, the industry-specific occupations display a similar symmetry of replacement and growth demand in the two timeframes.

This second linear pattern also includes one hundred and forty occupations with a value of 100 for both the short-term and long-term replacement index. In these occupations, replacement demand is the only active component of the two-year and ten-year projected annual openings. Not surprisingly, production occupations are the largest segment of these cases. The manufacturing sector is projected to decline in both time horizons and, therefore, the expectation in many production occupations is no creation of new jobs.

Appendix

Table 1- Comparison of Replacement Rates: Short-Term and Long-Term Files

Short-Term (years 1-5)		Long-Term (years 6-10)	
Mean	0.1150	Mean	0.1177
Standard Error	0.0019	Standard Error	0.0011
Median	0.1072	Median	0.1177
Mode	0.1072	Mode	0.1186
Standard Deviation	0.0538	Standard Deviation	0.0317
Sample Variance	0.0029	Sample Variance	0.0010
Kurtosis	16.5719	Kurtosis	2.9182
Skewness	2.9774	Skewness	0.9118
Range	0.5105	Range	0.2604
Minimum	0.0267	Minimum	0.0320
Maximum	0.5372	Maximum	0.2924
Sum	87.9725	Sum	90.0415
Count	765	Count	765

**Scattergram 1- Comparison of Replacement Rates:
Short-Term and Long-Term Files**

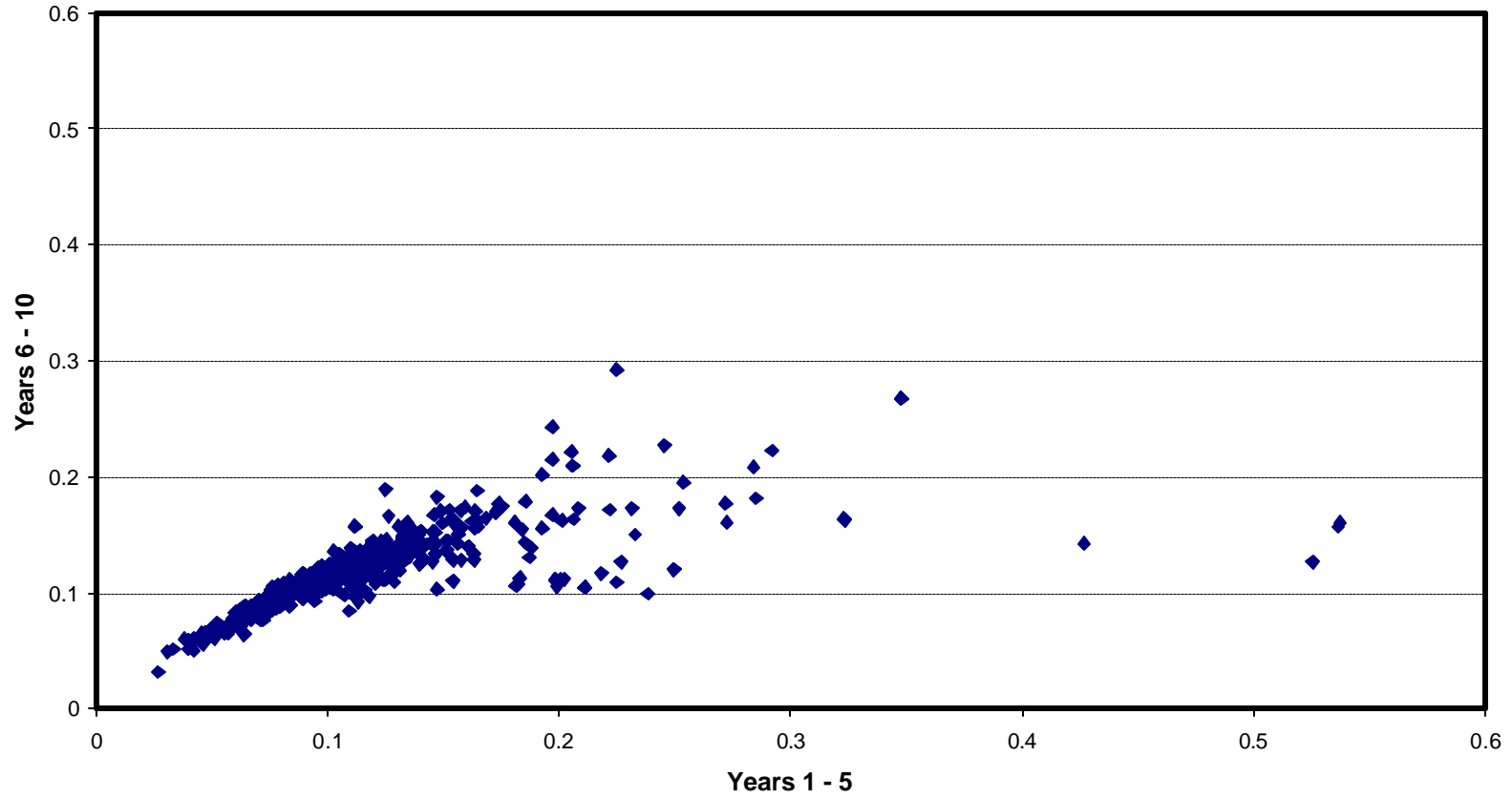


Table 2- Replacement Rates Short-Term File: Adjusted for Outliers
(four outliers deleted)

Short-Term (years 1-5)	
Mean	0.1129
Standard Error	0.0017
Median	0.1072
Mode	0.1072
Standard Deviation	0.0457
Sample Variance	0.0021
Kurtosis	4.2522
Skewness	1.5648
Range	0.3210
Minimum	0.0267
Maximum	0.3478
Sum	85.9463
Count	761

**Scattergram 2- Replacement Index:
Short-Term and Long-Term Occupational Projections**

