Earnings Mobility and the Great Recession

Brett Mullins
College of Information and Computer Sciences
University of Massachusetts, Amherst
Amherst, MA, 01003

David L. Sjoquist
Department of Economics and Center for State and Local Finance
Georgia State University
Atlanta, Georgia 30303

Sally Wallace
Department of Economics and Center for State and Local Finance
Georgia State University
Atlanta, Georgia 30303
African Tax Institute, University of Pretoria RSA

Abstract:

We calculate mobility indices for low-wage workers for 7-year periods to explore the differences in mobility between the pre- and post-Great Recession periods. We find that mobility is greater in the post-Great Recession period. We also calculate three-year mobility indices for the period 2000 – 2015 and find that there is substantial variation in mobility indices in the post-2007 period. We also find that the variation in three-year mobility indices over the period 2000 - 2015 is closely related to the unemployment rate.

Keywords: Earnings mobility; Low-wage workers

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1. Introduction

The Great Recession of 2007-09 was a very significant economic event. The seasonally unadjusted unemployment rate increased from 4.3 percent in May of 2007 to 10.6 percent in January 2010. Homeowners lost $7 trillion in home equity, and foreclosures quadrupled (Ellen and Dastrup 2012). Over 400 banks failed between 2008 and 2012 (Lazette 2017). The macro and economic sector effects were immense and had substantial impacts on individuals; many of these effects have been heavily studied. One important but unexplored consequence of the Great Recession is its effect on earnings mobility among low-income individuals. In this paper, we explore the relationship between the Great Recession and the intra-generational earnings mobility among a sample of low-income individuals. In particular, we compare earnings mobility among low-wage individuals pre- and post-Great Recession.

There is a substantial literature that explores income and earnings mobility in the U.S. Several reviews of the mobility literature have been published; the most recent is the very extensive review by Jäntti and Jenkins (2015). Most studies that measure intra-generational mobility use survey data such as the Panel Study of Income Dynamics (PSID) (for example, Hungerford 1993, 2011; Bradbury 2016; Fisher et al. 2016; Acs and Zimmerman 2008; Burkhauser, Holtz-Eakin, and Rhody 1998; Cantó and Ruiz 2015), income tax return data (for example, Larrimore, Mortenson and Splinter 2015; Carroll, Joulfaian, and Rider 2007; Auten, Gee, and Turner 2013; Auten and Gee 2009; Bradbury and Katz 2002), Social Security administrative records (for example, Kopczuk, Saez, and Song 2010), or the National Longitudinal Survey of Youth (NLSY) (for example, Buchinsky and Hunt 1999; Schiller and Mukhopadhyay 2013).

To the best of our knowledge, no one has focused exclusively on the earnings mobility of low-income individuals in the U.S. Nor has anyone compared mobility pre- and post-Great Recession. The labor market experiences of low-skilled workers are more volatile than that of higher-skilled workers since low-skilled workers have weaker attachment to the labor force, are more likely to suffer a spell of unemployment, and experience employment spells that are of shorter duration than workers with more education (Kiefer 1985; Royalty 1998). Thus, low-wage workers experience greater instability of earnings. We expect that this labor market instability would lead to increased earnings mobility, i.e., to changes in the rank order of low-wage workers.

The Great Recession caused an increase in labor market instability. Thus, by comparing earnings mobility pre- and post-Great Recession, we can explore the effect of increased labor market instability on earnings mobility. But the Great Recession could have also affected earnings mobility in other ways. The Great Recession might have lowered workers' tolerance for change, leading workers to be less inclined to change jobs. In addition, the social safety net (food stamps, earned income tax credit, Unemployment Insurance) could have provided low-income families with the finances that allowed them to remain in their less-than-ideal employment position. On the other hand, coming out of the Great Recession the low-skilled labor market might have been out of equilibrium, with workers not in their best employment position. Consequently, over the post-Great Recession period workers might have been more likely to shift positions, resulting in larger earnings mobility.

The published research that is most closely related to our research is Fisher et al. (2016). They use the PSID for 1999-2013 to investigate the level and trend in inequality in income, consumption, and wealth across the entire PSID sample. They calculate Shorrocks' mobility

index for two sub-periods, 2001-2007 and 2007-2013, and find that income mobility is slightly smaller in the second period. Our research differs from theirs in that we consider an individual's earnings rather than household income, consider only individuals in low-income households, and consider periods that more accurately capture the pre- and post-Great Recession periods. We also use a rich administrative dataset with a much larger sample than found in the PSID.

We examine the earnings mobility of low-income individuals in Georgia in the pre-Great Recession period and post-Great Recession period; the latter is identified as the period from the onset of the recession. We identify low-income individuals by their participation in the Supplemental Nutrition Assistance Program (SNAP). As described in detail in the next section, we assemble administrative records for SNAP beneficiaries in Georgia and match them with employment security (ES202) records on wages for the period 2000 through 2015.[1] We first calculate several indexes of mobility for two 7-year periods, January 2001 through December 2007, and January 2008 through December 2014. We also calculate three-year mobility indices over the period 2000 through 2015.[2] We calculate and analyze position-relative and dollar-relative changes for these individuals.[3]

This study makes four contributions to the literature on earnings mobility. First, we examine the earnings mobility of only low-earnings individuals. Second, we use administrative data rather than survey data; the advantage of using administrative data is that they are less prone to reporting errors than survey data like the PSID or the Supplemental Income and Program Participation (SIPP) and they offer large numbers of observations. Third, we examine earnings

[1] The ES202 is now more commonly referred to as the Quarterly Census of Employment and Wages (QCEW).

[2] We have created an R package called *mobilityIndexR* that calculates transition matrices and mobility indices following the methods described in this article (Mullins and Harkreader 2021).

[3] Position-relative mobility measures changes in rank order while dollar-relative mobility measures movement across inflation-adjusted earnings categories.

mobility over two 7-year periods pre- and post-Great Recession and for all three-year periods between 2000 to 2015. Fourth, we explore the relationship between the unemployment rate and mobility; we are unaware of any prior consideration of this relationship.

One limitation of this research is that we have data for only one state. Although the data are not nationally representative, Georgia is a large state (ranked 9th in population in 2010) and in many ways is representative of an average or typical U.S. state. For example, in 2008, Georgia's median household income ranked 23rd and the percentage of the population with a bachelor's degree or more and the percentage that are homeowners are essentially the same as the national average. Given the nature of this study, we believe that the advantages of administrative data are worth the tradeoffs in terms of limited geographic coverage. An additional limitation of the data is that we cannot include low-income individuals who did not participate in SNAP.

To preview our results, we find that the 7-year earnings mobility indices are statistically significantly larger in the post-Great Recession period than in the pre-Great Recession period. We find that three-year earnings mobility was relatively constant during the pre-Great Recession period, increased during the Great Recession and declined in the period since the end of the Great Recession. We find that the state unemployment rate explains a substantial percentage of the variation in the three-year earnings mobility.

The remainder of this paper is organized as follows. In the next section, we describe the data used in this study. The third section contains the findings for the pre- and post-Great Recession period, while the fourth section contains the analysis of the three-year earnings mobility. A summary section concludes the paper.

2. Data

We utilize two administrative datasets from Georgia – SNAP participants and unemployment insurance wage data. The SNAP data are monthly records of every person enrolled in SNAP and were obtained from the Georgia Department of Human Services (GDHS). The wage records are quarterly wages of employees covered by unemployment insurance and were obtained from the Georgia Department of Labor. We match the records in the two files using unique identifiers.

We create several samples of SNAP recipients to identify earnings mobility. Consider first the samples we use for the two pre- and post-Great Recession periods. *Exist2001* consists of all individuals enrolled in SNAP in January 2001, while *Exist2008* consists of all individuals enrolled in SNAP in January 2008. *New2001* is a file of SNAP participants who were enrolled in SNAP in January 2001, but not in December 2000. Thus, these are new SNAP enrollees in 2001. *New2008* is an equivalent file of those who were enrolled in SNAP in January 2008 but not in December 2007. Note that our definition of the post-Great Recession period includes the period of the Great Recession as well as subsequent years.

Since we are interested in long-run earnings mobility of program participants, we consider individuals who would potentially be in the labor force during the entire period. We therefore exclude seniors and minors from the sample. More specifically, we exclude individuals who would be at least sixty-five years old at any point during the sample period, i.e., individuals who are older than 57 in January 2001 for *New2001* and *Exist2001*, and in January 2008 for *New2008* and *Exist2008*. An individual is designated a minor and excluded from the samples if the SNAP enrollee is less than eighteen years of age in January 2001 or in January 2008. Table 1 provides demographic summaries of the samples. Of note is that the SNAP samples for the second period are much larger than for the first period, a result of the Great Recession.

One potential concern with our samples is that the demographic composition differs between the two periods (Table 1). To the extent that earnings mobility differs by demographic characteristics, differences in earnings mobility between the two periods could be due to the different composition of the sample and not due to the Great Recession. While the differences in demographic characteristics are small, they are statistically significant. The sample sizes are very large, so even extremely small differences in characteristics are statistically significant; the differences in the percent of individuals with children is particularly large. The differences between the two periods in the racial and gender composition are perhaps the most relevant for comparing earnings mobility.

To address this issue, we created alternative, matched samples for the second period, denoted *Exist2008M* and *New2008M*. To do this, we created sub-samples of *Exist2008* and *New2008* that are the same size as and have very similar demographic characteristics as *Exist2001* and *New2001*. We used propensity score matching to select the matched samples.[4] The differences in the demographic characteristics for *New2008M* and *New2001* samples and for the *Exist2008M* and *Exist2001* samples are very small and, other than the percent with children, are not statistically significant (Table 1).

When an individual is no longer enrolled in SNAP, we can no longer rely on SNAP records to observe earnings. Therefore, we use administrative records from the Georgia Department of Labor (GDOL) to measure annual earnings for all years. These data come from Form ES202, which is filed by employers as required for the administration of the unemployment insurance program and consist of quarterly employment and wage reports for

[4] To obtain matched samples for Exist2008 and New2008 with the distribution of demographics similar to Exist2001 and New2001, respectively, we use propensity score matching (PSM) where belonging to the 2001 dataset is the response and the demographics presented in Table 1 are the predictors. As is typical with PSM, we use a greedy algorithm to match like scores between Exist2001 and Exist2008 as well as New2001 and New2008.

each employee of a firm. The form includes the wages paid by the firm to that employee during a given quarter and a unique identifier for each employee, which permits us to match these data to the SNAP records.[5] If an individual has multiple employers in a given quarter, we construct their total wage and salary income by *quarter* by identifying each firm for which the individual has reported earnings. This permits us to construct a measure of *annual* earnings for each individual in the sample by summing over the quarterly reports of wage and salary income for every employer of that individual during a given year. Using ES202 data, we identify annual earnings for these individuals in the *Exist2001* and *New2001* samples for the four quarters of 2001 and the four quarters of 2007, and for the four quarters of 2008 and the four quarters 2014 for the *Exist2008* and *New2008* samples. Thus, we have the same number of years in the pre- and post-Great Recession periods. After matching the SNAP records with the Department of Labor earnings records, we drop any individual who had zero earnings in the first and last years of either of the two periods since they do not appear to be active workers and have zero mobility.

As with the demographic variables, we want the differences in the distributions of earnings between samples to be small. To reflect differences in the distribution of earnings we computed coefficients of variation for all 6 of our samples. The differences across the four pairs of samples equivalent to the pairs in Table 1 are small; the maximum percentage difference is 4.2 percent.

For the three-year mobility analysis, we identify new SNAP recipients following the same procedures as above; we do not use existing SNAP recipient samples for this analysis. Our

[5] We create a categorical variable for each month that indicates an individual's enrollment status with regard to SNAP; this variable is extracted from the Department of Human Services datasets. An individual is identified by a unique identifier; however, not all the identifiers could be matched in both datasets. Therefore, a number of individuals are excluded from the dataset. The proportion of unmatched identifiers in the SNAP dataset varies between 0.5 and 4.5 percent for a given month.

first sample consists of those who are in SNAP in the second quarter of 2000 but not in the first quarter of 2000. We compare earnings in the first four quarters of enrollment to earnings in the four quarters beginning two years after enrollment. We identify a new set of SNAP recipients each quarter, the last such quarter being the fourth quarter of 2012. Thus, we have a total of 51 three-year samples. We also calculated matched samples, using propensity score matching for each of the 51 quarters; however, since the mobility indices using the matched samples are essentially the same as those for the unmatched samples, we only report results using the unmatched samples.

There are some disadvantages to using ES202 data to measure earnings mobility. First, we cannot observe out-of-state earnings. Furthermore, we cannot observe wages from the informal sector as well as wages paid by an employer that for whatever reason does not file Form ES202 or fails to report the earnings of some or all of its employees. Finally, self-employed individuals are not required to file Form ES202; therefore, we cannot account for self-employment income.

There are a few observations for which reported earnings are unreasonably high for an individual on SNAP. This might occur because of errors in the matching, or because an individual might, for example, have been on SNAP in January but had large earnings in February and March. We dropped any observation that had real annual earnings in excess of $50,000 (2008 CPI = 100) for 2001 and for 2008. These adjustments reduced the samples by less than 0.25 percent. The data in Table 1 are demographics for the final samples.

3. Pre- and Post-Great Recession Results

We first compare earnings mobility in the pre-Great Recession period (2001 - 2007) to that in the post-Great Recession period (2008 - 2014). To calculate mobility indices, we first create *k* by *k* transition matrices, with the rows representing earnings at the beginning of the period and the columns representing earnings at the end of the period. The literature usually sets *k* equal to 5 and assigns 20 percent of the sample to each row. However, an issue that we confront is that individuals with zero earnings at the beginning of any period comprise more than 20 percent of the sample. We address this by adding a sixth earnings category, which is the first row of the transition matrix, that includes all zero earners, and then assign 20 percent of the remaining observations to each of the remaining 5 rows. (An alternative would have been to use a 5x5 matrix and thus put an arbitrary 20 percent of the zero earners in the first cell and the remainder in the second cell.)

For the position-relative mobility indices, we assign, based on ending year earnings ordering, the same percentage of the observations to each column of the transition matrices as we did for rows. For the dollar-relative mobility indices, the column widths of the transition matrices equal the dollar ranges, in real terms, of the corresponding rows.

We consider several indices since there is no singular concept of mobility, and as Jäntti and Jenkins (2015) note, different measures of mobility can yield different conclusions. We calculate both position-relative mobility indices and dollar-relative mobility indices. The former are measures of changes in rank, i.e., a change from row *i* to column *j* ($i \neq j$), while the later captures changes in real earnings. We calculate the following mobility indices: the Average Movement index, which measures the average change in rank; a rescaled version of Shorrocks' mobility index that we refer to as Weighted Group Mobility (WGM), which measures the conditional probability of changing rank weighted by the column totals; the Prais-Biddy

index, which measures the percentage of observations that move from the trace of the transition matrix; and two Origin Specific indices denote I_{OSTF} and I_{OSBF}, which are the probabilities that an individual moves from the top (bottom) rank to the 4th rank or lower (3rd rank or higher). See Appendix A for the formulas and a brief discussion of the indices.

Table 2 contains the calculated mobility indices for the position-relative (rank) transition matrices and the dollar-relative transition matrices. There are 40 inter-period comparisons, and all of them imply that mobility is larger in the post-Great Recession period. The results are similar regardless of which samples we use and whether we consider the position-relative or dollar-relative mobility indices.

To test the statistical significance of the differences in the mobility indices between the two periods, we calculate bootstrapped confidence intervals at the 95 percent confidence level. We test for whether the indices for the 2008 samples are greater than indices for the corresponding 2001 samples.[6] For the Average Movement, WGM, and Prais-Biddy indices, all inter-period differences in mobility are statistically significant. However, while the two Origin Specific indices suggest an increase in mobility, eight of the 16 Origin Specific index differences are statistically insignificant.

Our results imply that earnings mobility of low-wage workers was larger in the post-Great Recession period. This result is consistent with our discussion above that greater labor market instability should lead to larger earnings mobility. We cannot identify specific factors that caused the increase in mobility, but one obvious potential explanatory factor is that during the post-Great Recession period, unemployment, both rate and duration, was high. The shift from unemployment status at the beginning of the period to employment status will likely result in a

[6] The hypothesis tests are one-sided.

significant increase in earnings, leading to earnings mobility, measured both as position-relative and dollar-relative indices. (We explore more fully the effect of unemployment on mobility in the next section when we consider the three-year mobility indices.) Also note that for the dollar-relative mobility the difference in the value of I_{OSBF} is much larger than for $I_{OSTF.}$ That is, there is a larger percent of individuals in the bottom rank who move up ranks than those in top rank who move down ranks. This result is consistent with declining unemployment during the post-Great Recession period as employment recovered.

A concern with these data is that a zero earnings value in the last year could be due to the individual having moved out of state or otherwise attrited from the samples. Of course, zero earnings in the final year of the period does not mean that the individual moved out of the state or died. While we cannot identify attriters, we can consider the possible effect of attrition. First, there is little difference in the potential rate of attrition between the two periods. For *New2001*, 78.6 percent of individuals in the sample either had positive earnings or were enrolled in SNAP during 2007, the last year of pre-Great Recession period. Similarly, for *New2008*, 80.0 percent of the individuals in the sample either had positive earnings or were enrolled in SNAP during 2014. Second, except for the percentage of individuals with children, there is no statistically significant difference in demographic characteristics between individuals with either positive earnings or enrolled in SNAP during the last year of the period and those without earnings or not enrolled in SNAP for either of the 2001 and 2008 samples.

Third, we dropped observations that were not in the SNAP file and/or had zero earnings in the final year for each period, and calculated mobility indices for the two periods. As expected, given that we dropped individuals with zero earnings in the final years, the values of the mobility indices are a bit smaller than those reported in Table 2. (For example, the WGM

index is about 8 percent smaller for each period.) However, the mobility indices for the post-Great Recession period are statistically significantly larger than for the pre-Great Recession period, which is consistent with the results in Table 2. This suggests that the effects of actual attrition on differences in earnings mobility between the two samples are likely to be minimal.

It is possible that any difference in earnings mobility between the pre- and post-Great Recession periods is simply a continuation of an existing trend and not the result of the Great Recession. There are several papers that compare mobility between two recent periods. Those papers for which the second period ended sometime after 2000 generally find either that mobility was a bit lower in the second period or that there was no change. Cantó and Ruiz (2015) find a decrease in mobility using PSID data to compare mobility between two short periods, 2004-2006 and 2006-2008. Kopczuk, Saez, and Song (2010) use Social Security administrative data from 1937-2004 and find a slight decrease in earnings mobility since the early 1990s. Bradbury (2016), using PSID data, reports that there is little change in income mobility from one period to the next, although mobility was lower in the 2001-2011 period than in the 1991-2001 period. Acs and Zimmerman (2008) use the PSID and find no change in income mobility between 1984-1994 and 1994-2004. Auten and Gee (2009) use tax data and find that mobility was very similar in 1987-1996 and 1996-2005. Fisher et al. (2016) find a slightly smaller mobility index for the 2007-2013 period than the 2001-2007 period. Thus, there is no clear consensus from the literature regarding the trend in income mobility for the population at large.

As noted above, we calculate mobility indices for three-year sub-periods between 2000 and 2015. As we show in the next section, the trends in these three-year mobility indices suggest that earnings mobility did not increase over the 2001-2007 period. Thus, the greater mobility in

the post-Great Recession period does not appear to be a continuation of a positive trend in mobility.

Next, we explore how the changes in mobility between the pre- and post-Great Recession differ by gender and race (Table 3). We report the results using WGM indices, but the Average Movement and Prais-Biddy indices yield equivalent results. For females, whites, and nonwhites, mobility increased between the two periods, and the differences are statistically significant. For males, the differences are not statistically significant, although the difference is positive for the position-relative WGM index. It is of interest to note that the values of the WGM index are larger for males than for females and are larger for whites than nonwhites; we did not determine if these differences are statistically significant. The change in WGM is larger for females than for males, and is larger for whites than nonwhites for the position-relative WGM and the same for the dollar-relative WGM.

4. Three-year Mobility Indices

We turn now to an analysis of mobility indices for the three-year sub-periods. We calculate the position-relative and dollar-relative mobility indices and rely on the WGM and Prais-Biddy indices. The correlation between the Average Movement and the Prais-Biddy indices is 0.96, so we do not report the Average Movement index.

Figure 1 is a graph of the WGM position-relative index for the 51 three-year periods (the graph of the Paris-Biddy index is very similar and thus not shown). We distinguish between index values that are based on earnings that are entirely from the pre-Great Recession period, denoted *PRE*; that include any Great Recession quarters, denoted *GR*, and; that are entirely from

the quarters after the end of the Great Recession, denote *POST*.[7] Figure 1 suggests that there is a negative trend in the WGM indices in the pre-Great Recession period. Thus, as we noted above the positive difference in mobility between the 2001-2007 and 2008-2014 periods identified in Table 2 is not likely a continuation of a pre-Great Recession trend. Note that the values of the WGM index are larger for the Great Recession period than for the pre-Great Recession period, and that the values decline during the post-Great Recession period. While the three-year mobility indices in the post-Great Recession period fall over the period, the average of these mobility indices is larger for the post-Great Recession period than for the pre-Great Recession period.

Figure 2 is an equivalent graph for the dollar-relative WGM index. The graph is very similar to the graph for the position-relative WGM index (Figure 1). The dollar-relative WGM indices are slightly smaller than the position-relative WGM indices; on average they are 2.2 percent smaller. Similarly, the pattern for the dollar-relative Prais-Biddy index is very similar to the position-relative Prais-Bibby index.

To more precisely measure how mobility varies over the three periods, we estimated the following regression:

$$Index_T^i = \beta_0 + \beta_1 T + \beta_2 GR + \beta_3 POST + \beta_4 T * GR + \beta_5 T * POST + \epsilon_t \qquad [1]$$

where $Index_T^i$ is the value of mobility index i, T is an index reflecting the year and quarter and ranges from 1 to 51, *GR* is a dummy variable equal to one in the Great Recession period and zero otherwise, and *POST* is a dummy variable equal to one in the post-Great Recession period and zero otherwise. The pre-Great Recession period is the excluded period. Table 4 contains the results using WGM and Prais-Biddy indices as the dependent variables.

[7] The NBER dates the Great Recession from December 2007 through June 2009. We consider *PRE-GR* to go through the 4th quarter 2007, and POST-GR to begin the 3rd quarter 2009.Thus, there are 19 observations in the PRE-GR period, 18 in the GR period, and 14 in the POST period.

Consider first the position-relative indices (columns 1 and 2 of Table 4). The coefficient on *T* is negative and marginally significant for the WGM index and positive but statistically insignificant for Prais-Biddy index. These coefficients imply that the pre-Great Recession trend is not positive. The coefficients on *T*GR* are positive and statistically significant, implying that the mobility indices increased during the Great Recession period. The coefficients on *T*POST* are negative and statistically significant, implying that the mobility indices decreased during the post-Great Recession period. These coefficients are consistent with what is observed in Figure 1. Columns 3 and 4 are equivalent regressions for the dollar-relative indices; the coefficients are qualatively equivalent to those in columns 1 and 2.

There are significant differences in the trends in mobility across the three sub-periods, as implied by Figure 1 and Table 4. One likely explanation is the variation in unemployment over the periods. In Figure 3 we plotted the unemployment rate in the last month of each period (left hand axis) and the position-relative WGM (right-hand axis). As can be seen, the two lines track each other well.

To understand the relationship between unemployment and position-relative mobility, assume that there are no other changes in wages over a period other than through unemployment. Thus, in the absence of unemployment measured mobility would be zero, i.e., everyone would be on the trace of the transition matrix.

Consider first the case in which unemployment exists only in the final year, and as a result the unemployed suffer reduced earnings that year. If the decrease in earnings among the unemployed is large enough to shift workers to a lower rank, then the position-relative mobility index will be greater than zero, The larger the unemployment in the final year, then presumably the greater the position-relative mobility index.

Next consider the case of unemployment in the initial year but no unemployment in the final year. The effect of this case on the mobility index depends on the extent to which earnings return to their pre-unemployment level by the end of the period, and on whether that change in earnings is sufficiently large to shift workers to a higher rank. If so, then mobility would be larger the larger is initial unemployment.

Finally, consider the case in which there is unemployment in both the initial year and the final year. Consider a worker who is unemployed in both the first year and last year. If the effect on earnings from unemployment is the same in both initial and final year, and if the lower wages resulting from the first period unemployment recover, then the earnings in the first and last year will be the same. Thus, there will be no mobility for that worker and mobility will depend on the incidence across all individuals of unemployment in the first year and last year. Of course, the mobility indices will also reflect changes in wages unrelated to unemployment. However, if a larger initial-year unemployment results in changes in earnings that are smaller and less variable across workers, then larger initial year unemployment will result in less measured mobility.

Based on this discussion, we expect that position-relative mobility will be positively related to the ending year unemployment rate, but the effect on initial year unemployment rate is uncertain. To explore this issue, we first conducted a very simple simulation exercise (see the Appendix B for the details). For the simulation, we assumed an initial distribution of earnings, denoted *EarnA*. We then randomly assigned wage changes, and randomly assigned unemployment and unemployment durations from one of two alternative distributions. The first distribution assumes low unemployment level and short duration while the second distribution assumes a much worse employment condition. The resulting distributions of earnings after randomly assigning the change in wages, unemployment, and unemployment duration are

denoted *EarnB* and *EarnC*. The position-relative WGM index for the two pairs of earnings distributions, *EarnA*-*EarnB* and *EarnA*-*EarnC,* are 0.592 and 0.710, respectively.

As expected, a worse ending period employment condition results in a larger value of the position-relative WGM index. We also calculated the position-relative mobility index for the case in which there is unemployment in both the initial and final year and earnings recover from the first year unemployment, that is, we use the pair *EarnB*-*EarnC*. The resulting value of the position-relative WGM index, 0.335, which is substantially smaller than for either of the *EarnA*-*EarnB* and *EarnA*-*EarnC* distributions. The dollar-relative WGM indices are 0.585 and 0.634 for *EarnA*-*EarnB* and *EarnA*-*EarnC,* respectively, which are a bit smaller than for the position-relative indices.

The simulation results are consistent with what we observe in Figure 1, i.e., the growing value of the position-relative indices during the Great Recession and the declining value during the post-Great Recession period, and the more constant value of the dollar-relative indices throughout the entire period.

To further explore the effect of unemployment on mobility, we regressed the value of the position-relative and dollar-relative WGM indices against the Georgia unemployment rates for initial and ending month for each sub-period (Table 5). For the position-relative WGM index, the coefficient on the initial unemployment rate is negative, while the coefficient on the ending period unemployment rate is positive, both are statistically significant. For the dollar-relative WGM index, the coefficients on the unemployment rate are both positive but only statistically significant ending period unemployment rate.

We also explored whether it mattered if the initial month's unemployment rate was larger or smaller than the final month's unemployment rate. We created two variables, the smallest and

largest unemployment rate in each of the three-year periods. Using these two variables, we re-estimated the regressions in Table 5. The results are qualitatively similar to those reported in Table 5, but the R^2's are substantially smaller, suggesting that it is the initial year and final year unemployment rates rather than the minimum and maximum unemployment rates during any period that matters in explaining mobility.

5. Summary and Conclusions

We explore the effect of the Great Recession on earnings mobility among low-wage workers using Georgia administrative data. We estimate several mobility indices for the 7-year periods pre- and post- the onset of the Great Recession and argue that the larger earnings mobility is the result of the increased labor market instability during the Great Recession and subsequent years. We find that males (whites) have larger mobility indices than females (non-whites) (based on the WGM index) and that females (whites) have larger increases in earnings mobility post-Great Recession than males (non-whites).

We also calculate mobility indices for 51 overlapping three-year intervals over the 2000 to 2015 period. We find substantial variation across the period in earnings mobility, but with an increasing trend during the Great Recession, particularly early in that period, and a decreasing trend after the Great Recession ended. The variations in the three-year mobility measures are highly associated with the unemployment rates in the intervals.

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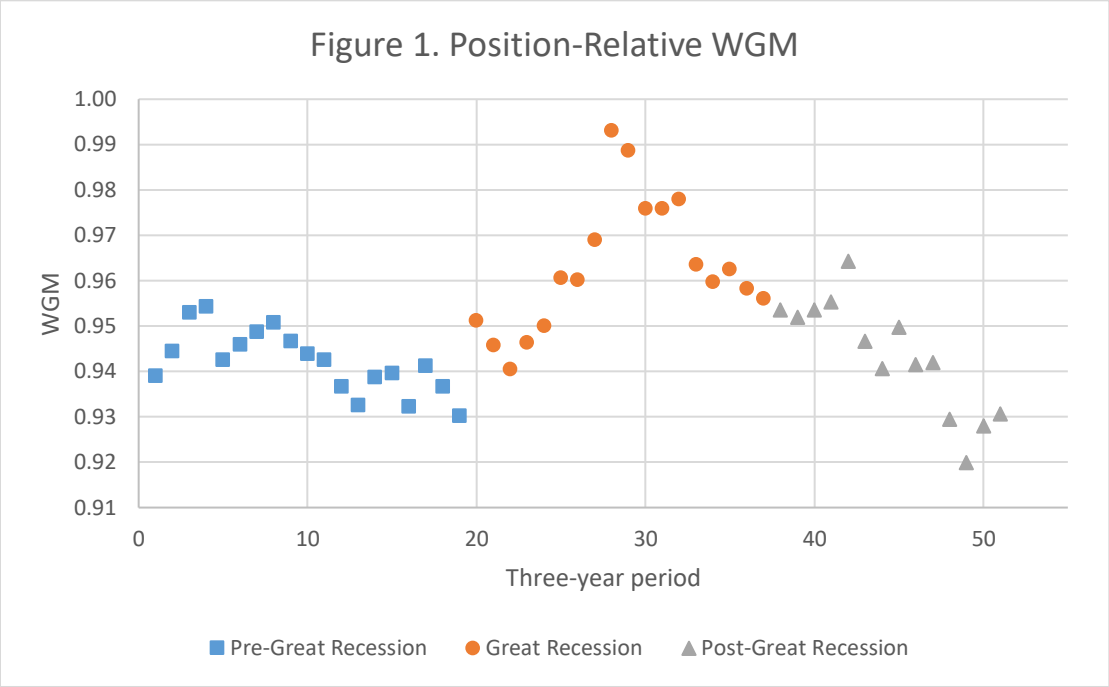
Figure 1. Position-Relative WGM
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
WGM
0
10
20
30
40
50
Three-year period
Pre-Great Recession
Great Recession
Post-Great Recession

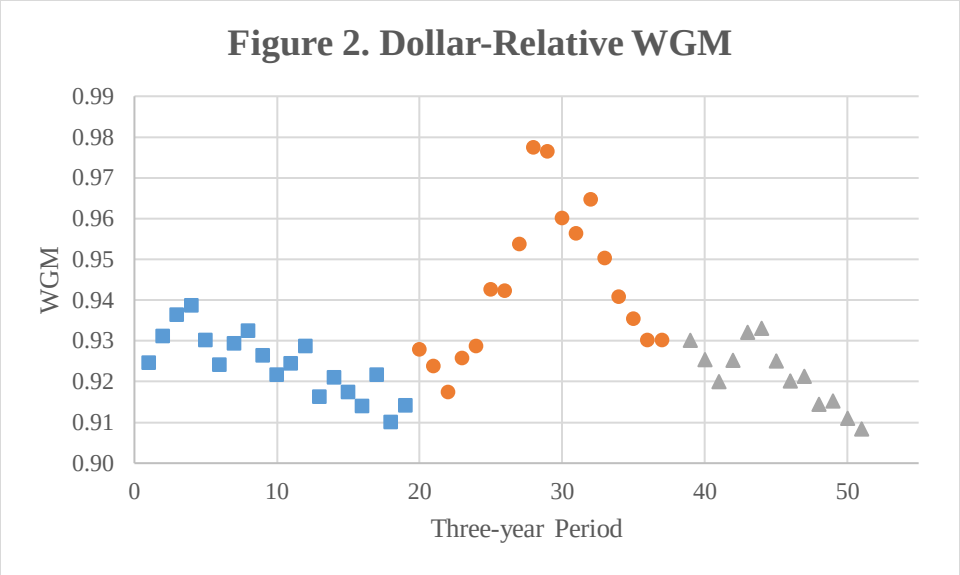
Figure 2. Dollar-Relative WGM
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
WGM
0
10
20
30
40
50
Three-year Period

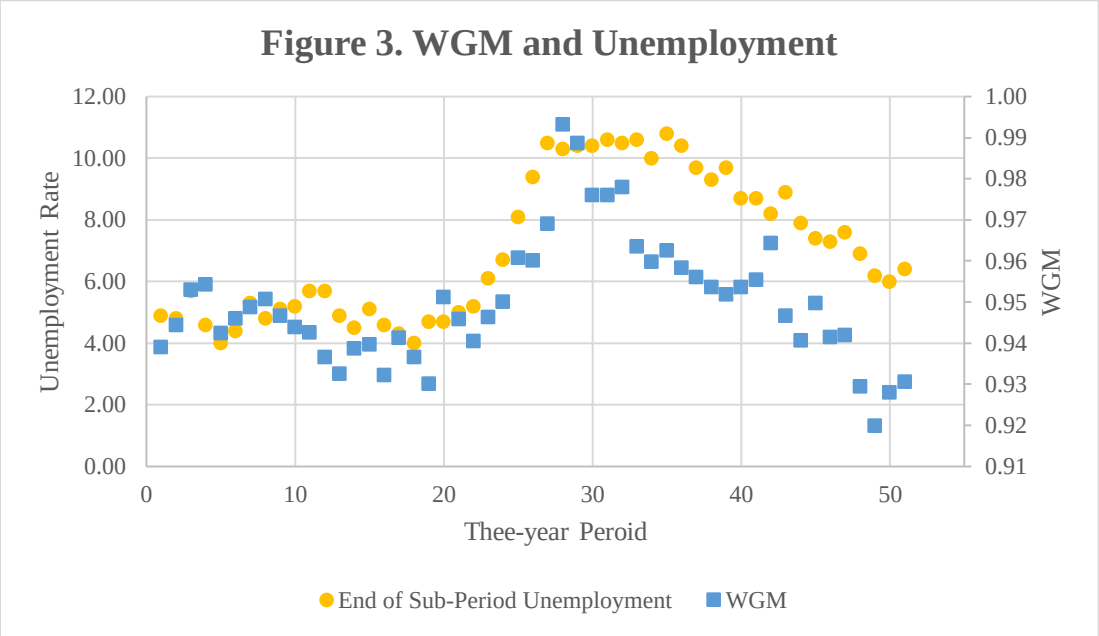
Figure 3. WGM and Unemployment
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Unemployment Rate
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
WGM
0
10
20
30
40
50
Thee-year Peroid
End of Sub-Period Unemployment
WGM

Table 1. Descriptive Statistics

Sample Name	Exist2001	Exist2008	Difference
Sample size	139,892	249,489	
% White	27.98%	31.87%	-3.89***
% Female	81.16%	78.09%	3.07***
Mean Age	30.69	31.24	-0.55***
% Married	13.83%	14.84%	-1.00***
% with children	53.42%	46.04%	7.38***
Sample Name	New2001	New2008	Difference
Sample size	16,218	20,094	
% White	38.77%	37.19%	1.59***
% Female	70.95%	66.43%	4.52***
Mean Age	30.91	31.89	-0.98***
% Married	18.71%	16.51%	2.20***
% with children	40.65%	31.37%	9.29***
Sample Name	Exist2001	Exist2008M	Difference
Sample size	139,892	139,892	
% White	27.98%	27.93%	0.05
% Female	81.16%	81.08%	0.08
Mean Age	30.69	30.72%	-0.03
% Married	13.83%	14.00%	-0.17
% with children	53.42%	53.29%	0.13
Sample Name	New2001	New2008M	Difference
Sample size	16,218	16,218	
% White	38.77%	39.02%	-0.25
% Female	70.95%	71.48%	0.54
Mean Age	30.91	30.93	-0.02
% Married	18.71%	18.48%	0.23
% with children	40.66%	37.63%	3.03***

*** $p < 0.01$

Table 2. Earnings Mobility Indices[a]

	Position Relative			Dollar Relative		
	New2001	*New2008*	*New2008M*	*New2001*	*New2008*	*New2008M*
Average Movement	1.789 (1.770-1.812)	1.884* (1.864-1.904)	1.863* (1.842-1.885)	1.878 (1.855-1.901)	2.010* (1.987-2.034)	1.993* (1.967-2.017)
Prais-Biddy	0.828 (0.823-0.835)	0.843* (0.838-0.848)	0.839* (0.833-0.845)	0.818 (0.813-0.824)	0.836* (0.831-0.841)	0.833* (0.827-0.838)
WGM	1.025 (1.019-1.033)	1.046* (1.040-1.053)	1.038* (1.031-1.045)	1.006 (0.999-1.013)	1.028* (1.022-1.035)	1.022* (1.014-1.027)
I_{OSBF}	0.698 (0.680-0.716)	0.709 (0.695-0.725)	0.709 (0.692-0.727)	0.808 (0.788-0.826)	0.842* (0.827-0.858)	0.839* (0.824-0.857)
I_{OSTF}	0.469 (0.453-0.486)	0.486 (0.471-0.500)	0.482 (0.465-0.498)	0.365 (0.347-0.382)	0.378 (0.362-0.395)	0.372 (0.354-0.388)
	Exist2001	*Exist2008*	*Exist2008M*	*Exist2001*	*Exist2008*	*Exis2008M*
Average Movement	1.714 (1.707-1.721)	1.782* (1.777-1.788)	1.757* (1.749-1.764)	1.810 (1.801-1.818)	1.861* (1.874-1.887)	1.856* (1.842-1.864)
Prais-Biddy	0.817 (0.815-0.819)	0.828* (0.826-0.829)	0.824* (0.822-0.826)	0.808 (0.806-0.810)	0.818* (0.817-0.820)	0.816* (0.814-0.817)
WGM	0.998 (0.996-1.000)	1.014* (1.012-1.016)	1.008* (1.005-1.010)	0.979 (0.977-0.982)	0.995* (0.993-0.997)	0.990* (0.968-0.992)
I_{OSBF}	0.678 (0.673-0.684)	0.682 (0.678-0.686)	0.678 (0.672-0.684)	0.770 (0.771-0.783)	0.790* (0.785-0.794)	0.786* (0.780-0.792)
I_{OSTF}	0.433 (0.421-0.438)	0.448* (0.443-0.452)	0.441* (0.435-0.446)	0.335 (0.329-0.342)	0.358* (0.353-0.362)	0.349* (0.343-0.355)

a. 95 % confidence intervals in parentheses. *Difference is statistically significant larger in the second period at better than 5%.

Table 3. WGM Earnings Mobility Indices[a]

	Position Relative			Dollar Relative		
	New2001	*New2008*	*Difference*	*New2001*	*New2008*	*Difference*
Males	1.073 (1.060-1.087)	1.083 (1.072-1.094)	0.010	1.059 (1.045-1.071)	1.055 (1.045-1.066)	-0.004
Females	1.013 (1.003-1.020)	1.033 (1.025-1.041)	0.020*	0.990 (0.982-0.998)	1.015 (1.008-1.024)	0.025*
Whites	1.051 (1.040-1.064)	1.081 (1.070-1.091)	0.030*	1.035 (1.023-1.045)	1.058 (1.046-1.067)	0.023*
Non-whites	1.012 (1.003-1.021)	1.029 (1.020-1.036)	0.017*	0.989 (0.980-0.999)	1.012 (1.005-1.019)	0.023*

a. 95 % confidence intervals in parentheses. *Difference is statistically significant larger in the second period at better than 5%.

Table 4. Quarterly Mobility Indices

	Position-Relative		Dollar-Relative	
	[1]	[2]	[3]	[4]
	WGM	Prais-Biddy	WGM	Prais-Biddy
T	-0.00084**	0.00024	-0.0011**	0.0002
	(0.0004)	(0.00024)	(0.0004)	(0.0002)
GR	-0.0181	-0.0280***	-0.0200	-0.0304**
	(0.0134)	(0.0079)	(0.0158)	(0.0083)
POST	0.1249***	0.1351***	0.0755**	0.0935***
	(0.0310)	(0.0183)	(0.0360)	(0.0192)
*T*GR*	0.0019***	0.0013**	0.0021***	0.0013***
	(0.0006)	(0.0003)	(0.0007)	(0.0004)
*T*POST*	-0.0036***	-0.0035***	-0.0026***	-0.0025***
	(0.0008)	(0.0004)	(0.0005)	(0.0005)
Constant	0.9505***	0.7150***	0.9355***	0.7576***
	(0.0046)	(0.0029)	(0.0054)	(0.0028)
R^2	0.641	0.786	0.561	0.700

* Statistically significant at better than 0.10; ** statistically significant at better than 0.05; *** statistically significant at better than 0.01. Standard errors in parentheses.

Table 5. The Relationship Between Unemployment and Quarterly Mobility

	WGM Index	
Variable	[1] Position- Relative	[4] Dollar-Relative
Initial UE	-0.003***	0.0002
	(0.0004)	(.00014)
Ending UE	0.006***	0.0038***
	(0.0005)	(0.0005)
Constant	0.9272***	0.916***
	(0.0039)	(0.003)
R^2	0.7559	0.595

*** Statistically Significant at better than 1 percent

Appendix A: Summary of Mobility Indices

In this Appendix we provide the formula for and a brief explanation of each of the mobility indices we report. Bradbury (2016) provides a discussion of various income mobility measures; see also Fields (2010). Note that in what follows rank refers to the column or row in transition matrix.

The Average Movement index measures the average rank change, and is given by $\frac{1}{N}\sum_{i=1}^{N}|rank(y_{ib}) - rank(y_{ie})|$, where N is the number of individuals, y is earnings, and b and e denote beginning and ending period. This index is bound between zero, i.e., no mobility, and 10 for a 6x6 transition matrix. If everyone changed by one rank, the value of the index is one. The index is not the average of the change in rank for those who changes rank. It does not reflect whether the rank change was more likely to be positive or negative.

Shorrocks' mobility Index measures the size of the off-diagonal where each rank is represented equally rather than proportionally with respect to the size of each rank and is given by $\frac{k-\sum_{i=1}^{n} q_{ii}}{k-1}$, where k is the number of ranks and $q_{ii} = \frac{r_{ii}}{\sum_{j=1}^{k} r_{ij}}$. Observe that q_{ii} is the conditional probability of ending at rank i given beginning at rank i, while r_{ii} is the unconditional probability of beginning and ending at rank i. Since column counts are not equal in our setting, we calculate an adjusted index we denote WGM, which is given by

$$WGM = \sum_{i=1}^{k} \frac{1 - q_{ii}}{k(1 - c_i)}$$

where $c_i = \sum_{j=1}^{k} r_{ji}$, i.e., column total.

The Prais-Bibby Index is given by $1 - \sum_{i=1}^{n} r_{ii}$. This index measures the probability that an individual is not in the same rank at beginning and ending years. The index ranges

from zero, the case where everyone is in the same rank in which they started, to one, the case where no one is the same rank in which they began.

The Origin-Specific Indices measure the share of the sample that moved from the top or from the bottom ranks by at least two ranks. For the transition matrices we construct, I_{OSTF} is the probability that an individual moves from the top rank to the 4rd rank or lower, and is given by $I_{OSTF} = \sum_{j=1}^{k-2} q_{kj}$, while I_{OSBF} is the probability that an individual moves from the bottom rank to the 3rd rank or higher, and is given by $I_{OSBF} = \sum_{j=3}^{k} q_{1j}$.

Appendix B. Simulations

To explore the effect that greater unemployment has on mobility, we conducted a simple simulation. We took the distribution of earnings of new SNAP recipients in 2001; we deleted any observation with earnings less than $1000. Refer to these data as *EARNA*. Using a truncated normal distribution, we randomly assigned percentage changes in earnings. The percentage changes ranged from 254.0 percent to –20.6 percent, with an average percentage change of 2.69 percent, which is close to the change in earnings per worker using data from the Bureau of Economic Analysis. Refer to these data as *EARNA'*.

We consider two unemployment scenarios. Using annual unemployment claims data, we calculated the percentage of workers who were unemployed at some point during 2000 and 2010; 10.77 percent in 2000 and 26.50 percent in 2010. We randomly assigned worker to the unemployed status. The distribution of the duration of unemployment across five categories of weeks is available from BLS; durations are longer for 2010 than 2000. Using the distributions for 2000 and 2010, we fitted regression to obtains the distribution by week for 52 weeks. We

randomly assigned these weeks to those who were assigned as being unemployed. We reduce *EARNA'* by the fraction of the year the employee was unemployed for each of the two unemployment scenarios. Refer to resulting earnings as *EARNB* and *EARNC* for the 2000 and 2010 unemployment conditions, respectively.

We calculated the WGM index for the two pairs of earnings, *EARNA* and *EARNB*, and *EARNA* and *EARNC*. The dollar-relative WGM index for *EARNA*-*EARNB* is 0.592 and for *EARNA*-*EARNC* is 0.710. Not unexpectedly our simple simulation implies that greater unemployment results in greater mobility. Note that the simulations are not meant to reflect the real world, although the calculations are based on data that does attempt to match the real world. Note that the values of the indices are much smaller than those in Table 2.

We also calculated the dollar-absolute mobility indices. The difference in values is much smaller, namely 0.585 and 0.634 for the WGM index for the two unemployment scenarios.