EFFECTS OF THE GREAT RECESSION ON THE U.S. AGRICULTURAL LABOR MARKET

MAOYONG FAN, ANITA ALVES PENA, AND JEFFREY M. PERLOFF

We empirically test four hypotheses regarding differences between agricultural worker earnings (wages and bonuses) during recession and non-recessionary times, between agricultural worker time use during recession and non-recession times, between outcomes for undocumented and documented workers, and between outcomes for agricultural workers versus those working in other sectors of interest. Regression analyses show that the wages of documented (legal) seasonal agricultural workers increased more during the last three recessions than did the wages of undocumented agricultural workers and low-skilled nonagricultural workers. Bonus pay and weekly hours also increased for some workers, suggesting general increases in the financial wellbeing of employed agricultural workers during recessions.

Key words: Agriculture, Great Recession, immigrants, recession, undocumented workers.

JEL codes: E32, J43, J61.

Although a large body of literature describes the adverse effects that recessions have on nonagricultural labor markets, only a few studies have examined the effects of recessions in the seasonal agricultural labor market.[1] We examine how the last three recessions affected hourly earnings, the probability of receiving a bonus, and weekly hours in the agricultural labor market. We compare those results to those in three nonagricultural labor markets that rely on immigrants and empirically test four hypotheses.

First, we expect seasonal agricultural workers' earnings (hourly earnings and the probability of receiving a bonus) to rise during major recessions. Because the income elasticities of demand for seasonal agricultural products such as fruits and vegetables are relatively inelastic (Naanwaab and Yeboah 2012), recessions cause a small, possibly negligible leftward shift of the labor demand curve in seasonal agriculture. In contrast, a recession may cause a more significant shift of the labor supply curve. Roughly half of hired, seasonal agricultural workers are undocumented.[2] The Great Recession significantly reduced the number of new, undocumented immigrants entering the United States (Papademetriou and Terrazas 2009; Passel, Cohn, and Gonzalez-Barrera 2013), presumably causing a substantial leftward shift of the agricultural labor supply curve.[3] Given a substantial leftward shift of the labor supply curve and only a minimal shift of the demand curve, agricultural workers' earnings therefore rise.

Second, we expect recessions to affect undocumented workers differently than documented workers (citizens and immigrants who may legally work in the U.S.) because their labor markets are partially segmented. For example, compared to documented workers,

Maoyong Fan is an associate professor in the Department of Economics, Ball State University, IN. Anita Alves Pena is an associate professor in the Department of Economics, Colorado State University. Jeffrey M. Perloff is a professor in the Department of Agricultural and Resource Economics, University of California, Berkeley, and a member of the Giannini Foundation. We are extremely grateful to the constructive feedback of the referees and especially to Brian Roe, the editor. We thank conference participants at the 2012 Western Economic Association International Annual Meetings and the Southern Economic Association Annual Meetings, especially our discussants Jose Martinez and Sandra Orozco-Aleman for helpful comments on an earlier version. Maoyong Fan would like to thank the UpJohn Institute for financial support (Mini-Grant No. 11-133-01). Correspondence may be sent to: mfan@bsu.edu.

[1] Most of this limited literature is descriptive and deals with recessions prior to the 1980s. Some of the best articles are Schuh (1976) and Gardner (1981). More recently, Martin (2009) discussed several reasons why the Great Recession might have differed from earlier recessions and why the effects of recession might differ from those in other sectors.

[2] We base these calculations on the National Agricultural Workers Survey. See table 1.

[3] Partially offsetting this supply effect, some workers from the service and other sectors who lost their jobs could look for agricultural jobs. However, this effect has probably been small in recent decades.

Source: United States Department of Agriculture Economic Research Service

Figure 1. Total agricultural output over time

Note: Data are available at: http://www.ers.usda.gov/data-products/agricultural-productivity-in-the-us.aspx.

undocumented workers are more likely to be employed by farm labor contractors as opposed to farmers, and to receive a (negative) pay differential (Taylor 1992; Isé and Perloff 1995; Pena 2010).

Third, we expect weekly hours of employed agricultural workers to increase to compensate for the reduced flow of new immigrants during major recessions (e.g., Papademetriou and Terrazas 2009; Passel, Cohn, and Gonzalez-Barrera 2013).

Fourth, we expect recessions to increase relative earnings of agricultural workers compared to construction, hotel, and restaurant workers. Because these nonagricultural sectors experience a large fall in demand, wages in these nonagricultural labor markets would fall were wages not sticky due to union and other contracts and minimum wage laws.

Our paper proceeds as follows: the first section discusses how recessions affect the supply curve of agricultural labor. The next section describes our two data sets. The third section presents our empirical results, while the final section discusses our results and draws conclusions.

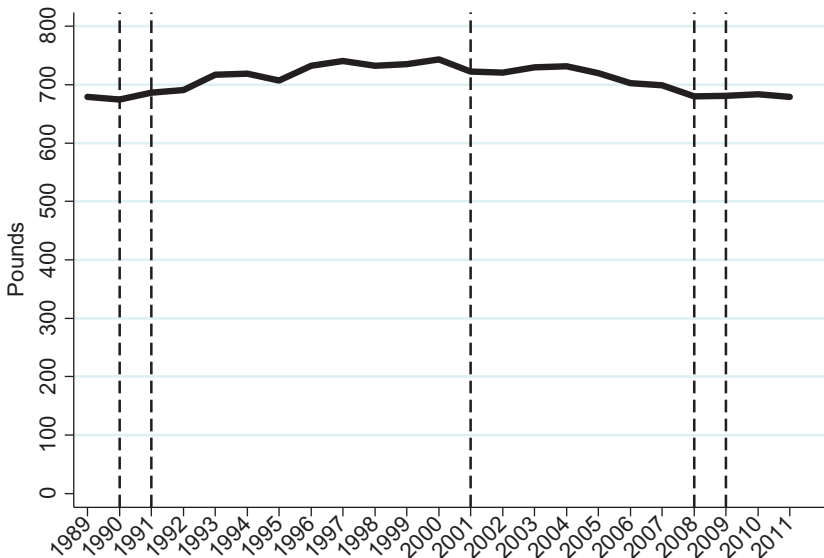## Recessions, Agricultural Output, and Immigration

We hypothesize that even major recessions have relatively small output effects for seasonal

agricultural crops. Given inelastic income elasticities for fruits and vegetables (Naanwaab and Yeboah 2012), we would not expect recessions to have a major impact on the demand for seasonal agricultural crops.[4] Figure 1 shows that total agricultural output (in billions of 2005 dollars) did not dip during the 1991–1992, 2001, or 2008–2009 recessions. Figure 2 shows that U.S. per capita consumption of fruits and vegetables (in pounds) did not vary substantially during these recessions. Other major field crops (such as rice and wheat) also did not see large decreases during recessions.[5]

In contrast, we expect a large labor response to major recessions. During a major recession, fewer undocumented immigrants enter the United States from Mexico and other countries. Passel, Cohn, and Gonzalez-Barrera (2013) reported a large drop in the number of undocumented immigrants during the Great Recession relative to the recovery years afterward and relative to preceding years, which include milder recessions. They estimated that the number of undocumented

---

[4] According to the USDA Economic Research Service, the income elasticity of the broad food category (food, beverage, and tobacco) is only 0.346 for the United States. Data are available at: http://www.ers.usda.gov/data-products/international-food-consumption-patterns.aspx.
[5] The annual output data of all major crops are available at: http://www.ers.usda.gov/topics/crops.aspx.

Source: United States Department of Agriculture Economic Research Service

Figure 2 U.S. per capita consumption of fruits and vegetables over time

Note: The data are from Fruit and Tree Nuts Yearbooks and Vegetables and Melons Yearbooks. Data are available at: http://www.ers.usda.gov/data-prod ucts/fruit-and-tree-nut-data/yearbook-tables.aspx and http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1212.

immigrants rose monotonically from only 3.5 million in 1990 until it peaked at 12.2 million in 2007. However, the number of undocu-mented immigrants fell to 11.3 million by 2009 during the Great Recession.[6] Moreover, Warren and Warren (2013) estimated that the net change of undocumented immigrants was negative during the Great Recession be-cause of a sharp decrease in the number of new undocumented immigrants. These results are consistent with reports from the Department of Homeland Security's Office of Immigration Statistics that apprehensions by border patrol dropped from 876,803 in 2007 to 556,032 in 2009.

Substantial reductions in quarterly remit-tances to Mexico in millions of U.S. dollars as reported by Banco de México ($7.2 billion in 2007, $6.7 billion in 2008, and $5.7 billion in 2009 in 2012 dollars) during the 2008–2009 Great Recession also suggest that fewer un-documented workers were making remit-tances.[7] Although none of these facts is

definitive on its own, these data collectively support our belief that the number of Mexican immigrants to the United States overall (including documented and undocumented categories) fell during the Great Recession.[8]

Evidence from the USDA Economic Research Service (ERS) further supports the presence of a labor supply decrease in agri-culture. The ERS estimates that the number of full- and part-time agricultural workers fell from 1.032 million in 2007 to 1.003 million in 2008 and 1.020 million in 2009 before rising to 1.053 million in 2010.[9] That is, the number of workers in 2008 was 3% to 5% lower than in the years before and after the Great Recession. Presumably the share of workers dropped by even more in seasonal

---

[6] In contrast, Passel, Cohn, and Gonzalez-Barrera (2013) found that the supply of immigrant labor rose marginally during the relatively mild 2001 recession. These authors estimated that the undocumented immigrant population was 8.6 million in 2000, 9.4 million in 2001 (which was a recession year), and 9.7 million in 2002. Unfortunately, Passel, Cohn, and Gonzalez-Barrera's (2013) estimated data series for the size of the undocumented population over time is not available by year prior to 1995.

[7] The remittance data are available at: http://www.banxico. org.mx/SieInternet/consultarDirectorioInternetAction.do?accion= consultarCuadro&idCuadro=CE81&sector=1&locale=en.

[8] According to the National Agricultural Worker Survey (NAWS), more than 80% of agricultural workers are born in Mexico and other Latin American countries. Massey (2012) ob-served some offsetting increases in temporary immigration from Mexico. However, since temporary workers work for part of the year only, numbers of workers in permanent and temporary cate-gories are not readily comparable in order to deduce whether to-tal migration from Mexico in terms of available worker hours increased or decreased during the recession.

[9] These estimates are from a USDA-ERS analysis of the National Agricultural Statistics Service (NASS) Farm Labor Survey data, which are available at: http://www.ers.usda.gov/ topics/farm-economy/farm-labor/background.aspx.

agriculture, which employs a high percentage of undocumented workers.

Data

We use the National Agricultural Workers Survey (NAWS) data set, which is a national random sample of hired seasonal agricultural employees who work primarily in seasonal crops.[10]

The NAWS is an employer-based survey that samples worksites rather than residences to overcome the difficulty of reaching migrant farm workers in unconventional living quarters. The NAWS randomly samples employers within the USDA's 12 agricultural regions (California is one region).[11] In each cycle, the NAWS randomly selects approximately 2,500 employees of the selected growers to obtain a nationally representative sample of crop workers. Surveyors interview these workers outside of work hours at their homes or at other locations that the workers choose.

The NAWS survey design incorporates questions aimed at data validation about legal status. Respondents receive a pledge of confidentiality and a nominal financial incentive for participation. Only 1–2% of workers in the overall sample refused to answer the legal status questions.

The NAWS contains extensive information about a worker's compensation, hours worked, and demographic characteristics such as legal status, education, family size and composition, and workers' migration decisions.[12]

The NAWS is conducted in three cycles each year (spring, summer, and autumn) to match the seasonal fluctuations in the agricultural workforce. The public-use data, which we use, suppresses information about the cycle (season) and aggregates the 12 regions into 6 regions. Our data set consists of repeated annual cross sections of workers from 1989 through 2012. Column 1 of table 1 presents national summary statistics for the variables used in our empirical analysis. Columns 2 and 3 provide data for undocumented and

documented workers, respectively. Compared to documented workers, undocumented workers tend to be younger and to have less education, farm experience, and job tenure; they are also more likely to be male and Hispanic.

For workers paid by time, hourly earnings are a worker's hourly earnings. We use the wage for hourly workers and the worker's average hourly earnings for piece-rate workers (constructed from the worker's reported earnings, output, and work time). The hourly earnings are adjusted by the consumer price index into 2012 dollars. The regressions use the natural log of hourly earnings. Weekly hours of work are the number of hours interviewees reported work at their current farm job in the previous week.

Mean hourly earnings and hours are lower for undocumented workers than for documented ones. The probability of receiving a bonus payment is substantially higher for documented workers than for undocumented ones (37% versus 19%). The bonus dummy equals one for workers who receive a money bonus from an employer in addition to the wage, and zero otherwise. The regional unemployment rate is an average of the relevant state unemployment rates weighted by the size of each state's labor force. Agricultural productivity is measured by total national agricultural output divided by total input.

After analyzing the effects of recessions on agricultural workers, we replicate the analysis for workers in construction, hotels, and restaurants, which also employ many immigrants. The data for workers in these comparison sectors come from the March Current Population Survey (CPS). In March of each year, workers in the basic CPS sample are administered a supplemental questionnaire in which they are asked to report their income such as hourly wage rate and additional labor force activity such as hours worked in the previous week.[13] Because information on immigration in the CPS is available only since 1994, our sample period is 1994–2013. We include all workers who are 18 years and older. The CPS does not provide information on legal status.

---

[10] The U.S. Department of Labor is responsible for collecting these data. Details about the data are available at: http://www.doleta.gov/agworker/naws.cfm.

[11] For a map of NAWS regions, see http://www.doleta.gov/agworker/pdf/NAWS_Map.pdf.

[12] We dropped 23% of workers from the sample because they were missing at least one of the relevant variables. Differences in major summary statistics across our sample and the full raw data are minimal.

---

[13] The public-use CPS data are available at: https://www.ipums.org/cps/index.shtml.

Table 1. Summary Statistics

	Nation	Undocumented	Documented
Continuous Variables			
Ln Hourly Earnings ($2012)	2.20	2.14	2.24
	(0.26)	(0.23)	(0.28)
Weekly Hours	43.27	42.70	43.78
	(13.30)	(12.83)	(13.69)
Age (Years)	34.93	29.85	39.48
	(12.36)	(9.91)	(12.57)
Education (Years)	6.76	6.21	7.26
	(3.74)	(3.22)	(4.09)
Farm Experience (Years)	11.20	6.35	15.53
	(9.81)	(5.88)	(10.57)
Job Tenure (Years)	5.13	3.18	6.89
	(5.72)	(3.08)	(6.86)
Regional Unemployment Rate (%)[a]	6.15	–	–
	(1.78)		
Agricultural Productivity[b]	0.93	–	–
	(0.08)		
Binary Variables			
Bonus Pay (=1)	0.28	0.19	0.37
Undocumented Worker	0.47	–	–
Female	0.19	0.15	0.22
Hispanic	0.87	0.99	0.77
Born in the United States	0.15	0.00	0.28
Speaks English	0.26	0.08	0.42
Field Crop	0.15	0.12	0.17
Fruits and Nuts	0.37	0.39	0.35
Horticulture	0.18	0.18	0.18
Vegetable	0.25	0.25	0.24
Other Crops	0.06	0.05	0.06
California	0.37	0.36	0.38
East	0.13	0.15	0.11
Southeast	0.17	0.20	0.15
Midwest	0.12	0.10	0.14
Southwest	0.08	0.05	0.11
Northwest	0.13	0.15	0.12
Number of Observations	43,677	20,641	23,036

Note: We use the National Agricultural Worker Survey 1989–2012 for this study. Superscript [a] indicates that the regional unemployment rate is based on 144 annual observations for 6 regions from 1989 to 2012. For each region, the unemployment rate is a population weighted average of state unemployment rates; [b] indicates that agricultural productivity is based on 24 annual observations from 1989 to 2012, and is calculated as the ratio of total agricultural output to total agricultural input.

Empirical Results

According to a National Bureau of Economic Research panel, during our 1989–2012 NAWS sample period, recessions occurred in 1990–1991, 2001, and 2008–2009 (National Bureau of Economic Research 2012). Compared to the two earlier recessions, the 2008–2009 Great Recession was more severe and had longer-lasting economic and labor market effects (Goodman and Mance 2011). We analyze the effects of these recessions on hourly earnings, the probability of receiving a bonus, and weekly hours of work of employed workers.

We use the same explanatory variables in all three of these equations. The explanatory variables include all the usual demographic variables: age, years of education, years of farm experience, job tenure (how long the worker has been with the current employer in years), gender, whether the worker is Hispanic, whether the worker was born in the United States, and whether the worker speaks English.[14] A legal status variable captures the effects of bifurcated labor markets for documented and undocumented workers. Other explanatory variables include crop and regional dummies, the agricultural productivity variable, and a time trend.

We are primarily interested in seven additional explanatory variables: dummies for each of the three recessions, the recession dummies interacted with the legal status dummy (undocumented = 1), and regional unemployment rates for workers in all sectors of the economy. We use separate dummies for each recession to allow for differential effects across recessions (cf., Gardner 1976; Goodman and Mance 2011). The interaction terms capture whether the effects of recessions vary with legal status. We include the unemployment rate because it peaks after the end of each recession (the National Bureau of Economic Research (2012) defines recessions based on changes in output rather than in unemployment). We do not include the unemployment rate interacted with the undocumented dummy because we cannot reject that its coefficient is zero in any equation. We treat all these variables as exogenous to the compensation and weekly hours of individual agricultural workers.

Hourly Earnings

We start by examining the effects of recessions on NAWS workers' hourly earnings. Column 1 of table 2 presents regression estimates for the ln hourly earnings equation. The coefficients on the demographic variables have the expected signs and are generally statistically significantly different from zero at the 5% level, as is a time trend variable. Undocumented workers' hourly earnings are approximately 3% less than those of documented workers overall. Females earn 6.5% less than males, Hispanics earn 5% less than non-Hispanics, and English speakers earn 3.9% more than non-English speakers. Unlike most previous studies, we find a statistically significant effect of education, though the magnitude is small. Similar to Moretti and Perloff (2002), we also find a small but statistically significant effect of education on hourly earnings: one extra year of schooling results in a 0.7% increase in hourly wage. The agricultural productivity variable is not statistically significant, but the time trend of 0.4% per year is statistically significant.

Following Halvorsen and Palmquist (1980), we transform the log linear equation and

calculate the effect of recessions on hourly earnings and the differences in the effect between documented and undocumented workers.[15] Column 1 of table 2a shows the calculated effects. Documented workers' hourly earnings rose 4.7% during the 1990–1991 recession, 3.8% during the 2001 recession, and 5% during the Great Recession. Thus, in all recessions, documented workers' wages *rose*, which suggests that recessions cause a larger shift in the hired-agricultural-worker supply curve than in the demand curve, as we expected.

The sum of the recession dummy coefficient and the coefficient on the recession dummy's interaction with the undocumented worker dummy captures the effect of a recession on undocumented workers. Hourly earnings for undocumented workers rose by 2.1% (not significant) and 3.2%, respectively, during the 1990–1991 and 2001 recessions. The Great Recession, however, did not have a statistically significant effect on undocumented workers. Not only do undocumented workers earn less than documented workers do in general, but their hourly earnings rose less during these recessions than did the earnings of documented workers (column 1 of table 2b shows that the recession effects are comparable across recessions for documented workers

Table 2. Regressions for Seasonal Hired Agricultural Workers

	Ln Hourly Earnings	Bonus Pay	Weekly Hours
1990–1991 Recession	0.046*	0.039*	0.086
	(0.007)	(0.010)	(0.329)
2001 Recession	0.037*	0.011	0.752*
	(0.007)	(0.013)	(0.343)
2008–2009 Recession	0.049*	0.024	0.680*
	(0.007)	(0.013)	(0.310)
Undocumented × 1990–1991 Recession	−0.025*	−0.006	2.068*
	(0.012)	(0.014)	(0.530)
Undocumented × 2001 Recession	−0.006	−0.009	−0.556
	(0.010)	(0.017)	(0.489)
Undocumented × 2008–2009 Recession	−0.047*	0.036*	0.563
	(0.008)	(0.016)	(0.410)
Undocumented Worker	−0.033*	−0.062*	−1.034*
	(0.003)	(0.006)	(0.183)
Regional Unemployment Rate	−0.000	0.006*	−0.498*
	(0.001)	(0.001)	(0.038)
Agricultural Productivity	−0.074	0.271*	0.484
	(0.047)	(0.081)	(2.386)
Female	−0.065*	−0.043*	−4.852*
	(0.003)	(0.005)	(0.152)
Age	0.005*	0.008*	0.312*
	(0.001)	(0.001)	(0.034)
Age Squared /100	−0.008*	−0.011*	−0.442*
	(0.001)	(0.001)	(0.042)
Hispanic	−0.050*	−0.039*	0.906*
	(0.006)	(0.011)	(0.305)
Born in the United States	−0.023*	−0.043*	−2.565*
	(0.006)	(0.011)	(0.316)
Speaks English	0.039*	0.072*	0.095
	(0.004)	(0.007)	(0.199)
Education	0.007*	0.006*	0.156*
	(0.000)	(0.001)	(0.021)
Farm Experience	0.007*	0.010*	0.159*
	(0.000)	(0.001)	(0.024)
Farm Experience Squared /100	−0.014*	−0.018*	−0.269*
	(0.001)	(0.002)	(0.059)
Tenure	0.007*	0.016*	0.223*
	(0.000)	(0.001)	(0.014)
Fruits and Nuts	0.051*	−0.136*	−6.930*
	(0.004)	(0.007)	(0.232)
Horticulture	0.047*	−0.027*	−4.310*
	(0.004)	(0.008)	(0.231)

continued

Table 2. Continued

	Ln Hourly Earnings	Bonus Pay	Weekly Hours
Vegetable	0.019*	−0.108*	−4.925*
	(0.004)	(0.007)	(0.243)
Other Crops	0.039*	0.015	−2.020*
	(0.006)	(0.011)	(0.329)
East	−0.020*	0.068*	−2.694*
	(0.004)	(0.007)	(0.235)
Southeast	−0.043*	0.103*	−3.797*
	(0.004)	(0.006)	(0.201)
Midwest	0.012*	0.117*	−2.864*
	(0.005)	(0.008)	(0.229)
Southwest	−0.094*	0.044*	−2.766*
	(0.005)	(0.008)	(0.256)
Northwest	0.047*	0.049*	−0.666*
	(0.004)	(0.007)	(0.201)
Time Trend	0.004*	0.002*	0.274*
	(0.001)	(0.001)	(0.029)
Constant	2.035*	−0.273*	41.425*
	(0.042)	(0.071)	(2.123)
Number of Observations	43,677	43,677	43,677
Adjusted R^2	0.164	0.169	0.109

Note: Robust standard errors appear in parentheses. Asterisk * indicates significant difference from 0; ($p < 0.05$).

and that the Great Recession had a smaller effect than the 2001 recession for undocumented workers). As a result, the wage gap between documented and undocumented workers widened during these recessions.

Bonus Payments

In addition to hourly earnings, 28% of the workers in our sample receive bonus payments (table 1). These deferred payments play a similar function to that of efficiency wages in other sectors (Moretti and Perloff 2002).

We use a binary indicator equal to one if a worker receives a money bonus. Column 2 of table 2 shows the results of a regression using a linear probability model (the results are similar for a probit model). During the 1990–1991 recession, the probability of receiving a bonus increased by 3.9 percentage points (11% relative to the mean) for documented workers and 3.3 percentage points (17% relative to the mean) for undocumented workers. Thus, this recession not only raised workers' hourly earnings, but it also increased the probability that they received a bonus.

However, the Great Recession had a 2.4 percentage point effect for documented workers, which is statistically significant at the 10% level. In contrast, for undocumented

Table 2A. Effects of Recessions

	Ln Hourly Earnings	Bonus Pay	Weekly Hours
Documented Workers			
1990–1991 Recession	0.047*	0.039*	0.086
	(0.007)	(0.010)	(0.329)
2001 Recession	0.038*	0.011	0.752*
	(0.007)	(0.013)	(0.343)
2008–2009 Recession	0.050*	0.024	0.680*
	(0.007)	(0.013)	(0.310)
Undocumented Workers			
1990–1991 Recession	0.021	0.033*	2.155*
	(0.011)	(0.012)	(0.476)
2001 Recession	0.032*	0.002	0.195
	(0.007)	(0.010)	(0.353)
2008–2009 Recession	0.002	0.060*	1.243*
	(0.005)	(0.011)	(0.299)
Undocumented Workers – Documented Workers			
1990–1991 Recession	−0.026*	−0.006	2.068*
	(0.012)	(0.014)	(0.530)
2001 Recession	−0.006	−0.009	−0.556
	(0.010)	(0.017)	(0.489)
2008–2009 Recession	−0.048*	0.036*	0.563
	(0.008)	(0.016)	(0.410)

Note: The top and middle panels of this table present the effects of recessions on three outcome variables and the corresponding standard errors. The bottom panel presents the test statistics and standard errors for the difference in the recession effect between undocumented and documented workers. For the hourly wage rates equation, the estimates are the percentage effect of a recession on hourly wage rates. To calculate the percentage effect for the hourly wage equation, we use a non-linear transformation to estimate the percentage effect of each recession on hourly wage rates as is detailed in footnote 15. For the bonus pay equation, the estimates are the effect of a recession on the probability of receiving bonus pay. For the weekly hours equation, the estimates are the effect of a recession on weekly working hours. Asterisk * indicates significant difference from 0; ($p < 0.05$).

Table 2B. Tests of Equality of the Recession Effects

	Ln Hourly Earnings	Bonus Pay	Weekly Hours
Documented			
2008–2009 Recession - 2001 Recession	0.012	0.013	−0.072
	(0.010)	(0.018)	(0.446)
2008–2009 Recession - 1990–1991 Recession	0.003	−0.014	0.593
	(0.010)	(0.016)	(0.458)
2001 Recession - 1990–1991 Recessions	−0.009	−0.028	0.665
	(0.010)	(0.016)	(0.461)
Undocumented			
2008–2009 Recession - 2001 Recession	−0.030*	0.058*	1.047*
	(0.009)	(0.015)	(0.449)
2008–2009 Recession - 1990–1991 Recession	−0.019	0.027	−0.912
	(0.012)	(0.017)	(0.562)
2001 Recession - 1990–1991 Recession	0.011	−0.031	−1.959*
	(0.012)	(0.016)	(0.579)

Note: This table presents the test statistics and standard errors of the difference between each pair of recessions. For the hourly wage rates equation, the estimates are the percentage effect of a recession on hourly wage rates. To calculate the percentage effect for the hourly wage equation, we use a non-linear transformation to estimate the percentage effect of each recession on hourly wage rates as is detailed in footnote 15. For the bonus pay equation, the estimates are the effect of a recession on the probability of receiving bonus pay. For the weekly hours equation, the estimates are the effect of a recession on weekly working hours. Asterisk * indicates significant difference from 0; ($p < 0.05$).

workers, the probability of receiving a bonus rose by 6.0 percentage points (32% relative to the mean). Given relatively large supply-side shocks during the recession, employers may have been more inclined to use bonuses to keep good undocumented workers. For undocumented workers, the Great Recession had a larger, positive effect on the probability of receiving a bonus than did the 2001 recession (see tests of equality of recession coefficients in column 2 of table 2b).

The regional unemployment rate has a statistically significant effect on the probability of receiving a bonus payment. A one percentage point increase in the unemployment rate raised the probability of

receiving a bonus by approximately 0.6 percentage points.

Weekly Hours

Because our data set includes information about only employed workers, we cannot directly observe the effect of a recession on total employment. However, we can examine the effect on employed workers' weekly hours. When employers have difficulty recruiting workers, they may employ workers for more hours per week to compensate.

For documented workers, weekly hours rose by 0.75 hours during the 2001 recession, and by 0.68 hours during the Great Recession.

For undocumented workers, weekly hours rose by 2.16 hours during the 1990–1991 recession and by 1.24 hours during the Great Recession—more than for documented workers.

An increase in the overall unemployment rate by 1 percentage point lowered the weekly hours by 0.5 hours. Thus, an increase in the overall unemployment rate lowered weekly hours, but weekly hours rose during

relatively large recessions holding the unemployment rate constant.

Robustness Checks

We conducted four robustness checks of our basic specification. First, to check for regional differences, we estimated separate regressions for California and for the rest of the United States (see table A1 in the supplemental

Table 3. Regressions for Construction, Hotel, and Restaurant Workers

	Construction		Hotel		Restaurant	
	Ln Hourly Earnings	Weekly Hours	Ln Hourly Earnings	Weekly Hours	Ln Hourly Earnings	Weekly Hours
2001 Recession	0.021	−0.700	0.009	−1.360*	0.034	0.115
	(0.013)	(0.361)	(0.029)	(0.639)	(0.021)	(0.344)
2008/09 Recession	0.007	1.185*	−0.007	0.743	−0.017	0.237
	(0.014)	(0.351)	(0.030)	(0.745)	(0.018)	(0.320)
Immigrant × 2001 Recession	−0.030	0.641	−0.040	−0.897	−0.069	−0.666
	(0.035)	(0.696)	(0.060)	(1.017)	(0.040)	(0.798)
Immigrant × 2008/09 Recession	0.039	−1.138*	−0.019	0.073	−0.003	−0.132
	(0.030)	(0.564)	(0.049)	(1.182)	(0.031)	(0.642)
Immigrant	−0.082*	−0.282	−0.034	−0.474	0.037*	0.528
	(0.015)	(0.318)	(0.022)	(0.453)	(0.014)	(0.284)
State Unemployment Rate	0.003	0.232*	−0.004	0.138	0.001	0.139*
	(0.003)	(0.059)	(0.005)	(0.107)	(0.003)	(0.059)
Female	−0.255*	−2.312*	−0.091*	−1.648*	−0.151*	−1.522*
	(0.013)	(0.300)	(0.016)	(0.329)	(0.009)	(0.175)
Age	0.050*	0.168*	0.021*	0.382*	0.009*	0.446*
	(0.002)	(0.047)	(0.003)	(0.066)	(0.002)	(0.036)
Age Squared	−0.001*	−0.002*	−0.000*	−0.004*	−0.000*	−0.005*
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
African American	−0.195*	−1.208*	−0.025	−0.261	0.121*	−0.131
	(0.017)	(0.395)	(0.022)	(0.472)	(0.013)	(0.279)
Hispanic	−0.100*	−0.491	0.008	0.914	−0.001	1.059*
	(0.015)	(0.317)	(0.025)	(0.483)	(0.015)	(0.282)
Some School	0.054	−0.939	0.115*	0.830	0.170*	0.966
	(0.063)	(1.100)	(0.055)	(1.033)	(0.057)	(2.269)
High School Graduate	0.205*	0.272	0.177*	1.498	0.182*	2.672
	(0.063)	(1.105)	(0.056)	(1.037)	(0.057)	(2.269)
Some College	0.256*	0.530	0.191*	1.107	0.138*	1.839
	(0.063)	(1.117)	(0.058)	(1.065)	(0.057)	(2.269)
College Graduate	0.328*	1.084	0.299*	1.797	0.148*	2.720
	(0.065)	(1.158)	(0.062)	(1.080)	(0.060)	(2.289)
Employed Full Time	0.097*	14.355*	0.140*	14.867*	0.157*	17.243*
	(0.011)	(0.277)	(0.017)	(0.385)	(0.009)	(0.177)
Firm Size	0.017*	0.321*	0.009*	0.154*	0.002	0.071*
	(0.001)	(0.032)	(0.002)	(0.058)	(0.001)	(0.025)
Time Trend	0.002*	−0.237*	0.004*	−0.251*	0.002*	−0.187*
	(0.001)	(0.023)	(0.002)	(0.041)	(0.001)	(0.023)
Constant	1.184*	23.740*	1.328*	17.982*	1.352*	13.988*
	(0.073)	(1.444)	(0.089)	(1.828)	(0.066)	(2.348)
State Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,535	10,535	2,786	2,786	10,579	10,579
Adjusted R^2	0.333	0.288	0.194	0.467	0.129	0.551

Source: March Current Population Survey 1994–2013. Earnings are adjusted to 1999 dollars using the Consumer Price Index(CPI).
Note: Robust standard errors are in parentheses. Asterisk * indicates significant difference from 0; ($p < 0.05$).

Table 3A. Effects of Recessions

	Construction		Hotel		Restaurant	
	Ln Hourly Earnings	Weekly Hours	Ln Hourly Earnings	Weekly Hours	Ln Hourly Earnings	Weekly Hours
Non-immigrant Workers						
2001 Recession	0.021	−0.700	0.009	−1.360*	0.035	0.115
	(0.013)	(0.361)	(0.030)	(0.639)	(0.021)	(0.344)
2008–2009 Recession	0.007	1.185*	−0.007	0.743	−0.017	0.237
	(0.014)	(0.351)	(0.030)	(0.745)	(0.017)	(0.320)
Immigrant Workers						
2001 Recession	−0.009	−0.060	−0.031	−2.257*	−0.034	−0.551
	(0.032)	(0.601)	(0.051)	(0.800)	(0.033)	(0.725)
2008–2009 Recession	0.047	0.048	−0.025	0.816	−0.020	0.105
	(0.028)	(0.462)	(0.040)	(0.970)	(0.025)	(0.569)
Immigrant Workers - Non-immigrant Workers						
2001 Recession	−0.030	0.641	−0.040	−0.897	−0.069	−0.666
	(0.035)	(0.696)	(0.059)	(1.017)	(0.039)	(0.798)
2008–2009 Recession	0.040	−1.138*	−0.018	0.073	−0.003	−0.132*
	(0.031)	(0.564)	(0.048)	(1.182)	(0.030)	(0.642)

Note: The top and middle panels of this table present the effects of recessions on two outcome variables and the corresponding standard errors. The bottom panel presents the test statistics and standard errors for the difference in the recession effect between immigrant and non-immigrant workers. For the hourly wage rates equation, the estimates are the percentage effect of a recession on hourly wage rates. To calculate the percentage effect for the hourly wage equation, we use a non-linear transformation to estimate the percentage effect of each recession on hourly wage rates as is detailed in footnote 15. For the weekly hours equation, the estimates are the effect of a recession on weekly working hours. Asterisk * indicates significant difference from 0; ($p < 0.05$).

on-line appendix). The wage results are qualitatively similar to the national results with the exception of the coefficient on hourly earnings for the 2001 recession in California which is still positive but indistinguishable from zero statistically. For bonus pay and weekly hours, the national results for the Great Recession overall appear driven by the rest of the country rather than by California. The regional unemployment rate has a statistically significant negative effect in California and a positive effect for the rest of the country. Because these effects are offsetting, the unemployment rate has no effect in the national equation.

Second, in table A2 of the supplementary online appendix, we estimated all three regressions eliminating the 3,370 (7.7% of the sample) newcomers—immigrants who arrived in the United States in the current year—to check whether compositional changes in the workforce during recessions are driving our results. However, the six recession coefficients were virtually unchanged.

Third, we estimated all three regressions leaving out the unemployment rate and agricultural productivity. Doing so had limited effects on the recession coefficients (see table A3 of the supplementary online appendix).

Fourth, we estimated the three equations separately for documented and undocumented workers. That is, we allowed all the

coefficients to vary between these two groups instead of only the recession dummies. The recession patterns identified are virtually unchanged (see table A4 of the supplementary online appendix). One difference is that the regional unemployment rate has a small positive effect on hourly earnings for the undocumented workers, but a zero effect for the documented workers. The 1990–1991 recession was also insignificant for hourly earnings but significant for weekly hours among the undocumented. Bonus pay is also significant for documented workers during the Great Recession in this specification, though the magnitude is lesser than that for undocumented workers.

Comparison with Other Sectors

Do recessions have different effects in agriculture than in other sectors of the economy that employ many undocumented immigrants, such as construction, hotels, and restaurants? To answer this question, we constructed a comparable data set based on the March Current Population Survey for 1994–2013 (Flood et al. 2014). We can look at the effects from only two recessions, 2001 recession and the Great Recession, because the CPS does not include certain key
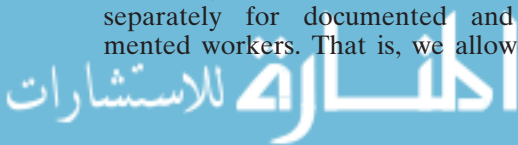
Table 3B. Tests of Equality of the Recession Effects

	Construction		Hotel		Restaurant	
	Ln Hourly Earnings	Weekly Hours	Ln Hourly Earnings	Weekly Hours	Ln Hourly Earnings	Weekly Hours
Non-immigrant Workers						
2008–2009 vs. 2001 Recessions	−0.014	1.886*	−0.016	2.103*	−0.052	0.122*
	(0.019)	(0.496)	(0.040)	(0.958)	(0.027)	(0.459)
Immigrant Workers						
2008–2009 vs. 2001 Recessions	0.056	0.107	0.005	3.073*	0.014	0.656
	(0.041)	(0.719)	(0.063)	(1.198)	(0.040)	(0.882)

Notes: This table presents the test statistics and standard errors of difference between two recessions. For the hourly wage rates equation, the estimates are the percentage effect of a recession on hourly wage rates. To calculate the percentage effect for the hourly wage equation, we use a non-linear transformation to estimate the percentage effect of each recession on hourly wage rates as is detailed in footnote 15. For the weekly hours equation, the estimates are the effect of a recession on weekly working hours. Asterisk * indicates significant difference from 0; ($p < 0.05$).

variables prior to 1994; it also lacks a variable on bonus payments.

In contrast to the NAWS, the CPS data does not record whether an immigrant is undocumented. Therefore, we focus on immigrants in general and form interaction terms between immigrant status and the recession dummies. Otherwise, we use a similar set of demographic variables. While the results therefore are not directly comparable to those using the NAWS, we examine complementary patterns to our recession story.

Table 3 presents the regression results for the ln hourly earnings and weekly hours in the three sectors. In none of these three sectors did either recession affect the wages of non-immigrants or immigrants. Presumably, wages are sticky in these sectors, partially due to union and other contracts and minimum wage laws. The unemployment rate also did not have a statistically significant effect on wages in these sectors, similar to the agricultural sector. The unemployment rate, however, was associated with increases in construction and restaurant hours, though the magnitudes of changes are very small. In addition, the 2001 recession reduced weekly hours for non-immigrant and immigrant workers in the hotel sector while the Great Recession saw small increases in weekly hours for non-immigrant workers in construction. Overall, however, for most employed workers in these three sectors, weekly hours remained relatively constant during recessions.

Conclusions

We examine how three recent recession have affected earnings and weekly hours in agriculture and compare our results to recent experiences in construction, hotels, and restaurants, which also hire many immigrants. Our results are generally consistent with our expectations.

Our first hypothesis was that during a major recession, agricultural hourly earnings and the probability of receiving a bonus payment would rise. Both rose during the Great Recession. These results are consistent with the labor supply curve shifting leftward by more than the labor demand curve.

Our second hypothesis was that recessions would affect undocumented workers differently than documented workers because their labor markets are segmented. For undocumented workers, the hourly wage did not change in a statistically significantly manner during the 1990–1991 recession and Great Recession, but rose 3.2% in 2001. These effects were all smaller than for documented workers. For undocumented workers, on the other hand, the probability of receiving bonus payments rose by 3.3 percentage points during the 1990–1991 recession, and rose by 6 percentage points during the Great Recession.

Our third hypothesis was that weekly hours of employed agricultural workers would increase to compensate for the reduced flow of new immigrants during major recessions. During the Great Recession, weekly hours rose by 0.7 hours for documented workers and by 1.2 hours for undocumented workers.

Our fourth hypothesis was that recessions would have larger hourly earnings effects in agriculture than in construction, hotel, and restaurant labor markets. Indeed, hourly wages were essentially unchanged during recessions in these latter three labor markets.

What are the implications of these results for farmers? Recessions raise farmers' labor costs and increase their risk. If farmers in seasonal agriculture cannot find workers when they need them, their crops may be ruined. While we lack the data to estimate a structural model of supply and demand, our reduced-form analysis strongly suggests that the labor supply curve shifts to the left during major recessions. This inference is consistent with other direct and indirect evidence about immigration during the Great Recession. Thus, the smaller supply forces farmers to pay more per hour during recessions, and the thinner labor market makes finding workers in a timely fashion more difficult.

Supplementary material

Supplementary material is available online at http://oxfordjournals.org/our_journals/ajae/.

References

Cameron, A.C., and P.K. Trivedi. 2005. *Microeconometrics: Methods and Applications.* Cambridge University Press.

Flood, S.M., S. King, S. Ruggles, and J.R. Warren. 2014. Integrated Public Use Microdata Series, Current Population Survey: Version 4.0. [Machine-readable database]. Minneapolis: University of Minnesota.

Gardner, B. 1981. On the Power of Macroeconomic Linkages to Explain Events in US Agriculture. *American Journal of Agricultural Economics* 63 (5): 871–8.

Gardner, B.L. 1976. The Effects of Recession on the Rural-Farm Economy. *Southern Journal of Agricultural Economics* 8 (1): 13–22.

Goodman, C.J., and S.M. Mance. 2011. Employment Loss and the 2007–09 Recession: An Overview. *Monthly Labor Review*, April: 3–12.

Halvorsen, R., and R. Palmquist. 1980. The Interpretation of Dummy Variables in Semilogarithmic Equations. *The American Economic Review* 70 (3): 474–5.

Isé, S., and J.M. Perloff. 1995. Legal Status and Earnings of Agricultural Workers. *American Journal of Agricultural Economics* 77 (2): 375–86.

Martin, P. 2009. Recession and Migration: A New Era for Labor Migration? *International Migration Review* 43 (3): 671–91.

Massey, D.S. 2012. *Immigration and the Great Recession.* Stanford: Stanford Center on Poverty and Inequality.

Moretti, E., and J.M. Perloff. 2002. Efficiency Wages, Deferred Payments, and Direct Incentives in Agriculture. *American Journal of Agricultural Economics* 84 (4): 1144–55.

Naanwaab, C., and O. Yeboah. 2012. Demand for Fresh Vegetables in the United States: 1970–2010. *Economics Research International* 2012(2012): 1–11.

National Bureau of Economic Research. 2012 US Business Cycle Expansions and Contractions http://www.nber.org/cycles/cyclesmain.html.

Papademetriou, D.G., and A. Terrazas. 2009. Immigrants in the United States and the Current Economic Crisis. Washington DC: Migration Policy Institute.

Passel, J., D.V. Cohn, and A. Gonzalez-Barrera. 2013. Population Decline of Unauthorized Immigrants Stalls, May Have Reversed. Washington DC: Pew Research Center.

Pena, A.A. 2010. Legalization and Immigrants in US Agriculture. *The BE Journal of Economic Analysis & Policy* 10 (1): 1–22.

Schuh, G.E. 1976. The New Macroeconomics of Agriculture. *American Journal of Agricultural Economics* 58 (5): 802–11.

Taylor, J.E. 1992. Earnings and Mobility of Legal and Illegal Immigrant Workers in Agriculture. *American Journal of Agricultural Economics* 74 (4): 889–96.

Warren, R., and J.R. Warren. 2013. Unauthorized Immigration to the United States: Annual Estimates and Components of Change, by State, 1990 to 2010. *International Migration Review* 47 (2): 166–82.