I Z A Institute of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 10492

# The Effect of Occupational Visas on Native Employment: Evidence from Labor Supply to Farm Jobs in the Great Recession

Michael A. Clemens

JANUARY 2017

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 10492

# The Effect of Occupational Visas on Native Employment: Evidence from Labor Supply to Farm Jobs in the Great Recession

**Michael A. Clemens**
*Center for Global Development and IZA*

JANUARY 2017



**IZA – Institute of Labor Economics**

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

# ABSTRACT

## The Effect of Occupational Visas on Native Employment: Evidence from Labor Supply to Farm Jobs in the Great Recession*

The effect of foreign labor on native employment within an occupation depends on native labor supply to that occupation – which is rarely directly measured – even if native and foreign labor are perfect substitutes in production. This paper uses two natural quasi-experiments to directly compare foreign to native labor supply in manual farm work. The first quasi-experiment is a legal requirement for employers to demand native labor with infinite elasticity at the wage earned by migrants; the second is a large exogenous shock to native workers' reserve option. Together these offer what is essentially a natural audit study in which tens of thousands of 'immigrant jobs' were offered to native workers with a range of exogenously varying terms. It uses novel data on the universe of domestic applicants to tens of thousands of farm jobs in the state of North Carolina over a 15 year period. The wage elasticity of unemployed domestic workers' relative labor supply is 0.0015. This implies that the effect of migrant labor supply on native employment is close to zero within this occupation, and may be positive outside it. Job-specific estimates of this kind are useful alongside more generalized evaluations of immigration because immigration policy often regulates access to specific occupations.

**JEL Classification:** F22, J61, O15

**Keywords:** immigrant, immigration, displacement, visa, labor-market, employment, wage, farm, agriculture, natural experiment, United States, Mexico

**Corresponding author:**
Michael A. Clemens
Center for Global Development
2055 L Street NW
Washington, DC 20036
USA
E-mail: mclemens@cgdev.org

* I thank Tejaswi Velayudhan and Marla Spivack for research assistance. I received generous support from the John D. and Catherine T. MacArthur Foundation, the William and Flora Hewlett Foundation, and Good Ventures. I thank Ann Bagchi, Gary Bullen, Willa Friedman, Conor Hartman, Andrei Gomberg, Jennifer Hunt, Thomas Hertz, Marina Mendes Tavares, David McKenzie, David Nagel, Çağlar Özden, Ben Powell, Lant Pritchett, Hillel Rapoport, Justin Sandefur, Peter Timmer, Mathis Wagner, and seminar participants at Australian National University, Southern Methodist University, Al Akhawayn University, the U.S. Department of Labor, and the Instituto Tecnológico Autónomo de México. I am solely responsible for any errors. Views expressed here are the author's only; they do not necessarily represent the views of the Center for Global Development and IZA, or their boards and funders.

# NON-TECHNICAL SUMMARY

Immigration policy frequently admits foreign workers to do specific jobs, and their effects of native employment depends critically on native workers' interest in doing those jobs. This study estimates the effect of Mexican hand-harvest farm workers on U.S. workers' employment in the same job. It does this by observing how 290,000 U.S. workers who became unemployed in one U.S. state during the Great Recession responded to offers of manual farm work, in a setting where employers were required to offer immigrant jobs to U.S. workers first on identical terms. Only about 50 of those workers were willing to even begin jobs mostly done by Mexican migrant workers, and the attrition rate of U.S. workers once hired was 32 times the Mexican rate. These imply that the effect of these occupation-specific visas for Mexican workers on U.S. employment was close to zero within farm work. It also implies that the effect of Mexican workers on U.S. employment outside farm work was positive, since they raised overall economic productivity in the state.

Past research on the labor-market effects of immigration has focused on the labor demand curve, particularly the substitutability of domestic and migrant labor in aggregate production (surveyed by Okkerse 2008). A recent literature goes beyond aggregate demand for skill-experience groups by considering the allocation of specific tasks between domestic and migrant workers (Autor 2013; Lewis 2013). It finds that labor market competition with natives could be limited by migrants' preferences for labor supply to occupations requiring systematically different tasks (Peri and Sparber 2009; Basten and Siegenthaler 2013; D'Amuri and Peri 2014; Foged and Peri 2016). This suggests that the labor-market effects of foreign workers admitted for specific occupations could differ from the effects of undifferentiated immigration, but little research has evaluated the effects of occupation-specific visas despite their importance as an immigration policy tool. It also suggests that the effects could depend on relative native and migrant labor supply to a given occupation, and little research has directly compared these.

This paper estimates occupation-specific native labor supply, and thus the effect of an occupational visa for migrant workers on native employment, using two natural quasi-experiments affecting farm workers. The first of these is a legal requirement for employers to demand domestic labor with infinite elasticity at the wage offered to migrants receiving the visa. The second is a large change in those domestic workers' reservation wage at the onset of the Great Recession, and indirect method to trace the labor supply curve (as in Kline and Tartari 2016; Dupas et al. 2016). Together, these allow the level and the elasticity of native labor supply to be characterized without the concern that different employment outcomes for domestic and foreign workers arise from differences in labor demand. It builds a simple model to clarify the assumptions under which the natural experiments are informative, and tests the model using novel internal data from a network of farms in the state of North Carolina. This includes data on the universe of domestic applicants to tens of thousands of farm jobs advertised to both foreign and domestic workers over a 15-year period.

It finds that the level and elasticity of domestic labor supply for manual farm work are positive and statistically significant as predicted by theory: greater unemployment causes increases in domestic workers' labor supply to manual farm work at both the extensive and intensive margins. But they are close to zero in magnitude: The wage elasticity of unemployed domestic workers' relative extensive-margin labor supply to manual farm jobs is 0.0015. Under the assumptions set out in the model, this suggests a direct effect of foreign labor supply on native employment within this occupation that is likewise close to zero. It presents evidence against a number of potential explanations for low native labor supply: these include domestic-migrant differences in labor demand, asymmetric information on job availability, and geographic mismatch between job and domestic unemployment. Finally, it explores the implications of this finding for spillover effects on domestic employment in other occupations. The findings imply that state-level output and employment are elastic to foreign farm worker supply, such that in the long run each 3.0–4.6 foreign farm workers create one native job in the state (all occupations).

The analysis makes three contributions. First, it characterizes and directly compares the occupation-specific labor supply curves of domestic and foreign labor for one occupation that is important to immigration policy. This direct examination arises from what is essentially a natural audit study in which tens of thousands of 'immigrant jobs' were offered to domestic workers.[1] This illustrates a mechanism that can limit the labor market effects of specific types of immigration even if domestic and migrant workers are perfect substitutes in production, even if immigration does not affect natives' choice of location (Card and DiNardo 2000; Hatton and Tani 2005; Cadena and Kovak 2016) or choice of human capital investment (Hunt 2012), and even if migrants' consumption does not affect demand for native labor (Altonji and Card 1991; Bodvarsson et al. 2008). Second, it evaluates a specific immigration policy, the admission of workers to perform one occupation. Occupation-specific research on the labor-market effects of immigration is rare.[2] Peri (2016, 25) urges more research on the effects of specific policies, beyond simple changes in the overall number of migrants. Finally, it considers the resulting effects of occupational visas on natives outside the occupation in question (as in Malchow-Møller et al. 2013; Del Carpio et al. 2015). An important limitation of the analysis is that its quantitative results are specific to manual labor on farms.

Section 1 begins by building a simple model of the occupation-specific effect of foreign employment on native employment under foreign-native differences in labor supply. Section 2 explains how the model assists interpretation of the two natural experiments, and Section 3 describes

[1] In this sense it complements indirect studies of native-migrant differences in occupational labor supply (e.g. Devadoss and Luckstead 2008) analogously to the way that the direct audit study of Bertrand and Mullainathan (2004) complements indirect statistical studies of discrimination.

[2] Some of the few papers that consider the impact of visas for specific occupations include Gibson and McKenzie (2014) on farm workers, Kaestner and Kaushal (2012) on nurses, and Peri et al. (2015) on computer programmers.

the empirical setting: a group of farms that is the largest single user of the U.S. farm work visa. Section 4 presents the results, and Section 5 discusses and summarizes.

# 1 Foreign and domestic labor supply to an occupation

This section builds a simple model of the effects of foreign workers on native employment within one occupation, to clarify how native labor supply matters more in an occupational setting than in the more general setting usually considered in the literature. Following LaLonde and Topel (1991) and Card (2001) as extended by Angrist and Kugler (2003), let the output $y$ of a firm employing native and immigrant workers in some occupation be

$$\begin{aligned} y &= f\left(\theta g(N, M)\right), \\ \text{where} \quad g &= \left(N^{\rho} + \gamma M^{\rho}\right)^{\frac{1}{\rho}}. \end{aligned} \tag{1}$$

$N$ and $M$ are the demands for native and migrant labor in the occupation in question; $\theta$ is an exogenous shifter; $0 < \rho \leqslant 1$ determines the elasticity of substitution between native and migrant labor $\left(\frac{1}{1-\rho}\right)$; $\gamma > 0$ sets the relative marginal revenue product of native and migrant labor; and $f$ is the production function such that $f'(\cdot) > 0$; and $f''(\cdot) < 0$. Normalizing the output price to unity, the employer sets demand to maximize profit $\Pi \equiv f(\theta g) - wN - w^{*}M$, where $w$ and $w^{*}$ are native and migrant wages respectively. Denoting the partial derivative with a subscript, demand for native labor $N^{D}$ is set by the first-order condition $\ln f' + \ln g_{N} = \ln w - \ln \theta$.

Now let natives have a different labor supply ($N^{S}$) than migrants ($M^{S}$) for the occupation in question, following Peri and Sparber (2009), D'Amuri and Peri (2014), and Foged and Peri (2016). For a manual, routine occupation, this might be because natives dislike manual or routine work itself, because they dislike circumstances of the work (dirt, stench, exposure to the elements), or because they incur a social stigma for performing such work. For example, there is empirical evidence that U.S. immigrants hold jobs systematically more arduous than natives' jobs (Zavodny 2015) and Mexican immigrants require less wage compensation to concentrate in riskier occupations (Hersch and Viscusi 2010). Migrant labor supply $M^{S}$ is fixed and wage-inelastic, while native labor supply is

$$N^{S} = h(w), \tag{2}$$

where $h > 0$ and $0 < h' < \infty$. Studies of labor supply to firms or groups of firms have found that it is not infinitely elastic to the wage, given search costs and costly investments in firm-specific knowledge (e.g. Depew et al. 2013; Falch 2017). Impose market clearing ($N = N^D = N^S$ and $M = M^D = M^S$) by substituting (2) into the first-order condition, and totally differentiate with respect to migrant employment $M$. This gives the response of native labor to an increase in migrant labor,

$$N_M = \left( \frac{\theta f''}{f'} g_M + \frac{g_{NM}}{g_N} \right) \cdot \Lambda\Big(h(w)\Big). \tag{3}$$

The first parenthetical term reflects how production and labor demand shape the impact of foreign labor; the second term captures how native labor supply to the occupation shapes the impact of foreign labor, $\Lambda \equiv \left( \frac{h_N^{-1}}{h^{-1}} - \frac{\theta f''}{f'} g_N - \frac{g_{NN}}{g_N} \right)^{-1}$. The first term of (3) is standard in the literature. The first additive component of that term shows the simple reduction in firms' use of native labor as migrant labor rises, assuming the two are perfect substitutes in production $\left( \frac{\theta f''}{f'} g_M < 0 \right)$. The second additive component shows the countervailing increase in use of native labor as the firm's production rises with greater use of migrant labor $\left( \frac{g_{NM}}{g_N} > 0 \right)$ if native and migrant labor are *imperfect* substitutes in production ($\rho < 1$).[3]

The second term of (3) is less standard, and captures how the impact of foreign labor on native employment in this occupation depends on native labor supply to the occupation. Because $\frac{h_N^{-1}}{h^{-1}}$ is the inverse elasticity of labor supply, the effect of migrant employment on native employment $N_M$ is greater in absolute value when the wage elasticity of native labor supply to the occupation is greater.[4] High native labor supply elasticity to the occupation exacerbates the effect of foreign labor on native employment. Conversely, and intuitively, if natives' distaste for the occupation is sufficiently great that even large increases in the wage do not induce large increases in labor supply (that is, the inverse elasticity $\frac{h_N^{-1}}{h^{-1}}$ is high), then any negative response of native employment to foreign employment within the occupation is attenuated. This channel of attenuation acts separately from the channel on which the literature focuses, native-migrant complementarity in production (captured here by $\frac{g_{NM}}{g_N}$). These two channels cannot be separated by reduced-form estimates of $N_M$ (e.g. Pischke and Velling 1997), which thus face challenges in predicting displacement of natives by work visas for any specific occupation.

[3] $\frac{\theta f''}{f'} g_M < 0$ because $g_M = \gamma \left( \frac{M}{g} \right)^{\rho - 1} > 0$.

[4] Note $\frac{\partial N_M}{\partial \left( h_N^{-1} / h^{-1} \right)} < 0$. Assuming imperfect substitution then $\Lambda > 0$, since $\frac{g_{NN}}{g_N} = N^{-1}(1 - \rho) \left( \left( \frac{N}{g} \right)^{\rho} \frac{\rho}{N} - 1 \right) \leqslant 0$.

If we now give up some flexibility and assume a functional form for native labor supply (2), it becomes clear how the natural experiments in this paper characterize the effect of foreign labor in equation (3). Consider an unemployed native worker choosing how much labor to supply to the occupation in question. Following the canonical model of labor supply in Cahuc and Zylberberg (2004, 33), the worker solves $\max_{C,L} U = C^{1-\beta}L^{\beta}$ subject to $C + wL = w\bar{L} + R$, where $C$ and $L$ are consumption and leisure, $\bar{L}$ is the total endowment of time available to be allocated between work and leisure, and $R$ represents expected future income from prospective future wages outside of farm work plus current nonwage income. For example, $R$ could include prospective future income from the best-available alternative employment (borrowed against), and/or current unemployment insurance payments.[5] We can replace the fully general equation (2) with a specific expression for total native labor supply $N^S$ that aggregates labor supply $n^{s,i}$ by each individual $i$:

$$N^S = \sum_i n^{s,i} \quad \text{where} \quad n^{s,i} = \begin{cases} 0 & \text{if } \frac{w}{R} < \frac{\beta}{1-\beta}\frac{1}{\bar{L}}; \\ (1-\beta)\bar{L} - \beta \cdot \frac{R}{w} & \text{if } \frac{w}{R} \geqslant \frac{\beta}{1-\beta}\frac{1}{\bar{L}}. \end{cases} \tag{4}$$

The first line shows labor supply at the extensive margin, the second line at the intensive margin. In this simple model, two shocks have inverse and symmetric effects: an increase in the wage $w$, and a decrease in prospective alternative income $R$. This symmetry holds at the extensive margin of accepting any manual farm work, and at the intensive margin of choosing how many hours to work. Labor supply is elastic to a large shock in $R$ if and only if it is elastic to a large shock in $w$.[6] This symmetry will be useful to interpret the empirical results.

The model clarifies how a policymaker can protect native employment in an occupation. Equation (3) suggests three ways to regulate the employment of migrant workers. First, this can be done with quotas: setting migrant labor supply $M^s$ to some low number, without changing the marginal effect $N_M$. Second, native employment can be protected by regulating a lower bound

[5]The reservation wage $\bar{w}$ is the marginal rate of substitution between leisure and working at the farm job, evaluated at the point of maximum leisure $\bar{L}$: $\bar{w} = \frac{U_C}{U_L}\big|_{R,\bar{L}} = \frac{\beta}{1-\beta}\frac{R}{\bar{L}}$. The participation constraint $w \geqslant \bar{w}$ is therefore $\frac{w}{R} \geqslant \frac{\beta}{1-\beta}\frac{1}{\bar{L}}$.

[6]A longstanding empirical labor literature supports for the form of labor supply in equation (4), showing that labor supply at a given wage rate responds positively to the duration of unemployment, corresponding to a reduction in expected $R$. The average duration of unemployment and the expected probability of finding a new job within a give time are clearly correlated with the unemployment rate. The observed Beveridge curve in the U.S. is further evidence of this pattern (Kasper 1967; Barnes 1975; Kiefer and Neumann 1979; Fishe 1982; Lancaster and Chesher 1983; Feldstein and Poterba 1984; Addison and Portugal 1989).

on wages in that occupation (that is, oblige firms to behave as if $\frac{\theta f''}{f'} g_M$ were less negative), which reduces the marginal effect $N_M$. Third, firms can be required to hire any native willing to work in that occupation (that is, oblige firms to behave as if natives and migrants were perfect substitutes in production, thus $\rho = 1$ and $\frac{g_{NM}}{g_N} = 0$). We observe policymakers doing all three of these. U.S. family-based visas are quota-limited but without limits on work (the first method); the H-2A seasonal agricultural work visa has no quota but wages and hiring are regulated (the second and third methods); and both the H-1B skilled temporary work visa and the H-2B seasonal nonagricultural work visa have quotas and both wage and hiring regulations (all three methods).

The model also clarifies that the effects of these regulations depend on native labor supply to that occupation. All three of the above types of regulation have less effect on native employment when native labor supply to the occupation is less elastic, in equation (3). And the elasticity of labor supply can be assessed by observing changes in native labor supply during a large shock to natives' reserve option, in equation (4), which characterize the local level and slope of natives' occupational labor supply curve. In occupations with very low and inelastic native labor supply, regulators can achieve very low effects of foreign workers on native employment even in the absence of tightly binding restrictions on entry, wages, or hiring.

## 2 Two natural experiments

This paper uses two natural experiments to estimate the local level and elasticity of the native labor supply to farm work, and thus estimate the effect of occupational visas to foreign workers on native farm employment. The first is a legal restriction on how employers express demand for native and foreign workers. The second is a large, exogenous shock to native workers' reserve option during the Great Recession. This section explains each in detail.

### 2.1 First experiment: Native labor demand requirements for the H-2A visa

The first natural experiment used here is a legal restriction on the hiring of foreign labor under one major work visa, the H-2A seasonal employment visa for low-skill farm work. Employers hiring H-2A workers face no visa quota, but are are required to make hiring decisions as if native and foreign workers were perfect substitutes. For this reason, any imperfect substitution in *employment* between these two groups is attributable to the relative shape of the labor supply curves for native and foreign labor, at current terms of contract.

Under the rules of this visa, employers wishing to hire seasonal agricultural labor can sponsor foreign workers to enter the U.S. and remain for up to 10 months per year. Prospective employers of H-2A workers must first receive a Foreign Labor Certification from the U.S. Dept. of Labor. To receive certification, employers must work with the State Workforce Agency to prepare a job order for intrastate and interstate recruitment of U.S. workers, advertise the positions in two local daily newspapers (and, in some states, on local radio stations), contact former U.S. workers to advise them of the opening, and prove to the Dept. of Labor National Processing Center (NPC) that they have done all of the above. This must occur at least 45 days before the job's start-date. Finally, "employers must submit a 'recruitment report' to the NPC at least 30 days before the start date that lays out the recruitment efforts made, identifies U.S. workers who applied for jobs, and explains 'lawful job-related reason(s)' for not hiring each U.S. worker who applied but was not hired; the number of jobs certified to be filled by H-2A workers is reduced for each U.S. worker wrongly rejected by the employer" (Martin 2008, 18). The requirement to hire any able and willing U.S. worker extends from the time of certification up to 50% of the way through the contract period. In fiscal year 2015, 283,580 workers were admitted to the U.S. on H-2A visas, of which 94.8 percent had Mexican nationality.[7]

Both native and foreign workers must be paid the same fixed wage, set for each state, called the Adverse Effect Wage Rate (AEWR)—or the state or federal minimum wage if it is higher. Employers must also provide identical housing, laundry, and sanitation facilities for both types of workers, and international transportation for foreign workers.[8]

[7] Similar restrictions on labor demand apply to the U.S.'s largest temporary ("nonimmigrant") employment-based visas: H-1B for skilled immigrants with "specialized knowledge" and H-2B for nonagricultural low-skill seasonal workers, though both of these visas due have an annual quota. The United States is not exceptional in this regard. Most principal migrant destination countries, in addition to restricting the supply of migrant labor, likewise regulate demand for foreign workers. For example, employers are also restricted from demanding foreign seasonal agricultural labor until they have proven no domestic workers are available in Canada, the UK, France, Germany, Sweden, Australia, and New Zealand (Migration Advisory Committee 2013, p. 87). Examples of demand-side restrictions on foreign labor outside agriculture are in Appendix C

[8] The H-2A program is unpopular with U.S. farmers. Most foreign labor hired for seasonal farm work in the U.S. is hired on the unauthorized labor market rather than through the H-2A program (Carroll et al. 2005). Farmers

In other words, employers who hire foreign labor through the H-2A program are required to demand domestic labor as if it were a perfect substitute for foreign labor in production. In a setting more typical of the empirical labor literature on migration, limited effects of foreign labor on native employment might be attributed to imperfect substitution in production ($\frac{g_{NM}}{g_N} > 0$ in equation (3) reduces the absolute value of $N_M$). That is not the case in the present setting, where employers must hire any domestic worker who supplies his or her labor to the occupation, displacing the employment of foreign labor one-for-one. They must demand native labor with infinite elasticity at the wage earned by foreign labor.[9]

## 2.2 Second experiment: Unemployment in the Great Recession

The second natural experiment uses the sharp, exogenous, unexpected rise in U.S. unemployment in 2008 to characterize the local level and elasticity of the native supply curve for this occupation—at terms of contract different from the present ones. Across the country, the Great Recession caused a sharp reduction in hiring and a large increase in layoffs, especially at smaller and younger firms (Fort et al. 2013). Figure 2 shows the consequent large and sudden change in unemployment in North Carolina. The present empirical problem is to measure the elasticity of labor supply by unemployed native workers for manual farm jobs. In principle, a suitable experiment might create exogenous changes of wage in job offers (as in Fehr and Goette 2007), or exogenous shifts in the labor demand curve (Camerer et al. 1997; Oettinger 1999; Farber 2015), allowing the labor supply curve to be traced.

An alternative method is to use exogenous shocks to labor demand in the workers' reservation wage (as in Kline and Tartari 2016; Dupas et al. 2016). This is the strategy followed here, and under the assumptions underlying equation (4) it is equivalent to methods that exogenously shift labor demand. The Great Recession of 2007–2008 caused a large negative shock to prospective income from alternative jobs for unemployed workers in the short- to medium-term. If the effect of a large shock to the unemployment rate on labor supply to any given occupation is very small, this suggests that $\beta$ for this occupation is very small—which in turn suggests a near-vertical labor

complain that the H-2A program is "costly, unpredictable, and administratively flawed" (Wicker 2012), including the bureaucratic burden of advertising to, hiring, keeping records of, training, and replacing U.S. workers who show limited and short-lived interest in the positions.

[9] Rare exceptions are allowed by labor regulators when the employer can demonstrate that the domestic applicant is physically, mentally, or substance-impaired and is strictly unable to perform the work.

supply curve.[10] Because domestic farm workers move frequently between farm work and non-farm work (Tran and Perloff 2002), the overall unemployment rate and the probability of finding non-farm work are relevant to the decision to supply labor to farm work.

Figure 1 sketches how these natural experiments provide new, occupation-specific information. The traditional approaches to evaluating labor-market effects of immigration (Figure 1a) trace the effects of a shift in foreign labor supply $M^S$ to geographic areas or statistical cells, where $L$ is quantity of labor and $w/R$ is the ratio of wage to reserve option in equation (4). The effect on native employment and wages (point $a$) depends on both the shape of native labor supply $N^S$ and the degree to which native and foreign labor are substitutes in the production function (the relationship between labor demand curves for native labor $N^D$ and migrant labor $M^D$). These approaches make it difficult to attribute observed effects to supply or demand. In this paper (Figure 1b), two natural experiments assist with isolating mechanisms. First, hiring restrictions force employers to express infinitely elastic demand for native workers ($N^D$) at the wage offered to foreign workers. Second, natural shocks to the reserve option $R$ exogenously shift $N^D$ up and down in $\{L, \frac{w}{R}\}$ space. Observed native employment outcomes thus trace the local level and slope of $N^S$.

## 3 Empirical setting: farm work visas in North Carolina

The data for this study come from the North Carolina Growers Association (NCGA), a network of approximately 700 farms across the state of North Carolina that hires several thousand Mexican farm workers each year on H-2A visas (Table 1), making it the largest single user of the H-2A visa program. Its members grow cucumbers, sweet potatoes, tobacco, and Christmas trees, as well as smaller quantities of other crops including peppers, hay straw, beans, corn, and horticulture plants. Unlike most of the otherwise similar farms in the United States, the NCGA comprises farms whose sole source of foreign manual seasonal labor is the H-2A program.

[10] This does not mean that the response of native labor-supply to changes in the unemployment rate can offer straightforward numerical estimates of the labor supply slope $\beta$. The percentage change in perceived $R$ for the average unemployed person could differ from the percentage-point change in the overall unemployment rate. This approach may nevertheless provide information about $\beta$. Assuming that changes in overall unemployment are well correlated with changes in $R$, any very large shock to the overall unemployment rate must cause a substantial percentage change in expected income from other employment options. If such shocks are not associated with substantial changes in labor supply, this is suggestive (but not conclusive) evidence that $\beta$ is small.

The NCGA was founded in 1989 as a nonprofit business association to secure Foreign Labor Certifications for its member farms, process foreign and domestic applicants for H-2A jobs, train and orient new workers, mediate in disputes between farmers and workers, and serve as the link between farmers and state and federal regulators. The NCGA hires the Mexican firm CSI Labor Services S.A. de C.V. of Monterrey, Nuevo León to recruit seasonal workers throughout Mexico. Most of these workers come from interior states of Mexico, not border states; the top five states of origin for NCGA workers in 2012 were, in decreasing order: Durango, Nayarit, San Luis Potosí, Guanajuato, and Hidalgo. Recruits are processed at the U.S. consulates in Monterrey and Nuevo Laredo, and brought by chartered bus to its headquarters at Vass, North Carolina before assignment to worksites across the state.

As described above, the NCGA is required to recruit unemployed U.S. workers for every H-2A job through the state workforce agency, the Division of Employment Security (DES) at the North Carolina Department of Commerce. Announcements of these jobs are mailed to any registered unemployed person who has expressed an interest in farm work, they are recommended by DES counselors monitoring unemployment benefits recipients, and they are listed at jobs terminals in DES offices statewide that are open to any member of the public. Upon request any DES office will refer an interested U.S. worker to the NCGA. The NCGA is furthermore required to purchase newspaper advertisements, in four newspapers across three states, for U.S. workers to fill every H-2A job.

Extremely few unemployed North Carolina residents processed by the DES show initial interest in NCGA jobs, and much fewer are willing to report for work and complete a harvest season. Table 2 summarizes these DES referrals to NCGA seasonal jobs over the last several years. The first three columns show the calendar year, the state unemployment rate in each year, and the annual average number of unemployed workers in the state. The next three columns show the number of new applications for jobs received by all DES offices statewide, and the number of referrals made to any employer in the state for non-agricultural and agricultural employment. The next column shows the number of these referrals that were sent to the NCGA. Almost all of these were hired by the NCGA, as shown in the next column. The following column shows how many of these reported for the first day of work. The penultimate column shows how many of these worked until the end of the contract, without quitting or being fired. The final column shows the number of missing observations—workers whose outcome was not recorded.[11]

Why are so few unemployed workers willing to consider, accept, or complete these jobs? The pattern cannot be easily explained by geographic separation between these farms jobs and DES offices, shown in Figure 3. While it is true that U.S. workers are less likely to show interest in farm jobs far from their residences, very large numbers of unemployed North Carolinians live close to NCGA worksites. Figure 3a shows the locations of NCGA H-2A jobs. Figure 3b shows the counties-of-residence of U.S. workers referred to the NCGA, and the locations of DES local offices. Figure 3c shows unemployment by county in 2011. The first two maps show that unemployed U.S. workers living close to NCGA worksites are more likely to show interest in the jobs.[12] But the unemployment map shows that every county that contains NCGA worksites either is or adjoins a county where unemployment was over 10% in 2011. The average width of a county in North Carolina is 23.2 miles, whereas the median U.S. migrant farm worker moves over 75 miles for work each year (Perloff et al. 1998). Furthermore, access to DES offices is unlikely to be a major factor limiting native labor supply; in Figure 3b there is little correlation between U.S. referrals' residences and the presence of a nearby DES office.[13]

## 4 Results

What is it, then, that so severely curtails native employment in these jobs? The analysis to follow explores alternative explanations. It could be that there is a special characteristic of the places with farm jobs that creates a spatial mismatch between unemployed U.S. workers and farm jobs. For example, the state workforce agency (Division of Employment Security, or DES) offices in places with farm jobs might not be the offices where large numbers of the unemployed go to seek work. It could be that unemployed U.S. workers, despite legal obligations for the farms to

[11] Due to a data fault, NCGA records on U.S. referrals for calendar year 2007 were not preserved.

[12] H-2A employers are required to provide basic, dormitory-style, state-inspected housing for workers who do not live nearby, so this pattern plausibly reflects a preference by U.S. workers to live at home during the work season and avoid employer-provided housing.

[13] Another candidate explanation can be set aside: There is no evidence that the member-farms of the Association are substantially out of compliance with the regulation to hire native workers as if they were perfect substitutes for foreign workers. Member farms are closely watched by state and federal regulators, and receive scores of inspections from the Dept. of Labor each year. Neither regulators nor advocacy groups currently allege that member farms systematically and illegally turn away substantial numbers of native workers willing and able to perform seasonal manual work in its H-2A jobs.

advertise through the DES and through local newspapers, do not learn of the jobs' existence. It could be that U.S. workers' access to unemployment insurance gives them a better option than manual farm labor. It could be that the farms pay too little to attract U.S. workers, but with modest increases in wages, native labor supply would rise. The results test each of these in turn.

The interpretation of these results rests on equations (3) and (4). In this setting, employers are obliged to treat native and foreign workers as perfect substitutes ($g_{NM}/g_N = 0$), thus any decrease in foreign employment should be offset by a corresponding increase in native employment ($N_M < 0$). But the magnitude of $N_M$ depends on the elasticity of native labor supply, approximated by exogenous changes in $R$ via equation (4).

## 4.1 The elasticity of native labor supply: Extensive margin

The first step is to explore the effect of local unemployment on DES referrals to farms and the outcomes of those referrals.[14] This analysis is conducted by DES office and month. Descriptive statistics are in Table 3.

Table 4 shows panel fixed-effects regressions with DES referrals and their outcomes as the dependent variable, local unemployment and office-level job-applications as the regressors, and DES office fixed effects. The first four columns show the relationship between the regressors and all referrals by each DES office to all jobs in the state, first non-agricultural jobs and then agricultural jobs. The final four columns show the same relationship for referrals by each DES office to a farm, and the outcomes of those referrals. To make all eight columns comparable, the farm-job referral data are restricted to the same months and years for which overall DES referral data are publicly available: February 2005–May 2011.

Two features of Table 4 are notable. First, there is a positive association between local unemployment and referrals of domestic workers to farm jobs, as well as hiring by the farms—controlling for how many applications the DES office has received in the current month and in each of the preceding 10 months (columns 5 and 6). This relationship is significant at the 1% level. There

[14] 'Local unemployment' means the unemployment rate at each DES office. This is calculated as the average unemployment rate in the counties served by that office, weighted by county labor force.

is a much weaker, but still statistically significant positive relationship between unemployment and the number of those referrals who arrive to begin work on farms (column 7). There is no detectable relationship between local unemployment and the number of U.S. referrals who complete their farm-work contracts (column 8).

To illustrate the magnitude of these effects, Figure 4 represents these coefficient estimates as margins plots. The vertical axes are multiplied by the number of DES offices in the sample and the number of months in a year, so that they represent the expected number of total U.S. workers statewide per year. The horizontal axes show local unemployment. Those plots reveal that the magnitude of these relationships is extremely small. A 10 percentage-point rise in unemployment is associated with roughly 100 additional referrals to the NCGA each year, controlling for all time-invariant traits of the DES office in question as well as the number of applications it has received in the preceding 10 months. The same shock to unemployment is associated with about 50 additional U.S. workers statewide per year who actually arrive to begin work, and has no significant association at all with the number who complete work. This implies that a 1 percent increase in $w/R$ in equation (4) due to the Great Recession caused only 0.0015 percent of unemployed workers in North Carolina to supply labor to H-2A manual farm jobs.[15]

A second notable feature of Table 4 is that farm-job referrals are negatively correlated with lagged numbers of overall job applications at each DES office for the first five months of lags, but positively correlated for lags 6–10. One explanation for this pattern is the fact that, under the Employment Security Law of North Carolina prevailing at the time, the maximum duration of state unemployment insurance benefits was 26 weeks. The coefficients are compatible with, but not conclusive evidence of, an effect of unemployment benefits that deters application to farm jobs: those who became unemployed during the coverage period are less likely to express interest in farm jobs (the negative coefficients in lags 0–5), and those whose coverage expires are more likely to show interest.[16]

[15] Take the pre-recession unemployment rate as 4.74% (Table 2) and suppose that $R$ is proportional to the probability of employment. A 10 percentage-point rise in unemployment means the employment probability changes by $1 - \frac{1-0.1471}{1-0.0471} = -10.5\%$, thus the percent change in $R$ is $1/(1-0.105) - 1 = +11.7\%$. Out of the net rise in unemployed workers 2007–2010, this caused $50/(504,885 - 213,276) = 0.0171\%$ to change their extensive-margin labor supply decision, and $\frac{0.0171\%}{11.7\%} = 0.0015$.

[16] This pattern reflects a common finding in the labor literature: Close to the maximum duration of unemployment benefits, there are declines in the reservation wage for labor supply (e.g. Fishe 1982) and increases in escape rates from unemployment (e.g. Katz and Meyer 1990; Hunt 1995; Røed and Zhang 2003; Farber and Valletta 2013; Hagedorn

Any such deterrence effect from unemployment insurance is controlled away in the last column of Table 4, but the coefficient on unemployment is indistinguishable from zero. This suggests that unemployment insurance is not a substantial reason that we observe no relationship between local unemployment and native-worker completion of these farm jobs.

### 4.2 The elasticity of native labor supply: Intensive margin

Does limited domestic labor supply reflect information asymmetry, arising for example from a lack of effective advertising of the positions by the farms or by the DES? The analysis now shifts to the level of individual employment episodes. I start by measuring the attrition of U.S. referrals between the referral date and the first day of the work contract, and exploring the relationship between this attrition and local unemployment.

Figure 5a shows that for every two weeks that pass between an unemployed U.S. workers' referral to the NCGA and the start date of work, roughly an additional half of the referred workers fail to begin work. The figure displays a Kaplan-Meier survival curve for all workers referred to the NCGA between 1998 and 2012, from the date of referral until the date the work contract begins, with a 95% confidence interval around the curve. Censoring is defined as reporting for work as scheduled. Workers drop out if they either contact the NCGA to cancel the job, or simply do not appear for work. The solid vertical line shows the sample mean time from referral to start date, with dotted lines showing a 95% confidence interval for the mean.

Figure 5b shows that this survival curve has the property predicted by theory by the second line of equation (4). It shows the results of a Cox proportional hazards model where the regressor is local unemployment in the U.S. worker's county of residence in the month of referral. When unemployment is high, referred workers are substantially more likely to begin work. Table 5 shows the underlying semiparametric Cox regression, along with alternative parametric specifications. The hazard rate is roughly 9% lower for each additional percentage point of local unemployment. In other words, domestic farm employment is not a corner solution in this case; it is elastic to the reservation option faced by domestic workers. But Figure 5b shows that this effect is quite small; even a very large shock to unemployment tends to delay this attrition by around two weeks.

et al. 2013; Valletta 2014; Card et al. 2015).

Similar patterns are seen in survival curves examining attrition from the start of work to the completion date of the work contract. Figure 6a shows these Kaplan-Meier survival curves for U.S. workers (solid black) and Mexican H-2A workers (dashed red), with 95% confidence intervals. Here, censoring is defined as completing the work contract. Workers drop out if they quit or are fired. The hazard rate for U.S. workers is roughly 35 times the rate for Mexican workers in the same jobs (Table 6).

There are two dimensions of missing data in the NCGA records, shown in Table 7. For some workers the outcome is unknown (for U.S. referrals, 111/1658 = 6.7%). In this case, I note that almost half of these missing values occur in a single year (2008, see Table 2), and the results are not materially sensitive to the omission of that year (results available on request). For other workers, the outcome is known but the duration is unknown (for U.S. referrals, 108/1658 = 6.5%). For these I impute survival times with a simple model.[17] The results of imputing U.S. worker survival times for observations with known outcome are shown with the dotted green line in Figure 6a and in the lower panel of Table 6. There is little change in the survival curve, and the U.S. worker day-to-day attrition rate from quitting or being fired remains above 32 times the Mexican rate.

Figure 6b shows the relationship between the U.S. worker survival curve (complete cases only) from start-of-work to contract completion, and local unemployment. Again it shows the result of a Cox proportional hazards model with local unemployment as the regressor. Table 5 shows the underlying Cox regression and fully parametric alternatives. Again the relationship corroborates the prediction about intensive-margin labor supply in equation (4): when unemployment is higher in a referred worker's county of residence, the worker lasts longer on the job. But the magnitude of this relationship is small, and only reaches conventional levels of statistical significance in the exponential survival model. These estimates suggest that with each additional percentage point of unemployment, U.S. workers' hazard rate following the start of work is around 3% lower, but this effect is not statistically precise. A 10 percentage-point increase in un-

[17]The imputation model assumes that unobserved survival times for U.S. workers are equal to the observed survival times of U.S. workers who are referred at the same local unemployment rate, who start after the same delay between referral and start-of-work, who finish work with the same outcome, in the same year and month. That is, survival time is predicted by an OLS regression of survival time on local unemployment in the month of referral, months between referral and start, a set of dummies for each outcome (completed, quit, fired), and a full set of interacted dummies for the year and month of application.

employment makes U.S. workers stay roughly two weeks longer on jobs whose typical contract length is 4.5–5.5 months.

Together, these estimates suggest that the slope of the native labor supply curve in the neighborhood of the current wage is indeed nonzero, but is close to zero. Native labor supply at the intensive margin—willingness to begin work, and willingness to complete work once begun—is extremely low. It is affected by the reserve options available to these workers, as theory predicts, but with an extremely small magnitude.

The preceding results test and reject some alternative explanations for low labor supply by U.S. workers. Low labor supply is not likely to arise from spatial variation across DES offices; the analysis in Table 4 and Figure 4 includes DES office fixed-effects. It is unlikely to arise because U.S. workers do not know about the jobs: intensive-margin labor supply among U.S. workers successfully referred for these jobs (and thus informed about them) is similarly low to extensive-margin labor supply by all unemployed U.S. workers. It is unlikely to arise from deterrence by unemployment insurance; Table 4 captures and controls for at least some of any such deterrence. Finally, it is unlikely to arise from an unwillingness or inability of farmers to modestly raise wages; the evidence is compatible with near-zero local slopes for the extensive-margin and intensive-margin labor supply curves.

The implication of these results for the effect of foreign workers on domestic employment in this occupation arises from equation (3). If the elasticity of native labor supply to the occupation is close to zero, $\Lambda \approx 0$ and the effect of foreign employment on native employment within the occupation is $N_M \approx 0$. In equation (3) this is a sufficient condition for $N_M \approx 0$, arising regardless of any imperfect substitution in production between domestic and foreign workers.

### 4.3 Indirect effects of foreign seasonal farm workers on native employment

Collectively, the above results imply that the level and slope of native labor supply to this occupation are positive but close to zero, at both the intensive and extensive margins in equation (4). By equation (3) this implies that the effect of granting work visas to foreign workers for this occupation has an effect on native employment in the occupation that is close to zero.

But this null result has a further implication for the effect of this occupational visa on native employment in other occupations, beyond the farm sector. The result furthermore implies that foreign seasonal laborers in North Carolina cause an increment to the economic product of the state, because in their absence, the total supply of farm labor would fall. This decline in overall output would tend to reduce the employment of domestic workers in other occupations (as in Malchow-Møller et al. 2013; Del Carpio et al. 2015). The magnitude of this decline depends on the substitutability of capital for labor within agriculture. The following analysis conducts a rough estimate of that statewide economic effect in the present case and its consequences for native jobs in all sectors of the state economy.

Table 8a reports estimates of the marginal revenue product (MRP) of manual seasonal harvest and planting workers in North Carolina, for three of the principal crops produced by NCGA farms. They are based primarily on crop budgets produced by researchers at North Carolina State University and are specific to the state. The short-run estimates of workers' MRP assume a Leontief production function, so that the MRP/hour/acre is simply equal to the MRP/acre/season divided by the hours of manual harvest and planting labor required per season. This certainly overestimates MRP, since farmers could be expected to adjust other inputs in response to a loss of manual labor. The long-run estimates assume a Cobb-Douglas production function, assuming that the production elasticity of manual labor equals its cost share.[18] This likely underestimates MRP, since it assumes capital to be substitutable for labor without limit, at unit elasticity, in these hand-harvest crops.[19] Details of the method and data sources are given in subsection A.2.

These estimates suggest that the short-run MRP of seasonal manual labor in NCGA jobs is somewhere around 4–6 times the wage paid to manual seasonal workers, and the long-run MRP is somewhere around 2–3 times the wage.[20] The short-run MRP is conservatively less than 6, and

[18] A basic implication of Cobb-Douglas production is that the output elasticity of an input is well approximated by its cost share. In the simplest version of the dual problem, $\min_{K,L} \left(wL + rK\right)$ s.t. $AK^{1-\alpha}L^{\alpha} = \bar{Q} \xrightarrow[FOC]{} \alpha = \frac{wL}{wL+rK}$. It is standard in the industrial organization literature to approximate firm-level output elasticities with industry-level input cost shares (e.g. Griliches 1963; Baily et al. 1992; Syverson 2004; Foster et al. 2008).

[19] The long-run elasticity of substitution between labor and machinery in U.S. agriculture has been estimated at 0.75 (Ray 1982) and 0.85 Binswanger (1974). This suggests that the Cobb-Douglas assumption of unit elasticity is conservative. It is moreover conservative because those estimates are driven by crops that fully mechanized after World War 2, such as wheat, corn, and cotton. The crops that employ H-2A workers, such as harvesting cucumbers and Christmas trees, are those with a lower elasticity of capital-labor substitution because viable technology to mechanize the harvest does not exist.

[20] These figures are corroborated by the only corresponding estimate of which I am aware in the agricultural eco-

the long-run MRP cannot go below 2—a value that would assume farmers can almost continuously substitute for any deficit in manual labor by adjusting other inputs.

Table 8b draws out the implications of these figures for the impact of foreign seasonal H-2A farm workers for economic product and jobs in all sectors of the entire state of North Carolina. Details and sources for this calculation are given in Appendix A. The MRP of 7,000 foreign seasonal agricultural workers per year is between about $300 and 450 million in the short run and about $150 and 225 million in the long run. The U.S. Bureau of Economic Analysis RIMS II regional economic model predicts that an increment of this magnitude in the agricultural economy of North Carolina generates roughly 2,800–4,300 jobs in all sectors of the state economy in the short run, and roughly 1,400–2,100 jobs in the long run. In other words, each 1.5–2.3 foreign H-2A workers create one U.S. job in North Carolina in the short run, and each 3.0–4.6 foreign H-2A workers create one U.S. job in North Carolina in the long run. The RIMS II output multiplier furthermore suggests that if the labor of the 7,000 H-2A workers employed by the NCGA were lost, the total economic output of North Carolina would decline by roughly $500–750 million in the short run (without any adjustment by farmers) and by at least $250–370 million in the long run (after the greatest plausible degree of adjustment by farmers).

These estimates are conservative for four reasons. First, the particular RIMS II jobs multiplier used here is the 'Type I' multiplier, which omits all effects of local expenditure by workers. While H-2A workers at the NCGA remit to Mexico the majority of their earnings, they do spend roughly 10–15% of earnings in North Carolina. Second, the 'Type I' multiplier ignores the effects of spending by non-seasonal hired workers on the same farms, most of whom are U.S. workers who live and spend in the area. Third, it ignores all effects of an expansion in the North Carolina economy on the economies of neighboring states and job creation in those states. Fourth, it ignores any effects on the U.S. economy from any eventual spending of dollars remitted to Mexico on U.S. exports.

nomics literature. Assuming Cobb-Douglas production, Huffman (1976, Table 5) finds that for representative farms in North Carolina, the marginal revenue product of hired labor is 1.75 times the wage. The corresponding figures in Table 8a are 1.44–1.99 times the wage.

## 5 Conclusion

These results use a natural audit study, in the context of a large shock to workers' reserve option, to characterize and directly compare domestic and foreign labor supply to a single occupation for the first time. They imply that the supply of foreign labor within the occupation—manual farm labor—has a negative effect on domestic employment that is statistically distinguishable from zero but very close to zero in magnitude. Although employers were required to demand domestic labor with infinite elasticity at the same wage that migrants' receive, the 290,000 net increase in unemployed workers in North Carolina 2007–2010 only caused about 50 unemployed workers to supply labor to manual farm work.

The evidence is inconsistent with a range of possible explanations for low native labor supply, including geographic mismatch, asymmetric information, and moral hazard from unemployment insurance. It appears that nearly all domestic workers prefer almost any labor-market outcome—including long periods of unemployment—to carrying out manual harvest and planting labor. This remains true across a wide range of reserve options, implying under equation (4) that it remains true across a wide range of compensation as well. This native-migrant difference in preferences informs the effects of a policy to relax barriers to international labor mobility for specific occupations, as the United States and many other countries do, and it is independent of whether natives and migrants are imperfect substitutes in production.

Native-migrant disparities in occupation-level labor supply have implications for the cost-effectiveness of regulatory efforts to protect domestic employment. For example, regulators require the North Carolina Growers Association to advertise all of the jobs studied here in four newspapers in three states. The Association reports spending $54,440 on these advertisements in 2011, and $35,906 in 2012, for a two-year total newspaper advertising expenditure of $90,346. During that two-year period, a total of five U.S. workers hired by the NCGA reported that they had first learned of the job through a newspaper advertisement.[21] Of those five, only one was willing to start the job, stay past the first few weeks, and complete the growing season—earning roughly $8,000 during the four-month season. That is, the advertising regulation in this case caused employers to spend approximately ten dollars to raise domestic workers' earnings by

[21] Full data are reported in Appendix D.

one dollar.

The principal limitation of these results is that they consider only a single occupation, though it is an occupation relevant to U.S. immigration policy. It would be useful for future research to directly compare, for other policy-relevant occupations, domestic and migrant labor supply at the occupation level. It would furthermore by useful to explore the reasons for such drastic differences in labor supply for specific occupations. Labor supply elasiticies have been found to be shaped by workers' social reference group (e.g. Grodner and Kniesner 2006) suggesting the possibility of multiple equilibria: Low initial native labor supply to some jobs leads them to be considered 'immigrant jobs' in those workers' reference group, which further reduces native labor supply, in a self-reinforcing cycle.

## References


**Addison, J. and P. Portugal**, "Job Displacement, Relative Wage Changes, and Duration of Unemployment," *Journal of Labor Economics*, 1989, *7* (3), 281–302.

**Altonji, J.G. and D. Card**, "The effects of immigration on the labor market outcomes of less-skilled natives," in J.M. Abowd and R.F. Freeman, eds., *Immigration, Trade and the Labor Market*, University of Chicago Press, 1991, pp. 201–234.

**Angrist, J.D. and A.D. Kugler**, "Protective or counter-productive? Labour market institutions and the effect of immigration on E.U. natives," *Economic Journal*, 2003, *113* (488), F302–F331.

**Autor, David H**, "The 'task approach' to labor markets: An overview," *Journal for Labour Market Research*, 2013, *46* (3), 185–199.

**Baily, M.N., C. Hulten, D. Campbell, T. Bresnahan, and R.E. Caves**, "Productivity dynamics in manufacturing plants," *Brookings Papers on Economic Activity: Microeconomics*, 1992, *1992*, 187–267.

**Barnes, W.F.**, "Job search models, the duration of unemployment, and the asking wage: Some empirical evidence," *Journal of Human Resources*, 1975, *10* (2), 230–240.

**Basten, Christoph Carl and Michael Siegenthaler**, "Do immigrants take or create residents' jobs? Quasi-experimental evidence from Switzerland," KOF Working Paper 335. Zurich: KOF Swiss Economic Institute 2013.

**Bertrand, Marianne and Sendhil Mullainathan**, "Are Emily and Greg more employable than Lakisha and Jamal? A field experiment on labor market discrimination," *American Economic Review*, 2004, *94* (4), 991–1013.

**Binswanger, Hans P**, "A cost function approach to the measurement of elasticities of factor demand and elasticities of substitution," *American Journal of Agricultural Economics*, 1974, *56* (2), 377–386.

**Bodvarsson, Ö.B., H.F. Van den Berg, and J.J. Lewer**, "Measuring immigration's effects on labor demand: A reexamination of the Mariel Boatlift," *Labour Economics*, 2008, *15* (4), 560–574.

**Cadena, Brian C and Brian K Kovak**, "Immigrants equilibrate local labor markets: Evidence from the Great Recession," *American Economic Journal: Applied Economics*, 2016, *8* (1), 257–290.

**Cahuc, P. and A. Zylberberg**, *Labor Economics*, Cambridge, MA: MIT Press, 2004.

**Camerer, Colin, Linda Babcock, George Loewenstein, and Richard Thaler**, "Labor Supply of New York City Cabdrivers: One Day at a Time," *Quarterly Journal of Economics*, 1997, *112* (2), 407–441.

**Card, David**, "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration," *Journal of Labor Economics*, 2001, *19* (1), 22–64.

**_ and John DiNardo**, "Do Immigrant Inflows Lead to Native Outflows?," *American Economic Review*, 2000, *90* (2), 360–367.

**_ , Andrew Johnston, Pauline Leung, Alexandre Mas, and Zhuan Pei**, "The Effect of Unemployment Benefits on the Duration of Unemployment Insurance Receipt: New Evidence from a Regression Kink Design in Missouri, 2003–2013," *American Economic Review*, 2015, *105* (5), 126–130.

**Carroll, D., R.M. Samardick, S. Bernard, S. Gabbard, and T. Hernandez**, "Findings from the National Agricultural Workers Survey (NAWS) 2001–2002: A demographic and employment profile of United States farm workers," Research Report No. 9, U.S. Dept. of Labor 2005.

**D'Amuri, Francesco and Giovanni Peri**, "Immigration, Jobs and Employment Protection: Evidence from Europe Before and During the Great Recession," *Journal of the European Economic Association*, 2014, *12* (2), 432–464.

**Del Carpio, Ximena, Çağlar Özden, Mauro Testaverde, and Mathis Wagner**, "Local Labor Supply Responses to Immigration," *Scandinavian Journal of Economics*, 2015, *117* (2), 493–521.

**Depew, Briggs, Todd A Sørensen et al.**, "The elasticity of labor supply to the firm over the business cycle," *Labour Economics*, 2013, *24* (C), 196–204.

**Devadoss, Stephen and Jeff Luckstead**, "Contributions of immigrant farmworkers to California vegetable production," *Journal of Agricultural and Applied Economics*, 2008, *40* (3), 879–894.

**Dupas, Pascaline, Jonathan Robinson, and Santiago Saavedra**, "The Daily Grind: Cash Needs, Labor Supply and Self-Control," Working Paper, Department of Economics, Stanford University 2016.

**Falch, Torberg**, "Wages and recruitment: evidence from external wage changes," *ILR Review*, 2017, *forthcoming*.

**Farber, Henry S.**, "Why you Canfit Find a Taxi in the Rain and Other Labor Supply Lessons from Cab Drivers," *Quarterly Journal of Economics*, 2015, *130* (4), 1975–2026.

**_ and Robert G. Valletta**, "Do Extended Unemployment Benefits Lengthen Unemployment

Spells? Evidence from Recent Cycles in the U.S. Labor Market," NBER Working Paper 19048, National Bureau of Economic Research 2013.

**Fehr, Ernst and Lorenz Goette**, "Do workers work more if wages are high? Evidence from a randomized field experiment," *American Economic Review*, 2007, *97* (1), 298–317.

**Feldstein, M. and J. Poterba**, "Unemployment insurance and reservation wages," *Journal of Public Economics*, 1984, *23* (1), 141–167.

**Fishe, R.P.H.**, "Unemployment Insurance and the Reservation Wage of the Unemployed," *Review of Economics and Statistics*, 1982, *64* (1), 12–17.

**Foged, Mette and Giovanni Peri**, "Immigrants' Effect on Native Workers: New Analysis on Longitudinal Data," *American Economic Journal: Applied Economics*, 2016, *8* (2), 1–34.

**Fort, Teresa C, John Haltiwanger, Ron S Jarmin, and Javier Miranda**, "How firms respond to business cycles: The role of firm age and firm size," *IMF Economic Review*, 2013, *61* (3), 520–559.

**Foster, L., J. Haltiwanger, and C. Syverson**, "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?," *American Economic Review*, 2008, *98* (1), 394–425.

**Gibson, John and David J McKenzie**, "Development through seasonal worker programs: the case of New Zealand's RSE Program," Policy Research Working Paper 6762 2014.

**Griliches, Z.**, "Estimates of the aggregate agricultural production function from cross-sectional data," *Journal of Farm Economics*, 1963, *45* (2), 419–428.

**Grodner, Andrew and Thomas J Kniesner**, "Social interactions in labor supply," *Journal of the European Economic Association*, 2006, *4* (6), 1226–1248.

**Hagedorn, Marcus, Fatih Karahan, Iourii Manovskii, and Kurt Mitman**, "Unemployment Benefits and Unemployment in the Great Recession: The Role of Macro Effects," Working Paper 19499, National Bureau of Economic Research October 2013.

**Hatton, T.J. and M. Tani**, "Immigration and Inter-Regional Mobility in the UK, 1982–2000," *Economic Journal*, 2005, *115* (507), F342–F358.

**Hersch, Joni and W Kip Viscusi**, "Immigrant status and the value of statistical life," *Journal of Human Resources*, 2010, *45* (3), 749–771.

**Huffman, W.E.**, "The productive value of human time in US agriculture," *American Journal of Agricultural Economics*, 1976, *58* (4 Part 1), 672–683.

**Hunt, Jennifer**, "The Effect of Unemployment Compensation on Unemployment Duration in Germany," *Journal of Labor Economics*, 1995, *13* (1), 88–120.

__ , "The impact of immigration on the educational attainment of natives," NBER Working Paper 18047. Cambridge, MA: National Bureau of Economic Research 2012.

**Kaestner, Robert and Neeraj Kaushal**, "Effect of immigrant nurses on labor market outcomes of US nurses," *Journal of Urban Economics*, 2012, *71* (2), 219–229.

**Kasper, H.**, "The asking price of labor and the duration of unemployment," *Review of Economics* *and Statistics*, 1967, *49* (2), 165–172.

**Katz, L.F. and B.D. Meyer**, "The impact of the potential duration of unemployment benefits on the duration of unemployment," *Journal of Public Economics*, 1990, *41* (1), 45–72.

**Kiefer, N.M. and G.R. Neumann**, "An Empirical Job-Search Model, with a Test of the Constant Reservation-Wage Hypothesis," *Journal of Political Economy*, 1979, *87* (1), 89–107.

**Kline, Patrick and Melissa Tartari**, "Bounding the labor supply responses to a randomized welfare experiment: A revealed preference approach," *American Economic Review*, 2016, *106* (4), 971–1013.

**LaLonde, R.J. and R.H. Topel**, "Labor Market Adjustments to Increased Immigration," in J.M. Abowd and R.B. Freeman, eds., *Immigration, Trade and the Labor Market*, Chicago: University of Chicago Press, 1991, pp. 167–199.

**Lancaster, T. and A. Chesher**, "An Econometric Analysis of Reservation Wages," *Econometrica*, 1983, *51* (6), 1661–76.

**Lewis, Ethan G.**, "Immigrant-Native Substitutability and The Role of Language," in David Card and Steven Raphael, eds., *Immigration, Poverty, and Socioeconomic Inequality*, New York: Russell Sage Foundation, 2013, pp. 60–97.

**Malchow-Møller, Nikolaj, Jakob Roland Munch, Claus Aastrup Seidelin, and Jan Rose Skaksen**, "Immigrant Workers and Farm Performance: Evidence from Matched Employer-Employee Data," *American Journal of Agricultural Economics*, 2013, *95* (4), 819–841.

**Martin, P.**, "Evaluation of the H-2A Alien Labor Certification Process and the U.S. Farm Labor Market," Consulting report from KRA Corporation, Silver Spring, Maryland, Employment and Training Administration, U.S. Dept. of Labor 2008.

**Migration Advisory Committee**, "Migrant Seasonal Workers: The impact on the horticulture and food processing sectors of closing the Seasonal Agricultural Workers Scheme and the Sectors Based Scheme," Technical Report, UK Border Agency, Home Office 2013.

**Oettinger, Gerald S**, "An empirical analysis of the daily labor supply of stadium venors," *Journal of political Economy*, 1999, *107* (2), 360–392.

**Okkerse, Liesbet**, "How to measure labour market effects of immigration: A review," *Journal of Economic Surveys*, 2008, *22* (1), 1–30.

**Peri, Giovanni**, "Immigrants, Productivity, and Labor Markets," *Journal of Economic Perspectives*, 2016, *30* (4), 3–29.

_ **and Chad Sparber**, "Task Specialization, Immigration, and Wages," *American Economic Journal: Applied Economics*, 2009, *1* (3), 135–169.

_ **, Kevin Shih, and Chad Sparber**, "Foreign and Native Skilled Workers: What Can We Learn from H-1B Lotteries?," NBER Working Paper 21175. Cambridge, MA: National Bureau of Economic Research 2015.

**Perloff, Jeffrey M, Lori Lynch, and Susan M Gabbard**, "Migration of seasonal agricultural workers," *American Journal of Agricultural Economics*, 1998, *80* (1), 154–164.

**Pischke, J.S. and J. Velling**, "Employment effects of immigration to Germany: An analysis based on local labor markets," *Review of Economics and Statistics*, 1997, *79* (4), 594–604.

**Ray, Subhash C**, "A translog cost function analysis of US agriculture, 1939–77," *American Journal of Agricultural Economics*, 1982, *64* (3), 490–498.

**Røed, K. and T. Zhang**, "Does Unemployment Compensation Affect Unemployment Duration?," *Economic Journal*, 2003, *113* (484), 190–206.

**Syverson, C.**, "Market structure and productivity: A concrete example," *Journal of Political Economy*, 2004, *112* (6), 1181–1222.

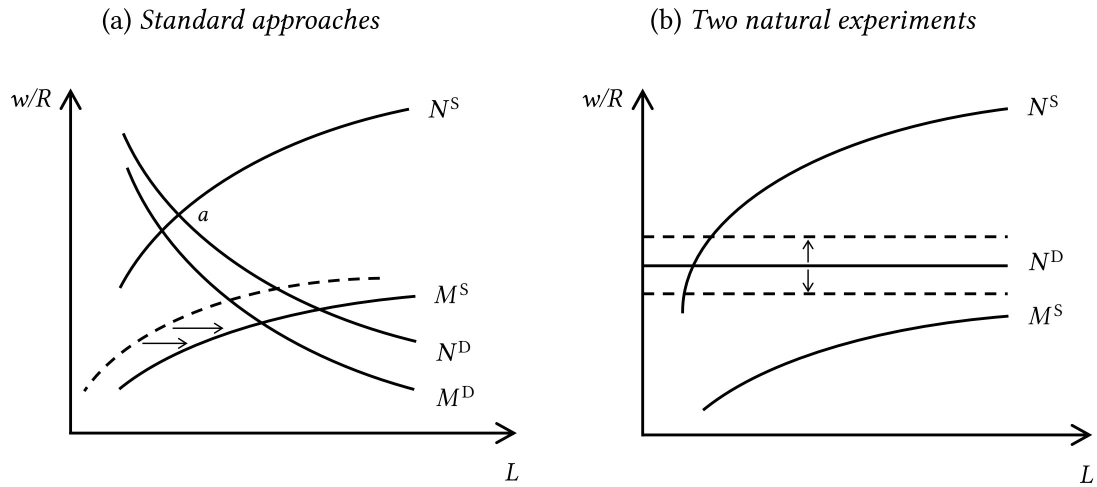
**Tran, Lien H. Tran and Jeffrey M. Perloff**, "Turnover in U.S. Agricultural Labor Markets," *American Journal of Agricultural Economics*, 2002, *84* (2), 427–437.

**Valletta, Robert G**, "Recent extensions of US unemployment benefits: search responses in alternative labor market states," *IZA Journal of Labor Policy*, 2014, *3* (1), 1.

**Wicker, H.L.**, "Regional Perspectives on Agricultural Guestworker Programs," Hearing before the Subcommittee on Immigration Policy and Enforcement, February 9, U.S. House of Representatives Committee on the Judiciary 2012.

**Zavodny, Madeline**, "Do immigrants work in worse jobs than US Natives? Evidence from California," *Industrial Relations*, 2015, *54* (2), 276–293.

**Figure 1: How two natural experiments characterize native labor supply**



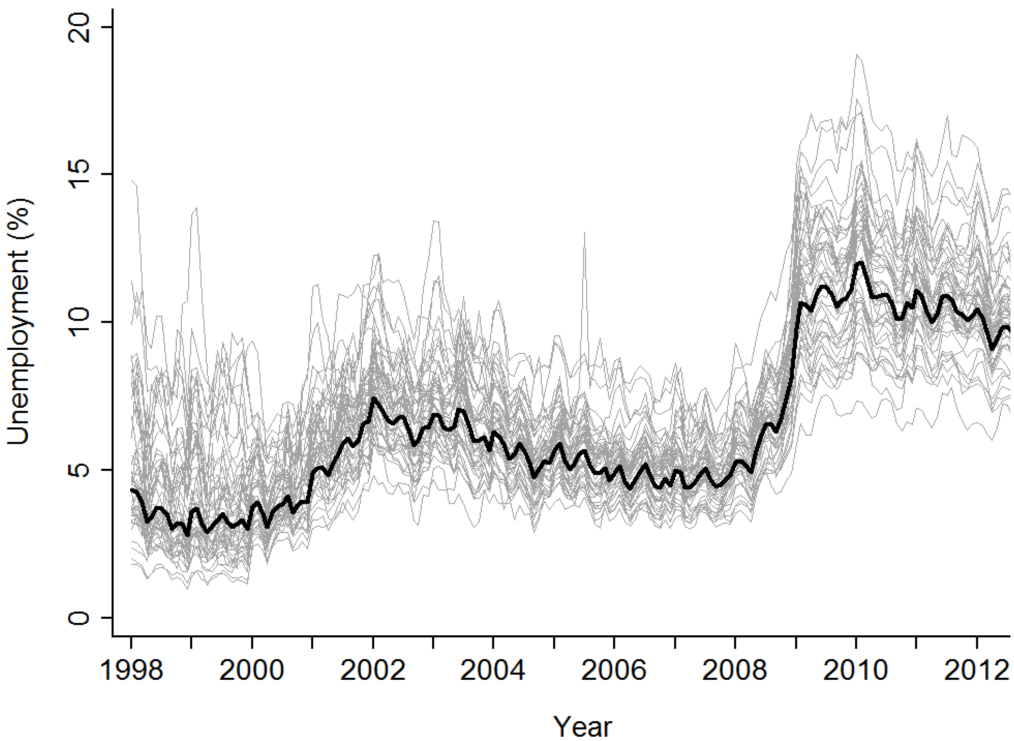

$N$ and $M$ represent native and migrant workers, respectively. Superscripts $S$ and $D$ represent supply and demand, respectively. $L$ is the quantity of labor utilized, and $\frac{w}{R}$ is the ratio of wage to reserve option in equation (4).

**Table 1:** Overview of Mexican H-2A Workers in North Carolina

| Year | Number | Months/worker |
|---|---|---|
| 2004 | 6799 | 4.454 |
| 2005 | 5602 | 4.527 |
| 2006 | 4786 | 4.571 |
| 2007 | 5410 | 4.797 |
| 2008 | 5969 | 5.233 |
| 2009 | 6237 | 5.084 |
| 2010 | 6201 | 5.613 |
| 2011 | 6474 | 5.496 |
| 2012 | 7008 | 5.506 |
| *Mean* | 6054 | 5.054 |

Number of workers shows number of unique individuals starting one or more H-2A employment events in each calendar year. Months/worker shows average months of work by each individual. 'Mean' row covers 2004–2012.

**Figure 2: North Carolina unemployment, at each DES office and statewide**




Black: North Carolina statewide average monthly unemployment rate (%). Gray: unemployment rate at each Department of Employment Security (DES) office—calculated as average unemployment rate in the counties served by that office, weighted by county labor force.

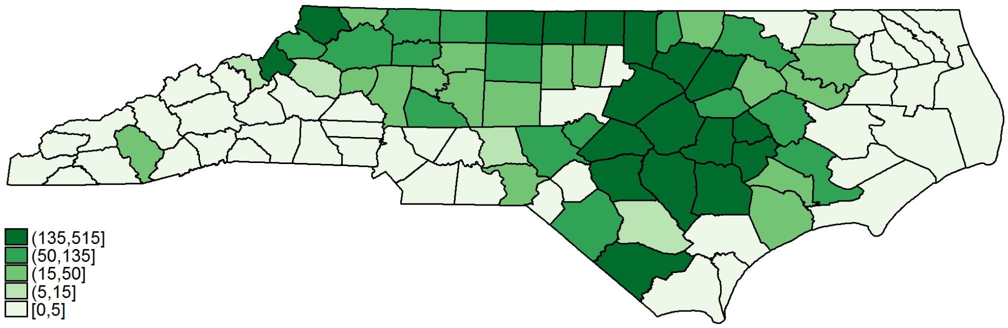
**Table 2: Overview of DES office referrals to all employers and to NCGA**

| | Unemp. | | DES to all employers | | | DES to NCGA | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rate | $N$ | New | Referred | | Referred | Hired | Started | Complete | Unknown |
| Year | (%) | | apps | Non-ag. | Ag. | | | | | |
| 1998 | 3.53 | 140782 | – | – | – | 112 | 98 | 14 | 0 | 25 |
| 1999 | 3.27 | 132707 | – | – | – | 41 | 39 | 6 | 0 | 3 |
| 2000 | 3.75 | 154577 | – | – | – | 35 | 34 | 4 | 0 | 1 |
| 2001 | 5.64 | 234934 | – | – | – | 46 | 44 | 13 | 0 | 0 |
| 2002 | 6.63 | 279281 | – | – | – | 99 | 91 | 43 | 2 | 2 |
| 2003 | 6.45 | 274193 | – | – | – | 244 | 242 | 83 | 3 | 0 |
| 2004 | 5.54 | 236328 | – | – | – | 134 | 134 | 37 | 2 | 3 |
| 2005 | 5.26 | 229030 | – | – | – | 57 | 57 | 22 | 6 | 2 |
| 2006 | 4.74 | 212099 | 236011 | 1642996 | 40880 | 88 | 88 | 22 | 10 | 15 |
| 2007 | 4.71 | 213276 | 238386 | 1586462 | 40924 | – | – | – | – | – |
| 2008 | 6.19 | 283048 | 256865 | 1498566 | 32958 | 170 | 167 | 58 | 11 | 50 |
| 2009 | 10.76 | 490010 | 276978 | 1396083 | 27168 | 108 | 105 | 48 | 6 | 0 |
| 2010 | 10.94 | 504885 | 267076 | 1604416 | 32245 | 74 | 73 | 30 | 10 | 10 |
| 2011 | 10.51 | 489095 | – | – | – | 268 | 245 | 163 | 7 | 0 |
| 2012 | 9.52 | 446469 | – | – | – | 253 | 213 | 143 | 10 | 0 |

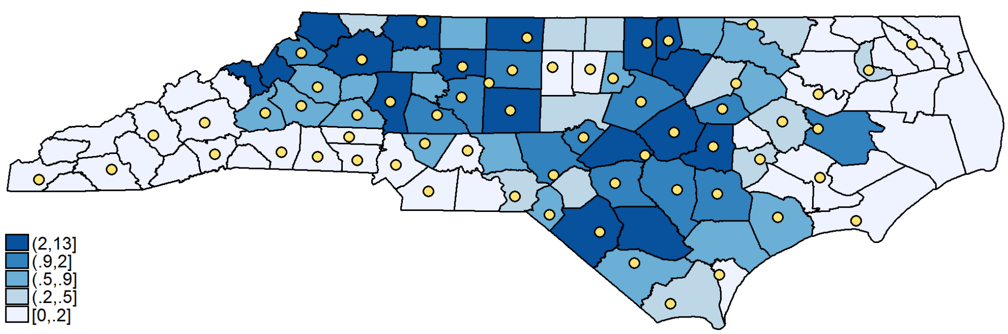
U.S. worker data for 2007 were not preserved by the NCGA. Unemployment (%) is average unemployment rate in the counties served by each Department of Employment Security (DES) office, weighted by size of labor force; Unemployed ($N$) is total number in those counties. The 2005 and 2011 DES totals are omitted from this table because published numbers only cover part of those two years: Feb.–Dec. 2005 and Jan.–May 2011.

**Figure 3: Locations of NCGA jobs, referred U.S. workers, and high unemployment**

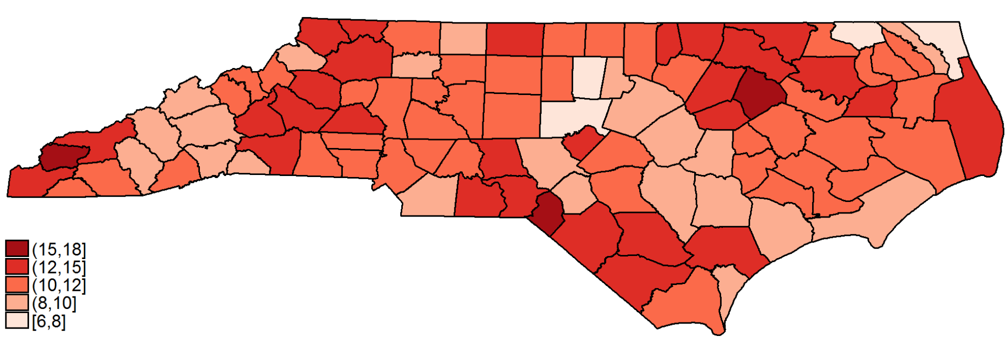
(a) *Average number of NCGA H-2A employment events per year (worksite)*




(b) *Average number of U.S. workers referred per year (residence), and DES offices (circles)*




(c) *Average unemployment rate in 2011 (%)*




All maps are divided into the 100 counties of North Carolina. In Figure 3b, shade of each county shows the average number of U.S. workers residing in that county referred by the Department of Employment Security (DES) to the North Carolina Growers Assocation (NCGA) each year, while yellow circles show locations of DES 'local' offices, excluding 'branch' offices (it omits the Warrenton local office because DES did not publish application/referral data for that office 2005–2011). North Carolina measures about 560 miles (901 km) from east to west; the average width of one county is 23.2 miles (37.3 km).

**Table 3: Descriptive statistics**

| | $N$ | Mean | S.D. | Min. | Max. |
|---|---|---|---|---|---|
| *Data by DES office and month, Jan. 1998 to Dec. 2012* | | | | | |
| Year | 11086 | 2005.01 | 4.32 | 1998 | 2012 |
| Month | 11086 | 6.49 | 3.45 | 1 | 12 |
| Unemployment (%) | 10980 | 7.03 | 3.10 | 0.97 | 23.75 |
| Unemployed ($N$) | 10980 | 4722.09 | 5996.88 | 65 | 59994 |
| Referrals to NCGA | 11086 | 0.16 | 0.93 | 0 | 31 |
| Hired by NCGA | 11086 | 0.15 | 0.86 | 0 | 31 |
| Began work at NCGA | 11086 | 0.06 | 0.51 | 0 | 24 |
| Completed work at NCGA | 11086 | 0.01 | 0.09 | 0 | 4 |
| *Data by DES office and month, Feb. 2005 to May 2011* | | | | | |
| Year | 4484 | 2007.76 | 1.85 | 2005 | 2011 |
| New job applications | 4484 | 349.46 | 284.98 | 57 | 2411 |
| Total non-agr. referrals | 4484 | 2171.71 | 1352.99 | 0 | 13756 |
| Total non-agr. placements | 4484 | 87.27 | 73.09 | 0 | 751 |
| Total agr. referrals | 4482 | 46.28 | 115.39 | 0 | 2102 |
| Total agr. placements | 4484 | 24.15 | 92.11 | 0 | 1922 |
| *Data by employment episode: U.S. workers, Jan. 1998 to Dec. 2012* | | | | | |
| Year of job start | 1594 | 2006.35 | 4.41 | 1998 | 2012 |
| Month of job start | 1594 | 4.69 | 1.92 | 1 | 12 |
| Unemployment (%) | 1526 | 7.75 | 2.88 | 1.37 | 16.48 |
| Time before work start (mo.) | 1595 | 0.38 | 0.41 | 0.00 | 5.06 |
| Time after work start (mo.) | 586 | 1.06 | 1.46 | 0.00 | 8.54 |
| Completed job, if referred? | 1658 | 0.04 | 0.20 | 0 | 1 |
| Completed job, if started? | 805 | 0.08 | 0.28 | 0 | 1 |
| *Data by employment episode: Mexican workers, Jan. 2004 to Dec. 2012* | | | | | |
| Year of job start | 61439 | 2008.35 | 2.62 | 2004 | 2012 |
| Month of job start | 61439 | 5.40 | 1.92 | 1 | 12 |
| Time after work start (mo.) | 61254 | 4.50 | 2.28 | 0.00 | 11.27 |
| Completed job, if started? | 61255 | 0.92 | 0.27 | 0 | 1 |

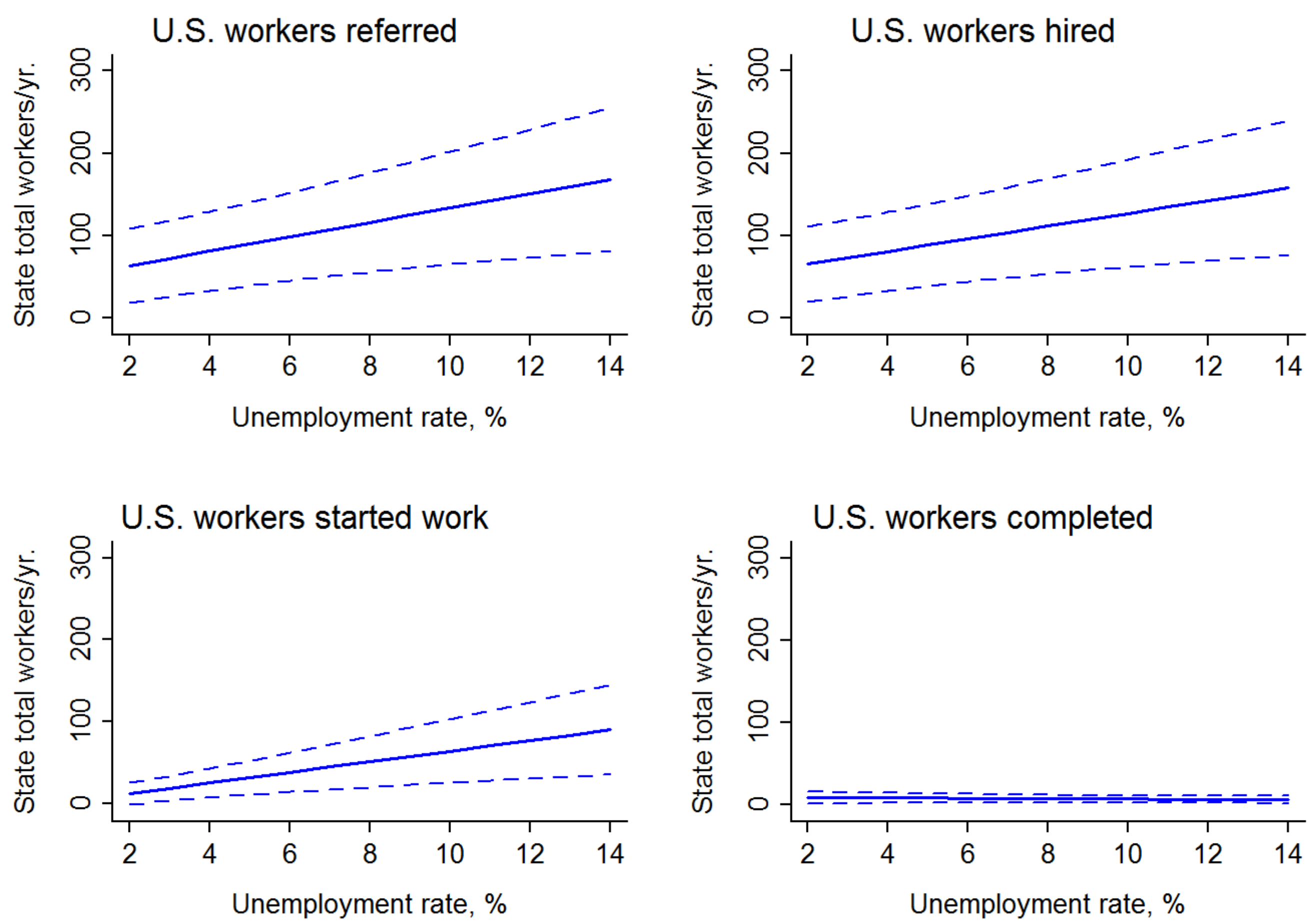
U.S. worker data for 2007 were not preserved by the NCGA. Unemployment (%) is average unemployment rate in the counties served by each Department of Employment Security (DES) office, weighted by size of labor force; Unemployed ($N$) is total number in those counties. All variables are shown unscaled; a scaled version of "new applications" (in thousands) is used in Table 4.

**Table 4: Effects of the recession on job referrals (Panel regressions with DES office fixed-effects), Feb. 2005–May 2011**

| | | All non-ag. jobs | | All ag. jobs | | NCGA jobs | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Referred | Placed | Referred | Placed | Referred | Hired | Started | Completed |
| Unemployment (%) | | −45.29$^{***}$ | −8.328$^{***}$ | −2.398$^{*}$ | −0.417 | 0.0122$^{**}$ | 0.0108$^{**}$ | 0.00909$^{**}$ | −0.000281 |
| | | (9.940) | (0.793) | (1.019) | (0.519) | (0.00410) | (0.00381) | (0.00289) | (0.000465) |
| New applications (000s), $t$ | | 2092.0$^{***}$ | 62.12$^{***}$ | 345.7$^{*}$ | 258.0 | −0.260 | −0.240 | −0.208 | −0.00985 |
| | | (441.0) | (11.90) | (168.3) | (146.1) | (0.168) | (0.155) | (0.120) | (0.0144) |
| ” | $t-1$ | 58.67 | 3.631 | 45.26 | 76.21 | −0.343$^{*}$ | −0.323$^{*}$ | −0.189$^{**}$ | −0.0258 |
| | | (148.8) | (11.92) | (29.50) | (45.29) | (0.145) | (0.142) | (0.0731) | (0.0207) |
| ” | $t-2$ | 45.26 | 5.188 | −33.14 | −36.53 | −0.376$^{*}$ | −0.349$^{*}$ | −0.173 | −0.0251 |
| | | (85.31) | (13.74) | (30.14) | (27.29) | (0.176) | (0.172) | (0.0955) | (0.0195) |
| ” | $t-3$ | −69.74 | −25.04 | −29.22 | −53.81 | −0.548$^{**}$ | −0.547$^{**}$ | −0.309$^{**}$ | −0.0298$^{*}$ |
| | | (92.16) | (15.80) | (19.56) | (32.93) | (0.176) | (0.168) | (0.113) | (0.0146) |
| ” | $t-4$ | −561.9$^{***}$ | 36.18$^{**}$ | −29.11$^{*}$ | −26.57 | −0.333$^{*}$ | −0.296$^{*}$ | −0.136$^{*}$ | −0.00699 |
| | | (97.15) | (13.61) | (12.89) | (15.20) | (0.133) | (0.127) | (0.0545) | (0.0167) |
| ” | $t-5$ | −177.2 | −16.81 | −55.91$^{**}$ | −49.36$^{*}$ | −0.390$^{*}$ | −0.396$^{*}$ | −0.156 | −0.0394$^{*}$ |
| | | (95.69) | (15.68) | (21.43) | (20.50) | (0.169) | (0.167) | (0.0831) | (0.0185) |
| ” | $t-6$ | −253.5 | −25.67 | −57.18$^{**}$ | −45.91$^{**}$ | 0.375$^{*}$ | 0.384$^{*}$ | 0.161$^{**}$ | 0.00613 |
| | | (159.0) | (13.54) | (19.32) | (16.93) | (0.171) | (0.171) | (0.0542) | (0.00929) |
| ” | $t-7$ | 227.8$^{*}$ | 16.56 | −50.86$^{*}$ | −52.23$^{*}$ | 0.459 | 0.455 | 0.277$^{*}$ | 0.108 |
| | | (109.3) | (23.75) | (23.17) | (22.66) | (0.266) | (0.271) | (0.137) | (0.0664) |
| ” | $t-8$ | 466.0$^{***}$ | 7.336 | −28.65 | −48.62 | 0.769$^{*}$ | 0.731$^{*}$ | 0.492 | 0.0212$^{*}$ |
| | | (135.3) | (11.43) | (15.82) | (25.34) | (0.326) | (0.321) | (0.253) | (0.0103) |
| ” | $t-9$ | 117.5 | 2.982 | 1.086 | 14.74 | 0.219 | 0.189 | 0.0361 | −0.0340 |
| | | (94.49) | (9.190) | (12.44) | (10.51) | (0.288) | (0.266) | (0.234) | (0.0404) |
| ” | $t-10$ | 139.4 | −27.88 | −49.35 | −22.89 | 0.385$^{*}$ | 0.362$^{*}$ | 0.163$^{*}$ | 0.0296 |
| | | (96.84) | (15.07) | (43.45) | (35.70) | (0.161) | (0.150) | (0.0808) | (0.0327) |
| Constant | | 1772.3$^{***}$ | 135.5$^{***}$ | 41.86$^{***}$ | 20.26$^{**}$ | 0.0779 | 0.0781 | 0.0117 | 0.0141$^{*}$ |
| | | (312.4) | (14.57) | (11.36) | (7.005) | (0.0412) | (0.0403) | (0.0168) | (0.00688) |
| $N$ | | 3828 | 3828 | 3828 | 3828 | 3828 | 3828 | 3828 | 3828 |

$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$. Observations are by Department of Employment Security (DES) office and month. All regressions use panel estimator with DES office fixed-effects. Standard errors in parentheses are clustered by DES office, given that $T > G$ ($T = 66$, $G = 58$). Data on NCGA referrals restricted to same period as the available data for DES referrals to all employers (Feb. 2005–May 2011). For this table only, new applications are measured in units of thousands (to make the coefficient estimates more compact). All dependent variables are in the original unscaled units: number of workers. NCGA jobs are linked by referral date: For example, “Completed” denotes the number of workers who completed an NCGA job for which they were referred in the month in question.

**Figure 4: Marginal effects of unemployment rate on U.S. labor supply to NCGA (state total/year)**




These figures represent the coefficients on the unemployment rate in columns 5–8 of Table 4. Those coefficients are in units of workers per office per month, so for this figure they are converted to statewide totals per year by multiplying by 720 (= 60 offices × 12 months). Dashed lines show 95% confidence interval.

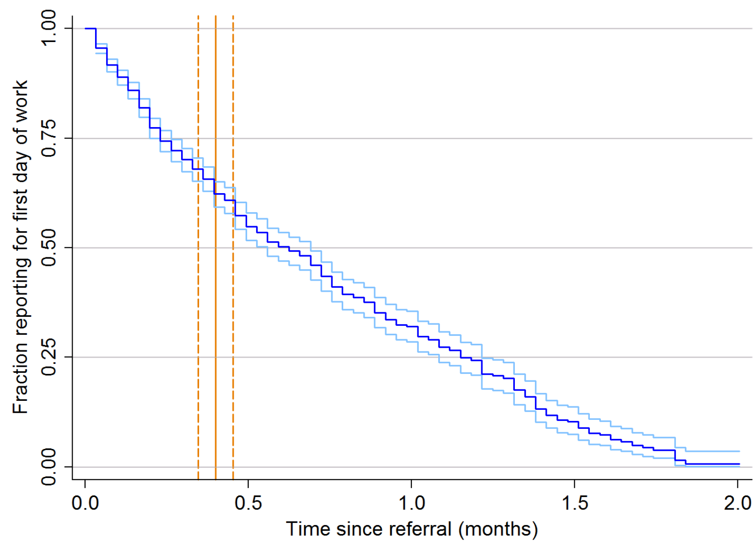
**Table 5: U.S. workers, by unemployment**

| | | Parametric survival estimation | | |
|---|---|---|---|---|
| | Cox | *Exponential* | *Gompertz* | *Weibull* |
| *From referral to start date*: | | | | |
| Unemployment (%) | 0.913*** | 0.912*** | 0.912*** | 0.911*** |
| | (0.0125) | (0.0125) | (0.0125) | (0.0125) |
| *N* | 1384 | 1384 | 1384 | 1384 |
| *From start date to quitting/termination* (Complete cases only): | | | | |
| Unemployment (%) | 0.972 | 0.946** | 0.972 | 0.964 |
| | (0.0184) | (0.0180) | (0.0183) | (0.0182) |
| *N* | 503 | 503 | 503 | 503 |

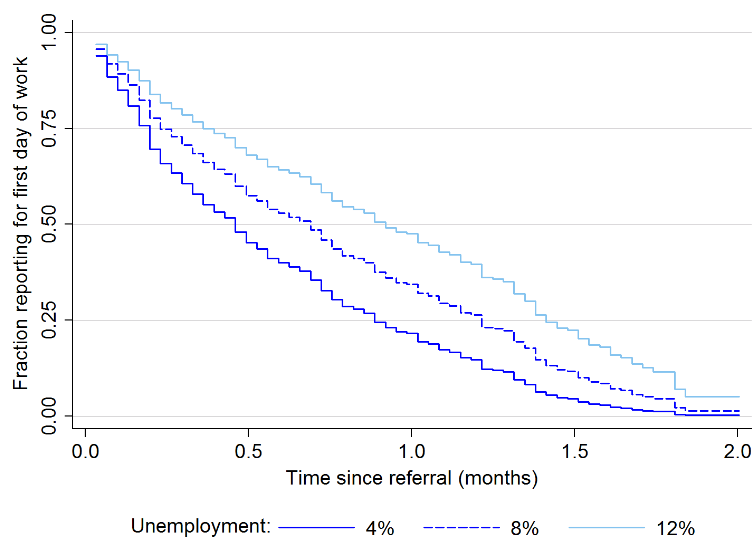
Exponentiated coefficients (log relative hazard form). Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
"Cox" is the semiparametric Cox proportional hazards model.

**Figure 5: U.S. workers, from referral to start date**

(a) *Kaplan-Meier survival curve*




(b) *Association with unemployment at referring office*




In Figure 5a, lines above and below survival curve show 95% confidence interval. Vertical orange line shows average duration to planned start date (with 95% confidence interval).

**Table 6: All workers, from start date to quitting/termination, by nationality**

| | | Parametric survival estimation | | |
|---|---|---|---|---|
| | Cox | *Exponential* | *Gompertz* | *Weibull* |
| *Complete cases* | | | | |
| U.S. worker | 34.28*** | 42.22*** | 35.57*** | 35.49*** |
| | (1.730) | (2.081) | (1.780) | (1.790) |
| *N* | 61691 | 61691 | 61691 | 61691 |
| *Missing survival times imputed* | | | | |
| U.S. worker | 31.89*** | 38.51*** | 32.60*** | 32.95*** |
| | (1.393) | (1.639) | (1.416) | (1.437) |
| *N* | 61865 | 61865 | 61865 | 61865 |

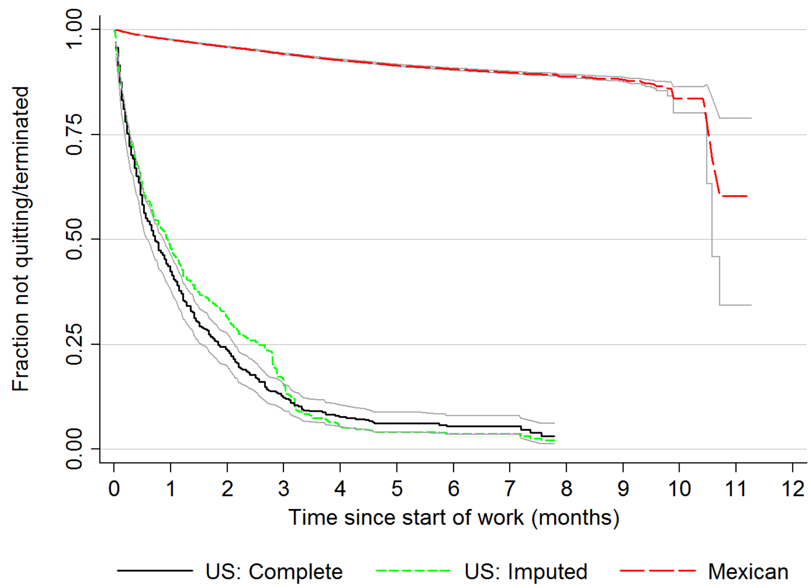
Base group is Mexican workers. Exponentiated coefficients (log relative hazard form). Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. "Cox" is the semiparametric Cox proportional hazards model. "Complete cases" are observations without missing survival time. "Imputed" means missing survival times modeled as a linear function of how the employment episode ended (completed, quit, fired); time from referral to start; unemployment rate at the referring DES office; and dummies for year, month, and year × month (for nonmissing survival times, model $R^2 = 0.4989$). "Extreme upper bound" means that each *U.S.* worker with a missing survival time is assigned the survival time of the average *Mexican* worker with the same job outcome (completed, quit, fired) who started work in the same month of the same year.

**Table 7: Missing observations on outcome and duration of work**

| | U.S. worker duration | | Mexican worker duration | |
|---|---|---|---|---|
| | *Not missing* | *Missing* | *Not missing* | *Missing* |
| Outcome: | | | | |
| *Completed* | 67 | 1 | 56505 | 0 |
| *Quit* | 488 | 100 | 2285 | 0 |
| *Fired* | 31 | 7 | 2464 | 1 |
| *Unknown* | 0 | 111 | 0 | 126 |

**Figure 6: U.S. & Mexican workers, from start of work to quitting/termination**

(a) *Kaplan-Meier survival curves*




(b) *Association with unemployment at referring office (U.S. complete cases)*

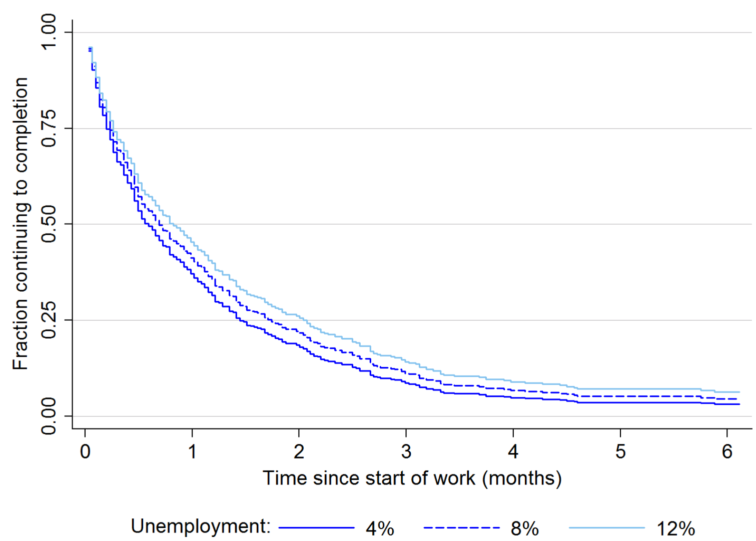


**Table 8:** Approximate effects on value-added and nonfarm employment

(a) *Approximate marginal revenue product (MRP) of manual farm labor*

| Crop | Cucumber | | Sweet potato | | Tobacco |
|---|---|---|---|---|---|
| Year | 2002 | 2013 | 2002 | 2012 | 2009 |
| Revenue/acre ($) | 2040.00 | 2325.00 | 2637.50 | 3375.00 | 4050.00 |
| Non-labor cost/acre ($) | 806.17 | 1168.20 | 1485.82 | 1696.56 | 2627.95 |
| Hours/acre | 80 | 80 | 50 | 50 | 60 |
| Revenue/acre/hr ($) | 25.50 | 29.06 | 52.75 | 67.50 | 67.50 |
| Non-labor cost/acre/hr ($) | 10.08 | 14.60 | 29.72 | 33.93 | 43.80 |
| Labor cost/acre/hr ($) | 10.54 | 13.58 | 10.54 | 13.58 | 13.08 |
| *Cost fraction* | 0.51 | 0.48 | 0.26 | 0.29 | 0.23 |
| NCGA wage/hour ($) | 7.53 | 9.70 | 7.53 | 9.70 | 9.34 |
| **Short run** (Leontief): | | | | | |
| MRP/hr/acre ($) | 25.50 | 29.06 | 52.75 | 67.50 | 67.50 |
| *Multiple of wage* | 3.39 | 3.00 | 7.01 | 6.96 | 7.23 |
| **Long run** (Cobb-Douglas): | | | | | |
| MRP/hr/acre ($) | 13.04 | 14.00 | 13.81 | 19.29 | 15.52 |
| *Multiple of wage* | 1.73 | 1.44 | 1.83 | 1.99 | 1.66 |

Seasonal crop budgets are representative for North Carolina; detailed method and sources given in Appendix A. These crops are the most common on NCGA farms, often grown on the same farm. Numbers for cucumbers and tobacco are for pickling cucumbers and manual-harvest tobacco, respectively. 'Labor' here refers exclusively to unskilled manual labor for harvest and some planting, but not to packing or more skilled work such as machinery operation or supervision.

(b) *Approximate statewide job creation by 7,000 H-2A workers*

| | Short run | | Long run | |
|---|---|---|---|---|
| | *low* | *high* | *low* | *high* |
| MRP multiplier | 4 | 6 | 2 | 3 |
| Total wage bill ($m) | 74.7 | 74.7 | 74.7 | 74.7 |
| Revenue product ($m) | 298.8 | 448.1 | 149.4 | 224.1 |
| Jobs multiplier | 9.527 | 9.527 | 9.527 | 9.527 |
| *US jobs created in NC* | 2846 | 4269 | 1423 | 2135 |
| *H-2A workers per US job* | 2.3 | 1.5 | 4.6 | 3.0 |
| Output multiplier | 1.657 | 1.657 | 1.657 | 1.657 |
| *Effect on NC economic output* ($m) | $495 | $743 | $248 | $371 |

Figures are for 7,000 H-2A workers per year. Total wage bill for all NCGA H-2A workers assumes 5.5 months work for average H-2A worker, at approximately 50 hrs/wk: Thus $9.70/hr × 1100 hrs/yr × 7,000 workers = $74.7m. Statewide US jobs and output multipliers from US Bureau of Economic Analysis RIMS II model ('Type I', ignoring workers' expenditures); details in Appendix A.

# Online Appendix:
## "The effect of occupational visas on native employment: Evidence from labor supply to farm jobs in the Great Recession"

## A U.S. job creation in North Carolina by value-added arising from H-2A manual farm labor

### A.1 Production functions

In the estimates of Table 8a I use two different assumptions on the form of farms' production function. For the fixed-proportions production function, $MRP_{\text{Leontief}} = Y$, where $Y$ is revenue/hour/acre. For the constant (unit) elasticity of substitution production function, $MRP_{\text{Cobb-Douglas}} = \kappa Y$, where $\kappa$ is the cost fraction of manual harvest labor.

### A.2 Marginal revenue product (MRP) of North Carolina manual farm labor

*Cucumbers (pickling)*: Data on revenue/season/acre and costs/season/acre (without manual harvesting & planting labor) for 2002 come from E. Estes, J. Schultheis, and H. Sampson (2002), "Cucumbers, Pickling: Est. Revenue, Operating Exp., Annual Ownership Exp., and Net Revenue Per Acre", Dept. of Agricultural and Resource Economics, North Carolina State Univ. (ARE/NCSU); and for 2013 come from G. Bullen and A. Thornton (2013), "Spring Cucumber for Pickles—Irrigated: Estimated costs per acre, 2013", ARE and Dept. of Horticultural Sciences, NCSU. Approximate worker-hours/season/acre for low-skill manual harvest labor is from Prof. David H. Nagel, Extension Professor in the Dept. of Plant and Soil Sciences, Mississippi State University, personal communication January 15, 2013. He is the author of D.H. Nagel (2000), *Commercial Production of Cucumbers in Mississippi*, Starkville, MS: Mississippi State University Extension Service.

*Sweet potatoes*: Data on revenue/season/acre and costs/season/acre (without manual harvesting & planting labor) for 2002 come from E. Estes, J. Schultheis, and H. Sampson (2002), "Sweetpotatoes: Estimated Rev., Operating Expenses, Annual Ownership Expenses, and Net Return Per Acre", ARE/NCSU; and for 2012 from G. Bullen (2012), Sweet Potato—2012: Estimated Costs per Acre, 2012, ARE/NCSU. Estimated worker-hours/season/acre for low-skill manual harvest and planting labor is from W. Ferreira, (2011), Sweet Potatoes—for fresh market, irrigated: Estimated Costs and Returns per Acre, Kingstree, SC: Clemson University Cooperative Extension Service; and from D. Parvin, C. Walden, and B. Graves (2000), *Estimated Costs and Returns for Sweetpotatoes in Mississippi*, Starkville, MS: Office of Agricultural Communications, Mississippi State Univ. Division of Agriculture, Forestry, and Veterinary Medicine.

*Tobacco*: To estimate typical revenue/season/acre I first take average yield/acre in North Carolina for the years 2009 (2,346 lb/acre) and 2010 (2,123 lb/acre), i.e. roughly 2,250 lb/acre (A.B. Brown et al. [2011], *Flue-Cured Tobacco Guide 2011*, Raleigh, NC: North Carolina State University, p. 7), and multiply by the average price received for all stalk positions (approximately $1.80/lb in 2009, *ibid.* p. 8) to get approximate revenue/season/acre of $4,050. Estimated costs/season/acre (without manual harvesting & planting labor) are from G. Bullen and L. Fisher (2012), "Flue-Cured Tobacco—Hand Harvest Piedmont 2012: Estimated Costs per Acre, 2012, ARE/NCSU. (Note that NCSU also publishes tobacco budgets for 2009 but they are for machine-harvested tobacco; the only current, recently published hand-harvest tobacco budget from NCSU is from 2012.)

*Wages and manual labor costs:* The 2012 and 2013 NCGA wage of $9.70/hr is from the NCGA and public records at the U.S. Dept. of Labor Foreign Labor Certification Center. The 2002 and 2009 wages are the North Carolina-specific "Adverse Effect Wage Rate" fixed for each year by the U.S. Dept. of Labor's Office of Foreign Labor Certification and published in the *Federal Register*. The employer's full cost of manual H-2A workers' labor is estimated at 1.4 × wage, in accordance with NCGA estimates. The additional costs are primarily for housing, transporting, equipping, and training workers.

## A.3 U.S. jobs multiplier

The Bureau of Economic Analysis at the U.S. Dept. of Commerce built the Regional Input-Output Modeling System (RIMS II) to create estimates of how local demand shocks affect gross output, value added, earnings, and employment in regions of the United States. RIMS II estimates two types of employment multipliers for economic shocks in the "Crop and Animal Production" subsector of the "Agriculture, forestry, fishing, and hunting" sector. Type I multipliers omit the effects of household spending by all workers; Type II multipliers include these effects. With the relevant region limited to the state of North Carolina, the Type I multiplier for shocks to this subsector is 9.527 and the Type II multiplier is 13.815. This multiplier "represents the total change in number of jobs that occurs in all industries within the state for each additional million dollars of output delivered to final demand by the selected industry."

The jobs effect estimated in this way is very different from popular estimates of the number of jobs "supported by" manual laborers, which do not typically take into account the ability of workers to find other jobs if their current jobs were to be eliminated. Instead, the RIMS II jobs multiplier estimates the number of jobs in all sectors of the entire state that are caused to exist by a given change in the economic activity happening within one sector, *including* the ability of workers who lose their jobs to find other jobs. It estimates the effect of economic change on the total pool of all jobs available to any individuals, not the effect on the current jobs of particular individuals.

The RIMS II Type I multiplier for state output used in Table 8b is 1.657, and the corresponding Type II multiplier is 2.134. The output multiplier "represents the total dollar change in output that occurs in all industries within the state for each additional dollar of output delivered to final demand by the selected industry".

# B Other data sources

All data on U.S. workers referred to and hired by the North Carolina Growers Association (NCGA), and on Mexican workers hired by the NCGA, were provided by the NCGA.[22] Data on DES offices[23] were disseminated in the monthly editions of *Employment Services and Unemployment Insurance Operations* published by the Employment Security Commission of North Carolina, Labor Market Information Division, Employment Services and Unemployment Insurance Reporting Unit, from February 2005 to May 2011.[24] Estimates of the size of the labor force and number of unemployed persons in each North Carolina county are from the Local Area Unemployment Statistics (LAUS) database at the DES, which creates its estimates based on two sources of data from the U.S. Dept. of Labor Bureau of Labor Statistics: the Current

[22] 6 growers in the data are listed as being located in "Ashe/Allegheny" country. They are assigned to Ashe county, since the data contain far more growers that are only in Ashe than only in Allegheny. 64 U.S. workers in the original data were referred by an agency outside North Carolina; most of these (45) are from Puerto Rico. They are ignored in this analysis.

[23] The Division of Employment Security (DES) at the North Carolina Dept. of Commerce was known as the Employment Security Commission (ESC) until November 2011, and is still commonly referred to by this name.

[24] At the time of writing, no earlier or later editions were posted by the DES at www.ncesc.com.

Employment Statistics (CES) and the Quarterly Census of Employment and Wages (QCEW). Their method for creating county-level unemployment estimates is described in Bureau of Labor Statistics (2009), Local Area Unemployment Statistics: Estimation Methodology, U.S. Dept. of Labor, accessed Jan. 24, 2013.

For each month, county-level data were resolved to DES office-level data as follows.[25] First, only one county (Guilford) has more than one DES office (Greensboro and High Point). These two offices were treated as a single office, comprising the total applications, referrals, and placements for the two offices in each month. Second, 14 offices each serve more than one county.[26] In these cases, county-level data on number of people in the labor force and number of people unemployed were totaled across counties served by each DES office, then divided to achieve the office-level unemployment rate. Finally, the Warrenton DES office is ignored because the DES did not publish application, referral, and placement statistics for that office between February 2005 and May 2011.

# C Regulation of demand for immigrant labor in other countries

**Canada's** temporary work visas require a "labor market opinion" from Human Resources and Social Development Canada that "there is no Canadian or permanent resident available", while skilled-worker permanent visas are only allowed in certain occupations. **United Kingdom** employers recruiting foreign workers for some skilled occupations—those not on a list deemed in "shortage" by the government—must first actively recruit and hire any available UK workers under the Resident Labour Market Test requirement. **France** has a similar system: Unless a skilled occupation is in shortage ("*en tension*"), employers must first prove that they have been unable to recruit French workers, while in **Germany** various work visas require a similar test (*Vorrangprüfung*). In **Australia**, prospective employers of both skilled and seasonal unskilled foreign workers must offer the government "evidence of the efforts made to recruit from the local labour market".

# D How domestic workers learned about the job availability

Table A1 reports U.S. workers' stated channel by which they learned about the availability of the manual farm job they applied for, in 2011 and 2012, the only two years for which internal records were availble.

Beyond this, the NCGA reports that it spends roughly $46,000 per year in staff time exclusively related to required cooperation with the DES on recruiting, hiring, and tracking U.S. referrals. Combined with newspaper advertising costs, this means that the NCGA spent about $182,000 over the two-year period 2011–2012 to recruit U.S. workers. This exclusively comprises administrative costs at the NCGA headquarters office and does not include time spent by farmers to train or replace U.S. workers who leave. It also does not include government expenditures in the effort to recruit U.S. workers—the time of employees of DES, the U.S. Dept. of Labor, or the North Carolina Dept. of Labor that was spent enforcing U.S. worker recruitment requirements. During that two-year period, 17 hired U.S. workers were willing to complete the season (Table 2). Each worked on average 5 months and earned about $9,700, for total

[25] Here a DES "office" refers to a local office, not a branch office. DES publishes application, referral, and placement data by local office only, where the data for each local office include data for any branch office that may be linked to that local office.

[26] Asheville office serves Buncombe, Madison; Edenton office serves Chowan, Gates, Perquimans, Tyrrell, Washington; Elizabeth City office serves Camden, Currituck, Pasquotank; Forest City office serves Polk, Rutherford; Hendersonville office serves Henderson, Transylvania; Kinston office serves Greene, Lenoir; Murphy office serves Cherokee, Clay, Graham; New Bern office serves Craven, Jones, Pamlico; Reidsville office serves Caswell, Rockingham; Roanoke Rapids office serves Halifax, Northampton; Rocky Mount office serves Edgecombe, Nash; Washington office serves Beaufort, Hyde; Williamston office serves Bertie, Martin; Winston-Salem office serves Forsyth, Stokes.

earnings of about $165,000 across all 17 willing U.S. workers. This is less than the direct cost that the NCGA headquarters incurred to recruit the same workers. This recruitment cost omits any costs to the farms themselves or to state or local government.

**Table A1:** How U.S. applicants learned about job

| | Year | | |
|---|---|---|---|
| | 2011 | 2012 | Total |
| Division of Employment Security | 156 | 227 | 383 |
| Friends or Family | 24 | 40 | 64 |
| Newspaper | 4 | 1 | 5 |
| Dept. of Social Services | 0 | 4 | 4 |
| Disaster Relief Fund | 0 | 1 | 1 |
| Division of Veterans Affairs | 0 | 1 | 1 |
| Employer | 0 | 1 | 1 |
| No answer | 2 | 1 | 3 |
| Total | 186 | 276 | 462 |

In 2011 the survey comprises those workers who were initially hired and did not drop out of the hiring process before the survey was administered (245 were initially offered the job, 163 started work). In 2012 the survey covers all who were hired plus a number who were offered the job but did not accept (213 were hired, 143 started work).