Visa Regulations, Agricultural Employment, and Productivity*

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Abstract

The H-2A visa program provides US farms access to foreign seasonal labor but requires employers to pay a federally mandated minimum hourly wage, the Adverse Effect Wage Rate, to both foreign and domestic workers performing comparable tasks. This paper studies how increases in the H-2A visa wage affect farms' allocation of agricultural inputs. Using county-level data from the 2002–2022 USDA Census of Agriculture and a border-county pair design that compares counties across state lines, I show that higher visa wages lead farms to substitute away from labor and toward capital and materials. I find that a 1% increase in the visa wage on average leads to a 1.2% increase in machinery values, increases intermediate input use by 3.9% on the intensive margin, and expands the range of inputs used by 1.1% on the extensive margin. I find no effect on employment or payrolls. The results are consistent with labor-cost-driven mechanization and input intensification, which together contribute to higher agricultural productivity.

Keywords: Migration Policy, Agricultural Labor, Labor Supply

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1 Introduction

The agricultural sector in the United States is characterized by labor shortages and its heavy dependence on migrant workers (Hamilton et al. (2022), Luckstead and Devadoss (2019), Bampasidou and Salassi (2019), Taylor (2010)). For instance, 56% of farmers participating in a California survey reported they were unable to hire all the workers they needed for their main crops (California Farm Bureau Federation and University of California, Davis, 2019). The lack of agricultural workers is not only a concern for crops but also for livestock, including the dairy industry (Charlton and Kostandini, 2021). A potential explanation for labor shortages is that the agricultural domestic labor supply is inelastic (Hill et al., 2021). Hence, farms offering higher wages would still have issues filling up their vacancies, and while new labor-saving technologies may be available, technology adoption is usually slow (Manuelli and Seshadri, 2014b).

The H-2A visa program allows farms to bring foreign temporary workers into the United States to address expected labor shortages in agricultural jobs. Farms petitioning for foreign workers must comply with the following regulations: 1) Provide evidence that they were unable to fill vacancies with domestic workers 2) Pay for travel expenses, 3) Provide housing, and 4) Pay foreign workers and domestic workers performing similar tasks a minimum hourly rate known as the Adverse Effect Wage Rate (henceforth, visa wage). The visa wage is set annually at a regional level for 17 regions: 15 multi-state regions plus California and Florida, which have their own visa wage rates. In 2024, the average visa wage was 60% higher than the average minimum wage, and between 2010 and 2024, the real average visa wage rose by 21% (nominally, 69%), significantly increasing the cost for farms to access H-2A foreign workers.

This paper studies how farms' allocation of agricultural inputs is affected by visa regulations, in particular the visa wage. In a competitive labor market, a binding price floor like the visa wage is expected to reduce the demand for foreign workers relative to the equilibrium quantity.[1] Farms can respond by hiring more domestic workers if available, or by substituting toward labor-saving technologies. If neither option is viable, production may be negatively affected. The research questions this paper studies are: How do farms respond to higher visa wages? Specifically, do farms employ fewer workers? do they use more machinery and equipment?, do they change their use of intermediate agricultural inputs? is their product affected?

Using data from the USDA Census of Agriculture for the years 2002, 2007, 2012, 2017,

[1] Consistent with research studying the negative effects of minimum wages on employment. However, a different branch do not find effects of minimum wages on employment.

and 2022, I implement a border-county pair design that compares counties across state lines following Dube et al. (2010), Dube et al. (2016), and Coviello et al. (2022). Because visa wages are determined at the multi-state level, this approach uses county-pairs on opposite sides of state borders, which are similar in observable and unobservable characteristics, making them a suitable counterfactual of each other. The main specification uses county fixed effects and pair-year fixed effects to account for idiosyncratic shocks at the county level and for time effects specific to each county pair, respectively. The USDA census of agriculture provides information for numerous outcomes, and I estimate the impact of visa wages on three type of outcomes: labor (payrolls and employment), machinery (value of machinery and units of machinery and equipment), and agricultural intermediate inputs (seeds and fertilizer expenses and number of farms using these inputs).

I find that increases in visa wages do not affect labor payrolls for farms and total employment levels remain largely unchanged. Visa wages do not affect the units of machinery. However, a 1% increase in the visa wage leads to an increase of 1.2% in the value of machinery and equipment. These results are suggestive evidence of labor-cost-induced mechanization. In addition, I find that a 1% increase in visa wages increase farms' expenses on intermediate inputs such as seeds and fertilizers by 3.9% and the number of farms spending on such inputs increases by 1.1%. That is, an increase in the intensive and extensive margins of intermediate inputs. The heterogeneity results suggest counties that produce more labor intensive crops increase productivity though mechanization, and counties that produce field crops, which are less labor intensive, increase their use of intermediate inputs.

To assess the broad implications of these findings, I study if higher visa wages affect productivity. Th ideal measure to approximate productivity is yields. However, there is limited information on yields in the USDA Census of Agriculture public data. Instead, I conduct the analysis using sales and I estimate the Revenue Total Factor Productivity (TFPR) following Levinsohn and Petrin (2003). I find that a 1% increase in visa wages leads to a 4.6% increase in crop sales, and a 2.3% increase in TFPR. The increase in productivity remains positive when using measures of productivity per acre and productivity per worker. This result is consistent with the efficiency wage hypothesis, higher wages can raise productivity by increasing worker effort, reducing turnover, or improving selection.

This paper contributes to three branches of literature. First, this paper contributes to the literature studying the impact of immigration restrictions on mechanization in agriculture

(Clemens et al., 2018a, San, 2023). These papers study the effects of the termination of the bracero program, a program to hire seasonal Mexican workers that ended in 1964, on employment of local workers and the development of innovation technologies. Their findings show little effect of the program termination on domestic worker employment and salaries. However, they find evidence of technical advance in farms through the adoption of new technologies.[2] A primary challenge in this literature is the lack of reliable information on inputs, the Bracero termination was a one-time event about six decades ago. I build on this literature by providing contemporaneous evidence on the impacts of restrictions for foreign workers on the use of machinery and intermediate inputs with fine detail on the technology side.

Second, this paper contributes to the literature studying the effects of H-2A visa wages on workers. Although this literature is relatively new, previous studies have documented the spillover impact of visa wages on domestic wages of farms that do not employ foreign workers (Rutledge et al., 2024) and on agricultural salaries (Paik (2024) and Smith et al. (2022)). Paik (2024) finds that visa wages positively affected the employment of less educated agricultural workers. Rutledge et al. (2024) find that domestic wages increase as a result of higher visa wages. I contribute to this literature by studying an overlooked response to visa wages, that is, the response on the farm side adjusting the use of agricultural inputs. I contribute to this literature by studying the effect of visa wages on farm payrolls, employment but also studying the response in the use of machinery, and intermediate agricultural inputs. These are broader responses by the employer when facing higher costs to hire. Kandilov and Kandilov (2020) is a closely related paper, which studies the effect of minimum wages on seasonal and year-round agricultural employment and their effect on capital investments using the USDA Census of Agriculture. They find that minimum wages negatively affect seasonal agricultural employment but they do not affect year round agricultural employment. A limitation of this study is that minimum wages are not directly affecting farm costs, as farms are exempt from paying minimum wages. On the other hand, visa wages are mandatory and likely increase the cost for farms as 18% of agricultural workers in the United States are H-2A workers (Ayoub, 2024). To the best of my knowledge, this is the first paper studying the effect of H-2A visa wages on productivity measures.

Finally, the paper contributes to the literature studying immigration restrictions for workers

[2]These results are consistent with Hornbeck and Naidu (2014) that show that labor scarcity after the Great Mississippi Flood of 1927 lead to modernized agriculture production and intensive use of capital.

and its broad consequences on labor markets and innovation (Bernstein et al., 2022, Cattaneo et al., 2015, Signorelli, 2024, Terry et al., 2024). This paper contributes by studying how visa regulations intended to protect domestic workers in US agriculture nudge farms to adopt technology, allocate inputs differently and affect their productivity.

The rest of the paper proceeds as follows: Section 2 provides a conceptual framework. Section 3 presents the background on the H-2A program and visa wages. Section 4 describes the data. Section 5 details the empirical strategy. Section 6 presents the main results. Section 7 presents heterogeneity results. Section 8 concludes.

2 Conceptual Framework

This section outlines a simple model of farm production to illustrate how changes in visa-mandated wages can affect farms' input choice including employment, technology and use of intermediate agricultural inputs.

Farms have a standard Cobb–Douglas production function where each farm produces a homogeneous agricultural output Y using capital K, labor L, and a bundle of intermediate inputs M, such as seeds, fertilizers, and fungicides:

$$Y = AK^{\alpha}L^{1-\alpha}M^{\beta}, \quad 0 < \alpha, \beta < 1,$$

where A denotes total factor productivity (TFP). In the model, technology displays increasing returns to scale, a restriction imposed for expositional convenience. However, the degree of returns to scale is immaterial to the comparative-static predictions. Farms face a wage w for hired labor, determined by the visa wage, a rental rate of capital r, and a normalized price of intermediate inputs $p_M = 1$. Farms minimize total cost subject to the production function:

$$\min_{K,L,M} C = wL + rK + M \quad \text{s.t.} \quad Y = AK^{\alpha}L^{1-\alpha}M^{\beta}.$$

The first-order conditions yield the standard relationship between factor prices and input ratios. The capital-labor ratio is:

$$\frac{K}{L} = \frac{\alpha}{1-\alpha}\frac{w}{r},$$

which implies the factor-price substitution effect. That is, the capital–labor ratio is increasing in wages: $\partial(K/L)/\partial w > 0$.

Prediction 1. *Higher visa wages (w) lead farms to substitute away from labor and toward capital, increasing the degree of mechanization.*

Suppose the elasticity of output with respect to intermediate inputs is $\beta > 0$, and that M and L are imperfect substitutes in production. A higher labor cost raises the relative cost-adjusted marginal productivity of intermediate inputs, inducing greater use of M in the cost-minimizing allocation. Hence,

$$\frac{\partial M}{\partial w} > 0.$$

Prediction 2. *Increases in visa wages raise farms' use and expenditures on intermediate inputs such as fertilizers, seeds, and fungicide chemicals.*

Following the induced innovation literature (Acemoglu, 2010), assume farms can adopt a capital-augmenting technology at a fixed cost F. Let technology be given by

$$A = A_0 + \mu w,$$

where $\mu > 0$ captures the responsiveness of technological adoption to higher labor costs. Substituting this expression into the production function implies that higher wages can increase productivity if induced innovation effects dominate pure substitution losses:

$$Y = (A_0 + \mu w)K^{\alpha} L^{1-\alpha} M^{\beta}.$$

Prediction 3. *Increases in visa wages may raise the TFP by making investment in capital-augmenting technologies more profitable.*

In the appendix section, I present a model that allows for substitution between different types of labor (foreign and domestic), the predictions of such model are consistent with the predictions presented in this section.

3 Agricultural Labor and the H-2A Visa Program

Agriculture in the United States relies on a mixed workforce of family operators and hired labor. Farmers and family members constitute 40% of employment in agriculture. Among the 60% who are hired, 75% are foreign workers with 69% coming from rural Mexico (Hill et al., 2021). Since about 1990, total employment has been stable, but hired workers remain essential, especially in labor-intensive fruit, vegetable, and nursery sectors, where labor costs account for a far larger share of expenses than on the average farm (U.S. Department of Agriculture, Economic Research Service, 2025). Historically, farms relied heavily on local and foreign domestic workers to meet seasonal labor demands, particularly for planting, cultivating, and harvesting labor-intensive crops.

One relevant feature of US agriculture is the inelastic nature of the domestic labor supply (Hill et al., 2021). That is, even if farms offer higher wages there are few workers willing to participate in the labor market. The seasonality and uncertainties of crop production and labor demand have implications for producers and agricultural households (Charlton et al., 2021), but also for the supply of labor, as seasonal jobs might not be desirable for workers willing to have a full time position. Hence, issues arise to adjust the agricultural labor supply to seasonal demands. Many farms face chronic difficulties in recruiting sufficient domestic labor, especially during peak seasons, which has led to increased dependence on foreign-born workers, both authorized and unauthorized.

The H-2A visa program was created in 1986 as part of the Immigration Reform and Control Act to address persistent labor shortages in US agriculture. The program targets seasonal work periods when there are not enough domestic workers available to fill agricultural job vacancies and the marginal productivity of labor is high.

Farms that hire foreign workers through the H-2A program must comply with a series of regulations designed to protect both domestic and foreign labor. First, farms must provide evidence that they were unable to fill their vacant positions with domestic workers. Second, employers are required to cover the travel expenses of foreign workers. Third, farms must provide housing for H-2A workers, which often represents the largest non-wage cost of participation in the program. Finally, farms must pay foreign workers an hourly wage that is at least the highest of three benchmarks: the federal or state minimum wage, the visa wage, or a prevailing wage rate. In practice, the visa wage is typically the highest of these three and therefore serves as the main wage floor for hiring H-2A workers.

The aim of the visa wage is to protect domestic workers from being crowd out of agricultural employment by foreign workers at lower wages and to protect their salaries to drop as the labor supply increases with the presence of foreign temporary workers. Hence, there is not a national visa wage but a wage rate that varies by region. In the contiguous US, there are 17 different visa wages for 15 multi-state regions and 2 states on their own California and Florida.

The visa wage in the current year is determined by the Farm Labor Survey (FLS) weighted average wage for field and livestock workers reported in the survey from the previous year and for each of the 17 regions. Figure 1 presents the regions that determine the visa wage. Table 1 reports the states that belong to each region. Field and livestock worker occupations represent the majority in agricultural jobs under H2-A program. The Department of Labor publishes a yearly schedule on the salaries that employers in each state must pay to their workers if they decide to make use of workers under the H-2A program.

Employers participating in the H-2A visa program face both substantial wage and non-wage costs when hiring temporary foreign agricultural workers. On the wage costs, the adverse effect wage rate (visa hourly wage) ranged from approximately $14 to over $18 per hour across states in 2023 (Castillo et al., 2024). Figure 2 shows the 2025 visa wages for each region, that ranged from $14.83 in the "Delta" region composed of the states Arkansas, Louisiana, and Mississippi to $19.97 in California.[3] In 2024, the average visa wage was 60% higher than the average minimum wage. Figure 3 shows the evolution of the average visa wage and average minimum wage. While both increase over time, is noticeable that the visa wage grows at a higher rate.

In addition to wage obligations, employers must cover a variety of required fees and recruitment expenses. These include a flat fee of $100 per labor certification application plus $10 per certified worker (up to $1,000), a $460 non-immigrant petition fee, and visa-related costs of $190 per worker plus a $6 border stamp fee. Employers are also responsible for both foreign and domestic recruitment expenses, which typically amount to $100–$250 per worker for foreign recruitment and $1,500–$3,500 per application for U.S.-based agent services. On a per-worker basis, these agent costs range from $15–$175 depending on the scale of the petition, with larger petitions achieving lower average costs (Castillo et al., 2024).

Transportation and housing costs represent additional, often substantial, components of the cost. The cost of transporting workers from their home countries to the US typically ranges between $400 and $650 per worker, with additional costs incurred for local transportation and meals. The single largest non-wage cost item is employer-provided housing, with USDA estimates ranging between $9,000 and $13,000 per worker. Combining these various components, the non-wage cost of hiring an H-2A worker is estimated at the lowest $10,000 per worker. Given that the average six-month H-2A contract has a wage bill of approximately $19,500, the total cost of employing an H-2A worker reaches at least $29,500 per contract. The cost structure potentially urges employers to group as many workers as possible onto a single petition (Castillo

[3] These visa wages refer to contiguous US, since Hawaii has a wage rate of $ 20.08

et al., 2024). By comparison, hiring U.S. workers at similar wage levels would add payroll taxes of 8–12%, narrowing the cost differential between H-2A and domestic labor. Importantly, some of these higher costs may be partially offset if H-2A workers are more productive or reliable than other workers. For example, **?** find that H-2A citrus harvesters in Florida earned 18–23% higher piece-rate earnings than unauthorized workers, reflecting higher productivity. However, this comparison is hardly generalizable as only about 7% of the agricultural workers are paid piece-rate wages (Richards, 2020). Moreover, H-2A workers are contractually tied to their employers and not exposed to deportation risk, providing a form of labor insurance that ensures tasks are completed on time (Castillo et al., 2024). This combination of productivity and reliability helps explain the rapid expansion of the H-2A program despite its high costs.

Despite the high wage and non-wage costs, the number of H-2A certification has increased over time. Figure 4 shows the evolution of H-2A authorizations that grew from less than 100,000 certifications in 2010 to about 380,000 certifications in 2024. The majority of these workers are authorized to work in Florida, Georgia, California and Washington as reflected in figure 5. Most of the job applications in the H-2A program are for farm operations and work with fruits and vegetables (Valencia and Paulson, 2025).

4 Data

The main source for the analysis is the USDA Census of Agriculture, which is conducted every five years by the National Agricultural Statistics Service (NASS) to provide a comprehensive snapshot of the US agricultural sector. It is an extensive survey that collects information on farm size, the types of crops and livestock produced, economic performance, use of labor, machinery, and intermediate agricultural inputs, among other variables. The census targets agricultural operations that meet specific thresholds, such as minimum sales or production levels, ensuring that data are collected from significant contributors to the industry. Data collection begins with the distribution of standardized questionnaires to all eligible operations, usually based on a minimum value of sales. Respondents have the option to complete these forms by mail, online, or over the telephone.

The data are aggregated to produce estimates at the national, state, and county levels. I use information at the county level for the years 2002, 2007, 2012, 2017, and 2022. The census provides information aggregated at the county level on: 1) Labor market variables such as labor payrolls, employment, farms hiring employees. 2) Machinery and equipment, including value of machinery and equipment and units of machinery for different types of machinery such as trucks, tractors, combines, harvesters, cotton pickers, among others. 3) Expenses on agricultural inputs such as seeds, and fertilizers and number of farms having expenses on these items. Additionally, it also provides information on fungicide use and sprayed acreage. The information permits to measure the extensive and intensive margin use of these agricultural inputs. 4) Sales of commodity products and then two subcategories crops and animals. I use the crop sales variable, a ratio of sales per acre, and a ratio of sales per worker. I then estimate revenue productivity using information on sales and agricultural inputs. Finally, the census provides information on income from farm operations, I use this variable to check the robustness of the productivity variables. The use of these variables represent a 'second best' alternative to an ideal productivity variable that use yields. However, the census does not provide yield on all crops.

The outcomes at the county level are: 1) Labor payrolls, these are annual expenses in hired labor measured in millions of US dollars. 2) Hired employees, this is the annual number of hired workers. 3) Value of machinery and equipment, is the average per farm estimated market value of machinery and equipment reported in US dollars. 4) Units of machinery and equipment, the variable aggregates the reported number of machinery and equipment including trucks, tractors, grain and bean self-propelled combines, self-propelled cotton pickers and strippers, self-propelled forage harvesters, and hay balers. 5) Intermediate input expenses, the variable adds expenses in seeds and fertilizers, these are reported in millions of US dollars. 6) Farms with intermediate inputs, the variable reports the number of farms that had expenses in fertilizers and seeds.

Table 2 presents summary statistics for the outcome variables for all years. One noticeable fact is the increase in average labor payrolls over the years, while there is a decrease in the average number of employees per county. The average farm value of machinery and equipment has also increase over the years but the number of units of machinery increased after 2002 but remained on average relatively constant after that. The value of intermediate inputs increased over time in a larger proportion than the increase in labor payrolls, but the number of farms with expenses in such intermediate inputs if anything decreased over time. The sample contains over the years between 1,038 and 1,088 counties.

The second source of data used in this paper comes from the US Department of Labor, Office of Foreign Labor Certification (USDOL), that provides information on H-2A visa work permit applications and authorizations. The information is provided yearly from 2008 to 2024 with information of applications at the zip code level, I aggregate information of zip codes at the county level for a comparison to the USDA census of agriculture data. The data contains information on the employer, number of workers requested, work required, salary, zip code, location of employment. Starting in 2019, they also collect information on whether the employer offers housing, meals, and other benefits. Importantly, the US Department of Labor also provides the schedule of Adverse Effect Wage Rates (visa wages) for all states and years. I also use information on minimum wages from USDOL.

Table 3 reports annual summary statistics on H-2A applications, the number of certified workers, and the number of counties participating in the program. As discussed in the background section, the data reveal a substantial expansion of the H-2A program over time. Between 2008 and 2024, the number of authorized workers increased from roughly 100,000 to about 380,000, reflecting the growing reliance of U.S. agriculture on foreign seasonal labor. Consistent with this trend, the average offered wage rose in parallel with the average visa wage, highlighting the upward adjustment in wage offers over the period.

Figures 6, 7, and 8 show counties that use H-2A workers in 2008, 2016 and 2024, respectively. These plots show the growth of the H-2A program throughout the contiguous US and its representation in all states.

5 Empirical Strategy

My empirical strategy compares county-pairs at state line borders in the spirit of Dube et al. (2010), Dube et al. (2016), and Coviello et al. (2022). Comparing county pairs across state borders allows for treated and control units that are comparable in key unobserved characteristics—for example, exposure to local shocks, climate conditions, and soil characteristics. Traditional panel methods use time fixed effects to account for shocks that affect all counties, and unit fixed effects to account for idiosyncratic shocks that affect each unit. The county pair approach improves over traditional methods by accounting for spatial heterogeneity (Dube et al., 2010). While traditional panel methods compare units that have different spatial characteristics, which are potentially confounders for identification, the counterfactual in the county pair design is a cross-border neighbor.

The contiguous county pair identification relies on within-pair differences. The specification allows for county fixed effects and pair-specific time effects. The county fixed effects account idiosyncratic shocks at the county level. The pair-specific time effects account for time effects specific to each county pair. This is a significant improvement over a time effect, as it accounts for aggregated shocks at the national level but also for local shocks that are common at both sides of the border pair (e.g. local weather shocks). Figure 1 illustrates the regional variation that allows for a plausibly causal identification. Table 1 presents the states that belong to each region with different visa wages. Figures 9, 10, and 11 characterize the contiguous counties across state lines. Figure 9 present the contiguous counties that are part of the sample at the national level. Figures 10 shows the contiguous counties that border the states of Colorado and Kansas, and 11 displays the contiguous counties that border Illinois and Wisconsin.

I use specification 1 to estimate the effect of visa wages on the outcome variables of interest, these are both expenses and units of inputs: labor, machinery and intermediate agricultural inputs. I use a logarithmic transformation for the outcome and the visa wage to interpret the coefficient as an elasticity. For example, when the outcome is employment, the estimated coefficient is the labor demand elasticity. In the specification, Y_{cpt} represents the outcome (e.g. employment) for county c in pair p and year t, γ_c is the county fixed effect, and δ_{pt} is the pair-time fixed effect. The specification controls for the log of county population in year t pop_{ct} following Dube et al. (2010) that absorbs population changes at the county level accounting for individuals moving to states that have higher visa wages among other demographic changes. The variable Visa Wage$_{ct}$ represents the adverse effect wage rate (visa wage) in county c and year t. The coefficient β represents the labor demand elasticity to the cost of hiring foreign workers.

$$ln(Y_{cpt}) = \alpha + \beta ln(VisaWage_{ct}) + \gamma_c + \delta_{pt} + \theta ln(pop_{ct}) + \epsilon_{cpt} \tag{1}$$

A potential concern with specification 1 is the presence of policies changing over time and across state lines.[4] To address this concern I present a robust estimation that accounts for the log of the minimum wage in each county $ln(MinWage_{ct})$ in specification 2. While the minimum wage should not be relevant in agricultural employment, as agricultural work is exempt of minimum wages, it provides a benchmark for regional wages.[5] Fan and Pena (2019) and

[4]All state policies that are constant over time are absorbed by the county fixed effect. For example, having states with different income taxes.

[5]It can also be interpreted as a benchmark for differential cost of living.

Kandilov and Kandilov (2020) find suggestive evidence on the relevance of minimum wages on agriculture. Moreover, if minimum wages affect individuals' interstate migration decisions, the inclusion of this variable controls for that effect. Hence, if minimum wages are not relevant, the expected value of coefficient τ in specification 2 is zero, otherwise we expect a statistically significant coefficient.

$$ln(Y_{cpt}) = \alpha + \beta ln(VisaWage_{ct}) + \tau ln(MinWage_{ct}) + \gamma_c + \delta_{pt} + \theta ln(pop_{ct}) + \epsilon_{cpt} \quad (2)$$

A third specification uses the log difference between visa wages and minimum wages, instead of log minimum wages on their own. This specification makes sense if the relative cost to hire matters more than the levels of other wages. For example, when the gap is high, it is relatively more expensive to hire foreign workers than native workers. Likewise, when the gap is low, it is relatively cheap to hire foreign workers, as it is not much more costly than hiring domestic workers. However, this specification's assumption is that the minimum wage is a good reference for a relative hiring wage.

$$ln(Y_{cpt}) = \alpha + \beta ln(VisaWage_{ct}) + \lambda ln(VisaWage_{ct} - MinWage_{ct}) + \gamma_c + \delta_{pt} + \theta ln(pop_{ct}) + \epsilon_{cpt} \quad (3)$$

The identifying assumption is that visa wage differences within a county-pair are not correlated with any residual employment in either county (when the outcome is employment). Formally, the expectation of the logarithm of the visa wage and the error term for county pairs is zero: $E(\ln(\text{visa wage}_{ct}, \epsilon_{cpt}) = 0$. An implication of the identifying assumption is that changes of visa wages within each county pair are as good as random. At first glance, the identifying assumption requires a lot less than the identifying assumption under traditional panel methods where changes of visa wages within states should be as good as random.

The main threat for identification lies in how the visa wage is defined. Section 3 provides the detailed institutional arrangements on visa wage settings. In a nutshell, the Farm Labor Survey (FLS) provides average gross hourly wage rates for field and livestock workers for each of the 15 multi-state regions and 2 states California and Florida. That average is used as the visa wage for the following year. For instance, the states of Nevada, Utah and Colorado have the same visa wage as defined by the FLS.

An endogenous regression would be wages on employment, as we would be facing simultaneity since both variables are jointly determined. A regression of lagged wages on employment would still be problematic if wages are serially correlated. In the H-2A visa regulation, the visa wage is determined as a lagged regional average. If the FLS perfectly captures the average field and livestock worker salary for all counties in each region. Then the visa wage for county c in year t in each region is:

$$\text{visa wage}_{ct} = \frac{1}{n}\sum_{c=1}^{N} w_{c,t-1}$$

The main threat is that the lagged regional wage indicates labor market conditions of the the current year in county c. That would occur if $wage_{ct} = w_{c,t-1}$ in the presence of serial correlation. For this equality to hold, the average of $N-1$ counties would need to equalize the visa wage.[6] Likely, there is variation in wages between counties within a region such that $wage_{ct} > w_{c,t-1}$ or $wage_{ct} < w_{c,t-1}$.[7] Despite this argument, endogeneity is still possible and more likely to arise if the wage of a county has a large contribution to the regional average introducing bias in the estimates.

In the contiguous county pair regression, each pair p is observed twice in the data, one for each county c. In addition, counties that have multiple contiguous cross state pairs appear multiple times in the data. This feature of the data introduces the need to cluster standard errors at the state and border segment. These double cluster standard errors account for correlation in two dimensions state and border-segment.

Figure 4 illustrates the counties that are part of the sample and have variation in the visa wage. This figure shows that the number of contiguous county-pairs are represented in all regions of the contiguous United States. Dube et al. (2010) and Paik (2024), given the nature of their data, do not have pairs distributed in all areas of the United States.

6 Main Results

This section presents the results grouped by outcome type. First, I present the estimates on the effect of visa wage on labor market outcomes. Then, I present the results on machinery and equipment outcomes, then on intermediate input outcomes. Finally, I present the estimates of visa wages on sales and productivity.

[6]For example, the wages in Cheyenne County, Colorado in year t are not necessarily reflecting the average wages for all counties in Nevada, Utah and Colorado in year $t-1$.

[7]To have the visa wage equal to the specific wage of a county: $\frac{1}{n-1}\sum_{c=1}^{N-1} w_{c,t-1} = visawage_{ct}$.

6.1 Labor Market

Table 4 presents estimates on the effect of visa wages on labor market outcomes. These effects are the estimated β coefficient presented in specifications 1 (columns 1 and 2), specification 2 (columns 3 and 4), and specification 3 (columns 5 and 6). All outcomes are logarithmically transformed in order to interpret all coefficient estimates as elasticities. Column 1 shows the effect of visa wages on labor payrolls. The estimated coefficient is positive but not statistically significant. Column 2 shows the effect of visa wages on number of employees, in other words, the elasticity of labor demand with respect to visa wages. The coefficient is positive but not statistically significant. To assess the robustness of the main findings, columns 3 and 4 present the results of specification 2, that augments over the main specification by including a minimum wage variable that also varies across state borders. Estimates of τ, the coefficient of the variable log(Min Wage) can be interpreted as the effect of minimum wages on the outcomes of interest, as the minimum wages have quasi-experimental variation across state borders as suggested by Dube et al. (2010). The results for the main variable of interest *Visa Wage* are robust and almost identical to the ones reported in columns 1 and 2. On the other hand, the magnitude of the coefficients of the minimum wage variable are close to zero, and smaller compared to the *Visa Wage* coefficients. These findings suggest that minimum wages are not relevant for farms' payrolls or employment decisions. The statutory minimum wage itself does not play a significant role in farms' labor allocation decisions. However, the relative difference between the visa wage and the state minimum wage may still be relevant. While absolute wage levels may not directly influence input choices, the wage gap could matter if the state minimum wage serves as a reference for cost-of-living or local outside options. In that case, a larger gap between the visa wage and the minimum wage may affect workers' locational preferences by increasing their relative purchasing power. Specification 3 addresses this possibility by replacing the minimum wage variable with the wage gap—defined as the difference between visa wages and state minimum wages (Visa W – Min W). The estimated coefficient λ thus captures the effect of this wage gap on the outcome variables of interest. The results, presented in columns 5 and 6 show that the coefficients on visa wages remain stable and consistent with those in the main specification. Interestingly, the coefficient for payrolls becomes statistically significant at the 10% level, indicating that a 1% increase in visa wages on average leads to a 1.7% increase in payrolls, but not a statistically significant effect on employment. Nonetheless, the estimated coefficients on the wage-gap variable are close to zero and statistically insignificant, suggesting that relative wage differentials play a limited role in shaping farms' labor choices.

The conceptual framework section proposed a simple model of optimization with a production function that uses labor, capital and intermediate inputs. The testable prediction of that model in regards to labor substitution suggests that higher visa wages reduce labor intensity. That is, $\partial L/\partial w < 0$. The empirical findings do not align with the testable prediction. Several factors may explain this divergence. First, the model abstracts from heterogeneity in the agricultural labor market by assuming that the visa wage defines the relevant reference wage for all workers, which may not hold in practice. Second, it treats the agricultural workforce as homogeneous, overlooking variation in skill, task specialization, and legal status that could attenuate the aggregate employment response. Third, the model omits a key empirical regularity—domestic agricultural labor supply is relatively inelastic (Hill et al., 2021)—which limits substitution possibilities in the short run.

On the empirical side, the evidence presented in table 4 suggest that the labor market outcomes are unaffected by the visa wages. Overall, we cannot reject the hypotheses of a null linear relation between the visa wages and labor market outcomes. These results are not surprising given that H-2A workers represent approximately 18% of all the agricultural labor force (Ayoub 2024, Valencia and Paulson 2025). Hence, the wage increase of a specific group of workers might not move payrolls or total employment. The results are consistent with empirical evidence showing null effects of minimum wages on employment in other industries (Dube et al. 2010; Dube et al. 2016). However, we cannot rule out the possibility that the estimation lacks sufficient power with which to find a statistically significant effects, as coefficients are consistently positive.

6.2 Machinery and Equipment

Table 5 presents estimates on the effect of visa wages on machinery and equipment outcomes. These effects are the estimated β coefficient presented in specifications 1 (columns 1 and 2), specification 2 (columns 3 and 4), and specification 3 (columns 5 and 6). All outcomes are logarithmically transformed in order to interpret all coefficient estimates as elasticities. Column 1 shows the effect of visa wages on value of machinery and equipment, the estimated coefficient is positive and statistically significant. The coefficient indicates that a 1% increase in visa wages on average leads to a 1.2% increase in the value of machinery and equipment. Column 2 presents the effect of visa wages on units of machinery and equipment. The estimated coefficient is positive but not statistically significant. The addition of the minimum wage variable does not affect the coefficients estimated for visa wages. The visa wage coefficients of columns 3 and 4 remain almost identical to those presented in columns 1 and 2. The minimum wage coefficients are small and not statistically significant. Finally, columns 5 and 6 present the estimates when controlling for the gap between visa wages and minimum wages. The estimated effect of visa wages on value of machinery and equipment remains unchanged. Interestingly, the coefficient for log units of machinery and equipment is statistically significant at the 10% level. The result indicates that a 1% increase in visa wages leads on average to an increase in 0.9% units of machinery and equipment. The estimated coefficient for the visa and minimum wage gap is close to zero and not statistically significant.

The conceptual framework predicts that higher visa wages increase mechanization: $\partial K/\partial w > 0$. The results presented in table 5 are suggestive evidence of labor cost induced mechanization. An increase in the visa wage, that increases the cost to hire foreign workers, leads to an increase in the value of machinery and equipment. The model aligns well with the observed patterns of machinery substitution measured by its value. On the other hand, the results suggest that the number of units of machinery and equipment is unaffected. The lack of statistically significant results on the number of units could be explained by the type of machinery that the Census of Agriculture inquires about, namely, standardized machines as trucks, combines, tractors, and cotton pickers, among others. Hence, the null result could be due the exclusion of other type of machinery not captured by the census.

6.3 Intermediate Inputs

The estimated effects of visa wages on intermediate inputs are reported in table 6. Intermediate inputs are defined as the sum of seeds and fertilizers. Column 1 reports estimates on the sum of expenses in seeds and fertilizers, and column 2 presents estimates on the sum of farms with expenses in these intermediate inputs. The coefficient reported in column 1 indicates that a 1% increase in the visa wage leads to a 3.9% increase in the expenses of intermediate inputs, a result statistically significant at the 1% level. The coefficient reported in column 2 shows that a 1% increase in visa wages leads to a 1.1% increase in the number of farms that use intermediate agricultural inputs, the result is statistically significant at the 5% level. Columns 3 and 4 report the estimates of specification 2, and columns 5 and 6 present the estimates of specification 3. The estimates of all specification are statistically indistinguishable, and the effects of minimum wages or the gap between the visa wage and the minimum wage are null.

The results presented in table 6 indicate that an increase in visa wages leads to significant increases in the use of intermediate inputs. The estimates presented in column 1 can thus be interpreted as the effect of visa wages on the intensive margin of intermediate inputs, that is, farms spend more in intermediate inputs. Estimates of column 2 can be interpreted as the effect of visa wages on the extensive margin of intermediate inputs, that is, the number of farms with expenses in intermediate inputs increases with higher visa wages. The input substitution coefficient magnitudes are high compared to the magnitudes reported for machinery substitution and the results are statistical significant at the 1% level. The empirical results match the predictions of input intensification presented in the conceptual framework. The model suggests that farms increase the use of intermediate inputs as a response to higher visa wages: $\partial M/\partial w > 0$.

From an empirical standpoint, the identification strategy provides credible estimates of the causal effect of visa wages on input choices, leveraging within-county and over time variation while controlling for unobserved heterogeneity. The consistency between the theoretical predictions and the estimated effects on machinery investment and input intensification supports the model's core mechanism of technological substitution, even if its simplifying assumptions restrict its ability to capture factors such as labor market frictions and compositional adjustments.

6.4 Sales and Productivity

The objective of this section is to examine the broader implications of visa regulations that raise the cost of hiring foreign workers, given the previous findings that farms respond by adjusting their use of other agricultural inputs.

The third prediction from the conceptual framework is that if induced innovation effects are sufficiently strong ($\mu > 0$), increases in visa wages should be associated with higher productivity, i.e., $\partial A/\partial w > 0$. To test this prediction, I use two sets of outcomes: sales and a measure of Revenue Total Factor Productivity (TFPR). Due to data limitations that preclude consistent yield measures across all crops, I rely on sales data from the USDA Census of Agriculture, which separately reports sales of crops and livestock. Crop sales is a first variable to approximate productivity. However, the main concern with this variable is that it combines prices and quantity, when ideally we are only interested in the quantity produced. A second caveat is that sales may include inventory from previous years rather than contemporaneous output. To augment on the productivity measure, I estimate TFPR following Levinsohn and Petrin (2003) that avoids simultaneity bias in the estimation as input choice is correlated with the error term to estimate productivity. I estimate a production function of sales on labor costs, capital costs, and using intermediate inputs as the proxy for unobserved productivity. Productivity can be written as a function of capital inputs and intermediate inputs such as materials and electricity. (Jiang et al., 2024) The method provides an estimated residual productivity term known as TFPR.

Table 7 presents the estimated effects of visa wages on sales and TFPR. Columns 1 to 3 report the results of the estimated coefficient for crop sales, crop sales per acre, and crop sales per worker, respectively. Columns 4 to 6 report the estimated coefficients when the outcome is TFPR, TFPR per acre, and TFPR per worker. A 1% increase in visa wages leads on average to a 4.6% increase in crop sales, a 2.1% increase in sales per acre, and a 3.8% increase in sales per worker. For the measures of productivity, column 4 reports that a 1% increase in visa wages leads to a 2.3% increase in TFPR, a 0.2% increase in TFPR per acre, and a 1.8% increase in TFPR per worker. All the results are statistically significant at the 1% level.

Higher visa wages not only affect sales but also TFPR across all the measures presented in table 7. It is worth noting that the increase in TFPR is lower than the increase in sales, suggesting that the estimation actually corrects for bias present in the sales variable.[8] The findings are consistent with the efficiency wage hypothesis, higher wages can raise productivity by increasing worker effort, reducing turnover, or improving selection. The evidence suggests that higher visa wages induce input reallocation that enhances productivity.

The empirical results match the conceptual framework prediction. Overall, these findings imply that wage floors for foreign agricultural workers can have substantial general-equilibrium effects on farm behavior. The results indicate that induced changes in input composition lead to higher productivity and farm income, even in the absence of direct employment effects. Consistent with the model's predictions, the estimated productivity response suggests that the parameter μ is sufficiently large to generate positive innovation and efficiency gains following increases in visa wages.

[8] Having a measure of productivity provides strength to the findings, as if the only available variable was sales, we could observe sales increasing due to a stock liquidation, and these results could indicate that farms respond to higher labor costs by selling inventories to maintain liquidity.

6.5 Additional results

The US Department of Labor provides information for all H-2A visa applications. This information includes the number of authorized workers and the wages offered to H-2A workers. Table 9 presents the result of specifications 1, 2 and 3 on the information of the Department of Labor dataset. The results indicate that employers comply with H-2A visa wage increases, a 1% increase in the visa wage leads to a 1.1% increase in the wage offered to these workers. Interestingly, the number of authorized workers also increases as a result of higher visa wages, a 1% increase in visa wages is associated to a 2.4% increase in the number oh H-2A authorized workers. This result is puzzling, as it suggests that higher wages lead to an increased demand for these workers. I interpret these results in two ways. First, in the presence of labor shortages and an inelastic labor supply of domestic workers, employers cannot recruit locally even at higher wages, having the opportunity to recruit foreign workers even at high rates is still valuable. Second, if the average marginal productivity of a foreign worker is higher than the visa wages then employers can still demand them. These results are also supportive of the efficiency wage hypothesis.

I present additional results to supplement the main findings. First, as a robustness exercise I present the estimation of specification 1 using only minimum wages in lieu of visa wages. Table 8 reports the effect of minimum wages on the outcomes of interest while excluding the visa wage variable. This table is reported to mitigate concerns regarding a positive correlation between the two type of wages that could mute the effect of minimum wages. The results reported in this table are null and not statistically significant for all outcomes, confirming the irrelevance of minimum wages on farms' choice of inputs.

I present additional analyses in table 10. Column 1 reports the estimated effect of visa wage on farm net cash income, column 2 presents the estimated visa wage effect on animal sales, and column 3 uses an additional dataset from the department of labor to measure the estimated effect of visa wages on unemployment at the county level. The estimated coefficient reported in column 1 indicates that a 1% increase in visa wages raises farm income by approximately 1.8%. This result reinforces the interpretation that higher visa wages are associated with higher productivity, since net income reflects contemporaneous returns rather than stock adjustments. Column 2 estimated coefficient shows that the increase in sales is a result of crops only, rather than an increase in animal sales. The coefficient is negative but statistically insignificant. The result aligns with the role of H-2A workers, as most of these workers are demanded for work on crops, only 4 to 5% of H-2A certifications are livestock positions (Holtkamp and Orazem, 2025). Finally, column 3 shows that the estimated effect of visa wages on county-level unemployment rates is small and statistically indistinguishable from zero, suggesting no adverse effects on local labor markets through unemployment.

7 Heterogeneity Results

This section presents heterogeneous effect estimates of visa wages on agricultural inputs. Different US regions produce different crops, ranging from field crops majorly produced in states like Iowa or Illinois, to specialty crops like strawberries or blueberries produced in California, Oregon, Georgia, among others. Given that the specialty crops are more labor intensive than field crops, we expect to observe variation in the main results depending on the county crop production.

I use the county ratio of harvested acres in vegetables to harvested acres in field crops as a variable that explains heterogeneity. Counties that mostly produce vegetables will have a larger value for the ratio and counties that produce mostly field crops will have a smaller value in the ratio. Figure 12 presents the histogram of the vegetable to field crop ratio. For most of the counties the ratio is below 1 indicating that the harvested area in field crops tends to be larger than vegetables. A few counties have the same area harvested on both type of crops (ratio =1) or more vegetable acres harvested. For the analysis, I use the median to split the sample in two, first I replicate the results on counties that are "field crop-intensive", that is, counties with a ratio smaller than the median 0.47. Then, I estimate the results on counties that are vegetable intensive, those have a ratio of acreage harvested above the 50th percentile.

Tables 11 to 15 present the heterogeneity results that replicate the main findings on the field crop-intensive sample. Tables 16 to 20 present the heterogeneity results for the vegetable-intensive sample. The null effect of visa wages on labor payrolls and employment remain null for both subsets. The estimated effect of visa wages on mechanization is mainly driven by vegetable-intensive crops. Table 12 shows that the effect of visa wages on the value of machinery and equipment for field crop-intensive counties is not statistically significant for the first two specifications, however it holds its significance for the third specification. On the other hand, table 17 shows that the effect of visa wages on the value of machinery and equipment for vegetable intensive crops is positive and statistically significant. The results on this subset suggest that a 1% increase in visa wages leads to an increase in the value of machinery that ranges between 1.45% to 1.69%. The magnitude of this effect is larger than the estimated effect on the full sample. Hence, the mechanization results seem to matter more in less ex-ante mechanized crops, such as vegetables. On the other hand, the magnitude of the effect of visa wages on intermediate agricultural inputs is stronger for field crop-intensive counties than vegetable-intensive ones. However, the coefficient of expenses on intermediate inputs is positive and statistically significant for both type of crops. The increase in productivity is mainly driven by vegetable-intensive crops. This result is suggestive of an increase in productive workers for labor intensive crops. Finally, minimum wages are not relevant in either case.

The heterogeneous effects of visa wages inform on the mechanism driving the gains in productivity. Field crop-intensive counties use more intermediate inputs as a response to higher wages. Counties with more vegetable crops respond by using more machinery. The coefficients for gains in productivity are similar for both type of crops. However, the vegetable intensive crops are statistically significant at the 1 and 5% levels. Productivity gains in vegetable crops arise mainly through mechanization or more productive labor.

8 Conclusions and Discussion

This paper investigates how farms' allocation of inputs and productivity respond to higher mandated wages for foreign workers. The H-2A visa program requires farms to pay a visa wage that serves as a minimum wage which has been steadily increasing in the last 20 years. Using data from the USDA Census of Agriculture and H-2A application information from the US Department of Labor, this paper examines the impact of these visa wages on farms' input allocation. I study the effects on employment and labor payrolls, the number and value of machinery units, and the use and expenses of intermediate agricultural inputs. The empirical strategy compares contiguous county pairs at state borders, this approach improves over traditional panel methods by controlling for spatial heterogeneity through pair-time fixed effects. The results indicate that higher visa wages do not affect labor payrolls and total employment levels remain largely unchanged. These findings align with existing literature on minimum wages that find null effects of minimum wages on employment(Dube et al. 2010; Cengiz et al. 2019).[9] I find evidence that a 1% increase in visa wages lead to a 1.2% increase in the value of machinery and equipment

[9]On the other hand, there is substantial evidence indicating that minimum wages have negative effects on employment (Neumark and Wascher 2008; Neumark et al. 2014 Clemens and Wither 2019; Clemens et al. 2025).

but no statistically significant effects on the units of machinery and equipment. These results are suggestive of mechanization and the null results on the units of equipment can be due a limitation on the information of machines and equipment in the USDA Census of Agriculture instrument survey. The findings are consistent with previous literature suggesting labor cost induced mechanization (Clemens et al., 2018a; San, 2023; Hémous et al., 2025). Furthermore, farms respond to higher labor costs through more intensive and extensive use of agricultural inputs such as seeds and fertilizers. These results can be interpreted as input intensification that farms decide to use as a short-term response to higher labor costs.

Changes in the composition of production inputs can translate into changes in output. Although yield data are not available for all crops, a measure of productivity can be estimated using crop sales, crop sales per acre, and crop sales per worker. The results indicate that all crop sales measures increase in response to higher visa wages as well as TFPR. In contrast, animal sales remain unaffected—a result consistent with the limited reliance on H-2A workers in the livestock sector, where they account for only about 5% of total employment (Holtkamp and Orazem, 2025).

Several mechanisms may explain these findings. First, visa wages may operate as efficiency wages, whereby higher pay raises the opportunity cost of unemployment and, consequently, worker effort and productivity. Second, higher visa wages may induce selection effects, attracting more productive or experienced workers, consistent with the evidence in Dal Bó et al. (2013). Third, farms may respond to higher labor costs by liquidating existing inventories to maintain liquidity. However, the concurrent increase in both sales and farm income does not support this last hypothesis. Further research is warranted to disentangle these mechanisms and establish the precise channels through which higher visa wages enhance farm productivity.

The findings of this paper carry important implications for public policy. By examining how farms respond to higher mandated wages for foreign workers, the analysis informs policymakers about the broader consequences of increasing the cost of H-2A labor. The evidence shows that, while higher visa wages have no measurable effect on domestic employment outcomes, they significantly influence farms' input allocation decisions and, consequently, production. Understanding these indirect effects is essential for designing labor market regulations that balance worker protection with sectoral productivity.

Contrary to the expectation that higher visa wages would reduce production by increasing labor costs, the results indicate that farms adjust by reallocating inputs—such as capital and intermediate factors—ultimately increasing their output as measured by sales and income. Local labor markets appear largely unaffected, suggesting that the policy achieves its primary objective of protecting domestic workers without generating adverse employment effects. Moreover, complementary evidence from Rutledge et al. (2024) and Paik (2024) suggests that domestic workers may even benefit from higher visa wages, reinforcing the view that the H-2A wage policy can enhance efficiency in agricultural labor markets.

Further research is needed to understand the broader set of adjustments farms may undertake to mitigate higher labor costs. One potential response is crop substitution, whereby farms shift toward less labor-intensive crops to reduce their dependence on manual labor. Farms may also adapt through other changes in production practices or related activities—such as altering planting schedules, adopting labor-saving technologies, or reallocating resources toward capital-intensive operations. Innovation in the agricultural sector represents about 10% of all patents related to labor saving technologies (Nain and Wang, 2023). Hence, understanding how increasing labor costs can lead to innovation is a natural avenue of research. In addition, it is important to understand if farms are better or worse off. While the visa wage is high relative to other domestic wages, having the opportunity to hire workers under this program might benefit farms if H-2A workers' productivity exceeds that cost. The results of this paper are supportive of this notion but further work is needed to understand this.

While this study contributes to the literature on employment of foreign workers, it also acknowledges a limitation to explain the consequences over undocumented employment, that is estimated to comprise 40 to 50% of the agricultural labor force in the United States (Martin, 2017). Data limitations prevent this study from exploring how undocumented employment changes as a consequence of high visa wages, posing challenges for comprehensive analysis of foreign employment in agriculture.

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A Tables

Table 1: USDA Farm Labor Regions

No.	Region	States
1	Northeast I	Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont
2	Northeast II	Delaware, Maryland, New Jersey, Pennsylvania
3	Appalachian I	North Carolina, Virginia
4	Appalachian II	Kentucky, Tennessee, West Virginia
5	Southeast	Alabama, Georgia, South Carolina
6	Lake	Michigan, Minnesota, Wisconsin
7	Cornbelt I	Illinois, Indiana, Ohio
8	Cornbelt II	Iowa, Missouri
9	Delta	Arkansas, Louisiana, Mississippi
10	Northern Plains	Kansas, Nebraska, North Dakota, South Dakota
11	Southern Plains	Oklahoma, Texas
12	Mountain I	Idaho, Montana, Wyoming
13	Mountain II	Colorado, Nevada, Utah
14	Mountain III	Arizona, New Mexico
15	Pacific	Oregon, Washington
16	Florida	Florida
17	California	California

Table 2: Summary Statistics: Agricultural Inputs

	Year				
Variable	2002	2007	2012	2017	2022
Labor payroll	4,414	4,996	6,456	7,653	10,636
	(9,295)	(9,649)	(12,275)	(13,887)	(22,375)
Employees	809	658	694	607	575
	(1,081)	(843)	(864)	(723)	(841)
Value of machinery	75,929	98,301	133,450	156,422	188,501
	(51,276)	(63,624)	(103,700)	(126,636)	(139,911)
Units of machinery	2,125	3,256	3,113	3,044	2,823
	(1,443)	(2,067)	(1,984)	(1,944)	(1,860)
Intermediate input expenses	6,000	10,458	17,503	15,944	22,022
	(7,124)	(13,895)	(24,279)	(21,346)	(30,096)
Farms with intermediate inputs	726	655	629	594	552
	(483)	(439)	(438)	(416)	(402)
Number of counties	1,038	1,088	1,086	1,086	1,078

Note: Table displays outcome mean and standard deviation statistics (in parenthesis) for all the years in the sample: 2002, 2007, 2012, 2017, and 2022 using the USDA Census of Agriculture. Values are reported in levels before any logarithmic transformation. The variable statistics are calculated at the county level, and are labor payroll (in millions of dollars), number of employees, average farm value of machinery and equipment (in dollars), units of machinery, intermediate input expenses (in millions of dollars), and number of farms with intermediate input expenses.

Table 3: H-2A Visa Program. Counties, Applications, Workers and Average Salaries, 2008-2024

Year	Counties	Applications	Workers	Wages
2008	1,372	8,424	99,850	10.2
2009	1,317	7,892	96,528	10.2
2010	1,201	7,174	92,324	9.4
2011	1,101	6,752	86,280	11.3
2012	1,114	7,513	95,409	14.6
2013	1,204	8,205	113,114	14.2
2014	1,281	9,252	132,175	10.1
2015	1,382	10,150	156,730	10.4
2016	1,437	11,342	181,067	11.0
2017	1,521	12,697	218,818	11.9
2018	1,631	14,222	255,944	11.8
2019	1,726	15,598	271,861	12.3
2020	1,755	13,835	271,075	13.5
2021	1,792	15,487	307,613	13.4
2022	2,030	18,811	367,499	14.3
2023	2,143	20,547	373,281	15.5
2024	2,199	22,241	380,518	16.6

Note: Table reports summary statistics by year from 2008 to 2024 of the number of counties using H-2A workers, the number of applications for workers submitted, the number of authorized workers and the average wage for every year. The wages are average hourly wages reported in US dollars. The source of the data is the US Department of Labor.

Table 4: Effect of Visa Wages on Labor Outcomes

	Payroll	Employees	Payroll	Employees	Payroll	Employees
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	1.226	0.807	1.159	0.757	1.689*	1.049
	(0.791)	(0.657)	(0.789)	(0.658)	(0.884)	(0.712)
Min Wage			0.250	0.186		
			(0.206)	(0.195)		
Visa Wage-Min Wage					-0.191	-0.100
					(0.151)	(0.127)
R^2	0.747	0.711	0.747	0.712	0.748	0.711
Observations	5,376	5,376	5,376	5,376	5,376	5,376
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 5,376 county observations that correspond to 2,688 county pair observations for the years 2002, 2007, 2012, 2017, and 2022. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log labor payrolls, columns 2, 4, and 6 on log employees. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 5: Effect of Visa Wages on Machinery and Equipment

	Value (1)	Units (2)	Value (3)	Units (4)	Value (5)	Units (6)
Visa Wage	1.221**	0.818	1.247**	0.792	1.180**	0.920*
	(0.487)	(0.511)	(0.494)	(0.519)	(0.526)	(0.508)
Min Wage			-0.095	0.097		
			(0.138)	(0.148)		
Visa Wage-Min Wage					0.017	-0.042
					(0.103)	(0.082)
R^2	0.862	0.722	0.862	0.723	0.862	0.722
Observations	5,376	5,376	5,376	5,376	5,376	5,376
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 5,376 county observations that correspond to 2,688 county pair observations for the years 2002, 2007, 2012, 2017, and 2022. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log value of machinery and equipment, columns 2, 4, and 6 on log units of machinery. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 6: Effect of Visa Wages on Intermediate Agricultural Inputs

	Expenses (1)	Farm Use (2)	Expenses (3)	Farm Use (4)	Expenses (5)	Farm Use (6)
Visa Wage	3.894***	1.078**	3.890***	1.058**	4.030***	1.114**
	(1.117)	(0.438)	(1.123)	(0.438)	(1.137)	(0.497)
Min Wage			0.013	0.074		
			(0.244)	(0.161)		
Visa Wage-Min Wage					-0.056	-0.015
					(0.177)	(0.096)
R^2	0.817	0.754	0.817	0.754	0.817	0.754
Observations	5,376	5,376	5,376	5,376	5,376	5,376
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 5,376 county observations that correspond to 2,688 county pair observations for the years 2002, 2007, 2012, 2017, and 2022. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log expenses in agricultural inputs (seeds and fertilizers), columns 2, 4, and 6 on log numbers of farms having expenses on seeds and fertilizers. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 7: Effect of Visa Wages on Sales and Productivity

	Crop Sales			Productivity		
	Overall	Per Acre	Per Worker	Overall	Per Acre	Per Worker
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	4.649***	2.145***	3.757***	2.251***	0.200**	1.790***
	(1.209)	(0.729)	(1.058)	(0.564)	(0.090)	(0.453)
R^2	0.794	0.795	0.810	0.759	0.699	0.751
Observations	4,130	4,130	4,130	4,130	4,130	4,130
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	No	No	No	No
Gap (Visa W -Min W)	No	No	No	No	No	No

Note: Sample is 4,130 county observations for the years 2002, 2007, 2012, 2017, and 2022. The table presents the estimation of specification 1 on two sets of outcomes: Sales and Productivity. Sales are presented in columns 1 to 3. Productivity outcomes are Revenue Total Factor Productivity (TFPR) presented in columns 4 to 6 and are estimated following (Levinsohn and Petrin, 2003). All outcomes and the Visa Wage are in logs. six different outcomes. Column 1 reports the coefficient on all crop sales, column 2 on crop sales per acre, column 3 on crop sales per worker. Column 4 reports the coefficient on overall crop productivity, column5 on productivity per acre, and column 6 on productivity per worker. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 8: Effect of Minimum Wages on Agricultural Inputs

	Labor		Machinery		Intermediate inputs	
	Log Payroll	Log Employees	Log Value	Log Units	Log Expenses	Log Farm use
	(1)	(2)	(3)	(4)	(5)	(6)
Min Wage	0.297	0.217	-0.045	0.129	0.171	0.117
	(0.203)	(0.180)	(0.150)	(0.126)	(0.288)	(0.152)
R^2	0.745	0.709	0.854	0.719	0.800	0.749
Observations	5,376	5,376	5,376	5,376	5,376	5,376
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes

Note: Sample is 5,376 county observations that correspond to 2,688 county pair observations for the years 2002, 2007, 2012, 2017, and 2022. The table presents the estimation of specification 1 with log Minimum Wage in lieu of log Visa Wage on six different outcomes. Column 1 presents the result on log labor payrolls, column 2 on log employees, column 3 on the log value of machinery and equipment, column 4 on log units of machinery, column 5 on expenses in agricultural inputs (Seeds and fertilizers), column 6 on the numbers of farms having expenses on seeds and fertilizers. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 9: Effect of Visa Wages on H-2A Wages and Authorized Workers

	Wages	Workers	Wages	Workers	Wages	Workers
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	1.069***	2.425***	1.037***	1.918***	1.062***	2.929***
	(0.093)	(0.777)	(0.115)	(0.668)	(0.163)	(0.973)
Min Wage			0.051	0.808		
			(0.129)	(0.640)		
Visa Wage-Min Wage					0.004	-0.311
					(0.073)	(0.260)
R^2	0.776	0.802	0.776	0.805	0.776	0.804
Observations	9,385	9,273	9,385	9,273	9,385	9,273
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 9,385 county observations for the years 2010 to 2024. These results use information from the US Department of Labor. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log wages, columns 2, 4, and 6 on log H-2A workers. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 10: Effect of Visa Wages on other Outcomes

	Farm Income	Animal Sales	Unemployment
	(1)	(2)	(3)
Visa Wage	1.801**	-0.234	0.122
	(0.899)	(1.515)	(0.309)
R^2	0.769	0.702	0.816
Observations	2,604	2,092	10,616
County FE	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes
Log Population	Yes	Yes	Yes

Note: The table presents the estimation of specification 1 using the following outcomes: net cash farm income, animal sales, and unemployment. All outcomes are reported in log units. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 11: Effect of Visa Wages on Labor Outcomes - Field Crop Intensive Counties

	Payroll (1)	Employees (2)	Payroll (3)	Employees (4)	Payroll (5)	Employees (6)
Visa Wage	0.946	0.452	0.524	0.161	1.793	0.913
	(1.661)	(1.178)	(1.540)	(1.249)	(1.711)	(1.262)
Min Wage			0.663*	0.458		
			(0.363)	(0.286)		
Visa Wage-Min Wage					-0.408	-0.222
					(0.256)	(0.196)
R^2	0.883	0.849	0.885	0.851	0.885	0.850
Observations	2,014	2,014	2,014	2,014	2,014	2,014
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 2,014 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations below the median in ratio of harvested vegetables on field crops. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log labor payrolls, columns 2, 4, and 6 on log employees. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 12: Effect of Visa Wages on Machinery and Equipment - Field Crop Intensive Counties

	Value	Units	Value	Units	Value	Units
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	1.250	1.078	1.156	0.943	1.578**	1.177
	(0.907)	(0.981)	(0.926)	(1.016)	(0.741)	(1.035)
Min Wage			0.149	0.212		
			(0.315)	(0.329)		
Visa Wage-Min Wage					-0.158	-0.048
					(0.193)	(0.201)
R^2	0.930	0.863	0.930	0.864	0.931	0.863
Observations	2,014	2,014	2,014	2,014	2,014	2,014
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 2,014 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations below the median in ratio of harvested vegetables on field crops. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log value of machinery and equipment, columns 2, 4, and 6 on log units of machinery. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 13: Effect of Visa Wages on Intermediate Agricultural Inputs - Field Crop Intensive Counties

	Expenses	Farm Use	Expenses	Farm Use	Expenses	Farm Use
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	4.462***	1.198	4.072***	1.036	5.239***	1.325
	(1.552)	(0.928)	(1.532)	(0.961)	(1.648)	(1.042)
Min Wage			0.613	0.254		
			(0.700)	(0.359)		
Visa Wage-Min Wage					-0.374	-0.061
					(0.404)	(0.229)
R^2	0.917	0.869	0.918	0.870	0.918	0.869
Observations	2,014	2,014	2,014	2,014	2,014	2,014
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 2,014 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations below the median in ratio of harvested vegetables on field crops. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log expenses in agricultural inputs (seeds and fertilizers), columns 2, 4, and 6 on log numbers of farms having expenses on seeds and fertilizers. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 14: Effect of Visa Wages on Sales and Productivity - Field Crop Intensive Counties

	Crop Sales			Productivity		
	Overall	Per Acre	Per Worker	Overall	Per Acre	Per Worker
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Visa Wage)	3.964*	1.336	3.695**	2.414*	0.194	1.787*
	(2.259)	(1.307)	(1.827)	(1.223)	(0.132)	(0.946)
R^2	0.892	0.862	0.888	0.889	0.841	0.887
Observations	971	971	971	971	971	971
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	No	No	No	No
Gap (Visa W -Min W)	No	No	No	No	No	No

Note: Sample is 971 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations below the median in ratio of harvested vegetables on field crops. The table presents the estimation of specification 1 on two sets of outcomes: Sales and Productivity. Sales are presented in columns 1 to 3. Productivity outcomes are Revenue Total Factor Productivity (TFPR) presented in columns 4 to 6 and are estimated following (Levinsohn and Petrin, 2003). All outcomes and the Visa Wage are in logs. six different outcomes. Column 1 reports the coefficient on all crop sales, column 2 on crop sales per acre, column 3 on crop sales per worker. Column 4 reports the coefficient on overall crop productivity, column5 on productivity per acre, and column 6 on productivity per worker. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 15: Effect of Minimum Wages on Agricultural Inputs - Field Crop Intensive Counties

	Labor		Machinery		Intermediate inputs	
	Log Payroll	Log Employees	Log Value	Log Units	Log Expenses	Log Farm use
	(1)	(2)	(3)	(4)	(5)	(6)
Min Wage	0.718*	0.475*	0.270	0.311	1.040	0.363
	(0.407)	(0.282)	(0.346)	(0.307)	(0.808)	(0.332)
R^2	0.885	0.851	0.927	0.861	0.909	0.867
Observations	2,014	2,014	2,014	2,014	2,014	2,014
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes

Note: Sample is 2,014 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations below the median in ratio of harvested vegetables on field crops. The table presents the estimation of specification 1 with log Minimum Wage in lieu of log Visa Wage on six different outcomes. Column 1 presents the result on log labor payrolls, column 2 on log employees, column 3 on the log value of machinery and equipment, column 4 on log units of machinery, column 5 on expenses in agricultural inputs (Seeds and fertilizers), column 6 on the numbers of farms having expenses on seeds and fertilizers. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 16: Effect of Visa Wages on Labor Outcomes - Vegetable Intensive Counties

	Payroll (1)	Employees (2)	Payroll (3)	Employees (4)	Payroll (5)	Employees (6)
Visa Wage	1.923	1.288	1.902	1.315	2.042	1.281
	(2.138)	(1.487)	(2.116)	(1.497)	(2.325)	(1.629)
Min Wage			0.034	-0.046		
			(0.540)	(0.447)		
Visa Wage-Min Wage					-0.068	0.004
					(0.296)	(0.225)
R^2	0.819	0.789	0.819	0.789	0.819	0.789
Observations	2,562	2,562	2,562	2,562	2,562	2,562
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 2,562 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations above the median in ratio of harvested vegetables on field crops. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log labor payrolls, columns 2, 4, and 6 on log employees. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 17: Effect of Visa Wages on Machinery and Equipment - Vegetable Intensive Counties

	Value	Units	Value	Units	Value	Units
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	1.447**	1.017	1.688***	1.006	1.139	1.069
	(0.666)	(0.858)	(0.596)	(0.900)	(0.866)	(0.881)
Min Wage			-0.399	0.019		
			(0.362)	(0.303)		
Visa Wage-Min Wage					0.177	-0.030
					(0.209)	(0.150)
R^2	0.896	0.789	0.899	0.789	0.898	0.789
Observations	2,562	2,562	2,562	2,562	2,562	2,562
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 2,562 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations above the median in ratio of harvested vegetables on field crops. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log value of machinery and equipment, columns 2, 4, and 6 on log units of machinery. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 18: Effect of Visa Wages on Intermediate Agricultural Inputs - Vegetable Intensive Counties

	Expenses	Farm Use	Expenses	Farm Use	Expenses	Farm Use
	(1)	(2)	(3)	(4)	(5)	(6)
Visa Wage	3.768*	0.879	4.058**	0.873	3.454	0.897
	(2.051)	(0.813)	(2.013)	(0.883)	(2.213)	(0.846)
Min Wage			-0.479	0.011		
			(0.543)	(0.366)		
Visa Wage-Min Wage					0.180	-0.010
					(0.323)	(0.190)
R^2	0.861	0.802	0.862	0.802	0.862	0.802
Observations	2,562	2,562	2,562	2,562	2,562	2,562
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	Yes	Yes	No	No
Gap (Visa W -Min W)	No	No	No	No	Yes	Yes

Note: Sample is 2,562 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations above the median in ratio of harvested vegetables on field crops. The table presents the estimation of the β coefficient from specifications 1 on columns 1 and 2, specification 2 on columns 3 and 4, and specification 3 on columns 5 and 6. Columns 1, 3, and 5 present the results on log expenses in agricultural inputs (seeds and fertilizers), columns 2, 4, and 6 on log numbers of farms having expenses on seeds and fertilizers. The variables Visa Wage, Min Wage, and Visa Wage-Min Wage are in logs. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 19: Effect of Visa Wages on Sales and Productivity - Vegetable Intensive Counties

	Crop Sales			Productivity		
	Overall	Per Acre	Per Worker	Overall	Per Acre	Per Worker
	(1)	(2)	(3)	(4)	(5)	(6)
Log(Visa Wage)	3.953***	1.549**	2.935***	2.328***	0.133**	1.760***
	(1.165)	(0.686)	(0.897)	(0.711)	(0.066)	(0.574)
R^2	0.794	0.744	0.795	0.767	0.682	0.753
Observations	2,089	2,089	2,089	2,089	2,089	2,089
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes
Min Wage	No	No	No	No	No	No
Gap (Visa W -Min W)	No	No	No	No	No	No

Note: Sample is 2,089 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations above the median in ratio of harvested vegetables on field crops. The table presents the estimation of specification 1 on two sets of outcomes: Sales and Productivity. Sales are presented in columns 1 to 3. Productivity outcomes are Revenue Total Factor Productivity (TFPR) presented in columns 4 to 6 and are estimated following (Levinsohn and Petrin, 2003). All outcomes and the Visa Wage are in logs. six different outcomes. Column 1 reports the coefficient on all crop sales, column 2 on crop sales per acre, column 3 on crop sales per worker. Column 4 reports the coefficient on overall crop productivity, column5 on productivity per acre, and column 6 on productivity per worker. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

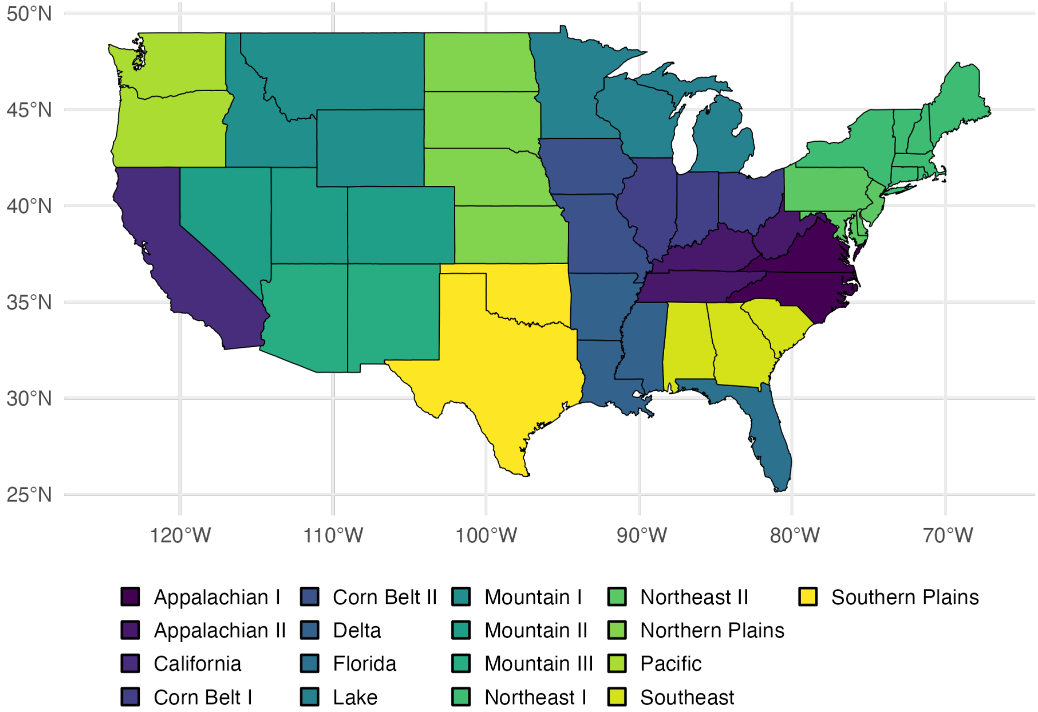
Table 20: Effect of Minimum Wages on Agricultural Inputs - Vegetable Intensive Counties

	Labor		Machinery		Intermediate inputs	
	Log Payroll	Log Employees	Log Value	Log Units	Log Expenses	Log Farm use
	(1)	(2)	(3)	(4)	(5)	(6)
Min Wage	0.222	0.084	-0.232	0.118	-0.078	0.097
	(0.577)	(0.459)	(0.377)	(0.274)	(0.568)	(0.323)
R^2	0.816	0.785	0.890	0.786	0.851	0.800
Observations	2,562	2,562	2,562	2,562	2,562	2,562
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair-Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Log Population	Yes	Yes	Yes	Yes	Yes	Yes

Note: Sample is 2,562 county observations for the years 2002, 2007, 2012, 2017, and 2022. The results use only observations above the median in ratio of harvested vegetables on field crops. The table presents the estimation of specification 1 with log Minimum Wage in lieu of log Visa Wage on six different outcomes. Column 1 presents the result on log labor payrolls, column 2 on log employees, column 3 on the log value of machinery and equipment, column 4 on log units of machinery, column 5 on expenses in agricultural inputs (Seeds and fertilizers), column 6 on the numbers of farms having expenses on seeds and fertilizers. All regressions include county fixed effects, pair-time fixed effects, as well as a control for log population. Standard errors clustered at state and border segment level reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

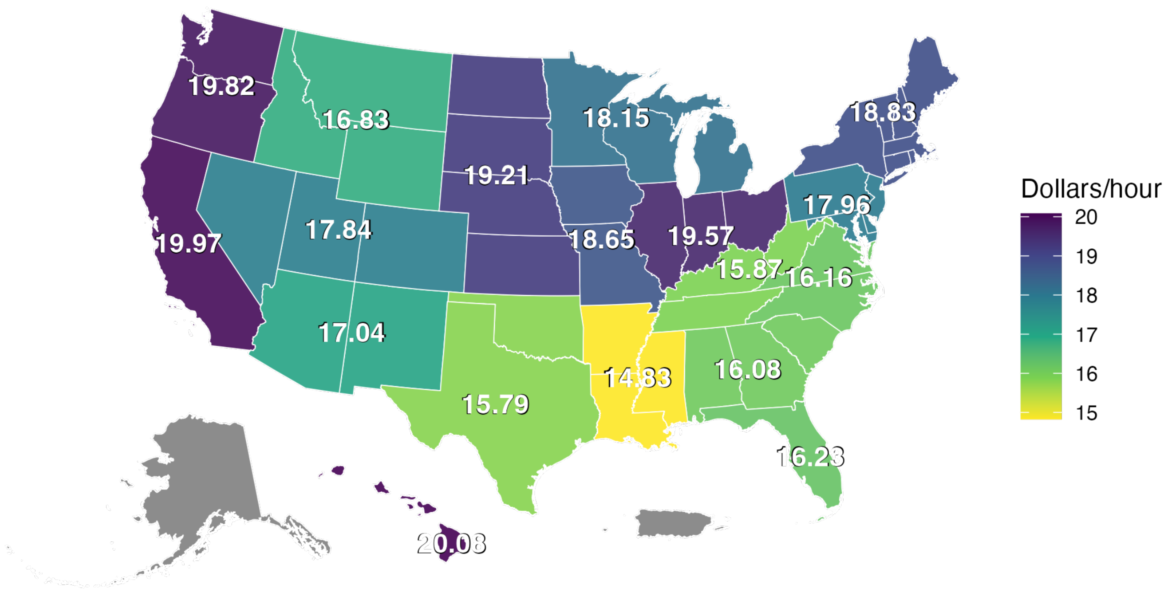
B Figures

Figure 1: USDA Farm Labor Regions that Determine Visa Wages



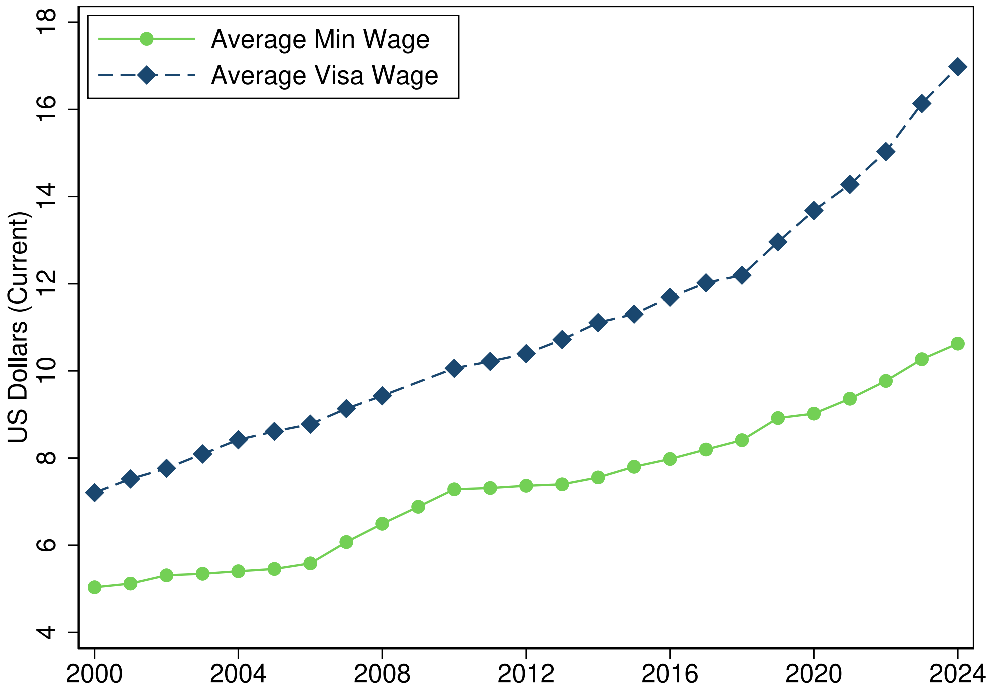
* *Note: Author's elaboration based on data from the US Department of Labor. The plot shows the USDA Farm Labor Regions in the Farm Labor Survey. These regions determine the visa wages.*

Figure 2: Visa Wages by Region, 2025



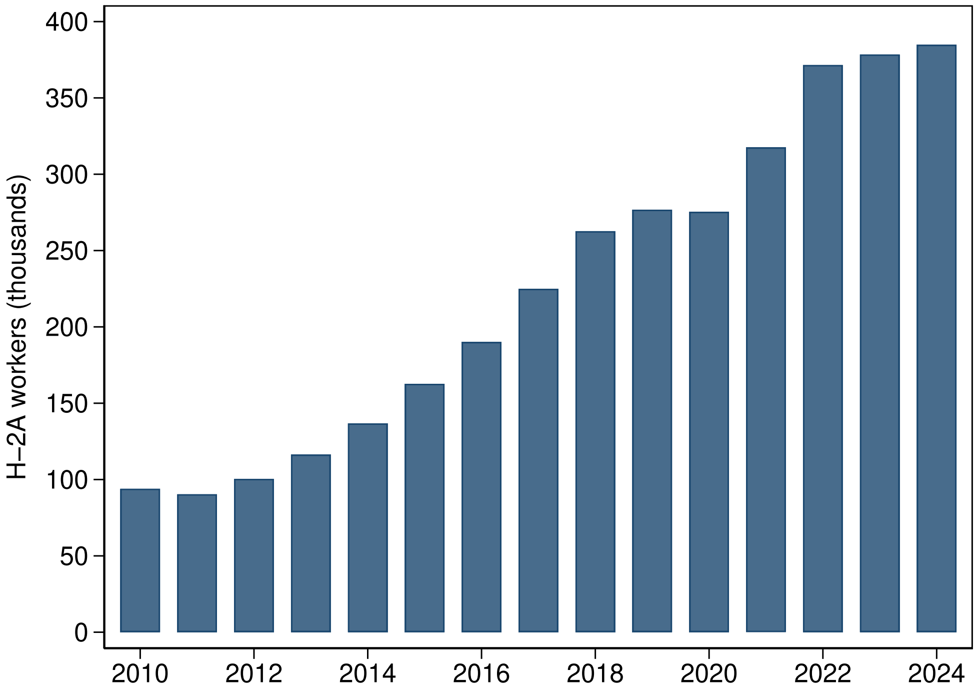
* *Note: Author's elaboration using information from the US Department of Labor. The plot presents the visa wage for the latest available year (2025) for each USDA farm labor region. The current visa wage is displayed at the center of each region.*

Figure 3: Minimum Wages and Visa Wages (National Average)



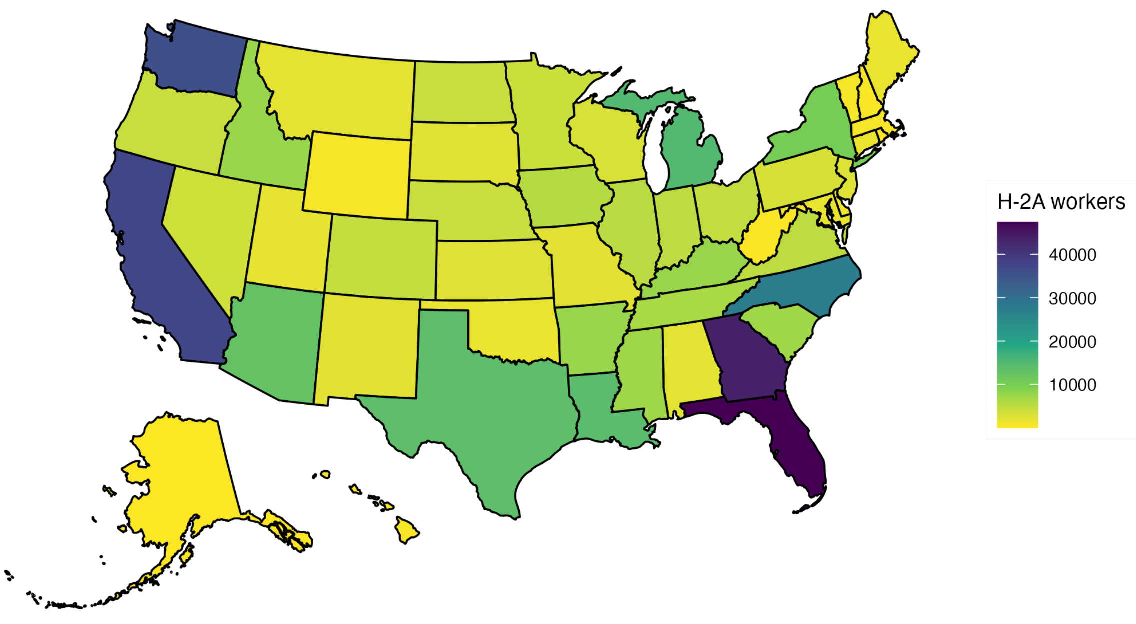
* *Note: The plot presents the evolution of simple average minimum wages and simple average visa wages from 2000 to 2024 using information from the US Department of Labor.*

Figure 4: Evolution of H-2A Authorized Workers 2010-2024



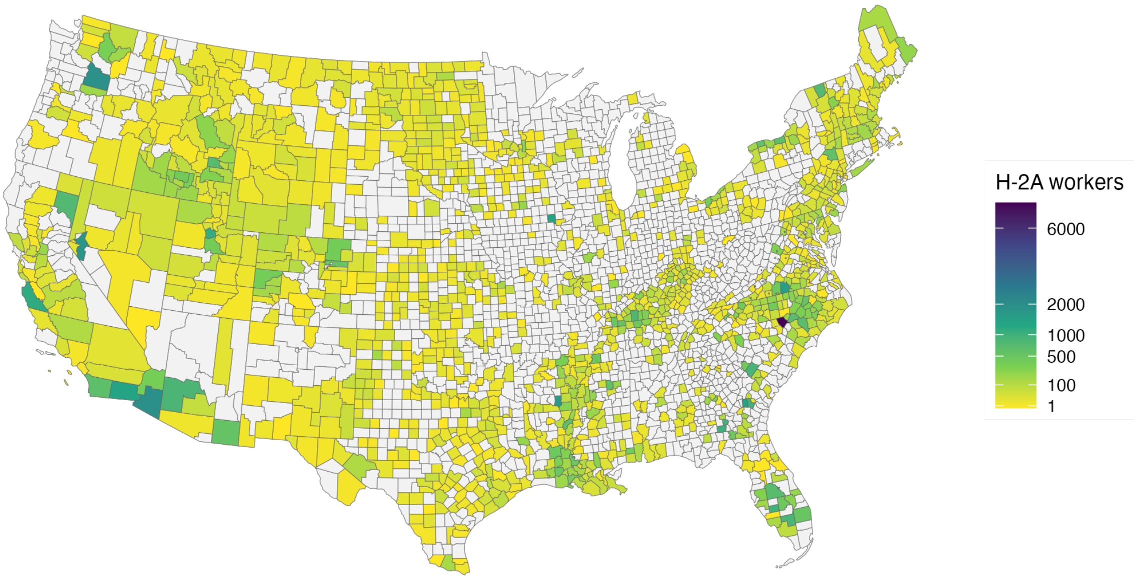
* *Note: The plot presents the evolution from 2010 to 2024 of the number of H-2A authorized workers using information from the Office of Foreign Labor Certification from the US Department of Labor.*

Figure 5: Authorized H-2A Workers by State in 2024



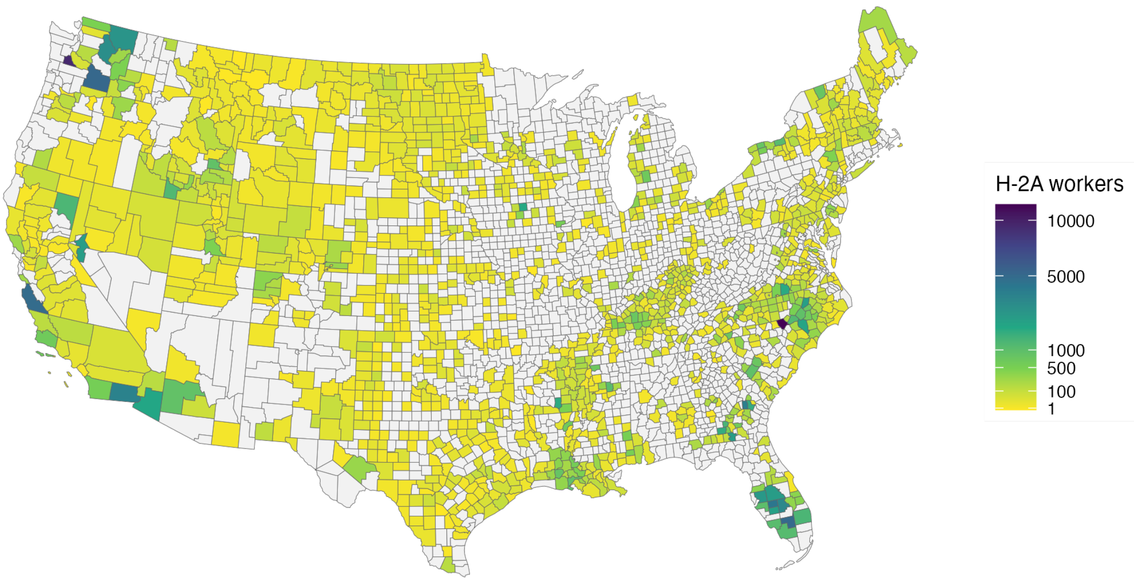
* *Note: The plot presents the distribution of H-2A workers by state in 2024 using information from the Office of Foreign Labor Certification.*

Figure 6: Authorized H-2A Workers by County in 2008



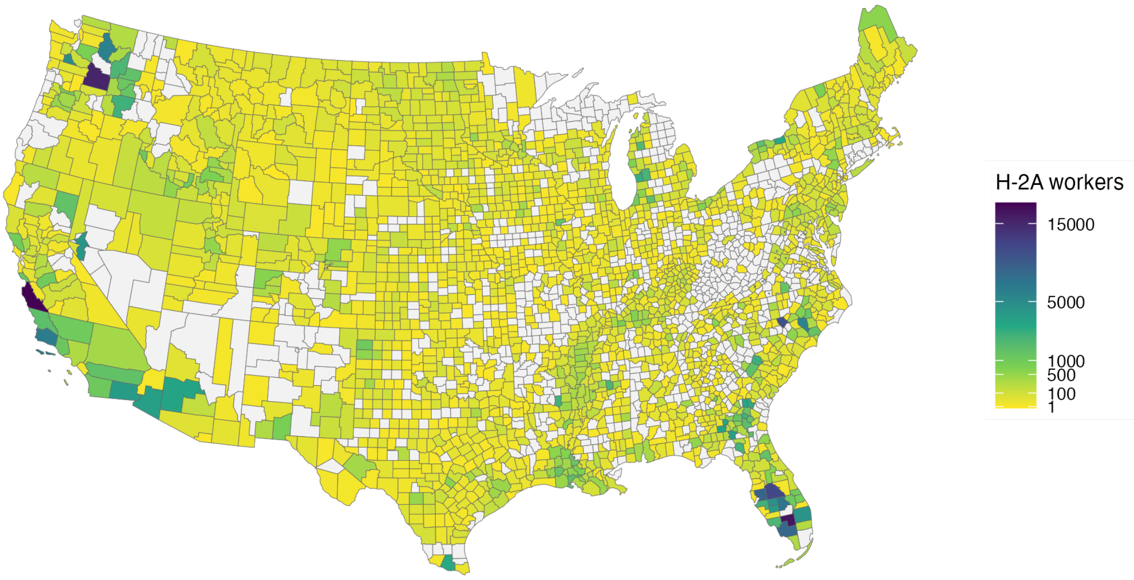
[*] *Note: The plot presents the distribution of H-2A workers by county in 2008 using information from the Office of Foreign Labor Certification.*

Figure 7: Authorized H-2A Workers by County in 2016



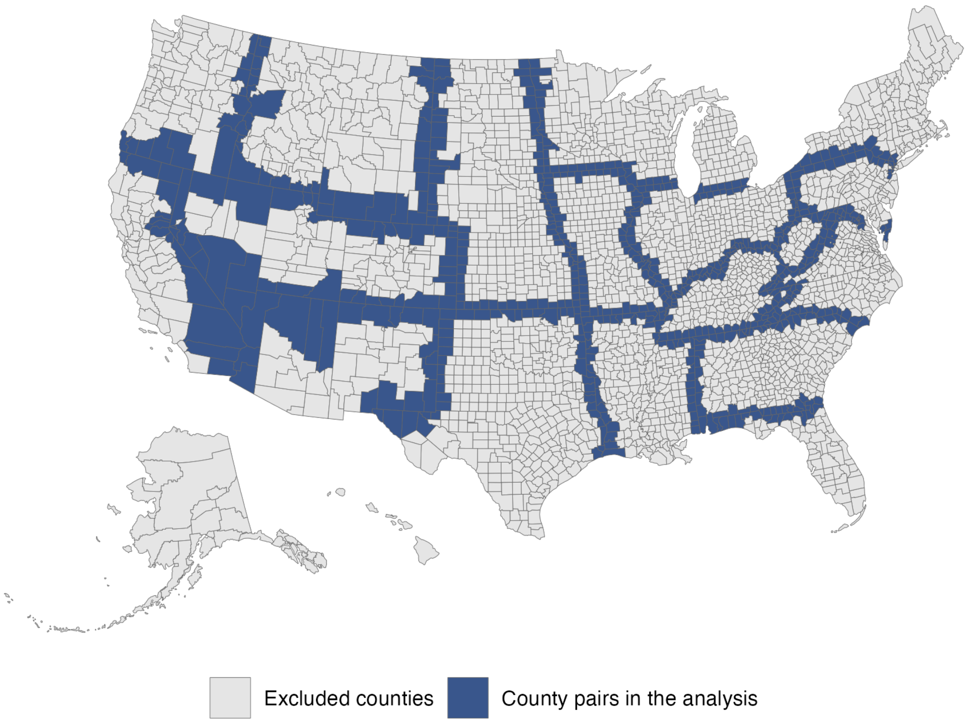
[*] *Note: The plot presents the distribution of H-2A workers by county in 2016 using information from the Office of Foreign Labor Certification.*

Figure 8: Authorized H-2A Workers by County in 2024



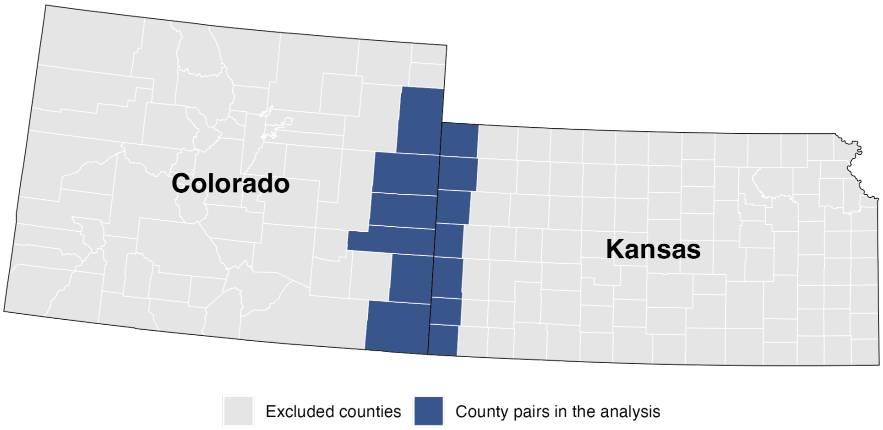
* *Note: The plot presents the distribution of H-2A workers by county in 2024 using information from the Office of Foreign Labor Certification.*

Figure 9: Contiguous Counties across States with Different Visa Wages



* *Note: This figure displays the counties that are part of the sample in the study at the national level (in navy blue) and the counties excluded from the analysis (in light gray).*

Figure 10: Contiguous Counties across Colorado and Kansas

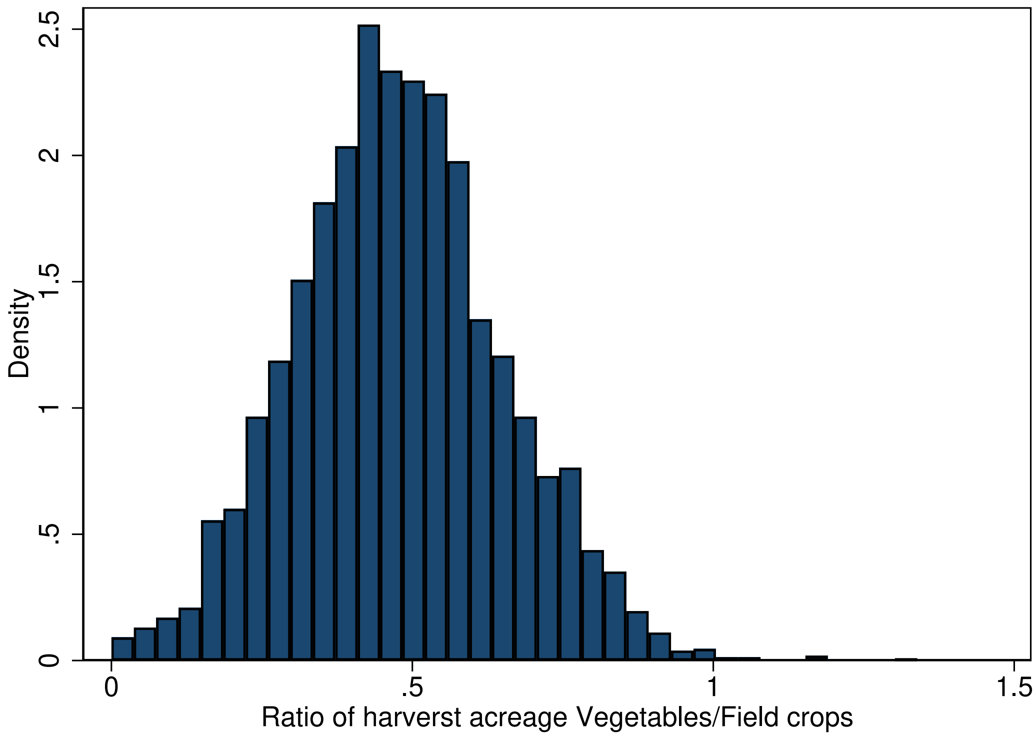


* *Note: This figure illustrates the contiguous counties that are part of the study sample between Colorado and Kansas (navy blue), and the counties excluded from the analysis (light gray).*

Figure 11: Contiguous Counties across Illinois and Wisconsin

* *Note: This figure illustrates the contiguous counties that are part of the study sample between Illinois and Wisconsin (navy blue), and the counties excluded from the analysis (light gray).*

Figure 12: Histogram of the Vegetables to Field Crop Harvested Ratio



[*] *Note: The figure presents the histogram of a variable that represents the ratio of acres harvested in vegetables to acres harvested in field crops at the county level.*

C Conceptual Framework with Nested labor structure

This section provides a simple model of farm production that illustrates how changes in visa wages affect farms' input choices.

The production technology is given by farms producing a homogeneous agricultural output Y_{it} using capital K_{it}, a composite labor input L_{it}, and a bundle of intermediate inputs M_{it} (e.g. seeds, fertilizers, chemicals), according to a Cobb–Douglas production function,

$$Y_{it} = A_{it}\, K_{it}^{\alpha}\, M_{it}^{\beta}\, L_{it}^{1-\alpha-\beta}, \tag{4}$$

where A_{it} is farm and time specific total factor productivity, and $0 < \alpha, \beta < 1$ with $\alpha + \beta < 1$ to allow for decreasing returns at the farm level.[10]

To understand the role of visa wages corresponding to the H-2A program, the model features a composite labor input L_{it} is itself a constant elasticity of substitution (CES) aggregate of domestic hired labor, L_{dit}, and foreign (H-2A) labor, L_{fit}:[11]

$$L_{it} = \left[\theta\, L_{dit}^{\rho} + (1-\theta)\, L_{fit}^{\rho}\right]^{\frac{1}{\rho}}, \qquad 0 < \theta < 1, \quad \rho \leq 1, \tag{5}$$

where θ captures the relative weight of domestic labor in effective labor services and ρ governs the elasticity of substitution between domestic and foreign labor. The implied elasticity of substitution is:

$$\sigma_{df} \equiv \frac{1}{1-\rho}. \tag{6}$$

When $\rho \to 0$, the CES nest converges to a Cobb-Douglas aggregate; when $\rho \to 1$, domestic and foreign labor become perfect substitutes; and when $\rho \to -\infty$, the two types of labor become Leontief. This nested structure allows for substitution between local and H-2A workers, but not necessarily one-for-one, because tasks, skills, productivity and regulations differ across worker types.

[10] A similar separable structure is standard in the induced-innovation and labor, capital substitution literature, see Manuelli and Seshadri (2014a) and Clemens et al. (2018b).

[11] This model abstracts from modeling separately undocumented labor, for simplicity it can be assumed to be a subset of the domestic labor.

C.1 Implications for labor demand

Let w_{dit} denote the wage of domestic labor and let w_{fit} denote the per-unit cost of foreign labor. For H-2A workers, this cost includes not only the Adverse Effect Wage Rate (visa wage) but also non-wage program requirements such as housing and transportation.

$$c_{fit} \equiv w_{fit} + \phi_{it}, \tag{7}$$

where ϕ_{it} is the per-worker non-wage cost of hiring through the H-2A program.

Given a target level of effective labor L_{it}, the farm chooses (L_{dit}, L_{fit}) to minimize

$$\min_{L_{dit}, L_{fit}} \; w_{dit}L_{dit} + c_{fit}L_{fit} \quad \text{s.t.} \quad L_{it} = \left[\theta L_{dit}^{\rho} + (1-\theta)L_{fit}^{\rho}\right]^{1/\rho}. \tag{8}$$

The first-order conditions imply the usual CES relative-demand equation:

$$\frac{L_{fit}}{L_{dit}} = \left(\frac{1-\theta}{\theta}\right)^{\frac{1}{1-\rho}} \left(\frac{w_{dit}}{c_{fit}}\right)^{\frac{1}{1-\rho}}. \tag{9}$$

Equation (9) delivers the key empirical prediction of the model: an increase in the effective cost of H-2A labor, c_{fit},—for example due to an increase in the visa wage or in housing/transportation requirements reduces the ratio of foreign to domestic labor hired by the farm. Because c_{fit} is partly policy-determined and varies across states and over time, this expression provides a direct bridge between policy variation and observable hiring patterns.

C.2 Implications for capital and intermediate inputs

At the outer level, the farm minimizes total cost conditional on factor prices $(r_t, p_{Mt}, w_{dit}, c_{fit})$:

$$\min_{K_{it}, M_{it}, L_{it}} \; r_tK_{it} + p_{Mt}M_{it} + w_{L,it}L_{it} \quad \text{s.t.} \quad Y_{it} = A_{it}K_{it}^{\alpha}M_{it}^{\beta}L_{it}^{1-\alpha-\beta}, \tag{10}$$

where $w_{L,it}$ is the shadow price of composite labor L_{it} induced by the inner nest. A policy-induced increase in c_{fit} raises $w_{L,it}$, which in turn induces substitution toward capital K_{it} and, potentially, toward labor-saving intermediate inputs M_{it} (e.g. mechanization services, herbicides).

The nested production structure follows a long tradition in applied micro and trade that uses CES nests to allow for imperfect substitution across worker types or technologies; see, among others, Ottaviano and Peri (2012) for immigration and native workers in the U.S. labor market, Dustmann et al. (2016) for refugee supply shocks, and Lagakos and Waugh (2013) for agricultural labor differences across countries. Closer to agricultural applications, Clemens et al. (2018b) study how migrant labor affects U.S. agriculture and highlight the role of policy-driven labor cost changes. The contribution of this framework is to bring this structure to the context of the H-2A program and to make the policy-induced component of foreign labor costs explicit via equation (7), which generates transparent, testable predictions for farm-level demand for foreign labor and for capital-labor substitution.

Without the nested labor structure, the model reduces to foreign and domestic labor being perfect substitutes.