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H-2A Wages and Livestock Farm Labor Demand

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This study examines how livestock farm labor demand responds to local wages for native workers and the adverse effect wage rate paid to foreign workers with an H-2A visa. Livestock producers' demand for domestic labor is elastic, but the demand for H-2A workers is more elastic. This implies that equiproportional increases in all wages will shift relative demand toward domestically sourced—but possibly undocumented—labor. Our analysis also shows that capital and labor are complementary inputs in livestock production, meaning that the use of hired labor increases as farms invest more in capital.

Key words: adverse effect wage rate, capital, complements, H-2A visa, quasi-fixed cost, substitutes

Introduction

The US agricultural industry has faced challenges filling job vacancies on farms (Christiaensen, Rutledge, and Taylor, 2021). Labor shortages have been reported by livestock producers, particularly in hog (Crews, 2023), dairy (Rosson, 2012), and cattle (Sitienei, Gillespie, and Scaglia, 2015) production. With too few native-born workers available, the H-2A Temporary Agricultural Visa Program is the primary way in which farmers can legally hire foreign labor. The program is considered to be a costly and time-consuming substitute for domestic and unauthorized foreign labor because of its application process and requirements, so it is not useful for quickly meeting unanticipated labor demand (Luckstead and Devadoss, 2019).

Minkoff-Zern et al. (2022) found that small and medium-sized farms have an especially challenging time using the program because of its associated costs and long application process. To use the H-2A program, farmers must apply at least 2 months in advance and pay the related application fees (US Department of Labor, Foreign Labor Application Gateway, n.d.). Producers must also provide housing for H-2A workers and workers in corresponding employment at no cost (20 CFR § 655.1304) and cover all travel expenses (20 CFR § 655.122) for H-2A workers.[1] Further, farmers must pay H-2A workers and workers in corresponding employment the adverse effect wage rate (AEWR), which is higher than most local wage rates because it is set high enough to prevent undercutting the wages of domestic workers. However, they do not have to pay Social Security or unemployment insurance taxes (Internal Revenue Service, 2023). It is easier for large operations, which have more resources and capital, to anticipate labor demand in advance and plan for H-2A workers accordingly. As a result of the fixed costs incurred when using the H-2A program, participating farms tend to hire large numbers of H-2A workers. Smaller farms that employ fewer

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[1] Corresponding employment refers to US workers that are employed by the same producer alongside H-2A workers to perform similar tasks.

than ten workers hire only 4% of all H-2A workers, while farms with 50 or more employees hire 71% of all H-2A workers (Minkoff-Zern et al., 2022).

H-2A workers may fill only jobs that are temporary or seasonal in nature, meaning that the need for work should be "tied to a certain time of year by an event or pattern" (20 CFR § 655.103(d), 2008). H-2A jobs generally last 10 months or less; in 2020, the average length of H-2A job orders was 24 weeks (Castillo, Martin, and Rutledge, 2022). Because livestock production is year-round, producers' need for long-term employees usually prevents them from using the H-2A program. Many organizations representing livestock producers have advocated for reforming the program so it can better accommodate year-round livestock positions, with groups like the National Pork Producers Council (Crews, 2023) and the National Council of Agricultural Employers among the most outspoken.[2]

This study analyzes the use of hired labor on livestock farms from 1998 to 2018. We show that livestock operations have increasingly employed foreign workers through the H-2A program over that period despite its temporary nature. The rising demand for H-2A workers is related to the complementarity between labor and capital on capital-intensive livestock operations. In contrast, there is no relationship between labor demand and the size of farm measured by acres of land. We show that labor demand responds elastically to local wage rates and even more elastically to the AEWR.

Literature Review

The livestock industry was responsible for 47% of agricultural cash receipts from 2016 to 2023.[3] Livestock production is slightly more capital intensive than the rest of agriculture. Hired labor costs averaged 7%–9% of all livestock operation variable expenses compared to 10% for all farm operations.[4] Animal agriculture has become increasingly capital intensive over time, which has significantly increased the productivity of operations and changed the structure of the market. Examples of this phenomenon, as reviewed by Schmitz and Moss (2015), include the adoption of hay balers and front-end loaders, tub grinders, and concentrated animal feeding operations that have expedited the feeding process on cow–calf operations. California's more rapid adoption of machine milking has led to the rising concentration of dairy production in California rather than Wisconsin. Mechanized feeding systems and technological innovations in manure handling and disposal have greatly increased scale and productivity on hog farms. Finally, highly mechanized incubation technology for broiler eggs has increased labor productivity in chicken and turkey production, allowing the US industry to gain a larger share of the world poultry market.

Mechanization has also led to greater concentration in the dairy, pork, beef, and broiler industries (Schmitz and Moss, 2015). MacDonald and McBride (2009) found that from 1987 to 2002, the locus of livestock production increased by 60% in the broiler industry; by 100% in cattle; by 240% in dairy; and by 2000% in hogs.[5] The study also found that the productivity of livestock operations increased due to economies of scale, which hastened industry concentration. Similarly, Kelloway and Miller (2019) found that in poultry, where nine out of ten chickens are raised under contract with processing firms, the market share of the largest four firms grew from 35% in 1986 to 54% in 2018. In beef production, about 17,000 cattle ranchers have gone out of business annually since 1980, and the number of cattle-feeding operations has also been declining. The number of hog

[2] The second policy priority listed on the council's website is "Support any and all efforts through agency action or legislation to maximize viability and accessibility of the H-2A program to all agriculture and all agricultural housing" (https://www.ncaeonline.org/issues-and-advocacy/ncae-policy-priorities/).

[3] Authors' computation of the share of cash receipts from animal and animal products of total cash receipts from 2016–2023, using USDA farm sector financial indicators.

[4] Authors' computation of the share of farm production expenses excluding operator dwellings that is composed of cash and noncash hired or custom labor expenses from 2016–2023, using USDA production expenses by category.

[5] The production locus measures the average size of farms (measured in annual sales) using a sample in which 50% of production comes from larger farms and 50% from smaller farms.

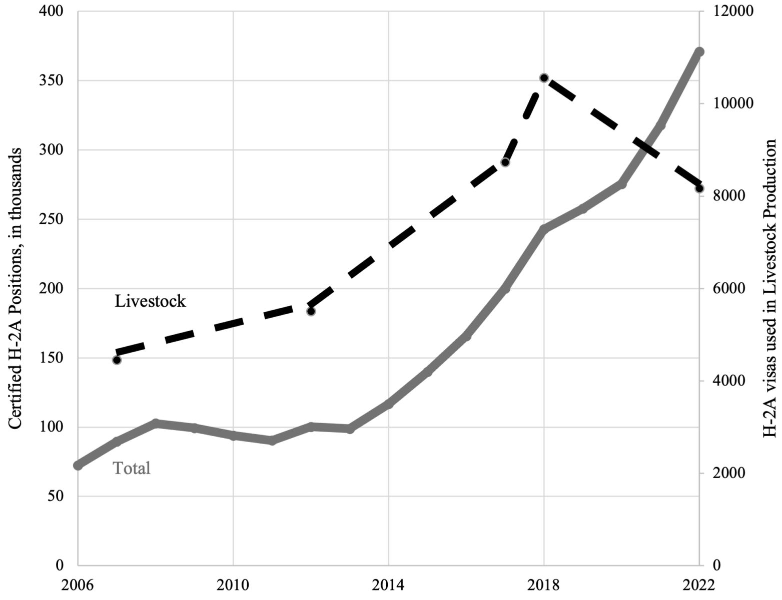

Figure 1. Total and Livestock-Related H-2A Certifications, 2006–2012

Notes: H-2A livestock certifications do not include jobs dealing with horses or stable attendants. A large share of the livestock H-2A certifications are for goat and sheep herding. The DOL makes exceptions to wage rules for these producers, allowing them to pay monthly wages instead of hourly.
Source: Authors' compilation of US Department of Labor data (https://www.dol.gov/agencies/eta/foreign-labor/performance).

farmers has declined by 70% since the 1990s, and the number of dairy farms in the United States has declined by about 94% since 1970.

Farms have traditionally addressed their labor needs by relying heavily on unpaid family labor. Martin (2012, 2017) estimated that 35% of agricultural labor and over half of the total hours worked on an average farm were provided by the principal operator or by unpaid family members. This was true of most livestock operations but not of the largest factory-scale farms (Fisher and Knutson, 2013). These larger, more capital-intensive operations also use more hired labor. As the number of family-operated farms decreases with greater industry concentration, the demand for hired labor will increase.

A rising share of agricultural labor has come from the H-2A program.[6] As seen in Figure 1, the number of total H-2A-certified jobs has increased dramatically in the last 2 decades, currently making up 17% of agricultural employment in the 2022 Census of Agriculture. Several scholars have raised concerns about the sustainability of this rising use of foreign agricultural labor in the United States (Charlton and Taylor, 2016; Richards, 2018; Charlton et al., 2019). Most H-2A workers come from Mexico, but the supply of Mexican agricultural workers has declined as workers shift away from farm work to higher-paying nonfarm jobs (Charlton and Taylor, 2016; Charlton et al., 2019). Rising rural education levels in Mexico have accelerated the rural-to-urban population shift, similar to what the United States experienced in the past century (Zahniser et al., 2018). Charlton et al. (2019) estimated that US real farm wage rates would have to increase by more than 10% to keep up with the rising wages in nonagricultural jobs in Mexico.

Along with the use of the H-2A program, US producers hire a significant amount of undocumented agricultural labor. The USDA Economic Research Service (US Department of Agriculture, 2023) estimates that about 41% of the farm labor force was unauthorized in 2020. This represents a continued declining share of undocumented workers in agriculture since 2000

[6] See Castillo, Martin, and Rutledge (2024) for a history of the H-2A program and its growth.

(Martin, 2017). The supply of undocumented agricultural labor is decreasing at a higher rate than the increase in H-2A visa holders, leading to rising wages in agricultural labor. Richards (2018) showed that eliminating the supply of undocumented agricultural labor would create a significant upward pressure on US agricultural wages. Simultaneously, analysis by Devadoss, Zhao, and Luckstead (2020) shows that wages in Mexico will fall when employment opportunities in the United States are curtailed.

Most studies on the demand for foreign labor in agriculture, documented or not, have focused on the harvest or post-harvest jobs in fruit and vegetable crops in the southern and western United States (Martin, 2012, 2017). However, as shown in Figure 1, the use of H-2A workers has grown rapidly in livestock operations, although the number is still very small compared to the total number of H-2A workers. As livestock operations increase in scale, the demand for foreign-born workers is likely to increase, and the same labor supply concerns that have commanded the attention of researchers in fruit and vegetable production are now spreading to animal agriculture.

Analysis of the relationship between hired labor and other production inputs has produced varying results. Espey and Thilmany's (2000) meta-analysis of agricultural labor demand studies found that estimated elasticities varied substantially depending on the type of agricultural production, region, and method of analysis. Whether capital and labor are substitutes or complements also varies across studies. Lopez (1984) found that hired labor and operator labor were complements in Canadian agriculture but that hired labor and capital were unrelated inputs. Huffman and Evenson (1989) found that labor and machinery were substitutes in US cash-grain farms. Shumway and Alexander (1988) found that energy inputs (fuels, oils, and electricity, which are all measures of machinery use) and hired labor were complements in some US regions but substitutes in others.

A recent strategy employed to assess the substitutability between capital and labor in agriculture is to examine how other input usage responds to increased enforcement of immigration laws, which causes a negative shift in undocumented labor supply. Ifft and Jodlowski (2022) reported rising energy expenditures on farms in areas experiencing increased enforcement, suggesting some capital for labor substitution. Similarly, Charlton and Castillo (2021) found that dairy farms introduced labor-saving technologies when immigration enforcement increased. However, in both studies, total production decreased, suggesting that the mechanism driving the move toward more capital-intensive methods may lead to the exit of the most labor-intensive operations.

Foreign and domestic workers are expected to be close, if not perfect, substitutes in agriculture. The imperfections would arise from differences in language, schooling, and the temporary nature of the H-2A contract, but the nature of the work performed by domestic and H-2A workers on livestock operations is similar. Because the actual number of undocumented workers is measured with considerable error, various strategies have been employed to reveal the degree of substitutability between foreign and domestic labor. One strategy is to assess how shocks to the number of foreign workers affect wages for domestic workers. Wei et al. (2016) found that native and foreign workers were close substitutes, so that a 10% increase in foreign labor supply reduced domestic wages by 5%. Charlton and Kostandini (2021) found that increases in state unemployment rates had large negative effects on demand for H-2A workers, suggesting considerable substitution of domestic workers for foreign workers during recessions. Kim (2019) also found that rising domestic unemployment lowered demand for foreign workers. Castillo and Charlton (2023) found that increases in housing demand caused domestic agricultural workers to move to construction jobs, and so farmers increased their use of H-2A employment to replace the falling supply of domestic farm labor. In contrast, Clemens (2022) found that a large increase in unemployment had virtually no effect on the supply of domestic workers in agriculture, despite a new legal requirement giving preference to hiring native workers. Card (2009) also found little evidence of substitution between foreign and native workers outside of agriculture.

In our application, we couch the demand for H-2A workers in the context of the short-run demand for factors, using a quasi-fixed translog cost function with fixed capital. In our analysis of livestock operations, we measure the statistical relationships between farm-level capital assets and the share of total farm expenditures used on labor to determine whether capital and labor are complements or substitutes. We assume that foreign and domestic labor are imperfect substitutes, meaning that an increase in the wage of one type of labor will not cause a proportionally equivalent increase in the use of the other labor type. By showing how the proportion of total farm expenditures used on labor varies with the wage rates of local domestic labor and H-2A workers, we can show whether demand for foreign and domestic workers is elastic or inelastic.

Empirical Model

The farm-level data collected by the US Department of Agriculture (USDA) under the Agricultural Resource Management Survey (ARMS) do not distinguish between foreign and domestic hired workers. As a result, the measure of a farm's hired labor aggregates foreign undocumented workers, temporary foreign workers employed under the H-2A program, foreign-born workers with permanent residency, and native-born workers. That means that we have to utilize a model that allows us to extract inferences from the relationships between the aggregate farm wage bill across all labor types, the price of foreign labor as measured by the AEWR, and the price of domestic labor as measured by the local market wage.

Following Berman, Bound, and Griliches (1994), we derive a short-run labor cost share equation from the quasi-fixed translog cost function. We treat capital as fixed in the short run, both because it is realistic to assume that farms cannot vary their buildings and equipment as readily as they can alter their variable labor input and because we do not have a plausible measure of the farms' cost of capital that is consistent across all livestock industries. In the cost function, we use farm size rather than the value of farm output because costs are tied to the size of operation. The same costs may be incurred under very different output levels depending on the vagaries of weather, pestilence, and harvest commodity prices.

As shown by Brown and Christensen (1981), if the variable cost function is everywhere convex in the quasi-fixed factors, meaning the matrix of second partials is positive definite, then a translog cost function of the following form is the dual to the production function:

$$
\begin{aligned}
\ln VC_{ijst} = {} & \alpha_j + \alpha_Y \ln Y_{ijst} + \alpha_{YY}\left(\ln Y_{ijst}\right)^2 + \alpha_t t + \alpha_{jA}\ln\left(W_{A_{ist}}\right) + \frac{\gamma_{w_A}}{2}\ln\left(W_{A_{ist}}\right)^2 \\
& + \alpha_{jC}\ln\left(W_{C_{it}}\right) + \frac{\gamma_{w_C}}{2}\ln\left(W_{C_{it}}\right)^2 + \gamma_{w_{AC}}\ln\left(W_{C_{it}}\right)\ln\left(W_{A_{ist}}\right) \\
& + \ln\left(A_{it}\right)\left[\beta_{AW_A}\ln\left(W_{A_{ist}}\right) + \beta_{AW_C}\ln\left(W_{C_{it}}\right)\right] \\
& + \ln\left(K_{it}\right)\left[\beta_{KW_A}\ln\left(W_{A_{ist}}\right) + \beta_{KW_C}\ln\left(W_{C_{it}}\right)\right] \\
& + \beta_A \ln\left(A_{it}\right) + \beta_{AA}\left(\ln\left(A_{it}\right)\right)^2 + \beta_K \ln\left(K_{it}\right) + \beta_{KK}\left(\ln\left(K_{it}\right)\right)^2 \\
& + \varepsilon_s\left[\ln\left(W_{C_{it}}\right) + \ln\left(W_{A_{ist}}\right)\right] + \varepsilon_{ijst}\left[\ln\left(W_{C_{it}}\right) + \ln\left(W_{A_{ist}}\right)\right] + \beta_Z \ln Z_{ijst},
\end{aligned} \tag{1}
$$

which represents farm i of farm type j in state s and year t. The variable cost function is allowed to vary by the log of output, $\ln Y_{ijst}$, and time, t. However, it is concave in the variable input prices and quasi-fixed factors. The AEWR set for the state is $W_{A_{ist}}$, and $W_{C_{it}}$ is the market wage for low skill labor in the county. The quasi-fixed factors include, A_{it}, the acreage for the ith farm, and K_{it}, the farm's capital stock. The α_{jA} and α_{jC} represent costs associated with hiring H-2A and local domestic workers in livestock j operations. The costs of hiring these workers are allowed to vary nonlinearly in the AEWR and local county wages. They are also allowed to vary with the level of acreage and capital on the farm. Variable costs can also vary with the level of acreage and capital directly as well as in other inputs that are independent of labor that we designate as $\ln Z_{ijst}$. The variable ε_s represents state-specific factors such as labor regulations and enforcement, human capital levels, and agroclimatic conditions that would plausibly affect the cost of labor and therefore, the calculation of the AEWR, and ε_{ijst} represents random factors that affect labor costs. Our specification differs from the general specification proposed by Brown and Christensen (1981) in that we impose homotheticity so that labor shares do not vary with output.[7]

Our interest is in evaluating how labor costs vary with AEWR and local wages. To assess that, we differentiate equation (1) with respect to the log wages. Applying Shephard's lemma, the resulting cost shares are

(2a) $$S_{ijst}^{A} = \alpha_{jA} + \gamma_{w_A} \ln\left(W_{A_{ist}}\right) + \gamma_{w_{AC}} \ln\left(W_{C_{it}}\right) + \beta_{AW_A} \ln\left(A_{it}\right) + \beta_{KW_A} \ln\left(K_{it}\right) + \varepsilon_s + \varepsilon_{ijst};$$

(2b) $$S_{ijst}^{C} = \alpha_{jC} + \gamma_{w_{AC}} \ln\left(W_{A_{ist}}\right) + \gamma_{w_C} \ln\left(W_{C_{it}}\right) + \beta_{AW_C} \ln\left(A_{it}\right) + \beta_{KW_C} \ln\left(K_{it}\right) + \varepsilon_s + \varepsilon_{ijst}.$$

Because we cannot observe separate shares for the H-2A and domestic workers, we combine their shares to get the aggregate labor cost share equation:

(3) $$\begin{aligned} S_{ijst}^{A+C} = {} & \left(\alpha_{jA} + \alpha_{jC}\right) + \left(\gamma_{w_A} + \gamma_{w_{AC}}\right) \ln\left(W_{A_{ist}}\right) + \left(\gamma_{w_C} + \gamma_{w_{AC}}\right) \ln\left(W_{C_{it}}\right) \\ & + \left(\beta_{AW_A} + \beta_{AW_C}\right) \ln\left(A_{it}\right) + \left(\beta_{KW_A} + \beta_{KW_C}\right) \ln\left(K_{it}\right) + 2\varepsilon_s + 2\varepsilon_{ijst}, \end{aligned}$$

where S_{ijst}^{A+C} is the summed labor cost share of H-2A workers and local domestic workers. Aggregating the two types of labor into a single labor type presumes that H-2A and domestic labor are close, and perhaps perfect, substitutes. This requires the cross-wage effect, $\gamma_{w_{AC}}$, to be positive, so that an increase in the price of one labor type raises the budget share of the other. This is a reasonable assumption, as the federal government attempts to limit the adverse effects on domestic labor demand from the use of H-2A labor by requiring farmers to pay at least the AEWR. In fact, farm labor demand will behave as if H-2A and domestic workers are perfect substitutes; by law, a farm that hires both H-2A workers and domestic workers must pay them the same wage, which will almost always be the AEWR.[8] If the local domestic wage is sufficiently low compared to the AEWR, the farm will only hire domestic labor at the local wage rate. If instead the local wage is considered too high, the farm will only hire H-2A labor at the AEWR wage rate. But if the two wage rates are considered comparable, the farm will hire both domestic and H-2A workers at the AEWR rate.

The labor demand elasticities for the H-2A workers and the local domestic workers are $\eta_A = \frac{\gamma_{w_A}}{s_{ijst}} + S_{ijst} - 1$ and $\eta_C = \frac{\gamma_{w_C}}{s_{ijst}} + S_{ijst} - 1$, respectively. These elasticities are derived in Appendix B. However, our combined labor cost share equation in (3) will have estimates of $\left(\gamma_{w_A} + \gamma_{w_{AC}}\right)$ and $\left(\gamma_{w_C} + \gamma_{w_{AC}}\right)$ instead. Presuming that $\gamma_{w_{AC}} > 0$ because H-2A and domestic workers are substitutes, we would expect that our estimates of the demand elasticities will be biased upward. Our approximate estimates will be

(4a) $$\eta'_A = \frac{\left(\gamma_{w_A} + \gamma_{w_{AC}}\right)}{s_{ijst}^{A+C}} + S_{ijst}^{A+C} - 1 \text{ and}$$

(4b) $$\eta'_C = \frac{\left(\gamma_{w_C} + \gamma_{w_{AC}}\right)}{s_{ijst}^{A+C}} + S_{ijst}^{A+C} - 1.$$

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[7] In their empirical application, Brown and Christensen (1981) imposed constant returns to scale, which effectively imposes homotheticity. We do not impose constant returns in our specification.

[8] The actual rule is that the farmer must pay the local prevailing wage rate, the agreed-upon collective bargaining wage, the federal or state minimum wage, or the AEWR, whichever is highest. In practice, the AEWR is the highest rate in over 98% of cases. Because farmers applying to hire H-2A must first actively recruit domestic workers, it is possible some jobs filled by H-2A workers will also include domestic workers hired earlier. The requirement that domestic and H-2A workers must be paid the same rate applies to all domestic workers on a farm, regardless of when they were hired, if they are doing the same or similar job as H-2A workers.

Because the two measures differ only in the own-wage effects, we can assess the true relative elasticity of demand by comparing the difference between the two approximate elasticities: $\eta'_A - \eta'_C = \eta_A - \eta_C = \frac{\left(\gamma_{w_A} - \gamma_{w_C}\right)}{s_{ijst}^{A+C}}$. The sign of the difference will establish which type of labor is demanded more elastically.

Another way to interpret the results is that if $(\gamma_{w_l} + \gamma_{w_{AC}}) < 0, l = A, C$, then the labor cost share falls as that wage rises. That finding is also consistent with elastic labor demand because the wage bill will fall when wages rise if labor demand is elastic.

Data

We base our analysis on farm-level data compiled by the Agricultural Resource Management Survey (ARMS), which is conducted annually by the USDA and serves as the primary source of data on the economic practices and conditions of US farms and ranches. Each year, the ARMS focuses on different operations based on its primary crop or livestock type. ARMS researchers conduct screening surveys to determine the primary commodity that farms are producing during "Phase I" of the data collection process. In "Phase III," farms producing the commodity that is the subject of the survey are randomly selected to complete a longer survey inquiring about their expenditures and assets. The data used in this survey come from only "Phase III" surveys.[9]

This study makes use of the ARMS surveys that emphasize livestock operations including poultry (2006, 2011), dairy (2000, 2005, 2010, 2016), hogs (1998, 2004, 2009, 2015), and cow–calf operations (2008, 2018). The time frame was dictated by the span of surveys with consistent data on costs, which began in 1998, and the possible disruption of livestock production and employment attributable to the COVID-19 pandemic in 2020.

As we demonstrated in Figure 1, the number of certified H-2A visas has risen substantially since 2006, which was the first year the Office of Foreign Labor Certification reported comprehensive data on their website. The pace of new certifications accelerated after 2013. The rate of growth slowed during the pandemic but accelerated again after 2020. Charlton and Castillo (2021) found that the COVID-19 pandemic and subsequent immigration restrictions caused the demand for H-2A workers to decrease but asserted that the program will continue to be integral to agricultural production. However, the number of livestock-related H-2A visas dropped during the pandemic, a sharp departure from the prior trend. That suggests that the farm-level use of the H-2A program was likely constrained by COVID-19-related factors, which would make livestock employment in 2020 and subsequent years inconsistent with the 1998–2018 sample period that reflected relatively unconstrained labor demand.

Past research has focused on the use of H-2A visas for fruit and vegetable harvesting in the western and southern United States. As shown in Table 1, livestock production is a relatively small user of H-2A visas. Program participation by state varies considerably, as only Colorado was among the five largest users of H-2A visas for animal production in both 2007 and 2018. The variability may reflect the challenges imposed by the H-2A program on livestock production. Livestock production occurs year-round and is less amenable to the temporary nature required for H-2A labor contracts (Castillo, Martin, and Rutledge, 2022). Nevertheless, livestock positions represented 4%–5% of all H-2A certifications issued between 2006 and 2018, before the share dropped during the pandemic.

The dependent variable in equation (3) is the hired labor cost share of variable costs. Using the financial characteristics of farm operations reported in Phase III of ARMS, we defined the hired wage bill as the combined expenditure on salaries and benefits paid to employees, contracted workers, or those engaged in custom services. Family labor, whether paid or unpaid, is viewed as a separate input.

[9] Phase II focuses on field-level production practices and variable costs. Phase III reports farm-level data. An overview of the USDA ARMS data is available at
https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Ag_Resource_Management/

Table 1. Top 10 States Using H-2A Workers in Livestock Production, 2007, 2018

Panel A. 2007			Panel B. 2018		
States	**State Share of All Livestock H-2A Workers**	**Percentage of All H-2A Positions in the State**	**States**	**State Share of All Livestock H-2A Workers**	**Percentage of All H-2A Positions in the State**
Utah	32.5	2.0	Iowa	22.6	1.6
Idaho	11.9	3.3	Nebraska	12.0	1.0
Wyoming	10.2	0.6	South Dakota	6.1	0.5
Colorado	9.8	2.7	Texas	5.1	1.8
California	9.3	2.8	Colorado	4.8	1.1
Washington	4.8	2.2	Idaho	4.6	1.7
Texas	4.7	2.2	Utah	4.6	0.5
Nevada	3.1	2.1	Illinois	4.4	1.0
Montana	2.3	0.8	Montana	4.0	0.4
Arizona	2.1	2.8	California	3.6	7.8

Notes: Author's compilation of data contained in the US Department of Labor H-2A disclosure files (https://www.dol.gov/agencies/eta/foreign-labor/performance).

The denominator of the hired labor cost share reflects all variable costs on the farm. These include seeds, chemicals, feed and livestock, utilities, veterinary services, irrigation, wages and salaries of the proprietor and family members, and all other business expenses. Details are included in Appendix A. In sum, the short-term hired labor cost share is the ratio of the hired wage bill over the total variable cost.

The quasi-fixed labor cost share specification requires that we hold fixed the level of capital and farm size. The level of capital is the value of all assets including buildings, machinery, orchards and vineyards. Farm size is measured by acreage, including owned and rented farmland. Details on these farm size measures are presented in Appendix A.

The two measures of labor cost reflect the cost of hiring H-2A workers in the state and the average cost of hiring local domestic workers by county. The federal government assumes a high degree of substitutability between H-2A and native labor because it sets policies to prevent H-2A labor from undercutting domestic labor. The Department of Labor (DOL) is required to ensure that the H-2A program does not reduce the wages of domestic workers (US Department of Labor, Employment and Training Administration, 2023). To do that, employers are required by law to pay H-2A workers the highest of the following wage rates: the federal or state minimum wage, the agreed-upon collective bargaining rate, the prevailing wage of the region (if applicable), or the AEWR (20 CFR § 655.122).

The DOL sets the AEWR annually using data on total weekly wages paid and total weekly hours worked from the USDA Farm Labor Survey (US Department of Labor, Employment and Training Administration, 2021). Except for California, Florida, and Hawaii, states are divided into 15 "multi-state crop regions," and an AEWR is assigned to each of these regions. For example, Oklahoma and Texas always have the same AEWR because they are in the same crop region, but California is assigned an AEWR based solely on California data (US Department of Labor, Employment and Training Administration, 2010). The AEWR is almost always the highest of the four wage rates so that less than 2% of H-2A workers in fiscal year 2020 were offered a higher rate than the AEWR. We use the AEWR converted to constant 2018 dollars as the de facto effective local wage for H-2A workers.[10] The AEWR is highest in the Midwest and Pacific states and lowest in the southeastern states (Castillo, Martin, and Rutledge, 2022).

[10] The DOL may modify the AEWR requirement for certain H-2A livestock producers, usually for jobs in sheep and goat herding, in which producers are sometimes allowed to pay a monthly wage that is less than the AEWR when assuming a 40-hour work week.

Our measure of the wage for local domestic labor was derived from the Quarterly Census of Employment and Wages (QCEW),[11] which uses data from state unemployment insurance programs and survey data to estimate average wage by industry and county every business quarter.[12] Since the AEWR is calculated primarily by region and the QCEW data are calculated by county, the wage variables are not collinear. We experimented with reported wages in three sectors—retail, agriculture, and construction—with all wages converted to constant 2018 dollars. QCEW reporting was subject to suppression if there were too few workers in the sector in the county. The retail wage data was the most commonly available, resulting in the fewest observations being lost. The agriculture wage was the least commonly reported due to small samples in many counties. Results were reasonably consistent in signs and magnitudes with all three local wage measures, but we lost 50% of the sample when we used the agricultural wage. Therefore, we focused our reporting on regressions that use the retail wage as our measure of the local wage for domestic labor.

We use these market measures of wages because the ARMS survey does not measure the actual wage rates paid on farms. The wage rate that a farmer pays hired labor is endogenous but must reflect the realities of the local market. The farmer must pay the opportunity costs of workers in the local market, which we measure by the average county wage in retail, construction, or agriculture. The alternative is to hire through the H-2A program, for which the wage is set exogenously by the USDA for all farms in the state or multistate region. Hence, the wage paid by farm i on operation type j in state s and year t will be based on the relevant local market options,

$$W_{ijst} = f\left(W_{A_{ist}}, W_{C_{it}}\right). \tag{5}$$

The specification in equation (3) uses the AEWR and local county wage as the reduced form in place of the endogenous paid farm wage. The AEWR is set outside the influence of the local agricultural labor market at the state or multistate level. Our preferred measures of the local county wage are the retail and construction wage, which are also exogenous to the local farm labor market. We also include the local agricultural wage for comparison, acknowledging that it is not a completely reliable measure for the actual wages paid on the farms examined.

Table 2 reports weighted sample statistics for all the variables used in the analysis are reported.[13] The hired labor cost share averaged 10.8% over the sample period with a slow trend of declining labor intensity. Real agricultural wages rose more rapidly than nonagricultural wages over the period. The AEWR rose 11% and the average agricultural wage rose 16% from 1998 to 2018, while retail and construction wages rose 6% and 9%, respectively. The mean number of acres of the sampled operations decreased by 105 acres, while the real market value of capital rose 16%.

Results

Table 3 presents the results of the weighted short-run quasi-fixed hired labor cost share equation. Standard errors are corrected for clustering by state and farm type.[14] We present three versions of the equation using the three alternative measures of average county domestic wages in the retail, agriculture, and construction industries. The regressions include fixed effects by state and by type of livestock operation to control for unmeasured variation in input and output prices.

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[11] These wages would also apply to undocumented workers employed in the local market.

[12] Details on the QCEW methodology are available at https://www.bls.gov/opub/hom/cew/.

[13] The ARMS data are a stratified random sample that oversamples a subset of farm types each year, and we examined data from the years in which livestock operations were oversampled. We applied the probability weights provided for each surveyed farm to convert the results to their population equivalents.

[14] In Appendix C, we report the results when estimating by type of livestock operation. Over the sample period, there were only 2–4 years of data for each type of farm. Because the AEWR is fixed by state, we are not able to correct for state fixed effects as there are too few years of data to yield reliable estimates. Therefore, the regressions by farm type are estimated without state fixed effects. The results pooled over farm types in Table 3 include 12 years of data, which was sufficient to identify state fixed effects.

Table 2. Weighted Means and Standard Errors

	Overall	1998	2018
Hired labor cost share	0.108	0.095	0.071
	(0.006)	(0.009)	(0.008)
ln(real AEWR)	2.426	2.353	2.465
	(0.01)	(0.01)	(0.01)
ln(real retail wage)	6.22	6.196	6.259
	(0.02)	(0.02)	(0.02)
ln(real agricultural wage)	6.455	6.398	6.555
	(0.02)	(0.01)	(0.02)
ln(real construction wage)	6.76	6.711	6.805
	(0.02)	(0.03)	(0.03)
ln(acres)	5.391	5.612	5.122
	(0.009)	(0.14)	(0.16)
ln(real K)	13.829	13.409	13.567
	(0.009)	(0.008)	(0.13)

Notes: All nominal values were converted to 2018 dollars using the Consumer Price Index. All means and standard errors apply the expansion factors (p-weights) provided in the ARMS data.

Table 3. Weighted Regressions on All Available ARMS Data on the Livestock Industry, Various Years, 1998–2018

	Sector Used to Compute Local Domestic Wage		
	Retail	Agriculture	Construction
ln(real AEWR)	−0.220**	−0.273**	−0.224**
	(3.72)	(3.48)	(3.60)
ln(real local domestic wage)	−0.056**	−0.014	−0.021*
	(2.21)	(0.86)	(1.88)
ln(acres)	0.001	0.005	0
	(0.14)	(1.37)	(0.06)
ln(real K)	0.027**	0.027**	0.027**
	(7.18)	(5.90)	(7.02)
R^2	0.114	0.139	0.115
No. of obs.	19,457	9,720	18,524
Clusters	321	278	317
Foreign labor elasticity: η'_A	−2.932**	−3.778**	−4.089**
Domestic labor elasticity: η'_C	−1.408**	−1.055	−1.220*
Difference: $\eta'_A - \eta'_C$	−1.52**	−2.72**	−2.87**

Notes: Values in parentheses are *t*-statistics. Single and double asterisks (*,**) indicate significance at the 10% and 5% level, respectively. Standard errors are corrected for clustering by type of livestock operation and state. Regressions include fixed effects by state and by type of livestock operation: cattle, hogs, chickens, turkeys, and sheep.

Hired labor cost share falls significantly as the AEWR rises, with the coefficients ranging from −0.22 to −0.27. The falling labor cost shares as the wage rises is consistent with an elastic demand for H-2A workers. The labor cost share also decreases as the local county wage rises, ranging from −0.014 to −0.056. The effect is not statistically significant when the local agriculture wage is used, perhaps reflecting that we lose half of the sample using this wage measure. While the coefficients imply that the demand elasticity for domestically sourced labor is also elastic, the coefficient is much smaller than that for H-2A workers.

We can be more precise by estimating the implied foreign and domestic labor demand elasticities using equations (4a) and (4b). These are reported at the bottom of each equation. Because all the estimates are in the elastic range, we can presume that demand for both foreign and domestically sourced hired labor is elastic. The relative magnitudes of the elasticities indicate that demand for foreign labor is more elastic than the demand for domestic labor. The differences in the elasticities, reported at the bottom of Table 3, strongly indicate that demand for H-2A workers is more elastic than demand for domestic workers because the potentially confounding effect of the cross elasticity, $\gamma_{w_{AC}}$ in equations (4a) and (4b), is differenced away.

Because H-2A and domestic workers are almost certainly substitutes, we expect $\gamma_{w_{AC}}$ to be positive. As a result, we expect that $(\gamma_{w_A} + \gamma_{w_{AC}}) > \gamma_{w_A}$ and $(\gamma_{w_C} + \gamma_{w_{AC}}) > \gamma_{w_C}$. Therefore, our approximate demand elasticities, η'_A and η'_C, understate the magnitudes of the true elasticities. The literal interpretation of our elasticities is that a 1% increase in all real wages in agriculture would correlate with a 2.9%–4.1% decrease in demand for H-2A workers and a 1.1%–1.4% decrease in demand for local domestic labor. These are lower-bound estimates of the true decrease in demand from an exogenous wage increase.

Hired labor demand is insensitive to the farm's number of acres in all regressions. Instead, labor demand in livestock operations is significantly tied to the scale of capital investment. The positive coefficient for capital suggests that in livestock operations, capital and labor are complements. This is consistent with the rising use of H-2A workers in livestock nationally as the average production capacity of livestock operations has increased. Smaller livestock operations might be able to meet their labor requirements with family labor, but the growing concentration of the livestock industry will lead to a decrease in the number of family farms and an increase in the use of hired labor.

Discussion

Since the demand for H-2A labor in livestock production is elastic, the labor cost share of total expenditures falls as the AEWR rises. Demand for domestic local labor is also elastic on livestock farms, but to a lesser degree than H-2A labor. As a result, increases in the AEWR and local wage rate causes livestock producers to reduce the proportion of their expenses spent on labor. The higher demand elasticity for H-2A workers is likely explained by barriers to using the H-2A program, which only allows the temporary hiring of workers—typically for a period of 6 months—while livestock production generally requires year-round labor. There are also other costs associated with using the program, such as financing H-2A workers' housing, meals, and transportation. Additionally, producers have claimed that the H-2A application process is long and complicated, making it difficult for smaller operations to participate (Bier, 2020). On the other hand, the costs of unemployment insurance and social security are not incurred when hiring under the H-2A program.

The elastic labor demand response to rising wages is not due to a substitution toward capital on livestock farms. Labor and capital are complements in our short-run demand analysis, so labor cost share is positively correlated with a higher end-of-year market value of the operations' capital assets. The other indicator of operation size, acreage, did not have a statistically significant effect on labor cost share.

Given that labor and capital are complements in the short run, livestock producers in areas with a more expensive labor supply may respond in several ways. In states with higher AEWR's, producers may lower their wage bill by finding cheaper labor. This could mean trying to attract domestic labor at the domestic prevailing wage, which is typically less than the AEWR. Because US workers are often unwilling to perform farmwork, producers may resort to using undocumented foreign labor. The wages paid to unauthorized foreign labor are included in our measure of farm labor expenses because the ARMS data do not distinguish between domestic and foreign workers, nor their documentation status.

Some producers may choose a less labor-intensive commodity. The coefficients of the livestock dummy variables (not reported) suggested that poultry operations had higher labor cost shares compared to dairy cattle, beef cattle, and hog operations. This implies that poultry operations are less likely to survive in higher-wage markets. Finally, some producers may choose to exit. Because our data are cross-sectional and not longitudinal, we are not following how livestock farms react to rising wages over time. Instead, we show how relative wages affect the types of farms that exist in higher and lower-wage markets. More labor-intensive and capital-intensive livestock operations congregate in lower-wage markets.

The statistically significant negative effect of the AEWR on livestock producers' labor cost share has other interesting implications. The AEWR is generally higher than the regional prevailing wage and any applicable minimum wage, and farmers must pay the AEWR to domestic workers in corresponding employment. In some regions, the AEWR may be increasing the reservation wage of domestic farm workers, which would affect the hiring practices of livestock producers and decrease the amount of labor they can afford to hire. While many livestock producers do not use the H-2A program, they are still affected by the AEWR, likely through competition with other agricultural producers paying that rate.

Despite numerous attempts, the H-2A program has not been reformed by Congress since its inception in 1986. In 2021, the Farm Workforce Modernization Act (FWMA) passed through the US House of Representatives with bipartisan support and the support of large organizations representing producers and workers (Nepal, 2021).[15] However, it did not gain enough support to be passed in the Senate and was not included in the omnibus spending bill in 2022. The FWMA would have established a pilot program for nonseasonal H-2A jobs, allowing visas to be valid for up to 3 years.[16] Half of the allotted year-round visas would have been reserved for the dairy industry (HR 1603, Title II subtitle A § 202, US Congress, 2021). Several organizations have advocated reforms that would allow easier access to foreign labor for livestock producers in all industries (Shike, 2022; AgDayTV, 2022; Sorenson et al., 2021), indicating that there may be strong demand for H-2A workers by livestock producers. If the AEWR is affecting the livestock producers' access to domestic labor by increasing this group's reservation wage, opening up access to the H-2A program or creating an alternative temporary visa program may be a more equitable policy that helps ameliorate these producers' labor issues.

Caveats and Future Work

US farmers have found it increasingly challenging to attract and retain labor. As shown in Figure 1, the H-2A program has been increasingly used as a labor source by farmers overall, including livestock producers. Rising uncertainty regarding the availability of foreign and domestic labor will require further analysis of labor demand elasticities and the substitutability of other inputs for labor in agriculture. Research is also needed on whether easing the temporary employment restrictions of the H-2A program will help ease the labor shortages in livestock production.

Currently available datasets on farm-level use of agricultural labor do not provide sufficient information to explore possible solutions for the agricultural labor shortage. While the ARMS data provide information on farm-level labor use, they do not differentiate between domestically sourced labor and H-2A visa workers. Consequently, this study had to limit its investigation to the AEWR's effects on aggregate labor demand rather than the separate demands for domestic and H-2A workers. This also required us to impose untestable assumptions regarding the cross-wage effects and the assumed high degree of substitutability between the two labor types.

Comprehensive data on H-2A employment petitions and jobs is disclosed by the DOL, but there was no way to match this data to the ARMS survey respondents because their identities were omitted to maintain confidentiality. Therefore, we do not know which, if any, of the ARMS survey

[15] Notable examples include the United Farm Workers and National Council of Farmer Cooperatives.

[16] The US Citizenship and Immigration Services allows H-2A visa holders to remain in the country for 3 years, but they must be working under a H-2A job order. Because the DOL will only grant H-2A certification to job orders lasting up to a year, the H-2A visa holder would have to transfer to another H-2A certified employer to remain in the country.

respondents employed H-2A workers. Nevertheless, our findings suggest that the AEWR, which partially determines the cost of labor of H-2A workers, has a statistically significant effect on the hiring practices of livestock producers.

Other datasets are also insufficient to enable more comprehensive research on the labor demands of livestock producers. Although the Department of Labor's National Agricultural Workers Survey offers detailed information on agricultural worker characteristics and employment, it is limited to the crop labor force and does not cover livestock workers (US Department of Labor, Employment and Training Administration, n.d.). The USDA's Census of Agriculture provides national and state-level data on labor practices and expenditures but does not differentiate between livestock and crop farms (US Department of Agriculture, 2024). Furthermore, neither of these data sources include wage data. Expanding the ARMS surveys to address these gaps would provide valuable insights into the labor needs and practices of livestock producers, especially because the ARMS is the primary source of data on other inputs and expenditures needed to examine the effects of local labor shortages.

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Appendix A: Computing Hired Labor Cost Share, Variable Costs, and Capital Expenses Using the Agricultural Resource Management Survey (ARMS)

We require a measure of the hired labor cost share. Using Phase III of the ARMS questionnaire, our measure of the hired labor cost is the sum of:

- salaries paid to other producers and all hired farm and ranch labor (excludes salaries paid to the principal producer and members of their household)
- expenditures on contract labor and custom work
- expenditures on payroll taxes and benefits for hired labor
- cash value of all commodities used as non-cash payments for farm work

The total variable cost will include all the costs above, plus:

- items such as seeds, plants, seed cleaning and treatments
- nutrients, fertilizer, lime, and soil conditioners
- agricultural chemicals and bio controls
- feed for livestock and poultry
- bedding and litter for livestock
- medical supplies, and veterinary and custom services for livestock
- all fuels, oils, and lubricants
- electricity
- purchased water for irrigation
- all other utilities
- general business expenses
- salary or wages paid to the principal producer
- salary or wages paid to members of the principal producers' household

The short-term hired labor cost share is the ratio of the hired wage bill over the total variable cost.

Size of operation can be measured by acreage, but livestock operations can have substantial capital investments on relatively small acreages. Therefore, we used two measures of operation size that can be viewed as fixed capital in the short run. Acreage was measured as the sum of all acres owned and rented or leased from others. Capital was measured as the expenditures on renting or leasing farm equipment, vehicles, and storage structures added to the end-of-year market value of the following assets owned by the operation:

- structures serving as living quarters
- farm buildings and structures plus the associated land
- orchard trees and vines, nursery trees, and trees grown for woody crops
- oil, gas, and mineral rights
- trucks and cars
- tractors, machinery, tools, and equipment

Appendix B: Approximating the Elasticity of Demand from the Total Labor Cost Equation

The labor cost share equation for H-2A workers, using equation (2a) in the text is:

$$S_{ijst}^{A} = \alpha_{jA} + \gamma_{w_A} \ln(W_{A_{ist}}) + \gamma_{w_A C} \ln(W_{C_{it}}) + \beta_{AW_A} \ln(A_{it}) + \beta_{KW_A} \ln(K_{it}) + \varepsilon_s + \varepsilon_{ijst}.$$

Note that the budget share for H-2A labor can be written $S^A = \frac{W_A L_A}{VC}$, where subscripts have been suppressed for ease of presentation. VC is the variable cost, L_A is the number of H-2A workers, and W_A is the associated H-2A wage. The demand for H-2A labor can then be written:

$$L_A = \frac{VC \cdot S^A}{W_A}.$$

Taking the derivative with respect to W_A, we have

$$\frac{\partial L_A}{\partial W_A} = \frac{VC}{W_A}\frac{\partial S^A}{\partial W_A} + \frac{S^A}{W_A}\frac{\partial VC}{\partial W_A} - \frac{VC \cdot S^A}{(W_A)^2}$$

$\frac{\partial VC}{\partial W_A} = L_A$ and $\frac{\partial S^A}{\partial W_A} = \frac{\gamma_{w_A}}{W_A}$. Applying these and multiplying both sides by $\frac{W_A}{L_A}$, we get $\frac{\partial L_A}{\partial W_A} \cdot \frac{W_A}{L_A} = \eta_A = \frac{W_A}{L_A}\frac{VC}{W_A}\frac{\gamma_{w_A}}{W_A} + \frac{W_A}{L_A}\frac{S^A}{W_A}L_A - \frac{W_A}{L_A}\frac{VC \cdot S^A}{(W_A)^2}$, or

$$\eta_A = \frac{\gamma_{w_A}}{S^A} + S^A - 1, \tag{A1}$$

which is the formula in the text. The same type of derivation yields the elasticity of demand for domestic labor, $\eta_C = \frac{\gamma_{w_C}}{s_{ijst}} + S_{ijst} - 1$.

If we apply the same formulas for the elasticity of demand for H-2A labor, using the parameters estimated using equation (3) in the text, we get:

$$\eta'_A = \frac{(\gamma_{w_A} + \gamma_{w_{AC}})}{S^{A+C}} + S^{A+C} - 1, \text{ and} \tag{A2a}$$

$$\eta'_C = \frac{(\gamma_{w_C} + \gamma_{w_{AC}})}{S^{A+C}} + S^{A+C} - 1. \tag{A2b}$$

Comparing (A1) with (A2a), it is apparent that the demand elasticities estimated using the summed labor cost shares will be similar to the true elasticities but of unknown bias. If H-2A and domestic workers are substitutes, $\gamma_{w_{AC}} > 0$, and so the numerator of the first terms in (A2a) and (A2b) will be biased upward. $S^{A+C} > S^A$, and so, the denominators will also be biased upward. The overall direction of bias is not known. However, the relative size of the true elasticities of demand for H-2A workers and domestic workers can still be inferred.

Appendix C: Robustness Checks

Why Include Both Capital and Acreage?

The specification in the text includes both capital and acreage, with capital having significant effects on labor shares and acreage having small positive, but insignificant effects. The implication is that labor share remains the same as acreage increases. Nevertheless, it is reasonable to ask why acreage is included.

When we repeat the regression excluding capital, as shown in Appendix Table C1, acreage has a strong and positive effect on labor share. As it turns out, acreage and capital are positively correlated, and so the exclusion of capital biases the coefficient on acreage upward.

When capital is excluded, the coefficients on both AEWR and the local domestic wage remain negative but fall in magnitude. The pattern of coefficients is consistent with a presumed positive correlation between wages and average capital per farm, and so excluding capital biases the coefficients on wages toward zero.

The theory suggests that all quasi-fixed inputs should be included in the specification. There is no guarantee that labor shares must increase in all the quasi-fixed inputs, and so the lack of significance on acreage reveals the invariance in labor shares with farm acreage.

What Happens When the Analysis Is Performed Separately by Livestock Type?

The Adverse Effect Wage Rate (AEWR) is set annually by state, and so identifying its impact on labor demand requires multiple years of data. In a single cross section, the AEWR is perfectly

Table C1. Weighted Regressions on All Available ARMS Data on the Livestock Industry, Various Years, 1998–2018, With and Without Capital

	Sector used to compute local domestic wage					
	Retail		Agriculture		Construction	
	With K	Without K	With K	Without K	With K	Without K
ln(real AEWR)	−0.220**	−0.162**	−0.273**	−0.228**	−0.224**	−0.166**
	(3.72)	(2.51)	(3.48)	(2.73)	(3.6)	(2.46)
ln(real local domestic wage)	−0.056**	−0.037	−0.014	−0.005	−0.021*	−0.013
	(2.21)	(1.46)	(0.86)	(0.03)	(1.88)	(1.18)
ln(acres)	0.001	0.018**	0.005	0.022**	0.00	0.018**
	(0.14)	(7.01)	(1.37)	(11.6)	(0.06)	(6.49)
ln(real K)	0.027**		0.027**		0.027**	
	(7.18)		(5.90)		(7.02)	
R2	0.114	0.099	0.139	0.122	0.115	0.1
No. of obs.	19,457	19,460	9,720	9,721	18,524	18,527

Notes: Values in parentheses are *t*-statistics. Single and double asterisks (*,**) indicate significance at the 10% and 5% level, respectively. Standard errors are corrected for clustering by type of livestock operation and state. Regressions include fixed effects by state and by type of livestock operation: cattle, hogs, chickens, turkeys, and sheep.

correlated with state fixed effects. State fixed effects such as labor regulations, enforcement effort, skill levels, and agroclimatic conditions, would affect labor costs and thus be correlated with the AEWR. The ARMS oversamples livestock farms by type in some years, but not sufficiently often to provide many years by type of operation. At the time of our analysis, there were only four oversampled surveys each for hog and dairy operations, and only two surveys each for cow-calf and poultry farms.

In Appendix Tables C2–C5, we present the results of cross-sectional regressions for each of the four types of livestock operations for the years available. As these are cross sectional regressions, we cannot control for state fixed effects like we did with the aggregate data in Table 3. The number of observations is also much smaller than in the pooled regressions which lowers the precision of the estimation. The commodity-specific estimates still find that the AEWR lowers labor share in most cases, with the poultry sector being the main exception. The local domestic wage effect is generally insignificant, and the H-2A wage has the more salient effect on labor demand. Labor shares generally rise with the quasi-fixed level of capital on the farm. Acreage has mixed effects on the labor share, lowering it on hog farms and raising labor share on dairy farms. Acreage effects are mixed on cow-calf and poultry operations.

The capital and AEWR effects are broadly consistent with those in Table 3, but the lack of ability to control for state fixed effects suggests that the Table 3 results are more reliable.

Table C2. Weighted Regressions of Labor Cost Share on Hog Farms

	1998	2004	2009	2015
ln(real AEWR)	−0.579**	−0.832**	−1.017**	−0.154
	(3.29)	(3.87)	(3.12)	(0.74)
ln(real local domestic wage)	−0.024	0.025	−0.007	0.069
	(0.89)	(0.69)	(0.12)	(0.71)
ln(acres)	−0.033**	−0.023**	−0.023**	−0.027**
	(3.22)	(4.24)	(2.42)	(2.81)
ln(K)	0.051**	0.052**	0.029**	0.044**
	(4.79)	(6.75)	(2.05)	(4.11)
R^2	0.119	0.175	0.142	0.129
No. of obs.	1,770	1,411	1,475	913
Foreign labor elasticity: η'_A	−7.000**	−9.135**	−8.345**	−2.474
Domestic labor elasticity: η'_C	−1.158	−0.653	−0.916	−0.201

Notes: Values in parentheses are *t*-statistics. Single and double asterisks (*,**) indicate significance at the 10% and 5% level, respectively.

Table C3. Weighted Regressions of Labor Cost Share on Dairy Farms

	2000	2005	2010	2016
ln(real AEWR)	−0.196	−0.218	−0.240	0.093
	(1.53)	(1.44)	(1.40)	(0.58)
ln(real local domestic wage)	−0.029	0.064	0.025	0.104*
	(0.47)	(1.62)	(0.56)	(1.68)
ln(acres)	−0.007	0.034**	0.014*	0.018**
	(0.49)	−5.75	(1.73)	(2.05)
ln(K)	0.019**	0.014*	0.024**	0.032**
	(2.20)	(1.78)	(2.81)	(3.25)
R^2	0.032	0.120	0.088	0.233
No. of obs.	965	1,933	2,135	1,652
Foreign labor elasticity: η'_A	−1.930	−2.121	−2.414	−0.170
Domestic labor elasticity: η'_C	−0.987	−0.452	−0.685	−0.084

Notes: Values in parentheses are *t*-statistics. Single and double asterisks (*,**) indicate significance at the 10% and 5% level, respectively.

Table C4. Weighted Regressions of Labor Cost Share on Cow–Calf Farms

	2008	2018
ln(real AEWR)	−0.142*	0.155
	(1.89)	(1.46)
ln(real local domestic wage)	−0.001	−0.030
	(0.02)	(0.63)
ln(acres)	0.011**	−0.630*
	(2.15)	(1.98)
ln(K)	0.017**	0.012
	(2.31)	(1.61)
R^2	0.04	0.084
No. of obs.	2,127	1,978
Foreign labor elasticity: η'_A	−2.098*	1.252
Domestic labor elasticity: η'_C	−0.89	−1.346

Notes: Values in parentheses are *t*-statistics. Single and double asterisks (*,**) indicate significance at the 10% and 5% level, respectively.

Table C5. Weighted Regressions of Labor Cost Share on Poultry or Egg Farms

	2006	2011
ln(real AEWR)	0.192*	0.033
	(1.81)	(0.20)
ln(retwage)	−0.029	0.088
	(0.6)	(1.34)
ln(acres)	0.000	−0.018**
	(0.03)	(2.84)
ln(K)	0.042**	0.060**
	(1.30)	(4.58)
R^2	0.073	0.061
No. of obs.	1,602	1,496
Foreign labor elasticity: η'_A	0.554	−0.63
Domestic labor elasticity: η'_C	−1.081	−0.286

Notes: Values in parentheses are *t*-statistics. Single and double asterisks (*,**) indicate significance at the 10% and 5% level, respectively.