

Online Appendix

“The effect of low-skill immigration restrictions on US firms and workers: Evidence from a randomized lottery”

Michael A. Clemens and Ethan G. Lewis — October 2022

In this Appendix we present derivations of the model in the main text, a discussion of monopsony power in rural labor markets, summary statistics for the firm sample (with comparisons of selected traits to the firm universe), and numerous extensions of the empirical analysis, some prespecified and others not.

Contents

A1. Derivations	A-3
A1.1. Nested CES	A-4
A1.2. Including Permanent Labor	A-6
A1.3. Labor Supply	A-7
A2. Imperfect competition and rural labor markets	A-8
A3. Summary statistics	A-10
A4. Compare sample to universe	A-10
A5. First-stage regressions	A-10
A6. Industry-level parameter assumptions	A-10
A7. Check for nonresponse bias and/or randomization irregularities	A-12
A8. Robustness to inverse hyperbolic sine transformation	A-12
A9. Robustness to industry composition	A-13
A10. Robustness to influential observations	A-13
A11. Robustness to randomization inference	A-14
A12. Full regression results from tests for heterogeneous treatment effects	A-14
A13. Item nonresponse	A-14
A14. Effect on U.S. year-round employment	A-14
A15. The 2020 lottery	A-15
A16. Kernel density plots of 2021 outcomes by lottery result without baseline controls	A-15
A17. Survey questionnaire	A-16

A1 Derivations

While we will ultimately execute derivations for CES production function shown in (3), let us begin with the general setup underlying proposition 1. Inverting the demand function (1) as $p = D^{\frac{1}{\eta}} Q^{-\frac{1}{\eta}}$, we have that revenues, $R = Q(p)p = D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}}$. The firm's problem is to maximize profits

$$\Pi(I, N, K) = D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}} - w_I I - w_N N - rK - \mathcal{F}$$

subject to $I \leq \bar{I}$ (if it faces the hiring constraint). In summary, they maximize the objective function:

$$\mathcal{L}(I, N, K) = D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}} - w_I I - w_N N - rK - \mathcal{F} + \lambda(I - \bar{I})$$

where $\lambda = 0$ for an unconstrained firm. This produces the following first order conditions:

$$\frac{\eta-1}{\eta} D^{\frac{1}{\eta}} Q^{-\frac{1}{\eta}} \frac{\partial Q}{\partial I} = w_I + \lambda \quad (\text{A.1})$$

$$\frac{\eta-1}{\eta} D^{\frac{1}{\eta}} Q^{-\frac{1}{\eta}} \frac{\partial Q}{\partial N} = w_N \quad (\text{A.2})$$

$$\frac{\eta-1}{\eta} D^{\frac{1}{\eta}} Q^{-\frac{1}{\eta}} \frac{\partial Q}{\partial K} = r \quad (\text{A.3})$$

...and $I \leq \bar{I}$ for a constrained firm. Notice that λ represents a positive wedge between a firm's marginal revenue product of immigrant labor and immigrant wages for constrained firms.

In light of this, we can compute optimal total costs as follows:

$$\begin{aligned} C^*(I, N, K, \mathcal{F}) &= w_I I + w_N N + rK + \mathcal{F} \\ &= \frac{\eta-1}{\eta} D^{\frac{1}{\eta}} Q^{-\frac{1}{\eta}} \left(\frac{\partial Q}{\partial I} I + \frac{\partial Q}{\partial N} N + \frac{\partial Q}{\partial K} K \right) + \mathcal{F} - \lambda I \\ &= \frac{\eta-1}{\eta} D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}} + \mathcal{F} - \lambda I \end{aligned}$$

where the last step follows from homogeneity. Optimal profits are then given by

$$\Pi^* = R^* - C^* = D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}} - \left(\frac{\eta-1}{\eta} D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}} + \mathcal{F} - \lambda I \right) \quad (\text{A.4})$$

$$= \frac{1}{\eta} D^{\frac{1}{\eta}} Q^{\frac{\eta-1}{\eta}} - \mathcal{F} + \lambda I \quad (\text{A.5})$$

Now let us contrast constrained and unconstrained firms. Since unconstrained firms can freely choose I – and, in particular, could choose $I_u \leq \bar{I}$, it must be that unconstrained firms have profits that are at least as large as constrained firms, and therefore $\frac{1}{\eta} D^{\frac{1}{\eta}} Q_u^{\frac{\eta-1}{\eta}} \geq \frac{1}{\eta} D^{\frac{1}{\eta}} Q_c^{\frac{\eta-1}{\eta}} + \lambda I_c$. But this implies that unconstrained revenues are weakly higher $D^{\frac{1}{\eta}} Q_u^{\frac{\eta-1}{\eta}} \geq D^{\frac{1}{\eta}} Q_c^{\frac{\eta-1}{\eta}}$, and therefore that unconstrained output is weakly higher $Q_u \geq Q_c$. Rearranging, the proportional revenue increase induced by a relaxation of the

hiring constraint is larger the larger is the demand elasticity:

$$\ln(R_u/R_c) = \frac{\eta - 1}{\eta} \ln(Q_u/Q_c)$$

As proposition 1 says, however, profit rates are not necessarily higher in the unconstrained firms:

$$\Pi_u/R_u - \Pi_c/R_c = \mathcal{F}D^{-\frac{1}{\eta}} \left(Q_c^{-\frac{\eta-1}{\eta}} - Q_u^{-\frac{\eta-1}{\eta}} \right) - \lambda I_c D^{-\frac{1}{\eta}} Q_c^{-\frac{\eta-1}{\eta}}$$

The first term of the expression is positive, but the second one is negative, so the impact on profit rates is ambiguous. This is because while relaxing the hiring constraint allows output and profits to increase (first term), it also reduces the wedge between the marginal revenue product of immigrant labor and wages (second term), reducing revenues and profits. The more important fixed costs are, the more the first term dominates, and the likely the impact on profit rates is to be positive. The impact on profit rates is also more likely to be positive at higher demand elasticities.

A1.1 Nested CES

We proceed to the CES production function (3) in steps. Returning to the full version in the next section, let us first consider a simpler version without permanent labor ($\gamma = 0$), which implies that revenue

$$R = D^{\frac{1}{\eta}} z^{\frac{\eta-1}{\eta}} K^{\beta \frac{\eta-1}{\eta}} \left(\alpha I^{\frac{\sigma-1}{\sigma}} + (1-\alpha) N^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta)} \quad (\text{A.6})$$

In this case, the first order conditions become:

$$\frac{\eta - 1}{\eta} (1 - \beta) D^{\frac{1}{\eta}} z^{\frac{\eta-1}{\eta}} K^{\beta \frac{\eta-1}{\eta}} \left(\alpha I^{\frac{\sigma-1}{\sigma}} + (1 - \alpha) N^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta) - 1} (1 - \alpha) I^{-\frac{1}{\sigma}} = w_I (+\lambda) \quad (\text{A.7})$$

$$\frac{\eta - 1}{\eta} (1 - \beta) D^{\frac{1}{\eta}} z^{\frac{\eta-1}{\eta}} K^{\beta \frac{\eta-1}{\eta}} \left(\alpha I^{\frac{\sigma-1}{\sigma}} + (1 - \alpha) N^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta) - 1} (1 - \alpha) N^{-\frac{1}{\sigma}} = w_N \quad (\text{A.8})$$

$$\beta \frac{\eta - 1}{\eta} D^{\frac{1}{\eta}} z^{\frac{\eta-1}{\eta}} K^{\beta \frac{\eta-1}{\eta} - 1} \left(\alpha I^{\frac{\sigma-1}{\sigma}} + (1 - \alpha) N^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta)} = r \quad (\text{A.9})$$

Solving for the total impact on factor demand of relaxing the immigrant hiring constraint uses the fact that these first order conditions hold in both constrained and unconstrained cases, and factor prices remain the same. For example, there is the well-known fact the Cobb-Douglas outer nest implies that capital's share is a constant:

$$\frac{rK_w}{R} = \frac{rK_\ell}{R} = \beta \frac{\eta - 1}{\eta} = s_K \quad (\text{A.10})$$

which implies $\ln(K_w/K_\ell) = \ln(R_w/R_\ell)$, per the lemma. Recall that substituting this into (2) also delivers (5), repeated here:

$$\ln(R_w/R_\ell) = \ln(K_w/K_\ell) \approx \frac{s_I}{1 - s_K} \ln(I_w/I_\ell) + \frac{s_N}{1 - s_K} \ln(N_w/N_\ell) \quad (\text{A.11})$$

For native employment, we can use the equality of (A.8) at different factor mixes:

$$\begin{aligned} \frac{\eta-1}{\eta}(1-\beta)D^{\frac{1}{\eta}}z^{\frac{\eta-1}{\eta}}K_w^{\beta\frac{\eta-1}{\eta}}\left(\alpha I_w^{\frac{\sigma-1}{\sigma}}+(1-\alpha)N_w^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)-1}(1-\alpha)N_w^{-\frac{1}{\sigma}} &= w_N \\ &= \frac{\eta-1}{\eta}(1-\beta)D^{\frac{1}{\eta}}z^{\frac{\eta-1}{\eta}}K_\ell^{\beta\frac{\eta-1}{\eta}}\left(\alpha I_\ell^{\frac{\sigma-1}{\sigma}}+(1-\alpha)N_\ell^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)-1}(1-\alpha)N_\ell^{-\frac{1}{\sigma}} \end{aligned}$$

to get that

$$-\frac{1}{\sigma}\ln(N_w/N_\ell) = -s_K\ln(K_w/K_\ell) - \left[\frac{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)-1}{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)} \right] \ln\left(\frac{\alpha I_w^{\frac{\sigma-1}{\sigma}}+(1-\alpha)N_w^{\frac{\sigma-1}{\sigma}}}{\alpha I_\ell^{\frac{\sigma-1}{\sigma}}+(1-\alpha)N_\ell^{\frac{\sigma-1}{\sigma}}} \right)^{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)} \quad (\text{A.12})$$

where the ugly ratio of parameters in front of the second term on right hand side is to get the second term back into the form it was in the revenue function, (A.6). This allows us to construct the approximation:⁴²

$$\ln(N_w/N_\ell) \approx \sigma s_K \ln(K_w/K_\ell) + \sigma \left[\frac{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)-1}{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)} \right] [s_I \ln(I_w/I_\ell) + s_N \ln(N_w/N_\ell)] \quad (\text{A.13})$$

After collecting the $\ln(N_w/N_\ell)$ terms, we have that

$$\ln(N_w/N_\ell) \approx \frac{\sigma s_K}{c_1} \ln(K_w/K_\ell) + \frac{\sigma s_I}{c_1} \left[\frac{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)-1}{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)} \right] \ln(I_w/I_\ell) \quad (\text{A.14})$$

$$= \frac{\sigma s_K}{c_1} \ln(K_w/K_\ell) + \frac{s_I}{c_1} \left[\frac{\sigma(\eta-1)(1-\beta)-\eta(\sigma-1)}{(\eta-1)(1-\beta)} \right] \ln(I_w/I_\ell) \quad (\text{A.15})$$

where

$$\begin{aligned} c_1 &= 1 - \sigma s_N \left[\frac{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)-1}{\frac{\sigma}{\sigma-1}\frac{\eta-1}{\eta}(1-\beta)} \right] \\ &= \frac{(1-\beta)[(\eta-1)(1-s_N) + (\sigma-1)s_N] + \beta s_N \eta(\sigma-1)}{(\eta-1)(1-\beta)} > 0 \end{aligned}$$

That c_1 is larger than zero comes from the fact that the numerator is a weighted average of positive parameters $(\eta-1, \sigma-1)$ and the denominator is also positive for a similar reason.

Before fully solving this, (A.15) reveals the results for intuitive the two factor case (in which we also impose $\beta=0$ so $s_K=0$) that was given in the lemma:

$$\ln(N_w/N_\ell) \approx s_I \frac{\eta-\sigma}{\eta(1-s_N) + \sigma s_N - 1} \ln(I_w/I_\ell)$$

...which is positive whenever $\eta > \sigma$.

⁴²This comes from applying (2) to (A.6), taking out the (ln separable) part assigned to capital.

To include the adjustment of capital, we substitute the expression for capital, (A.11), into (A.15) :

$$\begin{aligned}
\ln(N_w/N_\ell) &\approx \frac{\sigma_{SK}}{c_1} \left[\frac{s_I}{1-s_K} \ln(I_w/I_\ell) + \frac{s_N}{1-s_K} \ln(N_w/N_\ell) \right] + \frac{s_I}{c_1} \left[\frac{\sigma(\eta-1)(1-\beta) - \eta(\sigma-1)}{(\eta-1)(1-\beta)} \right] \ln(I_w/I_\ell) \\
&= \left[1 - \frac{\sigma_{SK}}{c_1} \frac{s_N}{1-s_K} \right]^{-1} \left[\frac{\sigma_{SK}}{c_1} \frac{s_I}{1-s_K} + \frac{s_I}{c_1} \frac{\sigma(\eta-1)(1-\beta) - \eta(\sigma-1)}{(\eta-1)(1-\beta)} \right] \ln(I_w/I_\ell) \\
&= \left[\frac{c_1(1-s_K)}{c_1(1-s_K) - \sigma_{SK}s_N} \right] \left[\frac{\sigma_{SK}}{c_1} \frac{s_I}{1-s_K} + \frac{s_I(1-s_K)}{c_1(1-s_K)} \frac{\sigma(\eta-1)(1-\beta) - \eta(\sigma-1)}{(\eta-1)(1-\beta)} \right] \ln(I_w/I_\ell) \\
&= s_I \left[\frac{\sigma_{SK}(\eta-1)(1-\beta) + (1-s_K)[\sigma(\eta-1)(1-\beta) - \eta(\sigma-1)]}{(\eta-1)(1-\beta)[c_1(1-s_K) - \sigma_{SK}s_N]} \right] \ln(I_w/I_\ell)
\end{aligned}$$

Some algebra, plus the fact that $s_K \times \eta = \beta(\eta-1)$ from (A.10), simplifies the numerator of this to:

$$\sigma_{SK}(\eta-1)(1-\beta) + (1-s_K)[\sigma(\eta-1)(1-\beta) - \eta(\sigma-1)] = (\eta-1)(1-\beta) - (\sigma-1) \quad (\text{A.16})$$

We can now we can write a simpler expression for $\ln(N_w/N_\ell)$:

$$\ln(N_w/N_\ell) = s_I \left[\frac{(\eta-1)(1-\beta) - (\sigma-1)}{c_2} \right] \ln(I_w/I_\ell), \quad (\text{A.17})$$

where $c_2 \equiv (\eta-1)(1-\beta)[c_1(1-s_K) - \sigma_{SK}s_N]$. The sign of c_2 is unfortunately not straightforward to determine, but it is positive in admitted ranges of parameter values. It can be rewritten further by defining the numerator of c_1 as $c_1^{num} = c_1 \times (\eta-1)(1-\beta)$ which gives

$$c_2 = c_1^{num}(1-s_K) - \sigma_{SK}s_N(\eta-1)(1-\beta). \quad (\text{A.18})$$

A1.2 Including Permanent Labor

To carry out accurate simulations of the model, we need to account for the substantial role permanent employees appear to take in production (see summary statistics in Table A1), even if their employment is not adjusting to seasonal fluctuations in the employment of other factors. So now using (3) from above, that is,

$$Q = zH^\gamma K^\beta \left(\alpha I^{\frac{\sigma-1}{\sigma}} + (1-\alpha)N^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}(1-\beta-\gamma)}, \quad (\text{A.19})$$

we have the revenue function:

$$R = D^{\frac{1}{\eta}} z^{\frac{\eta-1}{\eta}} H^\gamma K^\beta \left(\alpha I^{\frac{\sigma-1}{\sigma}} + (1-\alpha)N^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta-\gamma)}. \quad (\text{A.20})$$

We assume that permanent labor does not adjust to winning and losing the lottery, but rather stays at its optimal level for the *expected* mix of other inputs. (One might imagine that there is a cost of recruiting or firing permanent employees that make such adjustments not cost effective within a season.) A brief aside on this: larger changes not being considered in this model – like changes in visa quota, or permanent changes to demand conditions – could still impact on permanent employment. An expansion of the number of H2-B visas available might have a different – and likely larger – impact on revenue and native-born season employment at the average firm than simply “winning” a single year’s lottery.

Because H is fixed, the expressions above largely hold – for example the revenue growth identity stays the same (2) – but the factor shares need to be adjusted in some cases. (A.11), describing the responses of

revenues and capital to N and I , holds as is. (A.15), describing N 's response, requires adjustment to

$$\ln(N_w/N_\ell) \approx \frac{\sigma s_K}{c_3} \ln(K_w/K_\ell) + \frac{s_I}{c_3} \left[\frac{\sigma(\eta-1)(1-\beta-\gamma) - \eta(\sigma-1)}{(\eta-1)(1-\beta-\gamma)} \right] \ln(I_w/I_\ell) \quad (\text{A.21})$$

where

$$\begin{aligned} c_3 &= 1 - \sigma s_N \left[\frac{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta-\gamma) - 1}{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta-\gamma)} \right] \\ &= \frac{(1-\beta-\gamma)[(\eta-1)(1-s_N) + (\sigma-1)s_N] + (\beta+\gamma)s_N\eta(\sigma-1)}{(\eta-1)(1-\beta-\gamma)} > 0 \end{aligned}$$

Carrying this through to the expression for (N_w/N_ℓ)

$$\ln(N_w/N_\ell) \approx \left[\frac{c_3(1-s_K)}{c_3(1-s_K) - \sigma s_K s_N} \right] \left[\frac{\sigma s_K}{c_3} \frac{s_I}{1-s_K} + \frac{s_I}{c_3} \frac{(1-s_K)}{(1-s_K)} \frac{\sigma(\eta-1)(1-\beta-\gamma) - \eta(\sigma-1)}{(\eta-1)(1-\beta-\gamma)} \right] \ln(I_w/I_\ell) \quad (\text{A.22})$$

$$= s_I \left[\frac{\sigma s_K(\eta-1)(1-\beta-\gamma) + (1-s_K)[\sigma(\eta-1)(1-\beta-\gamma) - \eta(\sigma-1)]}{(\eta-1)(1-\beta-\gamma)[c_3(1-s_K) - \sigma s_K s_N]} \right] \ln(I_w/I_\ell) \quad (\text{A.23})$$

$$= s_I \left[\frac{(\eta-1)(1-\beta-\gamma\sigma) - (\sigma-1)}{c_4} \right] \ln(I_w/I_\ell) \quad (\text{A.24})$$

where $c_4 = c_3^{num}(1-s_K) - (\eta-1)(1-\beta-\gamma)\sigma s_K s_N > 0$ and c_3^{num} is the numerator of c_3 (when written out in long form), shown above. This implies that the response of native employment is positive if $(\eta-1) > \frac{(\sigma-1)}{1-\beta-\gamma\sigma}$, as was asserted in the lemma.

For revenues, we go back to (A.11) to obtain

$$\ln(R_w/R_\ell) \approx \frac{s_I}{1-s_K} \ln(I_w/I_\ell) + \frac{s_N}{1-s_K} \ln(N_w/N_\ell) \quad (\text{A.25})$$

$$= \frac{s_I}{1-s_K} \left(1 + s_N \left[\frac{(\eta-1)(1-\beta-\gamma\sigma) - (\sigma-1)}{c_4} \right] \right) \ln(I_w/I_\ell). \quad (\text{A.26})$$

A1.3 Labor Supply

Now suppose that native labor supply to the firm is upward sloping, due to “modern monopsony” labor market frictions (Manning 2021) or “classical monopsony” heterogeneity in natives’ preferences over firms (Card et al. 2018), with constant elasticity e_N . The first order condition then produces the well-known result that wages are marked down from the marginal revenue product R_N :

$$w_N = \left(1 + \frac{1}{e_N} \right)^{-1} R_N, \quad (\text{A.27})$$

where $w_N = a_N N^{\frac{1}{e_N}}$, and $a_N > 0$ is a constant. This leads to a modification of the expressions above. Ignoring capital and permanent labor for simplicity, notice that this alters (A.12) as follows:

$$\left(\frac{1}{e_N} + \frac{1}{\sigma} \right) \ln(N_w/N_\ell) = \left[\frac{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} - 1}{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta}} \right] \ln \left(\frac{\alpha I_w^{\frac{\sigma-1}{\sigma}} + (1-\alpha) N_w^{\frac{\sigma-1}{\sigma}}}{\alpha I_\ell^{\frac{\sigma-1}{\sigma}} + (1-\alpha) N_\ell^{\frac{\sigma-1}{\sigma}}} \right)^{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} (1-\beta)} \quad (\text{A.28})$$

Therefore we now have that:

$$\ln(N_w/N_\ell) \approx \frac{\sigma e_N}{\sigma + e_N} \left[\frac{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} - 1}{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta}} \right] [s_I \ln(I_w/I_\ell) + s_N \ln(N_w/N_\ell)] \quad (\text{A.29})$$

As $\left[\frac{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta} - 1}{\frac{\sigma}{\sigma-1} \frac{\eta-1}{\eta}} \right] = \left[\frac{\eta - \sigma}{\sigma(\eta-1)} \right]$, after collecting terms this expression simplifies to:

$$\ln(N_w/N_\ell) \approx \frac{s_I \frac{\sigma e_N}{\sigma + e_N} \left[\frac{\eta - \sigma}{\sigma(\eta-1)} \right]}{1 - s_N \frac{\sigma e_N}{\sigma + e_N} \left[\frac{\eta - \sigma}{\sigma(\eta-1)} \right]} \ln(I_w/I_\ell) \quad (\text{A.30})$$

$$= s_I \frac{e_N(\eta - \sigma)}{(\sigma + e_N)(\eta - 1) - s_N e_N(\eta - \sigma)} \ln(I_w/I_\ell) \quad (\text{A.31})$$

$$= s_I \frac{e_N(\eta - \sigma)}{e_N[(\eta - 1)(1 - s_N) + (\sigma - 1)s_N] + \sigma(\eta - 1)} \ln(I_w/I_\ell) \quad (\text{A.32})$$

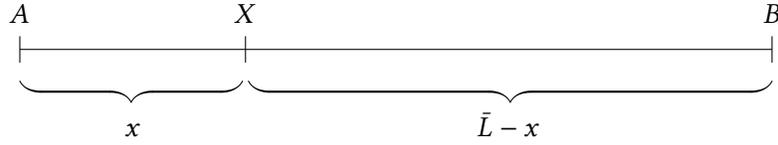
This is a modified version of the expression from [Lemma 2](#), and shows that the native employment response to immigration is increasing in magnitude in the native labor supply elasticity. The response is zero when native supply is inelastic ($e_N = 0$), and converges to the expression in [Lemma 2](#) as the elasticity increases.

A2 Imperfect competition and rural labor markets

The main text explained intuitively why the pre-analysis plan predicted less negative or more positive treatment effects of immigrant employment on native employment in rural areas relative to urban areas. This is a consequence of monopsony power in rural labor markets created by frictions in the national labor market between thin rural labor markets and thick urban labor markets. A consequence of those frictions is that the best alternative wage for two workers of identical marginal product can be lower in rural relative to urban areas. This would tend to make it easier for an alternative employer *within the rural area* to recruit “exploited” workers (Pigou’s term) in rural areas away from their best local alternative. That is, the elasticity of firm-level labor supply to an alternative employer within the rural area—and thus not isolated from rural residents by transportation costs or information costs—would tend to be higher than in an urban area.

This can be seen somewhat more formally in a simple Hotelling duopsony model, following [Monte and Pinheiro \(2021\)](#). Consider two firms producing a single tradable product in perfect competition, firm *A* in a small, remote rural area and firm *B* in a large, densely populated urban area. Workers are identical except for their location. They are distributed evenly—by travel cost or information cost—on a segment between the two firms ([Figure A1](#)). The total labor supply is \bar{L} and workers choose to supply labor to firm *A* or firm *B*. To work at either firm the worker incurs a cost κ per unit distance (transportation or information).

Figure A1: A rural-urban Hotelling model of labor-market duopsony



At location X , the marginal worker is indifferent between working for firm A at wage w_A or for firm B at wage w_B : $w_A - \kappa x = w_B - \kappa (\bar{L} - x)$. The optimum size of the rural labor supply is

$$x = \frac{\kappa \bar{L} + w_A - w_B}{2\kappa}.$$

That is, a necessary and sufficient condition for rural wages to be lower than urban wages ($w_A < w_B$) is for the rural labor market to be smaller than the urban labor market ($x < \frac{\bar{L}}{2}$). Recalling that all workers have identical marginal revenue product, this implies that wage markdowns are greater in the rural area.

Consider now two different attempts by a third employer to recruit workers currently employed by firm A in the rural area. First, suppose a firm *in the urban area* tries to recruit those workers, by offering just above the going rate in the urban area, $w_b + \varepsilon$. The marginal supply of rural labor to that urban firm barely rises, by $\frac{\varepsilon}{2\kappa}$. That supply elasticity is lower as the friction κ increases. This is the finite-elasticity labor supply that produces the wage markdown in the rural area, induced by the frictions associated with firm A 's remoteness.

Second, suppose a third firm *in the rural area* tries to recruit the same workers, those employed in the rural area. It offers just above the going rate in the rural area, $w_A + \varepsilon$. The marginal supply of rural labor to that *rural* firm, in this model, is infinitely elastic. All workers in the rural area (and a few just to the right of point X) would instantly supply their labor to the third firm.

Why, then, would the urban firm B not experience similarly infinitely-elastic labor supply within the urban area? To take an extreme case, suppose that the third firm's technology is such that the marginal revenue product of labor lies between w_A and w_B . Because the profit-maximizing firm cannot pay more than the marginal revenue product, at the margin the elasticity of labor supply to that firm would be zero if it were located in the urban area; it would be infinite if it were located in the rural area. In other words, workers in urban areas surrounded by high-productivity firms have better reserve options, reducing their elasticity of labor supply to the third firm.

A less extreme case of the same tendency, extending beyond the toy model above, is simply that of "classical monopsony" power originating from the existence of a range of firms with different productivity and different amenities, and a range of workers with different preferences (Card et al. 2018). The variation of firms and workers in a large, relatively diverse urban area would generally exceed the variation in small, more homogeneous rural area. This would create a greater tendency for less-than-infinite labor supply elasticities in urban areas than in rural areas, for reasons unrelated to spatial frictions in the worker's location choice.

A3 Summary statistics

Table A1 shows summary statistics across firms in the survey sample. The top panel shows firms time-varying traits in the second half of fiscal year 2021. The middle panel shows firms' time-varying traits in the second half of fiscal year 2020. The bottom panel shows firms' time-invariant traits.

A4 Compare sample to universe

Table A2 repeats the table in the main text comparing lottery results in the firm survey sample to lottery results in the sampling universe, this time restricting the survey sample to petitions by firms included in the core regression sample of 251 firms. The results are highly similar to the table in the main text. Fisher's exact test fails to reject the hypothesis that proportions of each lottery result in the core-sample petitions and the universe of petitions are identical, with $p = 0.501$.

Table A3 compares the industry breakdown of the number of requested workers in the sampling universe to the industry breakdown in the survey sample, for H-2B petitions entering the Dept. of Labor lottery for the second half of fiscal year 2021. The proportions of the industries among petitioned-for workers is broadly similar in the sample and universe. The ranking of industries in the sample and universe are similar, with the exception of forestry and construction: Forestry is overrepresented in the sample (ranked third in the sample, seventh in the universe) and construction is underrepresented in the sample (ranked eighth in the sample, third in the universe). In the sample relative to the universe, workers in hospital-ity and forestry are overrepresented by roughly 10 percentage points, while workers in groundskeep-ing/outdoor maintenance are underrepresented by 18 percentage points and workers in construction are underrepresented by 8 percentage points.

Table A4 displays the corresponding comparison by rural/urban location of the employer. The geographic distribution of firms in the sample corresponds closely to the distribution in the universe.

A5 First-stage regressions

Table A5 presents the first-stage regressions underlying the 2SLS estimates of Tables 2–5 in the main text. Both the 'lottery win' instrument and the 'expected share' instrument cause large and highly statistically significant increases in immigrant employment, conditional on predetermined firm traits. Losing the lottery reduces firms' employment of low-skill immigrants by $1 - e^{-0.822} = 56\%$.

A6 Industry-level parameter assumptions

Table A6 shows the sources and estimates of capital share for several of the leading industries for H-2B employment estimated by IBISWorld, a global research consultancy founded in 1971 in Australia, that compiles industry- and country-specific data including firms' typical costs structure. We include in the capital share: depreciation, amortization, rent, and net income (that is, operating profit minus insurance and taxes). A typical capital share in these industries is 0.3 (implying $\beta = s_K \cdot \frac{\eta}{\eta-1} \approx 0.35$ for $\eta \approx 8$), with a range of roughly 0.25 to 0.45 in plausible values ($\beta \approx 0.29$ – 0.51 for $\eta \approx 8$).

This leaves γ and α to be estimated for the firms in the core survey sample. The average firm's year-round U.S. employment as a fraction of total employment is 0.470 (std. err. 0.0659, $N = 251$). This implies $\gamma = 0.470 \cdot (1 - s_K) \cdot \frac{\eta}{\eta-1} = 0.349$ for $\eta = 8$. The average firm's share of foreign workers in all temporary employment is 0.544, implying a native share of the inner labor nest of 0.648 (std. err. 0.0572, $N = 251$).

IBISWorld rates concentration in each industry on a three-point scale. For all of the industries in **Table A6** except 'amusement parks', it assesses concentration as 'low'. It describes the 'landscaping' industry in the

Appendix Table A1: SUMMARY STATISTICS

	<i>mean</i>	<i>sd</i>	<i>min</i>	<i>max</i>	<i>count</i>
<i>2021 firm traits:</i>					
Revenue (\$)	6.6e+06	1.8e+07	5000.000	2.3e+08	258
Foreign temp. workers employed	28.882	65.138	0.000	630.000	289
U.S. temp. workers employed	48.460	173.163	0.000	1821.000	289
U.S. perm. workers employed	63.235	260.283	0.000	3600.000	289
Investment (\$)	4.8e+05	2.1e+06	0.000	3.0e+07	285
<i>ln</i> Revenue	14.786	1.329	8.517	19.232	258
<i>ih</i> s Foreign temp. workers employed	2.818	1.718	0.000	7.139	289
<i>ih</i> s Foreign temp. workers requested	3.731	1.122	1.444	7.244	289
Share of requested workers with 'A'	0.383	0.474	0.000	1.000	289
Share of requested workers with 'B'	0.198	0.387	0.000	1.000	289
Share of requested workers with 'C'	0.180	0.366	0.000	1.000	289
Share of requested workers with 'D'	0.212	0.398	0.000	1.000	289
Share of requested workers with 'E'	0.026	0.155	0.000	1.000	289
<i>ih</i> s U.S. temp. workers employed	2.717	1.944	0.000	8.200	289
<i>ih</i> s U.S. perm. workers employed	3.477	1.531	0.000	8.882	289
<i>ih</i> s Investment	9.949	5.346	0.000	17.910	285
Change in profit rate, year-on-year	0.067	0.601	-2.357	4.321	238
Lottery win	0.384	0.487	0.000	1.000	289
Expected share of workers	0.735	0.157	0.550	0.920	289
<i>2020 firm traits:</i>					
Revenue (\$)	5.8e+06	1.6e+07	5500.000	2.2e+08	251
Foreign temp. workers employed	21.720	61.894	0.000	500.000	289
U.S. temp. workers employed	40.239	149.878	0.000	1780.000	289
U.S. perm. workers employed	54.820	191.775	0.000	2000.000	289
<i>ln</i> Revenue	14.620	1.375	8.613	19.186	251
<i>ih</i> s Foreign temp. workers employed	1.950	1.961	0.000	6.908	289
<i>ih</i> s Foreign temp. workers requested	2.592	1.733	0.000	6.620	289
Share of requested workers with 'A'	0.381	0.466	0.000	1.000	212
Share of requested workers with 'B'	0.179	0.369	0.000	1.000	212
Share of requested workers with 'C'	0.155	0.342	0.000	1.000	212
Share of requested workers with 'D'	0.232	0.414	0.000	1.000	212
Share of requested workers with 'E'	0.053	0.217	0.000	1.000	212
<i>ih</i> s U.S. temp. workers employed	2.400	1.990	0.000	8.178	289
<i>ih</i> s U.S. perm. workers employed	3.335	1.619	0.000	8.294	289
Lottery win	0.373	0.485	0.000	1.000	212
Expected share of workers	0.429	0.353	0.062	0.881	212
<i>Fixed firm traits:</i>					
Competitors (number)	468.037	6076.605	0.000	1.0e+05	271
Competition on price (subjective)	3.125	0.807	1.000	4.000	279
Rural (non-metropolitan)	0.255	0.436	0.000	1.000	275
Population of ZIP code	2.2e+04	1.6e+04	48.000	6.4e+04	277
<i>Industry</i> : Landscaping	0.599	0.491	0.000	1.000	289
<i>Industry</i> : Food, hotel, entertainment	0.156	0.363	0.000	1.000	289
<i>Industry</i> : Other	0.246	0.431	0.000	1.000	289
<i>Region</i> : Northeast	0.197	0.399	0.000	1.000	289
<i>Region</i> : Midwest	0.291	0.455	0.000	1.000	289
<i>Region</i> : South	0.349	0.478	0.000	1.000	289
<i>Region</i> : West	0.121	0.327	0.000	1.000	289

NOTE: '*ih*s' is inverse hyperbolic sine.

Appendix Table A2: LOTTERY RESULTS IN SAMPLING UNIVERSE VS. SURVEY SAMPLE, 2021: RESTRICTED TO PETITIONS BY FIRMS IN THE CORE REGRESSION SAMPLE

Result	Frequency		Proportion		<i>p</i> -val.
	<i>Universe</i>	<i>Sample</i>	<i>Universe</i>	<i>Sample</i>	
A	2,029	128	0.377	0.390	0.642
B	1,046	69	0.195	0.210	0.484
C	1,065	65	0.198	0.198	0.998
D	1,125	57	0.209	0.174	0.124
E	111	9	0.021	0.027	0.405
Total petitions	5,376	328	1.000	1.000	0.501*

The unit of observation is petitions. The *p*-value is for a two-sample test of the null hypothesis that the fraction of petitions receiving each lottery letter in the survey sample is equal to that fraction in the universe of petitions. *The final row gives the *p*-value of Fisher’s exact test of the null hypothesis that the lottery-result distribution across all five letters is equal in the sample and the universe.

United States with the follow passage, typical of the other low-concentration industries: “*The Landscaping Services industry has a low level of market share concentration. ... The industry is characterized by a large number of small operators. According to the latest Economic Census, 94.0% of establishments employ fewer than 20 workers. Several companies have the resources to operate on a national scale and are typically integrated with landscape architecture departments, which enables them to bid for lucrative design-build-installation projects for commercial clients such as hotels and resorts. Nevertheless, the sheer volume of small-scale, low-value work conducted by nonemployers and small companies in the single-family housing market prevents these larger companies from capturing a substantial portion of revenue*” (Dmitry Diment, *IBISWorld Industry Report 56173: Landscaping Services in the US*, June 2022, p. 24).

A7 Check for nonresponse bias and/or randomization irregularities

Table A7 tests both for nonresponse bias and/or randomization irregularities by running a placebo test for spurious explanatory power of firm-level lottery results by firms’ baseline (pre-lottery) traits in the survey sample. The tests reveal no economically or statistically significant explanatory power of the lottery results by baseline traits. The is inconsistent with substantial nonresponse bias that is correlated with treatment status and relevant observed baseline traits. It is also inconsistent with any randomization irregularities favoring firms with certain observed traits, such as larger firms or firms that employ more U.S. workers. These results are compatible with genuine randomization.

A8 Robustness to inverse hyperbolic sine transformation

Table A8 reports core regression results without using any inverse hyperbolic sine or log transformations, using the Poisson pseudo-maximum-likelihood (PPML) estimator due to [Silva and Tenreyro \(2006\)](#).

The coefficient on foreign employment is interpreted as a semi-elasticity. That is, the observed cross-firm correlation between H-2B employment and revenue in 2021, controlling for baseline traits, is such that the employment of one additional H-2B worker is associated with 1.72% greater revenue (col. 1). The semielasticity of revenue to winning the lottery (col. 2) and the expected share variable (col. 3) are both larger than their magnitudes in **Table 2** of the main text.

Appendix Table A3: WORKERS REQUESTED BY INDUSTRY IN SAMPLING UNIVERSE VS. SURVEY SAMPLE, 2021

<i>Industry</i>	Frequency		Proportion	
	<i>Universe</i>	<i>Sample</i>	<i>Universe</i>	<i>Sample</i>
Grounds keeping/outdoor maintenance	52,738	4,022	0.540	0.355
Hospitality	9,604	2,288	0.098	0.202
Forestry	3,766	1,832	0.039	0.162
Seafood processing	4,457	695	0.046	0.061
Golf courses/country clubs	7,567	588	0.077	0.052
Restaurants	2,386	141	0.024	0.012
Carnivals	2,363	89	0.024	0.008
Construction	8,863	57	0.091	0.005
Other	5,910	1,613	0.061	0.142
Total workers	97,654	11,325	1.000	1.000

The unit of observation is workers requested on DOL petitions entered into the DOL lottery for H-2B visas for the second half of fiscal year 2021. For all industries the difference in proportions between universe and sample is statistically significant: the p -value is less than 0.0001 for two-sample tests of the null hypothesis that the fraction of workers is equal in the sample and universe for all rows of the table. Includes only workers on petitions in the universe and sample for which firms reported a NAICS code for the employer.

Across firms the one additional H-2B worker employed is associated with a 1.65% increase in the number of U.S. temporary workers employed, controlling for baseline traits. The semielasticity of U.S. temporary employment to winning the lottery (col. 2) and the expected share variable (col. 3) are, again, both larger than their magnitudes in [Table 3](#) of the main text. These results are statistically significant at the 0.054 level and 0.014 level, respectively.

In sum, the qualitative findings of the core regressions using the inverse hyperbolic sine transformation are robust to alternative specifications that do not use that transformation. The only substantial difference in the results from the PPML specification is that the effect of an advantageous lottery outcome on firms' employment of U.S. temporary workers is both positive and statistically significant at or below the ~ 0.05 level in these specifications; the corresponding estimates in the main text using the IHS transformation are positive but smaller in magnitude and less statistically precise.

A9 Robustness to industry composition

Firms with NAICS two-digit industry code 56 (groundskeeping and landscaping) represent the largest share of employers in the sample and universe. It is thus of interest to know if the core results are driven by treatment effects on that specific industry. [Figure A6](#) tests the heterogeneity of the core results according to whether or not a respondent firm's industry is groundskeeping and landscaping. The 2SLS point estimates on foreign worker employment are higher for non-landscaping firms than for non-landscaping firms in the revenue, U.S. employment, and investment regressions. This suggests that if anything, the local average treatment effect estimated for the firm sample is lower than it would be if groundskeeping/landscaping firms were less prevalent.

A10 Robustness to influential observations

[Table A12](#) repeats the core regression analysis with quantile regressions (p50) that are robust to influential observations. The IV quantile regressions are executed with the smoothed estimating equations method

Appendix Table A4: WORKERS REQUESTED BY RURAL/URBAN EMPLOYER IN SAMPLING UNIVERSE VS. SURVEY SAMPLE, 2021

<i>Employer address</i>	Frequency		Proportion	
	<i>Universe</i>	<i>Sample</i>	<i>Universe</i>	<i>Sample</i>
Rural	26,549	3,397	0.274	0.310
Urban	70,290	7,573	0.726	0.690
Total workers	96,839	10,970	1.000	1.000

The unit of observation is workers requested on DOL petitions entered into the DOL lottery for H-2B visas for the second half of fiscal year 2021. For both the rural and urban rows, the difference in proportions between universe and sample is statistically significant: the p -value is less than 0.0001 for two-sample tests of the null hypothesis that the fraction of workers is equal in sample and universe. Includes only workers on petitions in the universe and sample for which firms reported a postal code for the employer.

of Kaplan and Sun (2017) and Kaplan (2022). The qualitative pattern of results is similar to the results in the core regressions, which is incompatible with substantial sensitivity to a small number of influential observations.

A11 Robustness to randomization inference

Young (2018) notes that some data obtained from randomized controlled trials do not meet the conditions necessary to rely on the asymptotic properties of conventional standard errors. Table A13 shows the core results of the reduced-form regressions using the ‘lottery win’ instrument using Fisher’s randomization inference as implemented by Heß (2017). The first column is an OLS regression of 2021 H-2B employment on the instrument, controlling for the standard baseline (2020) traits. Columns 2–4 are randomization-inference versions of the reduced-form regressions in column 4 of Table 2, Table 3, and Table 4 respectively. The qualitative pattern of inference is identical to that in core regressions of the main text using conventional standard errors.

A12 Full regression results from tests for heterogeneous treatment effects

Table A11 reports the full regression results underlying the coefficient plots in Figure 7.

A13 Item nonresponse

The most important form of item nonresponse in the survey was firms that declined to identify themselves. Table A9 tests the sensitivity of the core results to restricting the sample to firms that did self-identify. The core results in Tables 2–4 are qualitatively and quantitatively similar in the subsample that *did* provide the firm name. The coefficient of principal interest in the subsample that *did not* provide a firm name (20 out of 251) is higher to a statistically significant degree for the revenue outcome. The coefficient is not statistically significantly different in the unidentified subgroup for the other two core outcomes.

A14 Effect on U.S. year-round employment

The preanalysis plan contained specified reporting tests of the effect of employing foreign temporary low-skill workers on an additional secondary outcome: employment of year-round, generally higher-

Appendix Table A5: First stage regressions, 2021

<i>Dep. var.:</i>	Foreign hired 2021 (IHS)	
	<hr/>	
Lottery win 2021	0.822 (0.162)	
Expected share 2021		3.232 (0.559)
U.S. temporary hired 2020 (IHS)	-0.062 (0.049)	-0.060 (0.048)
Revenue 2020 (ln)	0.376 (0.087)	0.384 (0.090)
Foreign hired 2020 (IHS)	0.290 (0.054)	0.284 (0.054)
U.S. year-round hired 2020 (IHS)	-0.005 (0.068)	0.001 (0.070)
Constant	-3.396 (1.124)	-5.595 (1.236)
<hr/>		
N	251	251

Presents the first-stage regressions from the rightmost columns of Tables 2–5.

skill U.S. workers. Table A10 reports these tests, analogous to the core outcomes of interest in the main text. Although firms with similar baseline traits but greater hiring of foreign workers in 2021 exhibit 3.8% higher employment of higher skill year-round U.S. workers (col. 2), this relationship could arise from unobserved confounders. In the corresponding 2SLS specifications (cols. 6 and 10) the *effect* of foreign hiring on year-round U.S. employment is statistically indistinguishable from zero by a wide margin. The present research design only measures effects in the short term—within the same same half-year (the second half of fiscal 2021).

A15 The 2020 lottery

Figure A3 reports the DOL decision dates for the 2020 lottery. The pattern is highly similar to the pattern in the corresponding decision dates for 2021, with the exception that no supplemental visas were issued in 2020.

Figure A4 shows the distribution of firm-level share of petitions receiving lottery result A in the 2020 lottery. The pattern is highly similar to the pattern in the 2021 lottery.

A16 Kernel density plots of 2021 outcomes by lottery result without baseline controls

Figure A2 displays kernel density plots of the core firm outcomes by lottery result, in 2021, without controlling for predetermined baseline traits.

Appendix Table A6: Capital share estimates from typical industry cost structures

Industry	Year	NAICS	Wages	Net inc.	Deprec.	Rent	K share	Source
Landscaping	2022	56173	32.6	8.8	3.7	1.8	0.305	(1)
Hotels	2021	72111	32.2	3.2	8.1	2.0	0.292	(2)
Golf courses	2022	71391	39.0	1.1	9.2	7.2	0.310	(3)
Amusement parks	2022	71311	41.6	9.9	8.4	5.7	0.366	(4)
Seafood preparation	2022	31171	11.8	2.1	1.1	0.6	0.244	(5)
Forest support serv.	2021	11531	29.2	13.6	3.6	6.6	0.449	(6)

Sources: 1. Dmitry Diment, *IBISWorld Industry Report 56173: Landscaping Services in the US*, June 2022; 2. Jared Ristoff, *IBISWorld Industry Report 72111: Hotels & Motels in the US*, September 2021; 3. Brigitte Thomas, *IBISWorld Industry Report 71391: Golf Courses & Country Clubs in the US*, June 2022; 4. Thi Le, *IBISWorld Industry Report 71311: Amusement Parks in the US*, July 2022; 5. Dmitry Diment, *IBISWorld Industry Report 31171: Seafood Preparation in the US*, July 2022; 6. John Madigan, *IBISWorld Industry Report 11531: Forest Support Services in the US*, November 2021.

A17 Survey questionnaire

Figure A7 reproduces the online survey exactly as respondents saw it, on 11 separate click-through screens. Respondents reached the survey form by clicking on a link named “<http://visalotterystudy.org>” in an email from an industry association of which their firm was a paying member. We estimate that it took the average respondent 15 minutes to complete.

Appendix Table A7: Placebo test for spurious explanatory power of lottery result by baseline traits in the survey sample

Dep. var.:	<i>Lottery win</i>	<i>Expected share</i>
	OLS	OLS
Revenue 2020 (ln)	0.015 (0.030)	0.001 (0.010)
Foreign hired 2020 (IHS)	0.007 (0.017)	0.004 (0.006)
U.S. year-round hired 2020 (IHS)	-0.013 (0.026)	-0.005 (0.008)
U.S. temporary hired 2020 (IHS)	-0.014 (0.016)	-0.004 (0.005)
Number of firms	251	251
R^2	0.005	0.006

Robust standard errors in parentheses. *IHS* is inverse hyperbolic sine.

Appendix Table A8: Core results in PPML specification, all variables in levels without inverse hyperbolic sine or log transformations

<i>Estimator:</i>	PPML						
	Revenue 2021			U.S. temporary hired 2021			
<i>Dep. var. (levels):</i>							
Foreign employed 2021 (<i>level</i>)	0.0172 (0.0014)				0.0165 (0.0032)		
Lottery win (<i>indicator</i> {0,1})	0.422 (0.233)			0.431 (0.224)			
Expected share (0–1)	1.183 (0.697)			1.678 (0.682)			
Full baseline controls (<i>levels</i>)	Yes	Yes	Yes	Yes	Yes	Yes	
Number of firms	251	251	251	251	251	251	
R^2	0.893	0.683	0.678	0.886	0.875	0.877	

Robust standard errors in parentheses. All regressions include constant term. All variables in levels (without log or IHS transformation). All columns include the same baseline variables as in the corresponding regressions of the main text, but in levels (untransformed): the 2020 values of revenue, number of U.S. year-round workers, number of U.S. temporary workers, and number of foreign temporary workers.

Appendix Table A9: Tests for sensitivity of the results to item nonresponse for firm name, 2021

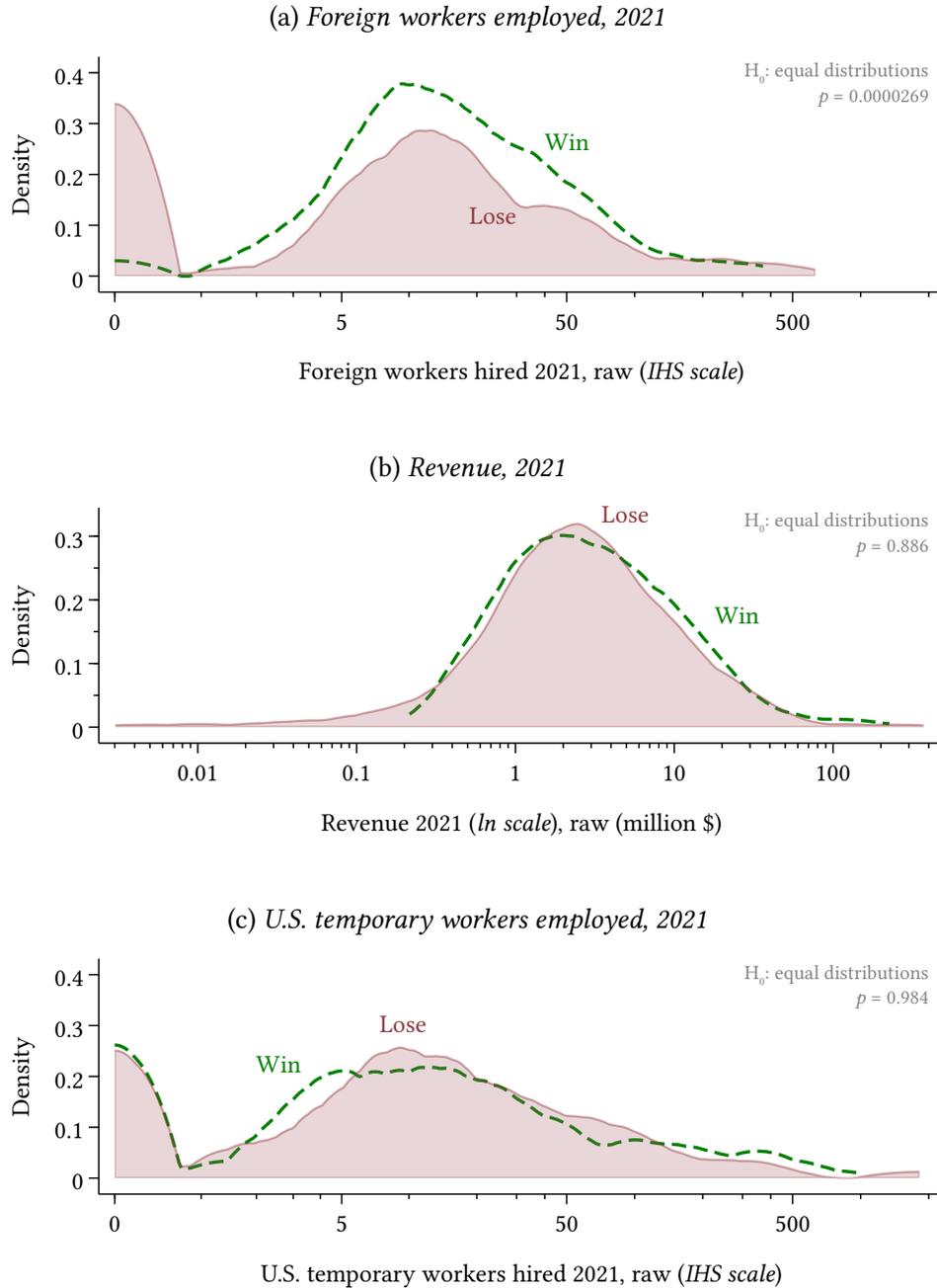
<i>Dep. var.:</i>	Revenue 2021 (ln)	U.S. hired 2021 (IHS)	Investment 2021 (IHS)
<i>Specification:</i>	2SLS	2SLS	2SLS
Foreign hired 2021 (IHS)	0.156 (0.072)	0.093 (0.127)	1.119 (0.548)
Foreign hired 2021 (IHS) \times unidentified	0.062 (0.027)	0.070 (0.098)	-0.696 (0.421)
Full baseline controls	Yes	Yes	Yes
Number of firms	251	251	249
R^2	0.816	0.696	0.103

'Unidentified' is an indicator variable taking the value one if the respondent left the firm name blank, 0 otherwise. All regressions are 2SLS with two endogenous variables and two instruments. The endogenous variables are 'Foreign hired 2021' and its interaction with 'unidentified'. The instruments are the 'expected shared' instrument and its interaction with 'unidentified'.

Appendix Table A10: EFFECT OF FOREIGN WORKER EMPLOYMENT ON HIGHER-SKILL, YEAR-ROUND U.S. EMPLOYMENT, 2021

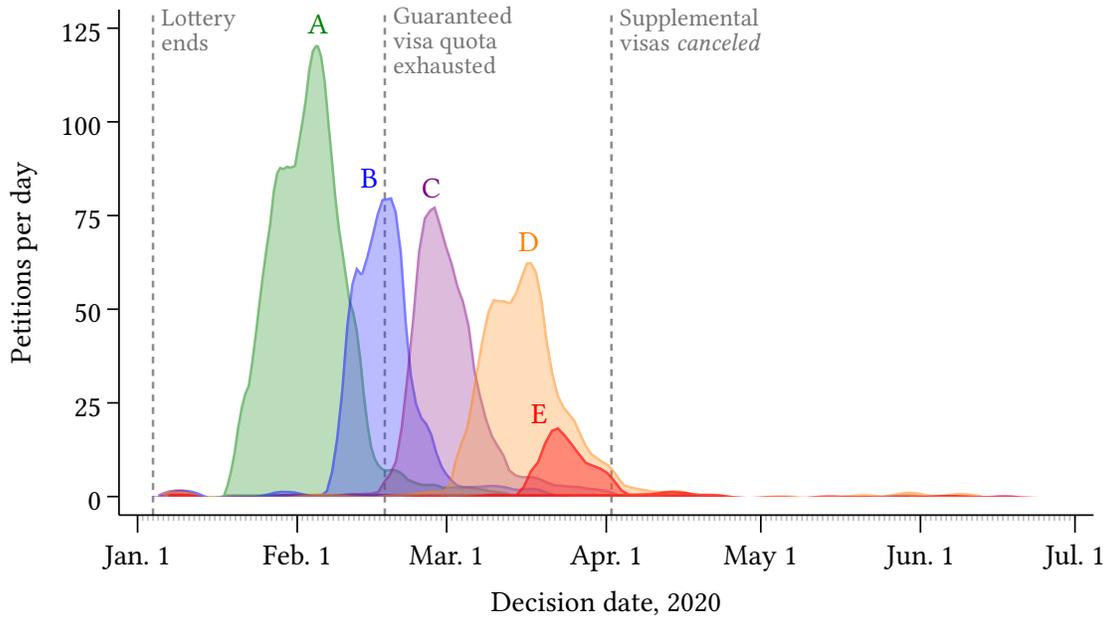
	<i>U.S. year-round workers 2021 (IHS)</i>			
<i>Dep. var:</i>	OLS	2SLS	OLS	2SLS
<i>Estimator:</i>		<i>Lottery win</i>		<i>Expected share</i>
<i>Instrument:</i>				
Foreign temp. employed 2021 (IHS)	0.216 (0.060) 0.038 (0.017)	-0.052 (0.221) -0.025 (0.073)		-0.105 (0.184) -0.013 (0.056)
<i>Anderson-Rubin p-val.</i>	—	0.812	0.729	0.557
Lottery win 2021	-0.047 (0.195) -0.021 (0.060)			
Expected share 2021			-0.354 (0.602) -0.041 (0.183)	
U.S. year-round workers 2020 (IHS)	0.908 (0.042) 0.858 (0.062) 0.917 (0.040) 0.857 (0.063) 0.922 (0.035) 0.857 (0.062) 0.917 (0.040) 0.857 (0.063) 0.921 (0.036) 0.857 (0.062)			
Full baseline controls	—	—	—	—
Number of firms	251	251	251	251
R ²	0.889	0.900	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	0.885
		0.885	0.896	0.885
		0.887	0.898	0.885
		0.885	0.898	0.885
		0.887	0.887	

Figure A2: REDUCED-FORM EFFECTS OF THE 2021 LOTTERY, WITHOUT BASELINE CONTROLS



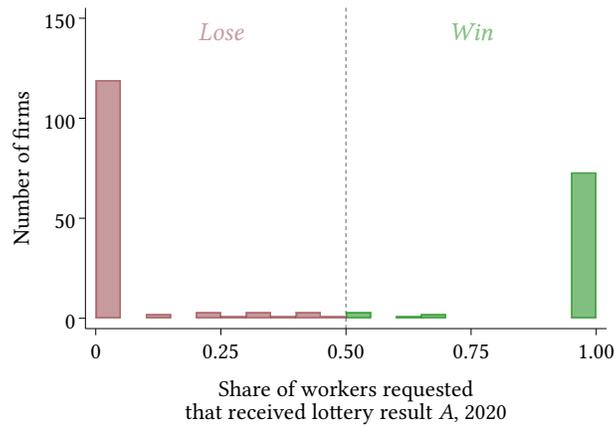
The unit of analysis is firms. ‘Win’ is defined as a firm receiving randomized lottery letter ‘A’ for petitions exceeding half of the total workers requested; all other results are defined as ‘lose’. Graphs show Epanechnikov kernel density estimates with a bandwidth of 0.15 inverse hyperbolic sine (IHS) points (a and c) or 0.5 ln points (b). Exact p -values are from nonparametric two-sample Kolmogorov-Smirnov tests of the null hypothesis of the equality of the ‘win’ and ‘lose’ distributions in each pane of the figure.

Figure A3: FOREIGN WORKER PETITION DECISION DATES BY LOTTERY RESULT, UNIVERSE OF FIRMS, SECOND HALF OF FISCAL YEAR 2020



Shown is the universe of firms entering each lottery. Epanechnikov kernel densities, bandwidth 2 days. ‘Decision date’ is the date of the Department of Labor’s decision on whether or not to certify each petition, a necessary condition of proceeding to petition USCIS for a visa. The 2020 lottery was conducted for DOL petitions received January 2–4, 2020. The statutory quota of 33,000 guaranteed visas for the second half of the fiscal year was reached on Feb. 18, 2020.

Figure A4: DEFINING A LOTTERY ‘WIN’ AT THE FIRM LEVEL, 2020 LOTTERY



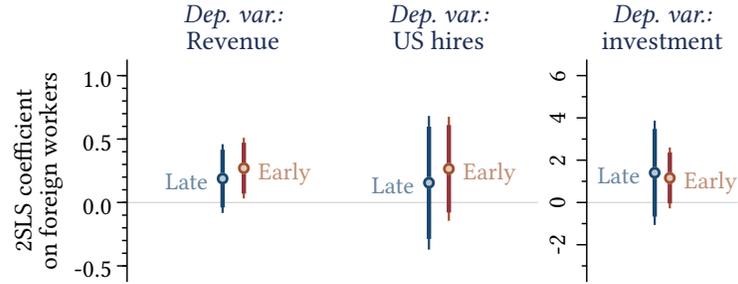
Only includes firms that voluntarily self-identified in the survey, allowing them to be matched to public records of their 2020 lottery result.

Appendix Table A11: HETEROGENEOUS EFFECTS BY COMPETITION, SIZE, AND LOCATION

	Number of competitors		Competition (subjective)		Small firm		Rural		Low population	
	High	Low	High	Low	Yes	No	Yes	No	Yes	No
<i>Dep. var.: Revenue 2021 (ln)</i>	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Foreign employed 2021 (IHS)	0.291 (0.131)	0.102 (0.078)	0.339 (0.253)	0.131 (0.081)	0.324 (0.119)	0.017 (0.122)	0.265 (0.194)	0.185 (0.094)	0.293 (0.167)	0.139 (0.098)
<i>And.-Rubin p-val.</i>	0.0366	0.2339	0.2111	0.1191	0.0061	0.8961	0.2173	0.0592	0.0890	0.1838
N	134	117	86	165	123	128	66	185	119	132
<hr/>										
<i>Dep. var.: U.S. temporary workers employed (IHS)</i>										
Foreign employed 2021 (IHS)	0.200 (0.264)	0.184 (0.181)	0.160 (0.433)	0.141 (0.165)	0.295 (0.205)	-0.003 (0.285)	0.514 (0.291)	0.054 (0.203)	0.270 (0.223)	0.086 (0.232)
<i>And.-Rubin p-val.</i>	0.4720	0.3488	0.7334	0.4121	0.1765	0.9910	0.0868	0.7943	0.2408	0.7217
N	134	117	86	165	123	128	66	185	119	132
<hr/>										
<i>Dep. var.: Investment (IHS)</i>										
Foreign employed 2021 (IHS)	0.896 (0.915)	1.330 (0.874)	1.622 (1.658)	1.410 (0.727)	2.506 (0.872)	-0.473 (1.411)	2.857 (1.426)	0.661 (0.745)	2.218 (1.107)	1.167 (0.789)
<i>And.-Rubin p-val.</i>	0.3340	0.1185	0.3586	0.0457	0.0012	0.7368	0.0161	0.3884	0.0347	0.1397
N	134	115	85	164	122	127	65	184	118	131

The unit of observation is firms. All regressions include constant term. All regressions are two-stage least squares with 'Foreign employed 2021 (IHS)' as the endogenous regressor, in a regression with full baseline controls, corresponding to the specification in column 6 of Tables 2, 3, and 4. The dichotomous instrumental variable is an indicator variable for winning the lottery, that is, receiving 'A' on petitions totaling at least 50% of workers requested. IHS is inverse hyperbolic sine. All regressions include the full set of predetermined baseline control variables: ln 2020 revenue and the inverse hyperbolic sine (IHS) of 2021 requested H-2B workers, 2020 employed H-2B workers, 2020 U.S. year-round workers, and 2020 U.S. seasonal workers. "High" number of competitors means greater than the median response (25). "High" subjective competition means the business self-reported that it would be "very easy" (4 on a 4-point scale of ease) for competitors to steal their customers by underpricing them. "Small" firms are those with less than median revenue at baseline (in 2020). "Rural" firms are those whose ZIP code is classified by the Census Bureau as anything other than "Metropolitan Area, Core" (RUCA code 1). "Low" population means the firm's ZIP code has less than the median population among all ZIP codes (20,459 residents) in the 2010 full-count census.

Figure A5: TEST FOR NONRESPONSE BIAS



The unit of analysis is firms. 'Late' responses are those that took more than the median time to complete the survey after it was first emailed. The first response was received on October 21, 2021 at 9:36am Eastern time; the median response was received on October 25, 2021 at 1:14pm Eastern time. The vertical axis in each pane shows the 2SLS coefficient on foreign workers employed (2021, IHS) in a regression with full baseline controls, corresponding to the specification in column 6 of Tables 2, 3, and 4. The coefficients can be interpreted as elasticities. Thin vertical line shows 95% confidence interval, thick line shows 90% confidence interval.

Figure A6: TEST FOR BIAS FROM SAMPLING OVERWEIGHT ON GROUNDSKEEPING/LANDSCAPING



The unit of analysis is firms. All regressions include constant term. 'Yes' indicates the firm's industry is groundskeeping and landscaping (two-digit NAICS industry code 56); 'no' indicates any other industry. The vertical axis in each pane shows the 2SLS coefficient on foreign workers employed (2021, IHS) in a regression with full baseline controls, corresponding to the specification in column 6 of Tables 2, 3, and 4. The coefficients can be interpreted as elasticities. Thin vertical line shows 95% confidence interval, thick line shows 90% confidence interval.

Appendix Table A12: ROBUSTNESS: QUANTILE REGRESSIONS (p50), 2021

<i>Dep. var:</i>	2021				2020			
	Revenue (ln)		U.S. temporary workers employed (IHS)		Revenue (ln)		U.S. temporary workers employed (IHS)	
	Quantile	IV quantile	Quantile	IV quantile	Quantile	IV quantile	Quantile	IV quantile
<i>Estimator:</i>								
Foreign employed (IHS)	0.080 (0.012)	0.090 (0.040)	0.060 (0.029)	-0.001 (0.105)	0.077 (0.048)	0.138 (0.112)	0.312 (0.150)	0.357 (0.556)
Revenue 2020 (ln)	0.893 (0.017)	0.873 (0.046)	0.000 (0.042)	0.024 (0.036)				
Observed baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	251	251	251	251	191	191	191	191
Pseudo R^2	0.693	—	0.570	—	0.204	—	0.076	—

The unit of observation is firms. Quantile IV estimator due to Kaplan and Sun (2017) and Kaplan (2022). All regressions include constant term. Standard errors in parentheses. The dichotomous 'Lottery win' instrumental variable is an indicator variable for winning the lottery, that is, receiving 'A' on petitions totaling at least 50% of workers requested. IHS is inverse hyperbolic sine. All regressions include the same baseline variables as in the linear regressions in the main text: For 2021, the baseline controls are: numbers of U.S. year-round workers, U.S. temporary workers, and foreign temporary workers in 2020. For 2020 the only observed baseline trait is the number of H-2B workers requested (IHS).

Appendix Table A13: Robustness: Randomization inference, 2021

<i>Dep. var:</i>	Foreign temp. workers employed (IHS)	Revenue (ln)	U.S. temp. workers employed (IHS)	Investment (IHS)
Lottery win	0.8216 (0.1624)	0.1700 (0.0760)	0.1462 (0.1422)	1.1372 (0.5604)
Rand. inference <i>p</i> -val.	<0.001	0.025	0.300	0.071
Full baseline controls	Yes	Yes	Yes	Yes
Number of firms	251	251	251	249
R^2	0.339	0.800	0.680	0.102

Robust standard errors in parentheses. Uses Fisher's randomization inference implemented by [Heß \(2017\)](#).

Figure A7: THE FIRM SURVEY QUESTIONNAIRE AS RESPONDENTS SAW IT ON 11 SCREENS

Survey of US businesses after the H-2B visa lottery

Welcome!

This research project is being conducted by Dr. Michael Clemens at the Center for Global Development in Washington, DC and Professor Ethan Lewis in the Department of Economics at Dartmouth College, Hanover, NH.

We are economists studying how the H-2B visa lottery in January 2021 affected American businesses that entered that lottery.

We want to hear from you whether or not you were able to hire any H-2B workers this year.

Please step inside...

[Click here to enter](#) Save

Survey of US businesses after the H-2B visa lottery

You should know

There are 10 questions. Please be sure to click "Save" or "Submit" when you're finished, or we won't receive your answers.

Your participation is voluntary. Participation requires the completion of a 15-minute computer-based survey. The survey asks simple questions about your employment of various workers and other business conditions in the past year. You may choose not to answer any or all questions, and you may withdraw from the survey at any time. The information collected will be maintained confidentially and securely.

If you have any questions or concerns, please reach out! You can reach us via our colleague Cassie Zimmer by email at [redacted] or by phone at 202-418- [redacted].

— Ethan and Michael

Please click below to begin...

[Start the survey](#) Save

Survey of US businesses after the H-2B visa lottery

1. In January 2021, how many H-2Bs did you petition for?

Please enter one petition per row

Number of H-2Bs requested	Letter group received	Job title (or occupation)
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

[Add Petition](#)

Check here if it's easier to upload a file instead.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

2. How many H-2B workers actually worked for your business...

...this year's season (Apr-Sep 2021)? ...LAST year's season (Apr-Sep 2020)?

Your best rough estimate is fine. Count all H-2Bs of any kind, including returning or supplemental.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

Now please think of all the US workers that your business employs year-round. Include managers and owners.

3. How many year-round US workers did your business employ...

...as of last week? ...as of one year ago (Oct 2020)?

Seven questions to go. If you ever get interrupted, please click "Save" so that we receive your responses.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

Now we'll ask about seasonal US workers.

4. How many seasonal US workers did your business employ...

...this year's season (Apr-Sep 2021)? ...LAST year's season (Apr-Sep 2020)?

Your best rough estimate is fine.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

5. What was your business's total revenue...

...so far this year (Jan-Sep 2021)? ...the same period of last year (Jan-Sep 2020)?

Your best rough estimate of these dollar amounts is absolutely fine.

You're halfway to the end.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

6. Are your normal monthly operating costs...

...higher or lower this year? ...by what percent (%)?

Higher than last year

Lower than last year

Your best rough estimate is absolutely fine. Enter 0 for unchanged.

By "operating costs" we mean all the expenditures it takes to keep your business running in a typical month, excluding occasional large purchases of equipment or real estate. That includes wages, recruiting, and overhead.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

7. How much did your business spend on large, occasional investments in equipment or real estate this year (\$)?

Your best rough estimate is absolutely fine.

Just three questions to go. If you ever get interrupted, please click "Save" so that we receive your responses.

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

8. How intense is competition?

Roughly how many other businesses compete directly with yours, in the market you serve?

How easy would it be for one of your business's competitors to steal your clients simply by underpricing you?

Your rough estimate is absolutely fine.

Very easy

Moderately easy

Moderately hard

Very hard

[Back](#) [Next](#) Save

Survey of US businesses after the H-2B visa lottery

9. What kind of business do you do, and where?

Your industry Your ZIP code

A few examples: Landscaping, hotel/motel, country club, restaurant, amusement park, roofing contractor, street paving, forestry, seafood products, spectator sports...

10. What is your business's name?

We will never disclose your business's name. It's only for our internal checks on data quality.

Any optional comments before you click "Submit"?

That's it!

Please be sure to click **SUBMIT** below so that we receive your responses:

[Back](#) [SUBMIT](#) Save