Online Appendix
"Labor Market Effects of Immigration Restrictions: Evidence from the Mexican *Bracero* Exclusion"

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Raw page-image scans of all primary archival documents used to create the database, as well as the digitized data and replication code, are available at https://dataverse.harvard.edu/dataverse/bracero.

Contents

A1 Background and prior research

Despite the limited evidence on the labor-market effects of *bracero* exclusion, a long strand of literature has interpreted those effects as well-established. During the program, economists like Hadley (1956, 355) used anecdotes to claim that the presence of *braceros* reduced domestic wages. "The availability of [*bracero*] workers," wrote Briggs (1980) long after the program ended, "significantly depressed existing wage levels in some regions," citing a calibrated simulation of what the wage effect of *bracero* exclusion in two crops might have been during the program, but not an empirical measurement of the wage effect of actual *bracero* exclusion (Wise, 1974). In arguing against a renewed US-Mexico temporary worker agreement in the 1990s, Martin (1998, 892) claimed that *bracero* exclusion caused farm wages to rise by 30 to 50 percent, without a source for this estimate. Grove (1996, 320), citing the problematic results of Morgan and Gardner, claimed that "employment of braceros reduced seasonal farm wages and domestic employment." Martin and Teitelbaum (2001, 194) claim, "The rise in farm workers' wages following the *bracero* program's termination also showed how much it had depressed wages"—but do not compare this rise in wages to wage trends prior to *bracero* exclusion, or to wage trends in places unaffected by *bracero* exclusion. A literature review by Levine (2006, 5) concludes that the *bracero* agreements caused "a decrease in domestic farm worker employment, and a decrease in farm wages," but without critical analysis of the evidence base.[1]

Social scientists outside of economics have made numerous similar claims. First, in an influential book that helped secure *bracero* exclusion, historian Ernesto Galarza (1964, 199-218) claimed that the effect of *braceros* on domestic workers' wages and employment was "severe." To support this claim he offered several pages of anecdotes about *braceros* being paid relatively low wages for certain crops in certain counties of California for work that in other years had been performed by domestic workers, but does not offer evidence on the wages earned by domestic workers for the work they performed instead. Second, law professor Austin Morris (1966, 1940) wrote, "It was charged that . . . Bracero-users never seriously tried to attract domestic labor, and that wages were kept down, and even lowered. . . . That little effort was made, either by administrative insistence or grower cooperation, to recruit local workers is evidenced by the fact that as the number of entrants was cut down toward the end of the program (from a high of 459,850 in 1956 to about 200,000 in 1964, and only 20,000 in 1965), their places were taken by domestic workers. If domestic workers could be recruited in 1965, as they were, then clearly they could have been recruited in 1956." He thus described it as"false, exaggerated, and baseless" to suggest that *braceros* had *not* displaced large numbers of domestic workers (p. 1943). But Morris—though he was writing two years after *bracero* exclusion and could have measured its observed effects—offers no evidence that hundreds of thousands of domestic workers did in fact enter seasonal farm work to replace *braceros* as claimed. Third, Bickerton (2000, 910) decries the "low wages that resulted from the importation of foreign workers" under the agreements. To support this claim Bickerton cites a passage where Calavita (1992, 65 *passim*) discusses some *bracero* employers' violations of their wage contracts; but this does not constitute direct evidence of adverse effects on the wages of other workers. Fourth, Mitchell (2012, 396) suggests

[1]In reviewing the evidence to draw her conclusion for the purposes of informing Congress in 2006 about the labor market effects of temporary work visas, Levine cites only the simulation of Wise (1974) and the regressions of Morgan and Gardner (1982) that did not account for the upward time-trend in wages nationwide, but omits the contradictory findings of Jones and Rice (1980).

that due to the exclusion of *bracero* workers from California, "[w]ages to domestic workers went up 23 percent", but does not offer evidence that this trend was any different in places unaffected by *bracero* exclusion, or that a similar trend was not occurring in California prior to *bracero* exclusion.

But a minor literature has dissented from this view. Just before *bracero* exclusion, Mamer (1961, 1205–1206) noted the absence of any systematic quantitative evidence for substantial labor-market effects of the program. And after exclusion was carried out, some economists predicted that rapid technological adjustment would negate its intended effects. Jones and Christian (1965, 528) predicted that any wage effects of *bracero* exclusion would be "almost completely nullified by an accompanying intensification of mechanization." William E. Martin (1966, 1137), later president of the Western Agricultural Economics Association, wrote that due to sudden substitution of capital for Mexican workers, "excluding foreign labor will not have any lasting beneficial effects on the domestic farm labor force." More recently, Alston and Ferrie (2007, 112) observe that many growers perceived hiring *braceros* not as a way to pay lower wages for equal productivity, but as a way to achieve higher productivity and workforce reliability—in spite of the fact that "the total cost of bracero labor exceeded that of domestic farm workers and most likely the cost of illegal Mexican workers."

Our findings corroborate contemporary statements of the U.S. Department of Agriculture's Economic Research Service, which wrote two years after exclusion, "Neither the growers nor the State Employment Service were able to recruit a labor force which would take over the jobs formerly performed by the braceros" (Metzler et al., 1967, 5). It was known in 1966 that domestic workers had not arisen to fill the open positions (U.S. Senate, 1966, 62–63). A report by Senator George Murphy (U.S. Senate, 1966, 64–77) describes the failed efforts of numerous farms to recruit and retain domestic interstate migrant workers in 1965. This result came despite many years of state and federal efforts to actively recruit domestic farm workers, both prior to *bracero* exclusion and immediately afterward (U.S. Senate, 1966; Metzler et al., 1967).

The *bracero* agreements are sometimes portrayed as a government policy to 'import' labor to offset shortages originating in the absence of U.S. workers during World War Two (e.g. Scruggs, 1963) and the Korean War (e.g. Morgan, 2004, 127). They are more correctly described as a relaxation of restrictions on private employers' contracting with Mexican workers, given that the principal lever of government policy in regulating migration—as in regulating trade—is the degree of restriction on private firms.[2] Long before the *bracero* agreements, there was large-scale private-sector Mexican labor supply to the U.S. Southwest and Great Plains states, from the late 19th century through the 1920s (Clark, 1908; Gamio, 1930; Smith, 1981; Durand et al., 2000). In Arizona, Kansas, and New Mexico, the Mexican-born fraction of the labor force was much higher in 1930—in peacetime—than it would be again until after 1990 (Borjas and Katz, 2007, 19). In 1929 began 13 years of tight restrictions including mass deportations that reduced the Mexican-born fraction of the U.S. by a third.[3] The *bracero* agreements temporarily eased these restrictions, from the 1940s until *bracero* exclusion after 1964.

A2 Data sources

Data on seasonal hired farm workers (foreign and domestic) are monthly stocks of hired workers on farms by state from 1943 to 1973. State coverage is complete after 1953, the period relevant to the empirics, but there are gaps before that. Due to changes in bureaucratic organization and responsibilities over this time period, the final publication outlet for these data varies. Worker numbers for 1943–1947 and 1954–1973 were compiled from six different Department of Agriculture and Department of Labor publications held in four archival locations. Data was not compiled on a national level for 1948–1953; state-level information for this time period for 15 states was sourced from twelve archival locations and library systems.

[2] The *bracero* agreements did not subsidize U.S. employers' hiring of Mexican workers, as employers paid for the wages, housing, and transportation of those workers.

[3] Most Mexican departures during the 1930s arose from an organized deportation campaign begun by President Herbert Hoover—the first important *de facto* restriction of labor mobility across the border—though roughly 40 percent of emigrants departed voluntarily as jobs dried up (Taylor 1934, pp. 23–25; Gratton and Merchant 2013, 957–959). Before 1929 there was very little restriction on labor mobility: "As late as 1928, [the Border Patrol] had only 747 men to police the vast international boundaries (Canadian and Mexican) under its jurisdiction. Nor did members of the organization ever consider the apprehension of would-be illegal Mexican immigrants to be their primary function until the very end of the decade: most of their efforts went towards the enforcement of customs regulations and prohibition laws" (Cardoso, 1980, 84).

For the main analysis period of 1953-1973, the information published in government sources over this time period was originally gathered through a monthly farm survey conducted by the Department of Labor's state-level employment service offices using the ES-223 form. The survey covered approximately 269 agricultural reporting areas: those with over 500 seasonal workers, any foreign workers, or with either significant shortages of farm workers or surpluses available for other areas. (DOL, 1956). The form defined seasonal hired workers as those hired to work on a farm for fewer than 150 consecutive days. Domestic workers encompass three separate, mutually exclusive groups: local (those living within commuting distance); intrastate (those whose permanent residence is elsewhere in the state but who are temporarily residing in the area of employment for the purpose of farm work); and interstate (those whose permanent residence is in a state different from the area of farm employment). It is important to note that the form defined foreign workers as those "who have legally entered the continental United States but who normally reside in a foreign country," specifically indicating that "illegal entrants are not to be included" (DOL, 1955). Data therefore exclude unauthorized farm workers. This survey was often used in combination with state and local office records to yield the final estimate; the exact methodology varied by state. (DOL, 1956). Survey results were reported in the unpublished U.S. Department of Labor series 'In-Season Farm Labor Reports' for collation at the national level (USDA, 1986, 17). Foreign seasonal worker employment data for 1943–1947 were reported in the same Department of Agriculture as farm wage data, described below.

This separate Department of Agriculture survey collected information on farm wage rates in areas estimated to employ over 500 migrant and/or seasonal farm workers during the enumeration period. Each survey respondent was asked to report average wage rates for hired farm labor in his/her locality on the date of enumeration. The survey was typically completed by 20,000–25,000 farmers each month by mail. These farm wages (and foreign worker numbers in the early years) were then reported quarterly in the Department of Agriculture publication *Farm Labor*, available online through Cornell University's Mann Library. We utilize two different wage measures with varying coverage. The first, the hourly composite wage rate, is a weighted average of reported per-hour rates calculated by the Department of Agriculture. These data are available from 1948–1970 with full geographic coverage. As a robustness check, we also use the daily wage without board, which covers more years but omits three states in most years (California, Oregon, and Washington). We report our findings using both wage measures.[4]

We are unable to directly observe the degree of sampling error or respondent bias in these farm surveys. But there is little evidence that these were large. First, the Departments of Agriculture and Labor constructed the samples to be representative of farms in each state. Contemporary criticism of the surveys centered on inconsistent definitions of hired 'workers' and treatment of family labor (Johnson and Nottenburg, 1951)—neither of which are an important concern with *bracero* workers—and did not mention concerns with sampling. Second, the same farms reported both the numbers of hired workers on their own farms and wages "in your locality." If there were discord between their survey reports of hired Mexican workers and reports from other sources, this would suggest that the sampled farms inadequately covered areas with Mexican workers and could miss any effects on wages those workers might have. But national totals of Mexican workers as reported in the farm surveys accord well with independent reports of *bracero* volumes departing Mexico, suggesting that the farm surveys exhibit good coverage of the establishments and geographic areas that employed Mexican seasonal labor.[5] Third, some of the most obvious forms of possible respondent bias would tend to make the subsequent analysis overstate the effects of *braceros* on labor market conditions. For example, if employers systematically understated the number of Mexican workers they hired, this would tend to bias upward any estimated wage impact of those workers.[6] Alternatively, if employers systematically reported agricultural wages as those paid only to non-Mexican workers, this would only make the wage reports more useful for the purpose of estimating the effect of Mexican workers on domestic workers.

[4]Farmers were asked about the going rate for hired farm labor in their locality. Thus if *bracero* workers were paid less than domestic workers, we would predict a purely compositional effect on the average wage in a locality due to removing *braceros*, separate from the equilibrium-price effect. Because no contemporary observers claimed that *braceros* were paid more than domestic workers, and many claimed the opposite (e.g. Galarza, 1956), we thus interpret the wage effects we measure—comprising both compositional and price-equilibrium effects—as upper bounds on the pure price-equilibrium effect.

[5]The data sources are compared below.

[6]For instance, if 10,000 workers caused wages to fall by one percent, but the presence of only 5,000 was reported on the surveys, the wage decline per Mexican worker would be estimated as double its true value. In subsection A5.7 we present independent corroborating data from the Mexican government suggesting that U.S. farmers did not greatly understate their employment of *braceros* in the U.S. Department of Agriculture surveys.

A2.1 State-level stocks of Mexican and non-Mexican farm workers

This section describes our construction of a novel database of monthly stocks of seasonal agricultural workers in the 48 continental United States, 1943–1973. It offers full monthly coverage of all 48 states from April 1953 to July 1973, with three minor gaps (July 1953, October 1953, and January–March 1970). This is the period that is relevant for the analysis in the present paper. The database also covers the earlier period of 1943–1953, but with some important gaps: state coverage is complete from June 1943 to December 1947 (except April 1944), but for the period January 1948 to March 1953, only four states have complete coverage, while another 11 states have partial coverage. Details follow below.

April 1953–June 1973, the relevant period for the present paper: Agricultural worker data from April 1953 to July 1973 was compiled as follows. Data for each month is typically reported in the month following (e.g. April 1953 worker statistics reported in May 1953 publication issue). The dates in this section refer to the month of employment, not the month of publication. Farm employment data are typically published in a clearly labeled appendix to each issue; the title of the relevant table varies slightly but is typically "Estimated employment and origin of seasonally hired workers in agriculture and food processing by State and selected agricultural reporting areas." Though data are reported at a sub-state level for some locations, we collect aggregate state information only. These reports were published seasonally, typically excluding winter months when minimal farm work occurred.[7] Data for July 1953, October 1953, and January–March 1970 were missing from all locations.

- April to September 1953: *Farm Labor Market Developments* (Library of Congress).
- November 1953: *Farm Labor Market Developments Employment and Wage Supplement* (National Agricultural Library).
- May 1954 to May 1957: *Farm Labor Market Developments Employment and Wage Supplement* (Library of Congress).
- June 1957: *Farm Labor Market Developments Employment and Wage Supplement* (National Agricultural Library).
- July 1957: *Farm Labor Market Developments Employment and Wage Supplement* (Library of Congress).
- August 1957: *Farm Labor Market Developments Employment and Wage Supplement* (National Agricultural Library).
- September 1957 to November 1957: *Farm Labor Market Developments Employment and Wage Supplement* (Library of Congress).
- May 1958: *Farm Labor Market Developments Employment and Wage Supplement* (National Agricultural Library).
- June 1958: *Farm Labor Market Developments Employment and Wage Supplement* (Library of Congress).
- July 1958: *Farm Labor Market Developments Employment and Wage Supplement* (National Agricultural Library).
- August 1958 to December 1959: *Farm Labor Market Developments Employment and Wage Supplement* (Library of Congress).
- May 1960 to May 1962: *Farm Labor Market Developments Employment and Wage Supplement* (Wirtz Labor Library).
- June 1962 to November 1962: *Farm Labor Market Developments Employment and Wage Supplement* (Library of Congress).
- December 1962 to November 1963: *Farm Labor Market Developments Employment and Wage Supplement* (Wirtz Labor Library).

[7] Omitted months are December to April for 1954, 1958, 1961, and 1962; December to March for 1955, 1956, and 1957; January to May for 1959; January to April for 1960; November and December for 1967.

- December 1963 to November 1964: *Farm Labor Market Developments Employment and Wage Supplement* (National Agricultural Library).
- December 1964 to October 1967: *Farm Labor Developments Employment and Wage Supplement* (National Agricultural Library).
- January 1968 to July 1970: *Farm Labor Developments* (National Agricultural Library).
- August 1970 to July 1973: *Rural Manpower Developments* (National Agricultural Library).

June 1943–December 1947: Hired seasonal farm worker statistics by state for June 1943 to December 1947 are reported in the United States Department of Agriculture National Agricultural Statistics Service's monthly *Farm Labor* publication, made available online through Cornell University's Mann Library. Each issue features a table of "foreign workers employed in or available for agricultural work by country of origin and state of employment." The date of reference for these tables varies; for those dated at the beginning of a month, we assume the workers reported were present in the month prior. For example, figures for workers present in April 1944 were taken from the May 1944 issue of *Farm Labor*. The publication reports all major groups of foreign workers present: typically Mexican, Bahamian, and Jamaican. The April 1944 issue reports only Bahamian and total numbers; there is no separate category for Mexican workers. Data for April 1945 is missing.

January 1948–March 1953: To our knowledge there is no primary- or secondary-source national compilation of state-level hired seasonal farm worker data for January 1948 to March 1953. We initially sought such a compilation in six archival locations.[8] U.S. National Archives staff supported the hypothesis that due to bureaucratic reorganization during this time period—responsibility for this data collection shifted from the Department of Agriculture to the Department of Labor—no such collation either existed or was made public. Since the ES-223 form was implemented by local employment service offices, we found it plausible that if any such data existed, it might be on a state level. We were able to track down at least partial data for fifteen states for this time period from twelve university libraries and archival locations. We were able to fill the gap entirely for four states: Arizona, California, Michigan, and Virginia. Data for individual states was sourced as follows (we exclude other available publication volumes that did not provide sufficiently granular information for inclusion in the database):

- *Arizona (1948–1953)*: 1948: Post-Season Farm Labor Report for 1948, table on p. 7 (Arizona State University); 1949: Post-Season Farm Labor Report for 1949, domestic numbers from table on p. 14 and bracero numbers from text on p. 20 (Arizona State University); 1950–1953: Agricultural Employment in Arizona 1950–1964, table on p. 10 (Wirtz Labor Library).
- *Arkansas (1951–1953)*: 1951: Arkansas Agricultural Activities 1951, table on p. 49, data from first semi-monthly period; 1952: Arkansas Agricultural Activities 1952, table on p. 45, data from first semi-monthly period; 1953: Arkansas Annual Agricultural Report 1953, table on p. 13 qualified by text on pp. 5–6 (all from University of Arkansas).
- *California (1948–1953)*: 1948, 1949, 1950: Recruitment and Placement of Farm Laborers in California 1950 (Special and Partial Report of the Joint Legislative Committee on Agriculture and Livestock Problems, California Senate), table on p. 22 (Wirtz Labor Library); 1951 & 1952: California Annual Farm Labor Report 1952, table on p. 33 (University of Colorado Boulder); 1953: California Annual Farm Labor Report 1954, table on p. 7 (Wirtz Labor Library).
- *Colorado (1949, 1950, 1953)*: 1949: Colorado Post Season Farm Report 1949, text on p. 13; 1950: Colorado Post Season Farm Report 1950, text on p. 14; 1953: Colorado Post Season Farm Report 1953, text on p. 16 (all from Colorado State Library).
- *Indiana (1950, 1952, 1953)*: 1950: Indiana Post Season Farm Labor Report 1950, table on p. 47; 1952: Indiana Farm Labor Report 1952, table entitled "Out of State Workers Employed in Seasonal Agricultural and Food Processing Activities," n.p. 1953: Indiana Farm Labor Report 1953, table entitled "Out of State Workers Employed in Seasonal Agricultural and Food Processing Activities," n.p. (all from Wirtz Labor Library).

[8] U.S. National Archives (College Park, MD), U.S. Department of Agriculture National Agricultural Library (Beltsville, MD), U.S. Department of Labor Wirtz Labor Library (Washington, DC), Library of Congress (Washington, DC), Harry S. Truman Presidential Library (Independence, MO), Dwight D. Eisenhower Presidential Library (Abilene, KS).

- *Louisiana (1952, 1953)*: 1952: Louisiana Post-Season Agricultural and Food Processing Report 1952, text on p. 10; 1953: Louisiana Annual Farm Labor Report 1953, table on p. 19 qualified by text on p. 20 (all from Wirtz Labor Library).
- *Maryland (1948, 1949, 1953)*: 1948 & 1949: The Maryland Farm Labor Program 1948–1949, text on page beginning "A careful appraisal of each crew leader ...", n.p. (Wirtz Labor Library); 1953: Maryland's Farm Labor Report 1953, text pp. 14–15 (University of Maryland College Park).
- *Michigan (1948–1953)*: 1948: Post Season Farm Labor Report State of Michigan 1948, table p. 18 (University of Michigan HathiTrust); 1949: Characteristics of Migratory Farm Labor in Michigan, table entitled "Agricultural and Food Processing Industries Seasonal Labor Force for 1949", n.p. (Truman Presidential Library, President's Committee on Migratory Labor (Record Group 220), Box 8, Folder "Hearing statements, Saginaw, Michigan, September 11–12, 1950"); 1950: Characteristics of Migratory Farm Labor in Michigan, table entitled "Agricultural and Food Processing Industries Seasonal Labor Force for 1950", n.p. (Truman Presidential Library, President's Committee on Migratory Labor (Record Group 220), Box 8, Folder "Hearing statements, Saginaw, Michigan, September 11–12, 1950"); 1951: Post Season Farm Labor Report State of Michigan 1951, table p. 13 (Wirtz Labor Library); 1952: Post Season Farm Labor Report State of Michigan 1952, table p. 12 (Wirtz Labor Library); 1953: Post Season Farm Labor Report 1953, table p. 33 (Wirtz Labor Library).
- *Minnesota (1950–1953)*: 1950: Post Season Agricultural and Food Processing Report 1950, summed by month from table entitled "Seasonal Agricultural Workers Hired for Principal Minnesota Farm Crops — 1950", n.p. ; 1951: Post Season Agricultural and Food Processing Report 1951, summed by month from table p. 14; 1952: Post Season Agricultural and Food Processing Report 1952, summed by month from table p. 14; 1953: Post Season Agricultural and Food Processing Report 1953, summed by month from table entitled "Seasonal Labor Used for Principal Farm Crops — 1953", n.p. (all from Minnesota Historical Society).
- *New Jersey (1949)*: Post-Season Agricultural and Food Processing Report for State of New Jersey 1949, text from p. 10 (Wirtz Labor Library).
- *New Mexico (1948, 1953)*: 1948: Annual Report Farm Placement in New Mexico 1949, text from p. 12; 1953: Annual Report Farm Placement in New Mexico 1955, text from p. 6 in comparison with "Exhibit C: State Summary — Employment," n.p. (both from University of New Mexico).
- *New York (1950)*: 1950 Annual Report Farm and Food Processing Labor, text from p. 9 (Wirtz Labor Library).
- *Oregon (1950, 1952, 1953)*: 1950: Oregon's Farm Labor Market, table entitled "Number of Hired Seasonal Agricultural Workers by Type of Worker, 1950," n.p. (Truman Presidential Library, President's Committee on Migratory Labor (Record Group 220), Box 8, Folder "Hearing statements, Portland, Oregon, October 16–18, 1950"); 1952: Post-Season Farm Labor Report 1952, Table C ("Number of Hired Seasonal Workers in Agriculture by Local Office and Type of Worker — 1952)", qualified by text on page beginning "carried on through the Clearance Program ..." n.p. (Wirtz Labor Library); 1953: Post-Season Farm Labor Report 1953, Table 5 ("Number of Hired Seasonal Workers in Agriculture by Agricultural Area, Local Office, and Type of Worker — 1953"), qualified by text on page beginning "it was estimated early in the season ..." n.p. (Wirtz Labor Library).
- *Virginia (1948–1953)*: 1948: Post-Season Farm Labor Report for 1948 State of Virginia, table on p. 12 qualified by text on p. 4 (Truman Presidential Library, President's Committee on Migratory Labor (Record Group 220), Box 8, Folder "Hearing statements, Washington, D.C., October 2–3, 1950"); 1949: Farm and Processing Labor Virginia 1949, text on p. 24 (University of Virginia); 1950: Farm and Food Processing Worker Placement Virginia 1950, text on p. 22 (Wirtz Labor Library); 1951: Farm Employment in Virginia 1951, table on p. 51 qualified by text on p. 45 (Wirtz Labor Library); 1952: Farm Employment in Virginia 1952, table on p. 44 qualified by text on p. 39 (Wirtz Labor Library); 1953: Farm Employment in Virginia 1953, table on p. 32 qualified by text on pp. 23–24 (Wirtz Labor Library).
- *Washington (1951, 1953)*: 1951: Annual Farm Placement Report 1951, Attachment 4A ("State of Washington Estimated Employment of Hired Seasonal Workers in Agriculture in 1951"), data from first semi-monthly period, n.p. ; 1953: Annual Farm Placement Report 1953, text from p. 11 (both from Wirtz Labor Library).

Measures of Mexican contract workers, local (domestic, nonmigratory) workers, intrastate migrants, and interstate migrants were consistent across the full time period. Information on other foreign workers was inconsistently collated in different publications. Jamaican and Bahamian workers were identified as such from 1943–1947; combined under the umbrella "British West Indies" from 1946 to 1954 and 1959 to 1973; and aggregated as "British West Indies and others" from 1953–1958. A similar trend holds for Canadians, identified as a single group from 1943 to 1954 and 1966 to 1972 and aggregated into "Canadians and others" from 1959–1964. "Other foreign" workers are reported from 1944–1954 and 1964–1966. Data on Puerto Rican workers are reported for the full time period.

A2.2 Wages

All farm wage data were sourced from the Department of Agriculture publication *Farm Labor* on a quarterly basis. The daily wage without board measure was consistently reported for the relevant quarter: for example, July 1945 rates reported in the July 1945 publication issue. Hourly composite wage rates are available beginning in January 1948. This composite index was computed by "converting the monthly, weekly, and daily rates to an hourly basis and weighting the rates by approximate distributions of workers hired by the different arrangement." (USDA, 1969, 16). The measure was rebased with new weights from a 1948 agriculture survey in the January 1951 edition of *Farm Labor*; we source data for January 1948 to October 1950 from this issue. Beginning in January 1951, hourly composite rates are reported alongside the daily without board rate in the relevant quarterly issue. The hourly wage has full state coverage but fewer years (1948–1971); the daily wage has more years (1942–1975) but is missing three states (CA, OR, WA) for most years (1951–1962 and 1965–1975). In order to balance the panel, we set the latter measure for these three states to missing for all years.

A2.3 Data availability, entry, and reconciliation

We began the search for missing worker data from 1948 to 1953 at the National Archives in College Park, Maryland. Data prior to 1948 was collected by the Bureau of Agricultural Economics in the Department of Agriculture; these records fall under Archives Record Group 83. Upon the abolition of this office in 1953, the Office of Employment Security of the Department of Labor assumed responsibility for collating and publishing data on farm employment in 1954; these records fall under Record Group 183 (U.S. National Archives, n.d.). Upon review of the relevant files for the years in question and consultation with archivists, it became clear that most of the National Archives content was correspondence and testimony. It was suggested that any historical statistical information would likely be stored within the Federal Depository Library system, charged with collecting and storing official government publications. Under the Superintendent of Documents Classification (SuDocs) system of the United States Government Publishing Office (GPO), the relevant files (Bureau of Employment Security) are held under SuDocs stem L7. Thanks to the help of Celina Nichols McDonald at the University of Maryland, we sent a request for this catalog entry to all US Federal Depository Libraries; none held the information we were looking for. With the help of Julie Day from the Department of Labor Wirtz Labor Library, we ascertained that Washington University in St. Louis, Missouri and the Dwight D. Eisenhower Presidential Library in Abilene, Kansas, possessed SuDocs L7 holdings. The former did not seem to include granular information on foreign workers; the latter not only held information under this call number, but also the full record of the President's Commission on Migratory Labor and supporting information, from 1938 to 1966.[9]

We therefore visited the Eisenhower Library in December 2015, pulling all archival material potentially related to *bracero* employment from 1948–1953. From record group 220 (U.S. President's Committee on Migratory Labor) this included boxes 1–4, 11–14, 62–76, 87–97, and 99. From the broader Migratory Labor subject guide, this included boxes 102, 139, 141, and 178 of the Mitchell papers; box 4 of the Eisenhower papers (Ann Whitman file), box 17 of the Oveta Culp Hobby papers, box 13 of the Clyde Wheeler papers, and boxes 10 and 20 of the White House Cabinet Secretariat records. We also visited the Harry S. Truman Presidential Library in Independence, Missouri for their nine boxes of material on the U.S. President's Committee on Migratory Labor.[10] These searches yielded important yet sporadic worker data by state to fill the national level gap from 1948 to 1953, as well as qualitative background material and methodological information.

[9] Full migratory labor subject guide available online.

[10] Box list available online.

We also reviewed all potentially relevant congressional hearings for this period stored at the Library of Congress. Though some offered relevant information, most data reported was for hires/contracts or border crossings over a certain time period, not the monthly stock estimates of farm employment we sought. This extensive archival work, in combination with a 1978 records disposal request authorizing the disposal of original ES-223 forms and related reports, gives us confidence that our dataset is complete to the fullest extent possible.

We outsourced the entry of both worker and wage data from scanned PDFs to Excel to two separate data entry professionals on Upwork, an online network for freelancers. These two individuals were selected through a rigorous sample data entry process; any discrepancies between the final dual entry datasets were hand-checked and harmonized in Stata to yield the final database.

A2.4 U.S. state population and harvested farmland

The 1950 total population of each U.S. state is from Richard L. Forstall (1996), *Population of the States and Counties of the United States: 1790 to 1990*, Bureau of the Census, U.S. Dept. of Commerce, Washington, DC: Government Printing Office. The 1954 acreage of total harvested farmland by state, from the Census of Agriculture, is from Edwin D. Goldfield (1957), *Statistical Abstract of the United States 1957*, Table 784, page 618. In each case the year of data was selected to be the latest available year that was predetermined relative to 1955 (the year the 'treatment' stock of *braceros* is measured).

A2.5 Total hired farmworkers (35 states)

State-by-month stocks of total hired farmworkers (including both Mexican and non-Mexican, and both seasonal and non-seasonal) were gathered from the Department of Agriculture publication *Farm Labor*, available online through Cornell University's Mann Library. Counts are reported from August 1957 through December 1973. 11 states are missing because the original sources do not report separate worker counts for those individual states, only by regional aggregations (e.g. 'New England'). These missing states are AZ, CT, DE, MA, MD, ME, NM, NV, UT, VT, and WY.

The methodology underlying these farm employment estimates varies in a number of key ways from that for the seasonal hired farm worker stocks utilized in the main analysis. The data were compiled from a variety of sources, including a mail questionnaire collected each month from approximately 20–25 thousand farmers—the same Department of Agriculture sample as for our wage data. In contrast to the seasonal worker data, this sample was chosen independently of any seasonal or foreign labor needs. These data were considered in combination with benchmark data from the most recent population census, baseline estimates of farm employment from a 1945–1948 nationally representative study, historical data on agricultural manpower requirements, and annual estimates of the number farms by states and regions to yield final the estimates (USDA, 1969, 15). These *Farm Labor* 'hired worker' estimates include all individuals doing one or more hours of farm work or chores for pay during the week and do not differentiate by national origin. The estimates focus solely on the total manpower requirements for crop production, in contrast to the specific reporting of authorized foreign workers and other seasonal agricultural labor needs in the data used for the main analysis.

A3 Details and derivation of the model

Placing land and materials in a separate CES nest allows us to mostly abstract from materials, though their costs will factor into the decision of how much land to use (in (A.1), below). We also assume, consistent with the evidence in Herrendorf et al. (2015) that $\mu, \sigma > 1$. K_0 is elastically supplied at rental rate r_0, so in equilibrium,[11] $r_0 = \left\{K_0^{\frac{\mu-1}{\mu}} + \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{1}{\mu-1}} K_0^{\frac{-1}{\mu}}$, and thus $Y_0 = \left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}} \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$. Farmers are willing to rent land as long as $r_T + m$ is less than the marginal product of land. This implies that there is a cutoff $\bar{\phi}$ such that if

[11] Derived below.

$\overline{L}/\overline{T} < \bar{\phi}$, farmers will not rent all of the land available. This cutoff is defined by

$$(1-a)\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a\bar{\phi}^{\frac{\sigma-1}{\sigma}}+(1-a)\right]^{\frac{\sigma}{\sigma-1}-1}=\underline{r_T}+m. \tag{A.1}$$

A potentially binding cutoff exists only if $\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}(1-a)^{\frac{\sigma}{\sigma-1}} < \underline{r_T}+m$ (which, notice, can occur even if $\underline{r_T}=0$). The existence of this cutoff implies that the equilibrium wage never exceeds $\overline{w}=a\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a+(1-a)\bar{\phi}^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1}=\left[\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{-\frac{\mu(\sigma-1)}{\mu-1}}-(1-a)^{\sigma}(\underline{r_T}+m)^{1-\sigma}\right]^{-\frac{1}{\sigma-1}}$. If the cutoff binds, only $\overline{L}/\bar{\phi}$ acres of land will be used.

In equilibrium, advanced production satisfies $Y_A=\left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[bL^{\frac{\sigma-1}{\sigma}}+(1-b)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$. It also only meaningful to talk about there being an "alternative technology" if each technology would be employed at least *some* values of labor/land ratios, which requires that $\left(\frac{1-a}{1-b}\right)^{\sigma} < \left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}/\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}(\sigma-1)} < \left(\frac{a}{b}\right)^{\sigma}$. Thus, without loss of generality, we assume that this condition holds whenever an alternative technology exists.[12]

Because it is more land intensive, the advanced technology is more productive only at low levels of labor per unit of land. The advanced technology does not dominate the traditional technology in the sense of producing more from given inputs. The optimal choice of technology depends on highly localized conditions of land price and capital price.[13] Indeed, farmers may use a combination of technologies in a competitive equilibrium. Let $[\phi_\ell,\phi_u]$ be the range of $\overline{L}/\overline{T}$ over which this occurs. That is, there exists an allocation of land (T_0, T_A with $T_0+T_A=\overline{T}$) and labor (L_0, L_A with $L_0+L_A=\overline{L}$) to each technology such that the marginal products of land and labor are the same in each technology—the cone of diversification. At the upper end, only the older technology is used, and at the lower end only the advanced technology is used. The cone of diversification is defined by the solution $[\phi_\ell,\phi_u]$ to

$$\begin{aligned}\hat{w}&=a\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a+(1-a)\phi_u^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1}=b\left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[b+(1-b)\phi_\ell^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1}\\ \hat{r_T}&=(1-a)\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a\phi_u^{\frac{\sigma-1}{\sigma}}+(1-a)\right]^{\frac{\sigma}{\sigma-1}-1}=(1-b)\left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[b\phi_\ell^{\frac{\sigma-1}{\sigma}}+(1-b)\right]^{\frac{\sigma}{\sigma-1}-1},\end{aligned} \tag{A.2}$$

where $\hat{w}$ and $\hat{r_T}$ are the fixed wage, and land rental rates, respectively, inside the cone. Dividing the first by the second equation reveals that $\phi_u=\left(\frac{1-b}{b}\frac{a}{1-a}\right)^{\sigma}\phi_l$, and hence that $\phi_u>\phi_l$, as is required for the existence of a meaningful cone of diversification. Furthermore,

$$\phi_l=\left(\frac{1-b}{b}\right)^{\frac{\sigma}{\sigma-1}}\left[\frac{\left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}\Big/\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}(\sigma-1)}-\left(\frac{1-a}{1-b}\right)^{\sigma}}{\left(\frac{a}{b}\right)^{\sigma}-\left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}\Big/\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}(\sigma-1)}}\right]^{\frac{\sigma}{\sigma-1}} \tag{A.3}$$

[12] Specifically, this is a necessary condition for the cone of diversification to exist. In contrast, if $\left(\frac{1-a}{1-b}\right)^{\sigma} > \left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}/\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}(\sigma-1)}$, then the alternative technology would produce less output than the traditional technology at all combinations of inputs (and so would never be used). The alternative technology will also never be used if $\bar{\phi}$ exceeds the labor/land ratio at the upper end of the cone of diversification, ϕ_u, defined below.

[13] Even if capital is frictionlessly mobile, the price of hiring capital could vary from place to place. For example, the efficient use of a particular machine could depend on planting an improved seed variety, the suitability of which could depend on local soil conditions.

Notice that the condition for the cone to exist is equivalent to $\phi_l > 0$, that is, there are positive land/labor ratios in which each technology is used. The wage inside the cone can also be written as

$$\hat{w} = b^{\frac{\sigma}{\sigma-1}} \left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}} \left[\frac{\left(\frac{a}{b}\right)^{\sigma} - \left(\frac{1-a}{1-b}\right)^{\sigma}}{\left(\frac{r_A^{\mu-1}}{r_A^{\mu-1}-1} \Big/ \frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}(\sigma-1)} - \left(\frac{1-a}{1-b}\right)^{\sigma}}\right]^{\frac{1}{\sigma-1}}. \tag{A.4}$$

Why are wages invariant to factor supply inside the cone? It is because factor proportions are fixed within each technology.[14] Regardless of factor supply, if the economy's labor/land ratio is inside the cone, i.e., if $\overline{L}/\overline{T} \in [\phi_\ell, \phi_u]$, then the advanced technology will be employed at labor/land ratio ϕ_ℓ and the old technology will be employed at labor/land ratio ϕ_u. In both cases, the marginal product of labor is given by $\hat{w}$, the market wage. To prove this, one needs only to show that there is an allocation of land and labor to each technology at these factor proportions that clears both markets. There is. Define T_A and L_A, respectively, as the land and labor allocated to the advanced, and T_0 and L_0 as the land and labor allocated to the old technology. The share of land allocated to advanced and old technologies is given, respectively, by $\frac{T_A}{\overline{T}} = \frac{\phi_u - \overline{L}/\overline{T}}{\phi_u - \phi_\ell}$ and $\frac{T_0}{\overline{T}} = \frac{\overline{L}/\overline{T} - \phi_\ell}{\phi_u - \phi_\ell}$. Notice that if $\overline{L}/\overline{T} \in [\phi_\ell, \phi_u]$, these are both between zero and one and they add up to one. Finally, using the fixed factor ratios in each technology, $L_A = \phi_\ell T_A$ and $L_0 = \phi_u T_0$, clears the labor market:

$$L_A + L_0 = \overline{T}\left(\phi_\ell \frac{T_A}{\overline{T}} + \phi_u \frac{T_0}{\overline{T}}\right) = \overline{T}\left(\phi_\ell \frac{\phi_u - \overline{L}/\overline{T}}{\phi_u - \phi_\ell} + \phi_u \frac{\overline{L}/\overline{T} - \phi_\ell}{\phi_u - \phi_\ell}\right) = \overline{L}.$$

Therefore, wages are constant within the cone of diversification. Below we describe the results with capital and labor in the inner nest instead, making the advanced technology explicitly more capital intensive. It would also be possible to model the advanced technology as more skill-intensive, similar to Beaudry et al. (2010).[15] Indeed, any pair of production functions with output expansion paths that cross, like in Figure 1, will have a cone of diversification.

Portions of the model in the main text are derived as follows.

A3.1 Equilibrium output under traditional technology

The expression for Y_0 at equilibrium is derived by noting that

$$\begin{aligned}
r_0 &= \left\{K_0^{\frac{\mu-1}{\mu}} + \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{1}{\mu-1}} K_0^{-\frac{1}{\mu}} \\
\iff r_0^{\mu-1} &= 1 + K_0^{\frac{1-\mu}{\mu}} \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}} \\
\iff K_0 &= \left(r_0^{\mu-1} - 1\right)^{\frac{\mu}{1-\mu}} \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}},
\end{aligned}$$

and substituting into the production function we have that

$$Y_0 = \left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}} \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}.$$

[14] This "factor price insensitivity" result is the same as in the traditional two-sector small, open economy interpretation of this model. See Leamer (1995).

[15] Harper (1967) argued that mechanized harvest of tomatoes was not really less labor intensive, but instead less low-skill labor intensive, replacing low- with high-skill labor (e.g. the harvester operator).

A3.2 Change in wage with and without capital adjustment

Expression (4) uses the fact that $\frac{\partial \ln w}{\partial \ln(L/T)} = \left(\frac{\mu}{\mu-1} - 1\right)(1 - s_K)\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}\frac{\sigma-1}{\sigma}\frac{s_L}{1-s_K} + \frac{\mu-\sigma}{(\sigma-1)\mu}\frac{s_L}{1-s_K}\frac{\sigma-1}{\sigma} + \frac{-1}{\sigma}$. This comes from differentiating the expression for the wage under the traditional technology, and substituting in expressions for factor shares which are:

$$s_K = \frac{r_0 K_0}{Y_0} = \left\{K_0^{\frac{\mu-1}{\mu}} + \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{-1} K_0^{\frac{\mu-1}{\mu}}$$

$$1 - s_K = \left\{K_0^{\frac{\mu-1}{\mu}} + \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{-1} \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}$$

$$s_L = a\left\{K_0^{\frac{\mu-1}{\mu}} + \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{-1} \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}-1} L^{\frac{\sigma-1}{\sigma}}$$

$$\frac{s_L}{1-s_K} = \left[aL^{\frac{\sigma-1}{\sigma}} + (1-a)T^{\frac{\sigma-1}{\sigma}}\right]^{-1} aL^{\frac{\sigma-1}{\sigma}},$$

with $s_L + s_T = 1 - s_K$. After capital adjusts,

$$w = \left(\frac{r_0^{\mu-1}}{r_0^{\mu-1} - 1}\right)^{\frac{\mu}{\mu-1}} \left[a\left(\frac{L}{T}\right)^{\frac{\sigma-1}{\sigma}} + (1-a)\right]^{\frac{1}{\sigma-1}} a\left(\frac{L}{T}\right)^{-\frac{1}{\sigma}}.$$

$$\text{Thus } \frac{\partial \ln w}{\partial (B/L)} \approx -\frac{\partial \ln w}{\partial \ln(L/T)} = -\left[\frac{1}{\sigma-1}\frac{\sigma-1}{\sigma}\frac{s_L}{1-s_K} + \left(-\frac{1}{\sigma}\right)\right] = \frac{s_T}{s_L + s_T}\frac{1}{\sigma}.$$

A3.3 Alternative Nesting

The qualitative results presented are not dependent on the particular nesting of the CES structure used in the main text (nor are they even dependent on the CES functional form – see Figure 1). In particular, consider this alternative nesting:

$$Y_j = \left\{T_j^{\frac{\mu-1}{\mu}} + \left[a_j L_j^{\frac{\sigma-1}{\sigma}} + (1-a_j)K_j^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}},$$

where $j \in \{0, A\}$, where $a_0 > a_A$, where L_j,K_J and T_j denote the amount of labor, capital, and land applied to production process j, with $T_A + T_0 = \overline{T}$, $L_A + L_0 = \overline{L}$ and the kind of capital used in process j is supplied elastically at price r_j. This is similar to the model above, except capital is now in the inner nest of the CES form. (In the main text $a \equiv a_0$ and $b \equiv a_A$.)

Capital can no longer be simply factored out of this functional form, so define $k_j = K_j/T_j$ as the equilibrium capital/land ratio in process j (if it is used). So now the cone of diversification is defined by the k_0, k_A, ϕ_ℓ and ϕ_u that are the solution to the system of four equations

$$r_0 = (1-a_0)\left\{1 + \left[a_0\phi_u^{\frac{\sigma-1}{\sigma}} + (1-a_0)k_0^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1} \left[a_0\phi_u^{\frac{\sigma-1}{\sigma}} + (1-a_0)k_0^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}-1} k_0^{-\frac{1}{\sigma}} \quad \text{(A.5)}$$

$$r_A = (1-a_A)\left\{1 + \left[a_A\phi_\ell^{\frac{\sigma-1}{\sigma}} + (1-a_A)k_A^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1} \left[a_A\phi_\ell^{\frac{\sigma-1}{\sigma}} + (1-a_A)k_A^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}-1} k_A^{-\frac{1}{\sigma}} \quad \text{(A.6)}$$

$$\begin{aligned}\hat{w} &\equiv a_0 \left\{1 + \left[a_0\phi_u^{\frac{\sigma-1}{\sigma}} + (1-a_0)k_0^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1} \left[a_0\phi_u^{\frac{\sigma-1}{\sigma}} + (1-a_0)k_0^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}-1} \phi_u^{-\frac{1}{\sigma}} \\ &= a_A \left\{1 + \left[a_A\phi_\ell^{\frac{\sigma-1}{\sigma}} + (1-a_A)k_A^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1} \left[a_A\phi_\ell^{\frac{\sigma-1}{\sigma}} + (1-a_A)k_A^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}-1} \phi_\ell^{-\frac{1}{\sigma}}\end{aligned} \tag{A.7}$$

$$\hat{r_T} \equiv \left\{1 + \left[a_0\phi_u^{\frac{\sigma-1}{\sigma}} + (1-a_0)k_0^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1} = \left\{1 + \left[a_A\phi_\ell^{\frac{\sigma-1}{\sigma}} + (1-a_A)k_A^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1}. \tag{A.8}$$

By rearranging (A.8) and substituting into (A.7) one can show that $\phi_\ell = \phi_u \left(\frac{a_0}{a_A}\right)^\sigma < \phi_u$. Additional substitutions allow for closed form solutions for k_0, k_A, ϕ_ℓ and ϕ_u , $\hat{w}$ and $\hat{r_T}$.

In the absence of a viable alternative technology, the shutdown margin is the minimum labor/land ratio, $\overline{\phi}$, (and the capital/land ratio, $\overline{k}$) which solve the system:

$$\underline{r_T} + m = \left\{1 + \left[a_0\overline{\phi}^{\frac{\sigma-1}{\sigma}} + (1-a_0)\overline{k}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1}$$

$$r_0 = (1-a_0)\left\{1 + \left[a_0\overline{\phi}^{\frac{\sigma-1}{\sigma}} + (1-a_0)\overline{k}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}}\right\}^{\frac{\mu}{\mu-1}-1} \left[a_0\overline{\phi}^{\frac{\sigma-1}{\sigma}} + (1-a_0)\overline{k}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\frac{\mu-1}{\mu}-1} \overline{k}^{-\frac{1}{\sigma}}$$

Together, these equations imply that wages will never exceed

$$\overline{w} = a_0^{\frac{\sigma}{\sigma-1}} \left(\underline{r_T} + m\right) \left[(\underline{r_T} + m)^{\mu-1} - 1\right]^{-\frac{1}{\mu-1}} \left\{1 - (1-a_0)^\sigma \left(\frac{\underline{r_T} + m}{r_0}\right)^{\sigma-1} \left[\left(\underline{r_T} + m\right)^{\mu-1} - 1\right]^{-\frac{\sigma-1}{\mu-1}}\right\}^{-\frac{1}{\sigma-1}}.$$

A3.4 Model extensions

Domestic labor supply. Suppose non-*bracero* workers are drawn from a population P and supply labor to farms as $\ln \frac{N}{P} = \varepsilon \ln w$, with $\varepsilon > 0$. If $\frac{\partial \ln w}{\partial (B/L)} = 0$, then excluded *bracero* workers will not be replaced with domestic (non-*bracero*) workers. Alternatively if $\frac{\partial \ln w}{\partial (B/L)} > 0$, then domestic workers will flow into the farm sector, further reducing the magnitude of the wage response.[16] However, estimates of the domestic labor supply elasticity to the farm sector tend to be small (Devadoss and Luckstead, 2008; Clemens, 2017). Devadoss and Luckstead (2008) find that the simulated wage impacts of adding workers are nearly identical over a reasonable range of estimated supply elasticities.

Worker specialization. Now suppose there are two kinds of farm jobs, skilled (S) and unskilled (U), and redefine $L \equiv \left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L)S^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$. The expression for how average wages respond to a differential change in L/T remains as above, so to determine the impact of the *bracero* exclusion on average wages in this setup, we need only to update our expression for how it affects L/T. Log-differentiating, $d\ln(L/T) = \frac{s_U}{s_L} d\ln(U/T) + \frac{s_S}{s_L} d\ln(S/T)$, where s_U is the unskilled share of output and $s_S \equiv s_L - s_U$. So regardless of whether the *braceros* are skilled or unskilled, we can continue to expect $d\ln(L/T) < 0$, and thus weakly positive average wage impacts, as before.

The magnitudes may change, however. Consider briefly the specific case in which all *braceros* (and some non-*braceros*) are unskilled, so that $d\ln(L/T) = \frac{s_U}{s_L} d\ln(U/T) = \frac{s_U}{s_L} B/(B+N_U)$, where N_U is the non-*bracero* unskilled workforce. Also define N_S to be the skilled non-*braceros* workforce, so $N_U + N_S = N$. In this case, if $\frac{s_U}{s_L} < \frac{B+N_U}{B+N}$,

[16] In this case, ε could be estimated from the relative response of domestic employment, $\frac{\partial \ln N}{\partial (B/L)} / \frac{\partial \ln w}{\partial (B/L)}$.

then the average wage impact will be systematically smaller than was described above (and if $\frac{s_U}{s_L} > \frac{B+N_U}{B+N}$, it will be larger).

Furthermore, regardless of skill mix, the change in average wages is not necessarily the same as the change in wages for non-*bracero* workers. That is instead given by

$$\frac{N_U}{N}\mathrm{d}\ln w_U + \frac{N_S}{N}\mathrm{d}\ln w_S = \mathrm{d}\ln w + \left[\frac{N_S}{N}\frac{s_U}{s_L} - \frac{N_U}{N}\frac{s_S}{s_L}\right]\frac{1}{\rho}\mathrm{d}\ln\left(\frac{U}{S}\right), \tag{A.9}$$

where w_S, w_U are skilled and unskilled wages.[17] The term in brackets can be positive, which is especially likely when *braceros* are disproportionately unskilled.[18] In this case $d\ln\left(\frac{U}{S}\right) < 0$, so the average wages of non-*bracero* workers may even fall – rather than rise – after exclusion, an outcome that is more likely if skilled and unskilled labor are highly complementary (ρ small) or if we are in one of the cases where the average wage impact is near zero. Furthermore, this would lead to smaller magnitude increase (or even a decrease) in employment responses to the exclusion of *braceros* (using the model of labor supply above).

A3.5 Change in average wages under differentiated skill

Expression (A.9) uses the change in the average wages of skilled and unskilled workers as follows. Consider the traditional technology modified by the two labor types, S and U. The corresponding wages are

$$w_U = \alpha_L \cdot a\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a + (1-a)\left(\frac{L}{T}\right)^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}\left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L)S^{\frac{\rho-1}{\rho}}\right]^{\frac{1}{\rho-1}} U^{-\frac{1}{\rho}}$$

$$w_S = (1-\alpha_L) \cdot a\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a + (1-a)\left(\frac{L}{T}\right)^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}\left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L)S^{\frac{\rho-1}{\rho}}\right]^{\frac{1}{\rho-1}} S^{-\frac{1}{\rho}}$$

$$w_U U + w_S S = a\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a + (1-a)\left(\frac{L}{T}\right)^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}}\left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L)S^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}.$$

And in this setup define $s_L \equiv \frac{w_U U + w_S S}{Y_0}$ and $s_U \equiv \frac{w_U U}{Y_0}$. Then

$$\frac{s_U}{s_L} = \left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L)S^{\frac{\rho-1}{\rho}}\right]^{-1}\alpha_L U^{\frac{\rho-1}{\rho}}.$$

Note that the expression for $w_U U + w_S S$ can be also be used to show that the expression for average wages remains as it was before,

$$w = \frac{w_U U + w_S S}{L} = a\left(\frac{r_0^{\mu-1}}{r_0^{\mu-1}-1}\right)^{\frac{\mu}{\mu-1}}\left[a + (1-a)\left(\frac{L}{T}\right)^{-\frac{\sigma-1}{\sigma}}\right]^{\frac{1}{\sigma-1}},$$

since $L = \left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L)S^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$. This expression for w is equivalent to the expression for w in the preceding subsection.

One can also use the above expressions to show

$$d\ln w_U = d\ln w - \frac{1}{\rho}\left(1 - \frac{s_U}{s_L}\right)d\ln\left(\frac{U}{S}\right),$$

[17] Expression (A.9) uses expressions for the change in the average wages of skilled and unskilled workers derived below.

[18] $\frac{N_S}{N}\frac{s_U}{s_L} - \frac{N_U}{N}\frac{s_S}{s_L} > 0 \Leftrightarrow \frac{N_S}{N_U} > \frac{s_S}{s_U} = \frac{w_S(N_S+B_S)}{w_U(N_U+B_U)} = \frac{w_S N_S/N_U + w_S B_S/N_U}{w_U(1+B_U/N_U)} = \frac{w_S}{w_U(1+B_U/N_U)}\frac{N_S}{N_U} + \frac{w_S B_S/N_U}{w_U(1+B_U/N_U)}$, where B_U are unskilled *braceros* and B_S are skilled *braceros*. This holds for sufficiently high B_U/N_U, especially if B_S is small. Suppose, for example, that there are no skilled *braceros*, i.e., $B_S \equiv 0$. In that case, a sufficient condition is that $\frac{w_S}{w_U} < 1 + \frac{B_U}{N_U}$.

since $w_U = w \cdot \alpha_L \left[\alpha_L U^{\frac{\rho-1}{\rho}} + (1-\alpha_L) S^{\frac{\rho-1}{\rho}}\right]^{\frac{1}{\rho-1}} U^{-\frac{1}{\rho}} = w \cdot \alpha_L \left[\alpha_L + (1-\alpha_L)\left(\frac{U}{S}\right)^{-\frac{\rho-1}{\rho}}\right]^{\frac{1}{\rho-1}}$. Similarly,

$$d \ln w_S = d \ln w + \frac{1}{\rho}\frac{s_U}{s_L} d \ln\left(\frac{U}{S}\right),$$

since $w_S = w \cdot (1-\alpha_L)\left[\alpha_L \left(\frac{U}{S}\right)^{\frac{\rho-1}{\rho}} + (1-\alpha_L)\right]^{\frac{1}{\rho-1}}$.

A4 Descriptive statistics

Table A1 presents descriptive statistics for the variables used in the regressions in the main text.

Table A2 shows the fraction of total seasonal farm workers made up by Mexicans, averaged across the months of 1955, and the corresponding classification into groups of states with 'high', 'low', and 'no' exposure to *bracero* exclusion.

A5 Robustness checks

This section present a range of results to supplement the results in the main text and check their robustness to alternative assumptions and specifications.

A5.1 Parametric fixed-effects regressions

Here we present parametric linear fixed-effects regressions analogous to the semiparametric regressions presented in the main text. These use the specification

$$y_{st} = \boldsymbol{\alpha' I_s} + \boldsymbol{\beta' I_t} + \delta \ln L_{st}^{\text{mex}} + \zeta X_{st} + \varepsilon_{st},$$

where X_{st} is a time-variant state characteristic that in some regressions is the stock of non-Mexican hired seasonal workers, $\ln\left(L_{st} - L_{st}^{\text{mex}}\right)$. Table A3 shows this linear regression with two different farm wage indices as the outcome. Table A4 shows the specification with four different domestic seasonal farm employment measures as the outcome (total, local, intrastate migrant, and interstate migrant). In all cases the results are similar to those in the semiparametric regressions of the main text.

A5.2 Pre-trends

The differences-in-differences method in the main text rests on the 'common trends' assumption that outcome trends in high-exposure states and low-exposure states would have been similar in the absence of exclusion. Divergent trends prior to exclusion could suggest a violation of this assumption and therefore bias in the differences-in-differences estimates.

Here we explore the possibility of bias from pre-trends in three ways: By recasting the wage and employment regressions as year-by-year event-studies, by graphing the raw employment data for high-exposure states, and by running the core regressions from the main text with added state-specific time-trends. The results do not support substantial bias from pre-trends. Significant pre-trends are found only for employment and are no longer present when no-exposure states are excluded. As discussed in the main text, excluding no-exposure states still leaves a wide range of exposure in the dataset (Table A2), but does not substantially alter the conclusions of the core employment regressions.

Event studies: Figure A1 shows the core regressions with real hourly wage as the outcome, reformulated as a year-by-year event study. The wage in each quarter is used in a separate event study, with the omitted time dummy being the dummy for that quarter of 1964, and all four such event studies are overlaid. No confounding pre-trend is evident; if anything, the wage gap between high-exposure and low-exposure states was rising before exclusion, which would tend to bias the results toward finding a positive impact of exclusion on wages.

Appendix Table A1: Descriptive statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
State-by-quarter wage regressions					
Year	1958.128	9.6	1942	1975	6384
Quarter	2.489	1.121	1	4	6384
Wage, hourly (1965 US$)	0.905	0.222	0.154	1.578	4512
Wage, daily (1965 US$)	8.604	2.28	2.087	15.169	6077
$\ln(L^{\text{mex}})$	6.343	2.436	0	11.828	783
$\ln(L - L^{\text{mex}})$	9.118	1.44	2.89	12.431	1759
$I_{t\geqslant 1965} \cdot \overline{\ell}_s^{1955}$	0.016	0.068	0	0.609	6118
State-by-month employment regressions					
Year	1959.143	9.323	1942	1975	15831
Month	6.482	3.409	1	12	15831
Total domestic	11974.255	27401.271	0	260941	10777
Local domestic	9479.707	22438.368	0	248050	10777
Intrastate domestic	1627.754	5746.037	0	118315	6475
Interstate domestic	2523.787	4361.898	0	46643	6476
ln Total domestic	8.960	1.457	1.386	12.472	6491
ln Local domestic	8.676	1.524	1.386	12.421	6844
ln Intrastate domestic	6.061	1.897	0.693	11.681	4721
ln Interstate domestic	6.842	1.783	0.693	10.75	5842
$\ln(L^{\text{mex}})$	6.321	2.467	0	11.828	2417
$I_{t\geqslant 1965} \cdot \overline{\ell}_s^{1955}$	0.017	0.071	0	0.609	15181
State-by-year mechanization regressions					
Year	1963	7.214	1951	1975	1200
Cotton mechanization	0.526	0.375	0	1	344
Sugar beet mechanization	0.414	0.263	0	0.92	52
$\ln(L^{\text{mex}})$	6.037	2.041	2.204	11.218	299
$I_{t\geqslant 1965} \cdot \overline{\ell}_s^{1955}$	0.022	0.08	0	0.609	1150
State-by-year crop production regressions					
Year	1958.5	9.814	1942	1975	1632
Tomatoes	112.205	52.302	0	433.333	544
Cotton	83.162	32.698	1.471	222.54	301
Sugar beets	93.637	33.953	0	239.965	240
Asparagus	99.406	24.755	0	162.264	144
Strawberries (fresh)	107.856	64.745	10.087	520	434
Lettuce	111.163	61.193	31.586	681.592	276
Celery	131.24	113.755	41.176	986.667	162
Cucumbers (pickling)	131.184	61.445	41.698	425.139	106
Citrus	132.055	83.433	3.819	427.083	64
$\ln(L^{\text{mex}})$	5.95	1.929	1.712	11.218	408
$I_{t\geqslant 1965} \cdot \overline{\ell}_s^{1955}$	0.016	0.07	0	0.609	1564

Appendix Table A2: Mexican fraction of total seasonal farm workers, average across months of 1955

High exposure		Low exposure		No exposure	
NM	0.609	NV	0.090	ME	0.000
NE	0.323	AR	0.080	NJ	0.000
AZ	0.269	WY	0.050	SC	0.000
TX	0.241	CO	0.045	LA	0.000
CA	0.231	MI	0.034	KY	0.000
SD	0.212	UT	0.026	DE	0.000
		MT	0.025	KS	0.000
		IN	0.017	ND	0.000
		MO	0.015	OK	0.000
		ID	0.012	CT	0.000
		MN	0.010	NC	0.000
		WI	0.008	AL	0.000
		IL	0.007	MD	0.000
		WA	0.006	WV	0.000
		TN	0.006	PA	0.000
		OR	0.005	OH	0.000
		GA	0.003	VT	0.000
				IA	0.000
				NY	0.000
				VA	0.000
				FL	0.000
				MA	0.000
				MS	0.000
				NH	—
				RI	—

Rhode Island and New Hampshire are missing in all regressions using the 1955 *bracero* fraction. The original sources do not report domestic or foreign farm worker stocks for those two states in 1955 (and most other years).

Appendix Table A3: Parametric fixed-effects regression of real wage on *bracero* stock, quarterly, under nonzero *bracero* stocks

Specification:	Fixed effects				Fixed effects, AR(1) err.	
Dep. var.	Real wage (Hourly composite)		Real wage (Daily w/o board)		Real wage (Hourly composite)	Real wage (Daily w/o board)
$\ln\left(L^{\text{mex}}\right)$	0.00855	0.00482	0.0727	0.0191	0.0104	−0.0120
	(0.00452)	(0.00512)	(0.0226)	(0.0253)	(0.00425)	(0.0468)
$\ln\left(L - L^{\text{mex}}\right)$		0.0109		0.0317	0.0538	−0.656
		(0.0133)		(0.0414)	(0.00637)	(0.108)
Std. err. clustered by	State	State	State	State	—	—
Assumed error struc.	—	—	—	—	AR(1)	AR(1)
N	499	429	713	380	400	353
adj. R^2	0.571	0.498	0.503	0.618	0.686	0.395
Clusters	30	29	32	27	—	—

Observations are state-quarters. All regressions include state and quarter-by-year fixed effects. Standard errors clustered by state in parentheses. L^{mex} is stock of Mexican hired seasonal agricultural workers at the beginning of each quarter, by state; L is total stock of hired seasonal agricultural workers of any nationality (domestic and foreign), by state. The hourly wage has full state coverage but fewer years (1948–1971); the daily wage has more years (1942–1975) but is missing three states (CA, OR, WA).

Appendix Table A4: Parametric fixed-effects regression of domestic farm employment on *bracero* stock, by state-month

	ln Employment of domestic seasonal farm workers			
Dep. var.	Total domestic	Local domestic	Intrastate domestic	Interstate domestic
$\ln\left(L^{\text{mex}}\right)$	0.274	0.228	0.301	0.438
	(0.0340)	(0.0345)	(0.0729)	(0.0427)
N	1246	1442	1207	1286
Clusters	30	31	29	31

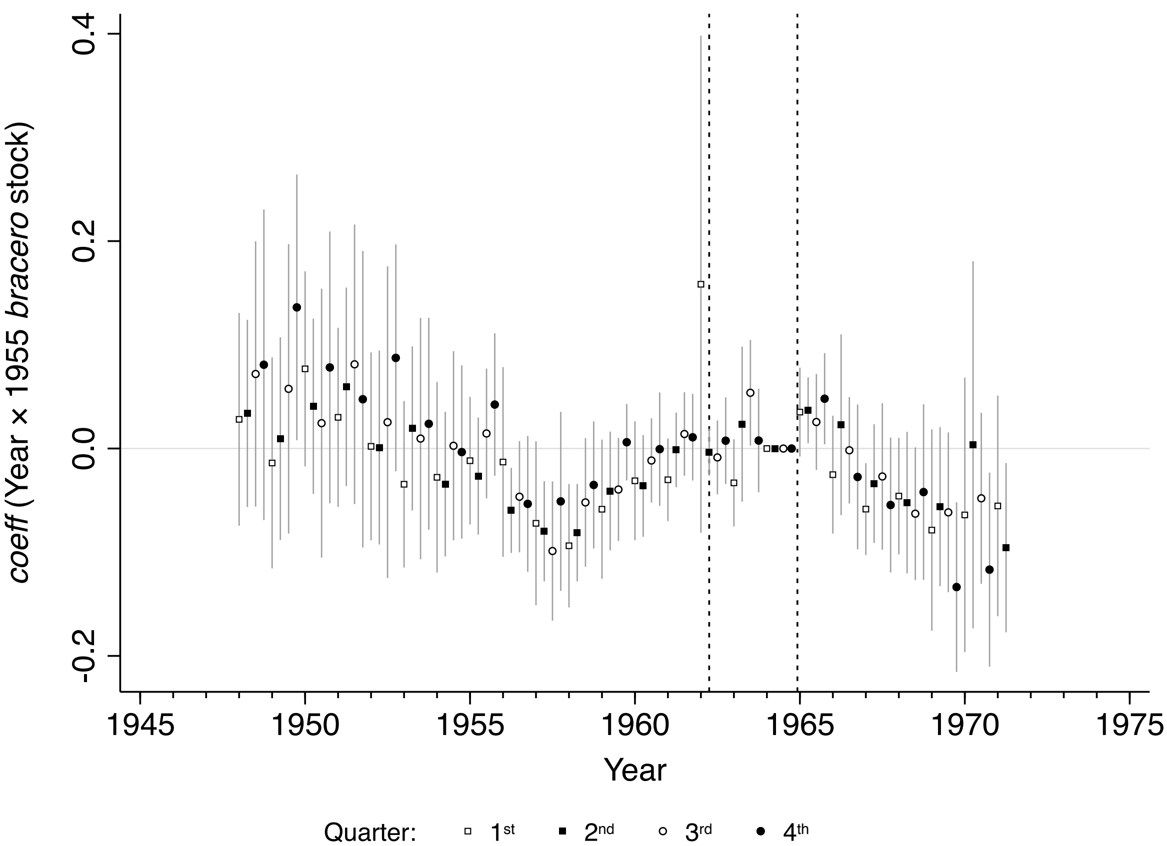
Observations are state-months. All regressions include state and month-by-year fixed effects. Standard errors clustered by state in parentheses. L^{mex} is stock of Mexican hired seasonal agricultural workers in each month, by state. "Total domestic" is the sum of "local domestic", "intrastate domestic", and "interstate domestic."

Figure A2a shows a similar exercise where the outcome is (natural log of) domestic hired seasonal workers in each state-month. Here the superposition of all 12 event studies (one for each month) makes the graph illegible, so we select one early-season month (June) and one late-season month (September) to illustrate. There is a clear and statistically significant pre-trend in the late-season months. As is clear from inspection of the graphs in the main text, the domestic seasonal farm employment gap between high-exposure states and low-exposure states was already falling before *bracero* exclusion. This bias is potentially confounding because such a trend would bias downward any positive impact of exclusion on domestic employment measured by differences-in-differences. However, as is also evident in the graphs in the main text, this pre-trend is limited to states with zero exposure to exclusion. If we restrict the sample to states that had a nonzero number of *braceros* in 1955 (Figure A2b), there is no longer a statistically significant pre-trend in either the late- or early-season months prior to exclusion. The main text shows that the employment results are robust to dropping the zero-exposure states where this pre-trend was occurring.

Raw data: This same point is illustrated by inspection of the raw employment data for the nine highest-exposure states, in Figure A3. Domestic hired seasonal farm employment in each state-month is shown by the black line, *braceros* by the gray line. Consider California: there is no evident widening of the domestic-Mexican employment gap prior to exclusion. The same is true in other important states like Texas, Arizona, and Wyoming. In New Mexico, the gap widened somewhat in the two years prior to the beginning of exclusion; but if anything the number of domestic workers fell after exclusion. Inspection of the raw data does not offer a clear reason to suspect that pre-trends substantially bias the core results of the paper.

State-specific time trends: The coefficient estimates shift but all remain statistically insignificant when the specification is adjusted to control for pre-existing state-specific linear time trends in wages or in domestic hired seasonal farm employment. Here we present a re-analysis of the differences-in-differences regressions in the main text with added state-specific time trends. That is, we change the original differences-in-differences specification to $y_{st} = \boldsymbol{\alpha}' \boldsymbol{I_s} + \boldsymbol{\beta}' \boldsymbol{I_t} + \gamma \left(I_{t \geqslant 1965} \cdot \bar{\ell}_s^{1955} \right) + \boldsymbol{\xi}' \boldsymbol{I_s} \cdot t' + \varepsilon_{st}$, where $\boldsymbol{\xi}' \boldsymbol{I_s}$ is a state-specific slope on the year t'. The coefficient estimates shift but statistical inference is qualitatively unchanged, as shown in Table A5 and Table A6.

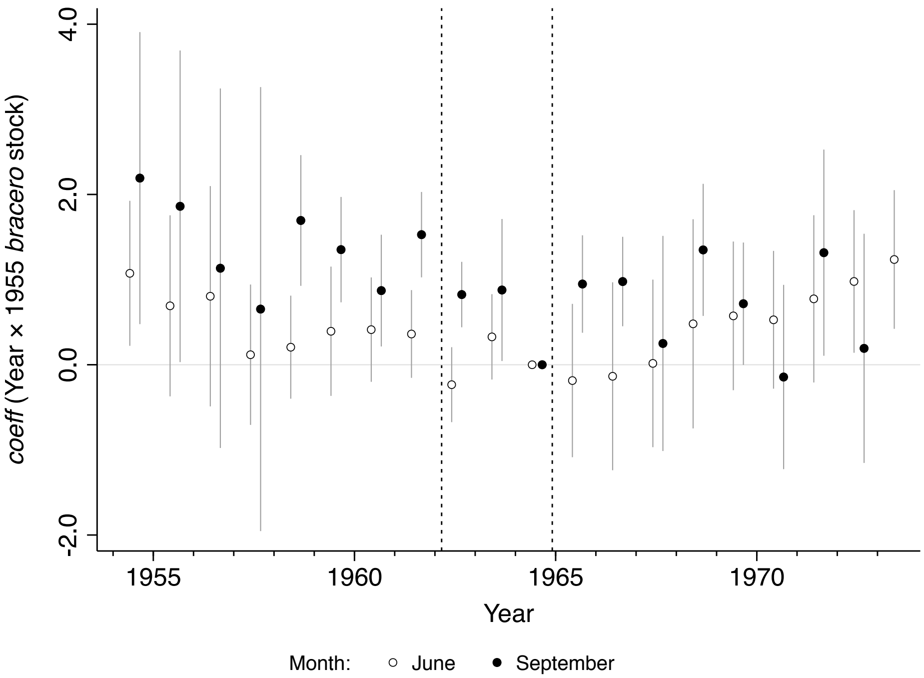
Figure A1: Event study for hourly wage, composite



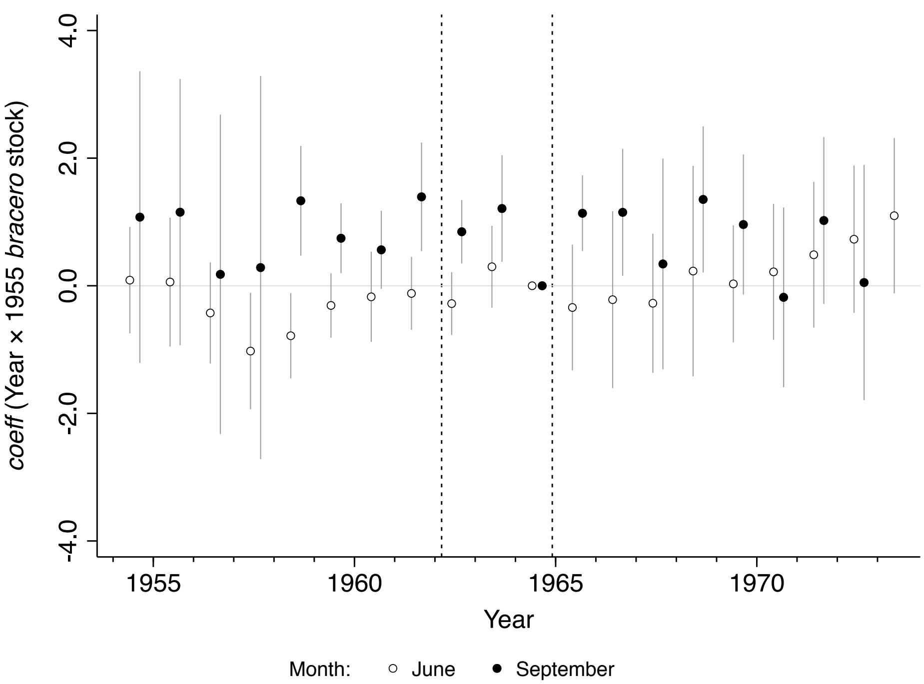
Observations are state-quarters. Omitted year is 1964, in an event-study regression for each quarter separately. Solid gray vertical lines show 95% confidence interval around the coefficient on the interaction of the year dummy and the 1955 *bracero* fraction $\left(I_t \cdot \bar{\ell}_s^{1955}\right)$. Vertical dotted lines show the beginning of major government efforts toward *bracero* exclusion (March 1962) and near-complete exclusion at the termination of the program (December 1964).

Figure A2: Event study for *ln* domestic hired seasonal workers, selected months

(a) *All states*

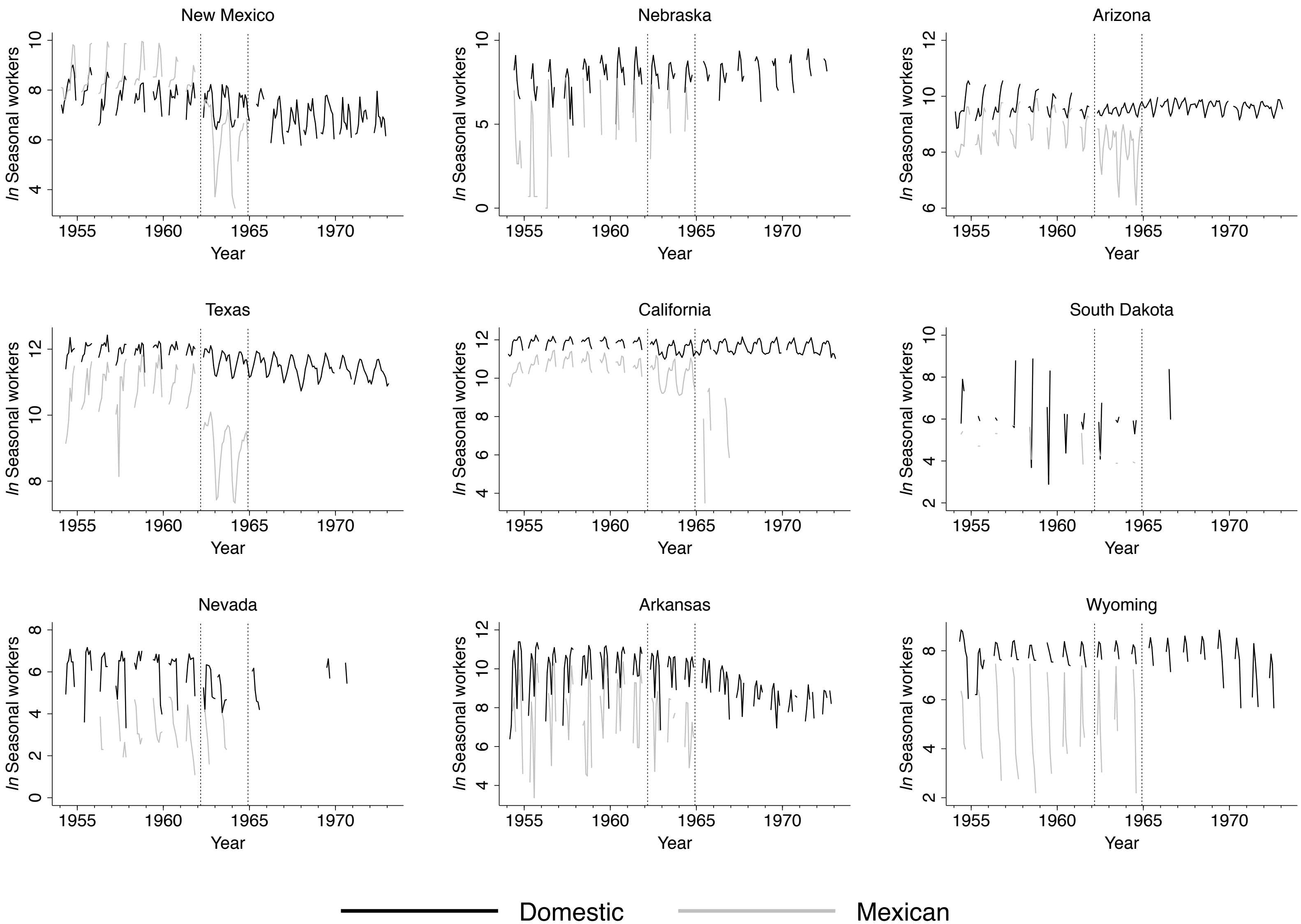


(b) *Only states exposed to exclusion (1955 bracero stock > 0)*



For clarity, superimposed event study graphs are shown for two selected months of the year: June is chosen to represent the early season, September to represent the late season. Observations are state-months. Omitted year is 1964, in an event-study regression for each month separately. Solid gray vertical lines show 95% confidence interval around the coefficient on the interaction of the year dummy and the 1955 *bracero* fraction $\left(I_t \cdot \bar{\ell}_s^{1955}\right)$. Vertical dotted lines show the beginning of major government efforts toward *bracero* exclusion (March 1962) and near-complete exclusion at the termination of the program (December 1964).

Figure A3: Number of domestic and Mexican workers by month, nine highest-exposure states



States shown are those where *braceros* constituted five percent or more of the hired seasonal farm workforce in 1955. States are shown above in decreasing order of relative exposure to *bracero* exclusion (see Table A2).

Appendix Table A5: Effects of *bracero* exclusion on real wages, with linear state-specific quarter-by-year trends: Differences-in-differences with continuous treatment, quarterly

	Wage, all years		Wage, 1960–1970	
Dep. var.	Hourly composite	Daily w/o board	Hourly composite	Daily w/o board
$I_{t\geqslant 1965} \cdot \overline{\ell}_s^{1955}$	0.0228 (0.0322)	0.386 (0.368)	0.0498 (0.0322)	0.229 (0.298)
N	4324	5813	2024	1901
adj. R^2	0.817	0.887	0.788	0.860
Clusters	46	46	46	46
Semielasticity $\frac{\partial \ln w}{\partial (B/L)}$	0.00649 (0.0406)	0.0339 (0.0497)	0.0387 (0.0325)	0.0263 (0.0295)
p-val. of χ^2 test: $\frac{\partial \ln w}{\partial (B/L)} = 0.1$	[0.0259]	[0.1903]	[0.0657]	[0.0161]

'Treatment' is the degree of exposure to exclusion. Observations are state-quarters. All regressions include state and quarter-by-year fixed effects. Standard errors clustered by state in parentheses. $\overline{\ell}_{1955}$ is average fraction of Mexicans among the state's total hired seasonal workers across the months of 1955. Wages in constant 1965 US$ deflated by CPI. The hourly wage has full state coverage but fewer years (1948–1971); the daily wage has more years (1942–1975) but is missing three states (CA, OR, WA). Farm worker stocks missing in original sources for 1955 in Rhode Island and New Hampshire. 'Linear quarter-by-year trends' means that the regression includes an interaction term of a dummy for each state and a time variable that takes a unique value for each quarter-by-year in ascending order (e.g. 1960Q1 = 1, 1960Q2 = 2, . . . , 1961Q1 = 5, etc.).

A5.3 Alternative 'treatment' year: 1962

Here we present re-analysis of main-text Tables 1 and 2 with the new assumption that 'treatment' begins in 1962, when the first major restrictions were placed on farms' hiring of *braceros*, rather than 1965 when the program was terminated. Table A7 shows the differences-in-differences analysis of wage effects under this new assumption, and Table A8 shows the analysis of employment effects. There are no substantial differences from the original results.

A5.4 Unauthorized migration and other labor-market explanations

Here we consider whether the above results are likely to arise from short-term substitution of unauthorized Mexican workers for excluded *braceros*.

First, we test the robustness of the core results to a different measure of farm labor that has the advantage of including all hired farm workers (U.S. or not, authorized or not, seasonal or not). One important disadvantage of this measure is that the original sources only report it for 35 states, not the full 46 we use in the rest of the analysis[19]—and only between August 1957 and December 1973, so no direct comparison to the 1955 treatment intensity can be drawn.

Another important disadvantage is that the original sources do not separately count domestic and foreign workers, so these figures cannot be used to test the impact of Mexican employment on domestic employment. We can, however, explore the relationship between Mexican employment and *overall* employment, using the regression specification suggested by Card (2009) and Peri and Sparber (2011). Here we simply carry out a panel fixed-effects regression, with state and month-by-year fixed effects, of this total hired farm workers measure on the number of *braceros*—where each of these has been adjusted for the scale of farm employment in different states. We use three different plausible, predetermined scaling factors: total hired farm workers in 1957, state population in 1950, and harvested crop area in 1954. Because *braceros* are included in total hired farm workers, the null hypothesis of no substitution of *braceros* by any other workers—including unauthorized Mexican workers, or domestic nonseasonal workers—corresponds to a coefficient of unity. Table A9 shows that, regardless of which scaling factor is used, we fail to reject a coefficient of unity. This does not rule out that *bracero* workers were replaced in some small measure by unauthorized Mexican workers, both because the confidence interval around unity also includes values below 1 which are compatible with

[19] Omits DE/MD, NM/AZ, WY/UT/NV, and New England, all of which are reported as aggregates in the original sources.

Appendix Table A6: Effects of *bracero* exclusion on domestic seasonal agricultural employment, with linear state-specific month-by-year trends: Differences-in-differences with continuous treatment, monthly

Dep. var.: Domestic seasonal workers	All states, all years		All states, years 1960–1970		Exposed states only, all years	
Specification:	linear	ln	linear	ln	linear	ln
$I_{t \geqslant 1965} \cdot \overline{\ell}_s^{1955}$	13292.8	0.232	−6795.1	0.204	11303.2	0.0948
	(12753.9)	(0.295)	(4036.7)	(0.329)	(11895.8)	(0.241)
N	10329	6386	6072	3707	5168	3189
adj. R^2	0.118	0.166	0.108	0.119	0.053	0.106
Clusters	46	46	46	46	23	23

‘Treatment’ is the degree of exposure to exclusion. Observations are state-months. All regressions include state and quarter-by-year fixed effects. Standard errors clustered by state in parentheses. $\overline{\ell}_{1955}$ is average fraction of Mexicans among the state’s total hired seasonal workers across the months of 1955. Covers only January 1954 to July 1973, as in original sources. Farm worker stocks missing in original sources for 1955 in Rhode Island and New Hampshire. If no workers reported for state-month in a month when source report was issued, assume zero. ‘Exposed states’ means states with nonzero *bracero* stocks in 1955 (i.e., only the ‘high’ and ‘low’ groups in the figures). ‘Linear month-by-year trends’ means that the regression includes an interaction term of a dummy for each state and a time variable that takes a unique value for each month-by-year in ascending order (e.g. January 1960 = 1, February 1960 = 2, …, January 1961 = 13, etc.).

Appendix Table A7: Alternative ‘treatment’ year 1962: Effects of *bracero* exclusion on real wages: Differences-in-differences with continuous treatment, quarterly

	Wage, all years		Wage, 1960–1970	
Dep. var.	Hourly composite	Daily w/o board	Hourly composite	Daily w/o board
$I_{t \geqslant 1962} \cdot \overline{\ell}_s^{1955}$	−0.0167	−0.323	−0.00626	0.240
	(0.0367)	(0.454)	(0.0248)	(0.263)
N	4324	5813	2024	1901
adj. R^2	0.773	0.835	0.732	0.758
Clusters	46	46	46	46
Semielasticity $\frac{\partial \ln w}{\partial (B/L)}$	−0.0189	−0.0373	−0.00655	0.0264
	(0.0414)	(0.0549)	(0.0260)	(0.0290)
p-val. of χ^2 test: $\frac{\partial \ln w}{\partial (B/L)} = 0.1$	[0.0041]	[0.0123]	[< 0.001]	[0.0113]

‘Treatment’ is the degree of exposure to exclusion. Observations are state-quarters. All regressions include state and quarter-by-year fixed effects. Standard errors clustered by state in parentheses. $\overline{\ell}_{1955}$ is average fraction of Mexicans among the state’s total hired seasonal workers across the months of 1955. Wages in constant 1965 US$ deflated by CPI.

Appendix Table A8: Alternative 'treatment' year 1962: Effects of *bracero* exclusion on domestic seasonal agricultural employment: Differences-in-differences with continuous treatment, monthly

Dep. var.: Domestic seasonal workers	All states, all years		All states, years 1960–1970		Exposed states only, all years	
Specification:	linear	ln	linear	ln	linear	ln
$I_{t\geqslant 1962} \cdot \overline{\ell}_s^{1955}$	−10770.9 (9155.2)	−0.536 (0.458)	3814.2 (8297.2)	−0.243 (0.284)	−565.3 (6735.3)	−0.285 (0.535)
N	10329	6386	6072	3707	5168	3189
adj. R^2	0.056	0.086	0.079	0.076	0.028	0.053
Clusters	46	46	46	46	23	23

'Treatment' is the degree of exposure to exclusion. Observations are state-months. All regressions include state and quarter-by-year fixed effects. Standard errors clustered by state in parentheses. $\overline{\ell}_{1955}$ is average fraction of Mexicans among the state's total hired seasonal workers across the months of 1955. Covers only January 1954 to July 1973, as in original sources. Farm worker stocks missing in original sources for 1955 in Rhode Island and New Hampshire. If no workers reported for state-month in a month when source report was issued, assume zero. 'Exposed states' means states with nonzero *bracero* stocks in 1955 (i.e., only the 'high' and 'low' groups in the figures).

some substitution, and because this dataset omits important states such as Arizona and New Mexico. It does, however, include numerous important states such as California and Texas.

Appendix Table A9: All hired farm workers, Aug. 1957–Dec. 1973, monthly

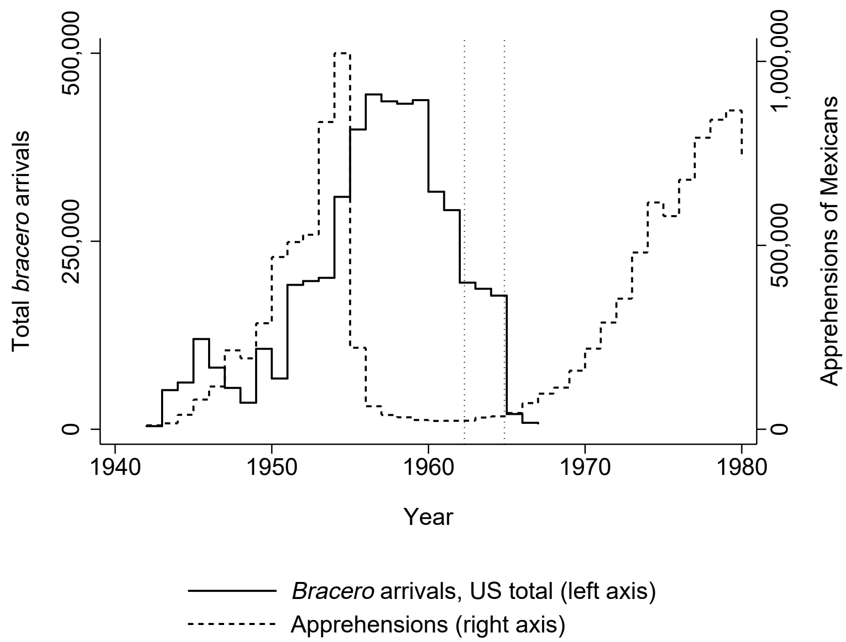
Dep. var.	$L_t^{\text{tot}}/L_{1957}^{\text{tot}}$	$L_t^{\text{tot}}/\text{pop}_{1950}$	$L_t^{\text{tot}}/\text{land}_{1954}$
$L_t^{\text{mex}}/L_{1957}^{\text{tot}}$	1.192 (0.518)		
$L_t^{\text{mex}}/\text{pop}_{1950}$		1.511 (0.558)	
$L_t^{\text{mex}}/\text{land}_{1954}$			1.348 (0.208)
N	6475	6475	6475
Clusters	35	35	35

Standard errors clustered by state in parentheses. L^{tot} is all hired farm workers (of all nationalities, seasonal and non-seasonal). pop_{1950} is state population in the 1950 census (thousands). land_{1954} is state acres of harvested cropland in the 1954 Census of Agriculture (thousands). All regressions include state and month-by-year fixed effects. 11 states are missing because the original sources for *total hired farm workers* (seasonal and nonseasonal) do not report separate worker counts for those states, but only include them in aggregated groupings of states. These missing states are AZ, CT, DE, MA, MD, ME, NM, NV, UT, VT, WY. Data series for L^{tot} begins in original sources in August 1957.

Second, it is possible in principle that when the program was terminated, *braceros* simply became unauthorized workers, or were replaced by unauthorized workers. Prima facie this appears unlikely to explain the lack of measurable increases in domestic wages or employment caused by exclusion, given that during the program—when employers could access Mexican labor without hiring on the black market—there is no negative relationship between *bracero* stocks and lower domestic wages or employment (Tables A3 and A4).

We nevertheless consider more direct evidence. Third, very few Mexican workers overstayed their *bracero* visas when the program was terminated. This is evident in the statistics of the Mexican government, which conducted all recruitment under the agreements and tracked each *bracero*'s exit from Mexico and reentry into Mexico (González

Figure A4: Annual *bracero* flows compared to apprehensions of Mexicans



Mexican nationals only in both series. Total *bracero* arrivals per year from Gastelúm (1991, 54, Cuadro 3). Apprehensions of unauthorized Mexican nationals (also "Mexican deportable aliens located") from *Statistical Yearbook of the Immigration and Naturalization Service* and *Yearbook of Immigration Statistics*, various editions 1960–2013. Vertical dotted lines show start of major efforts toward exclusion (March 1962) and near-complete exclusion (December 1964).

1974, 141, Cuadro 39). In 1963, for example, 189,528 *braceros* left Mexico and 188,512 returned the same year (a discrepancy of 1,106, or 0.54 percent). In 1964, the last year of the program, 179,298 *braceros* left Mexico and 179,535 returned (a discrepancy of 237, or 0.13 percent). If it were the case that Mexican workers on the black market substituted for *braceros* in 1965, this would require a very large and immediate jump in *new* unlawful entries.

Fourth, there is no evidence of such a jump in apprehensions in 1965. Figure A4 compares the total number of *bracero* visas given each year to the number of Mexican nationals apprehended by the U.S. Border Patrol. Apprehensions barely rose in the several years that followed *bracero* exclusion. There is no evidence of any stand-down in enforcement effort in the years just before or after 1965 that would allow minimal apprehensions to coincide with massive new unauthorized flows; Border Patrol staffing did not fall but in fact rose modestly during this period (North and Houstoun, 1976, 53). Bibliometric analysis of contemporary newspaper content independently confirms that unauthorized migration remained very low for several years after *bracero* exclusion (Massey and Pren, 2012, 10).[20]

A5.5 Alternative controls for scale effects in worker stocks

The paper's core differences-in-differences regressions with domestic employment as an outcome assume that differences in scale between states are captured by the state fixed effect. Here we present alternative regressions with the outcome scaled by either arable land area (thousands of acres of predetermined 1954 harvested cropland) or state population (thousands of predetermined state residents in 1950). These alternative scaling methods do not substantially affect the results. Table A10 shows the differences-in-differences regression. In the first column the outcome is the number of *braceros* in each state-month, divided by predetermined arable land area. As expected, exclusion causes a large negative change in this outcome. In the second column the outcome is domestic hired seasonal farm workers

[20]The analysis of Massey and Pren (2012, 10) counts in major newspaper content "the number of times undocumented, illegal, or unauthorized migrants or aliens were paired with Mexico or Mexicans and with the words crisis, flood, or invasion each year from 1965 through 2009." They find that these mentions closely track trends in Border Patrol apprehensions after 1965, remaining very low until sharply rising in the early 1970s.

divided by the same measure of arable land area. The coefficient is negative and statistically insignificant. The third and fourth columns repeat the same exercise with an alternative denominator: predetermined state population. The results are essentially unchanged.

Appendix Table A10: Differences-in-differences regressions with alternative scaling of outcome variable, monthly, Jan 1954–Jul 1973 only

Dep. var.	$L_t^{mex}/\text{land}_{1954}$	$L_t^{dom}/\text{land}_{1954}$	$L_t^{mex}/\text{pop}_{1950}$	$L_t^{dom}/\text{pop}_{1950}$
$I_{t\geqslant 1962} \cdot \bar{\ell}_s^{1955}$	−6.349	−0.415	−10.13	−1.625
	(1.610)	(1.507)	(2.303)	(1.875)
N	9918	10329	9918	10329
adj. R^2	0.173	0.037	0.160	0.085
Clusters	46	46	46	46

'Treatment' is the degree of exposure to exclusion. Observations are state-months. All regressions include state and month-by-year fixed effects. Standard errors clustered by state in parentheses. $\bar{\ell}_{1955}$ is average fraction of Mexicans among the state's total hired seasonal workers across the months of 1955. Covers only January 1954 to July 1973, as in original sources. Farm worker stocks missing in original sources for 1955 in Rhode Island and New Hampshire.

A5.6 Alternative assumptions about missing values

In the differences-in-differences regressions in the main text with domestic employment as the dependent variable, we assume that when there were no domestic seasonal agricultural workers reported for a state-month in a month when the source document was issued, there were zero domestic workers of each type in that state-month. This accords with inspection of the source documents, where missing values for a state-month typically precede or follow very low values for that state in other months, which would be expected if the report authors used nonreporting to represent zero.

Here we make the alternative assumption: for months in which the source report was issued, if there is no report of domestic workers stocks for a state-month, that stock is assumed to be missing, not zero. This is done in columns 1 and 3 of Table A11. The results in the main text are qualitatively invariant to this alternative assumption.

Of course, the logarithmic specification of these regressions in the main text takes zero values as missing by construction. To allow for such nonlinearity *without* truncating zeros from the dataset, we repeat the regressions of the main text using the inverse hyperbolic sine of domestic employment as the dependent variable (returning to the assumption that missing values in the original sources, in months were the source document was issued, represent zeros). These results are shown in columns 2 and 4 of Table A11. These results, too, are qualitatively the same as the results in the main text.

A5.7 Independent measurements of *bracero* (outward) flows and inward stocks

Figure A5 compares the annual total outflow of *braceros* reported by the government of Mexico (a) with snapshots of the national-total stocks of *braceros* reported in state-by-state data by the U.S. Department of Agriculture in various months (b). The quantities are not strictly comparable: the flow measure captures how many people made the trip at any point in the year, which will exceed the stock present in the U.S. at any given moment to a greater degree the shorter the duration of stay for each worker. But given that some *braceros* were contracted only for spring work rather than the fall harvest, and some fall workers' contracts for early-harvest crops ended before October, it is plausible that the stock of *braceros* present in October would be roughly 60 percent of the number that had departed for the U.S. at any point in the year—as is the case in the mid- to late-1950s. This comparison suggests that the stock measures collected from farmers by the U.S. Department of Agriculture were not severely undercounting the number of *braceros* present in each state.

Appendix Table A11: Alternative handling of missing or zero worker stocks: Effects of *bracero* exclusion on domestic seasonal agricultural employment: Differences-in-differences with continuous treatment, monthly

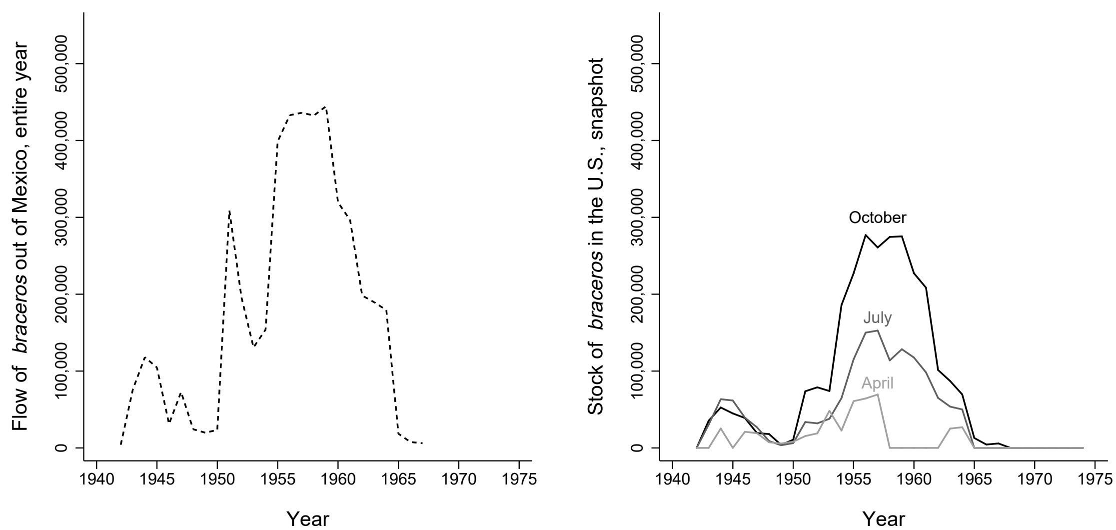
Dep. var.	Domestic seasonal workers, all years		Domestic seasonal workers, 1960–1970	
Specification:	linear	inverse hyperbolic sine	linear	inverse hyperbolic sine
Missing vals assumed:	missing	zero	missing	zero
$I_{t \geqslant 1965} \cdot \bar{\ell}_s^{1955}$	−21403.0	−1.224	−9217.1	−0.930
	(25675.8)	(1.298)	(15578.7)	(1.250)
N	6386	10329	3707	6072
adj. R^2	0.060	0.244	0.054	0.258
Clusters	46	46	46	46

'Treatment' is the degree of exposure to exclusion. Observations are state-months. All regressions include state and month-by-year fixed effects. Standard errors clustered by state in parentheses. $\bar{\ell}_{1955}$ is average fraction of Mexicans among the state's total hired seasonal workers across the months of 1955. Covers only January 1954 to July 1973, as in original sources. Farm worker stocks missing in original sources for 1955 in Rhode Island and New Hampshire. If no workers reported for state-month in a month when source report was issued, assume missing in the regressions with linear dependent variable; assume zero in regressions with inverse hyperbolic sine dependent variable.

Figure A5: Comparing outward *bracero* flows reported by Mexico with inward stocks reported by U.S. Dept. of Agriculture

(a) *Outflows from Mexico reported by Mexican government, entire year*

(b) *Stocks reported in U.S. by U.S. farmers, snapshot in various months*



Sources: In Figure A5a the annual total outflow of *braceros* from Mexico to the U.S. is from González Navarro (1974, Vol. 2, Cuadro 39, p. 141), which sources principally the *Anuario Estadístico de los Estados Unidos de México* but contains data not reported in the *Anuario*, for years 1955–1957, gathered directly from the government by the author.

A5.8 Sensitivity of wage graph to smoothing and wage measure

Here we show smoothed and unsmoothed versions of the wage graph in the main text (**??**), the hourly composite wage, in Figure A6a and Figure A6b. Where the graph in the main text averages wages by season (July and before, August and after) for comparability with the graph of Mexican fraction, Figure A6b shows the full quarterly data. The smoothed plots show Fan-Gijbels (1992) local linear regressions of state-quarter wage on quarter-by-year, Epanechnikov kernel, bandwidth 2 quarters. We also show the same analysis with a different measure of the wage—the average daily wage without board, which covers more years but omits three states (California, Oregon, and Washington)—with and without smoothing, in Figure A6c and Figure A6d.

A5.9 Other explanations

Other alternative explanations are likewise unsupported by the data: 1) Excluded *braceros* were not replaced by lawful but non-Mexican foreign workers: stocks of Jamaican, Bahamian, and other non-Mexican foreign seasonal agricultural workers barely rose after *bracero* exclusion.[21] 2) It is unlikely that the labor-market effects of *bracero* exclusion were offset by reduced labor demand due to the loss of local expenditures from *bracero* earnings, the effect posited by Altonji and Card (1991) and tested by Hong and McLaren (2015), since *braceros* tended to live in isolated work-camps and spend only a small fraction of their earnings in the United States. 3) There is no evidence that substantial numbers of domestic seasonal farm workers moved between states to offset the loss of *bracero* labor supply, the effect considered by Card and DiNardo (2000) and Hatton and Tani (2005), given the lack of response by domestic interstate migrants in Tables 3 and A4. This accords with the recent finding of Cadena and Kovak (2016) that domestic workers are far less mobile across U.S. states than Mexican workers. 4) Finally, it is unlikely that policy-generated wage rigidities are responsible for the lack of wage effects in Tables 2 and A3. Hired farm workers were exempt from the federal minimum wage until years after *bracero* exclusion (Gardner, 1972).[22] And even if there had been a binding minimum wage before and after exclusion, this would leave unexplained the lack of effects on employment.

A6 Suggestive evidence of mechanization due to *bracero* exclusion

The main text offered indirect evidence of mechanization caused by *bracero* exclusion, as well as direct evidence of tomato harvest mechanization. Here we present additional evidence for cotton and sugar beets that, while direct, we consider only suggestive because of limitations in the original source data described below.

A6.1 Cotton mechanization

Beyond tomatoes, another crop with coexisting traditional and advanced technologies was cotton. Commercial-scale mechanical picking of cotton had been technically feasible since the 1920s. It took two decades to become practically feasible for a substantial number of farmers, after the development of technologies complementary to mechanical picking—including cotton plant varieties with taller and more uniformly opening bolls, chemical for weed control to reduce trash in machine-picked cotton, and gins apt for machine-picked cotton (Fite, 1980, 191–5). These were in place by the late 1940s and harvesting of upland cotton entered the cone of diversification, with eight percent mechanical harvesting by 1950, rising to 78 percent by 1964 (USDA, 1974, 218).

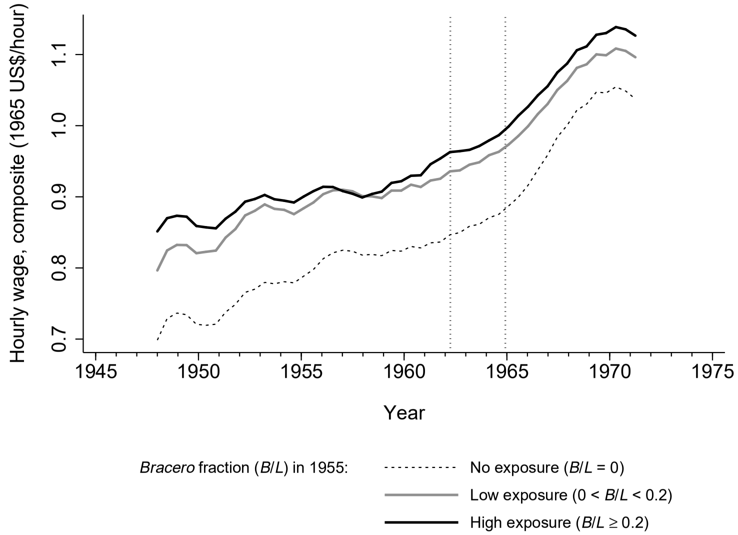
The literature broadly agrees that the presence of *braceros* slowed harvest mechanization (Grove, 1996) and *bracero* exclusion accelerated mechanization (Vialet and McClure 1980, 46; Morgan and Gardner 1982, 399; Heinicke and Grove 2008, 288). McBride (1963) details how Labor Secretary James Mitchell's regulatory actions to restrict *bracero* usage caused cotton farmers to universally adopt mechanical harvesters in the Lower Rio Grande Valley of Texas.

[21] See subsection A7.1.

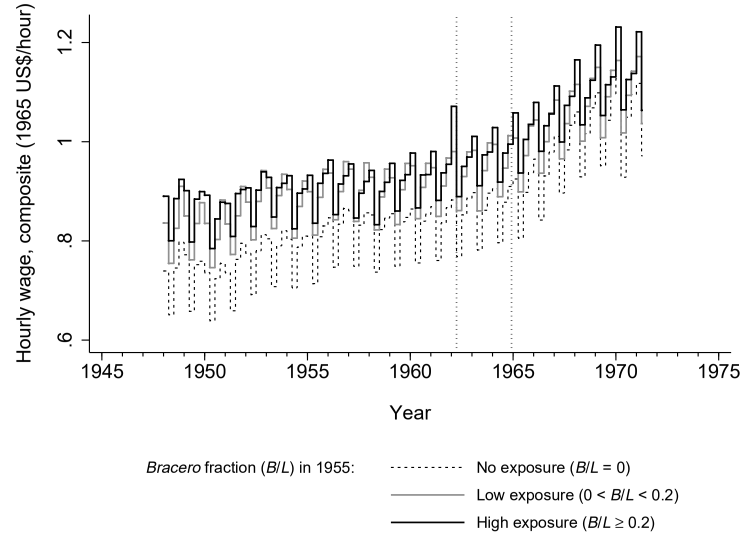
[22] The federal minimum wage for farm workers was only effective after 1967, and only covered about one third of hired domestic farm labor as it exempted all but the largest one percent of U.S. farms. Prior to this only five continental U.S. states had a state-level minimum for farm workers: California, Michigan, New Jersey, North Dakota, and Wisconsin (Koziara, 1967). An immaterial exception to the lack of a federal minimum was sugar-beet workers, whose wage was regulated by a crop-specific minimum during the early postwar years (BLS, 1946, 197).

Figure A6: Quarterly average real farm wages in states grouped by exposure to *bracero* exclusion

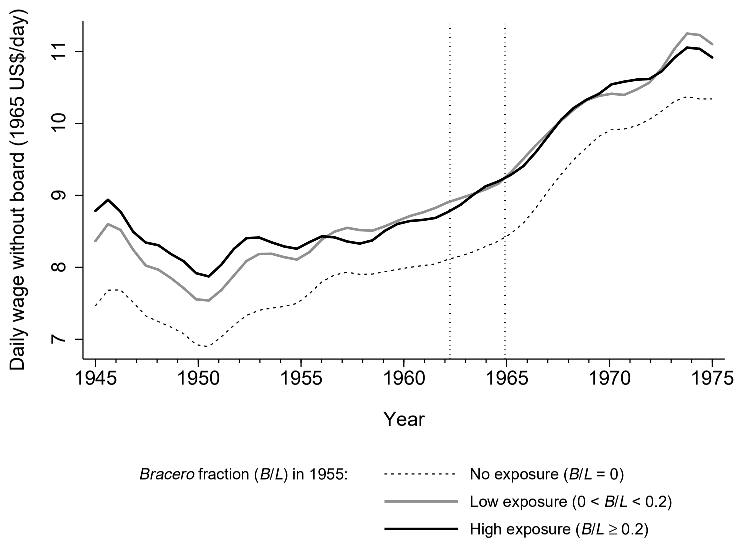
(a) *Hourly composite wage, smoothed (bwidth 2 qtrs)*



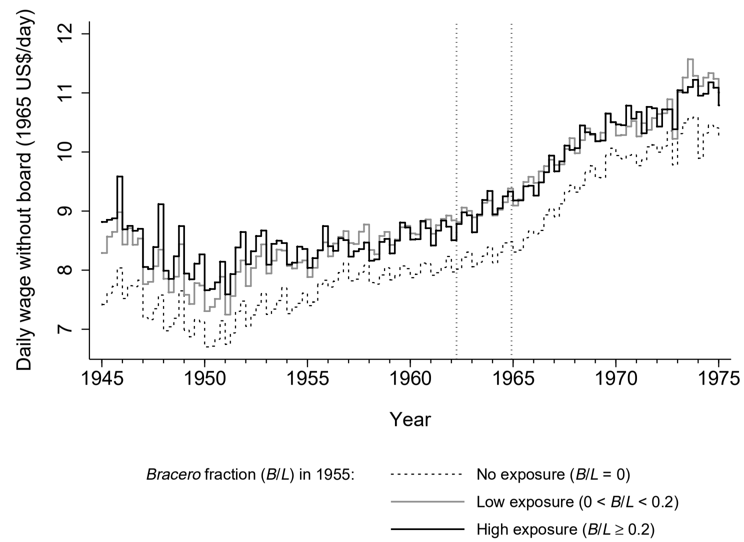
(b) *Hourly composite wage, unsmoothed*



(c) *Daily wage without board, smoothed (bwidth 2 qtrs)*



(d) *Daily wage without board, unsmoothed*



We observe the effect of *bracero* exclusion on cotton mechanization in Table A13. The table shows difference-in-difference regressions in the first column, with state-year cotton harvest mechanization as the outcome, and shows in columns 3 and 4 the corresponding panel fixed-effects regressions. The first panel of Figure A7 shows the fixed-effects result graphically. The difference-in-difference effect of exclusion is positive, and *bracero* stocks are negatively correlated with adoption during the program. We note that mechanical harvesting was only part of the technological change induced by *bracero* exclusion. Other labor-saving changes included pre-harvest technologies such as greater use of herbicides, flame cultivators, and rotary hoes (Martin, 1966, 1144).

A6.2 Sugar beet mechanization

At the time of *bracero* exclusion, the mechanization transition in sugar beet production was not in harvesting—where mechanization had been near universal since the early 1950s—but in field preparation and maintenance. Sugar beet cultivation requires blocking and thinning (the removal of some plants so that the eventually-harvested plants can thrive) as well as weeding, activities traditionally employing intensive field labor. Mechanization of these tasks had been technically feasible for two decades (Mervine and Barmington, 1943), but its spread was slow until the concomitant spread of seed varieties that avoided irregular growth and clumping of plants that reduced the efficiency of such machines. At the time of exclusion about 40 percent of U.S. farms had adopted mechanized thinning and weeding (Rogers and Cohen, 1963, 11, 22, Table 3), placing the crop near the middle of the diversification cone.

The literature broadly agrees that *bracero* exclusion created a large new incentive for mechanization (Rasmussen 1967, 35; USDA 1971, 16). The president of the American Society of Sugar Beet Technologists made this plain just before exclusion:

> "*In agriculture, complete mechanization from planting through harvest has been demonstrated and is practiced in limited areas. The demand for faster progress is being thrust upon us, however, by the imminent loss of a great proportion of the available hand labor through expiration of Public Law 78, commonly referred to as the Bracero Program. …Those who have depended upon availability of Mexican Nationals for thinning and weeding operations must look elsewhere to get this work accomplished. …Work to bring about the desired full mechanization must be pushed with all speed and in an all-out cooperative effort*" (Rorabaugh, 1964, 2–3).

We also observe the effect of *bracero* exclusion on sugar beet mechanization in Table A13. Column 2 shows the difference-in-difference results for state-year adoption of mechanized thinning and weeding in sugar beet production. These are less reliable than the analogous figures for cotton, because data are available for a more limited window of time.[23] Columns 5 and 6 show the corresponding fixed-effects regressions, shown graphically in the second panel of Figure A7. Just as for cotton, the difference-in-difference is positive and *bracero* stocks are negatively correlated with adoption.

A6.3 Potential reverse causation: Voting data

As discussed in the main text, there is an important potential pathway for reverse causation of *bracero* exclusion by technical change. It could be the case that agribusiness lobbyists dropped their support of the program once technical advance had already eliminated the need for *bracero* labor. In this case we would observe technical advance to be correlated with, but not caused by, *bracero* exclusion. Voting data in the U.S. House of Representatives, however, are not compatible with this possible channel. Alston and Ferrie (2007, Table 5.3, pp. 110–111) show that the political defeat of the *bracero* program arose from changing votes by representatives of states with few or no *braceros*, not by representative of the states that used the program to a substantial degree.

We graph Alston and Ferrie's data in Figure A8. Figure A8a shows the number of Representatives voting in favor of extending the program (that is, *against* exclusion) in the four state groups used by the original authors. Figure A8b shows the same data using the state group classification used in the present paper. Regardless of which definition of '*bracero* states' is used, political support for the program barely changed in the *bracero* states. It declined precipitously

[23] The only state-year data of which we are aware for sugar beet thinning/weeding mechanization cover the period 1960–65, thus including only one post-exclusion year.

Appendix Table A12: U.S. employment of Mexican hired seasonal labor by crop, 1964

Crop	Thousand man-months: Total labor	Thousand man-months: Foreign labor	Foreign/ total, %	% of all foreign labor
Tomatoes	345.1	90.5	26.2	14.3
Citrus	319.8	69.1	21.6	10.9
Lettuce	122.5	67.8	55.3	10.7
Cotton	1769.4	65.2	3.7	10.3
Strawberries	308.5	42.5	13.8	6.7
Sugar beets	160.6	31.9	19.9	5.0
Cucumbers	105.5	28.9	27.4	4.6
Melons	64.7	18.4	28.4	2.9
Celery	44.4	14.4	32.4	2.3
Asparagus	60.5	11.5	19.0	1.8

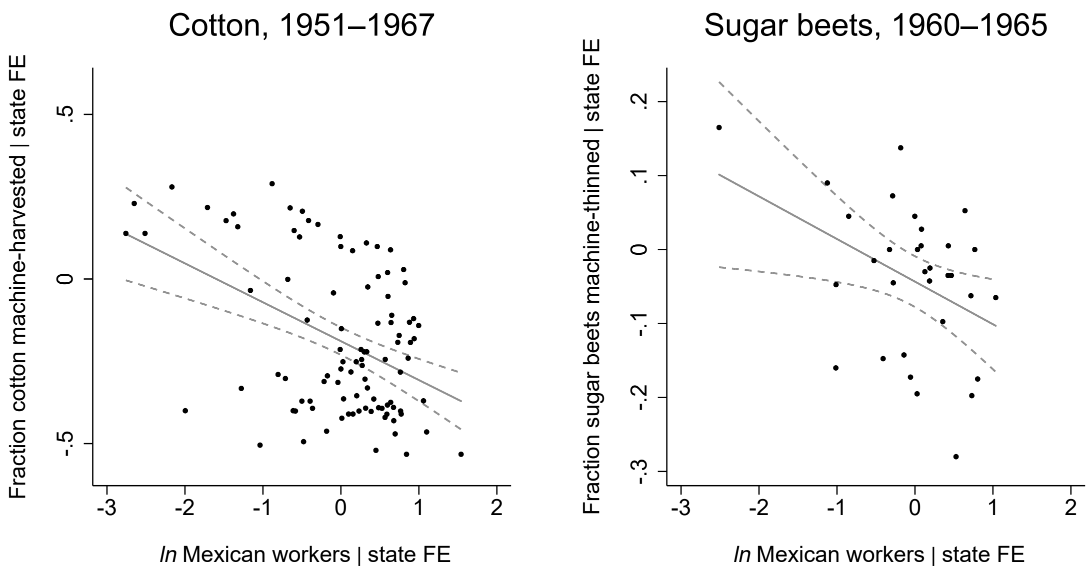
From Hirsch (1966, 6). For these crops the 'foreign labor' employed was almost entirely Mexican labor. Two other crops had a comparable intensity of foreign labor—tobacco and sugarcane harvesting—but these employed primarily non-Mexican hired seasonal workers.

Appendix Table A13: Cotton and sugar beet mechanization, annual

Specification:	Diffs-in-diffs		Fixed effects			
Dep. var.	Cotton mech.	Sugar beet mech.	Cotton mechanization		Sugar beet mechanization	
$I_{t \geqslant 1965} \cdot \overline{\ell}_s^{1955}$	1.205	1.363				
	(0.258)	(0.384)				
$\ln\left(L^{\text{mex}}\right)$			−0.113	−0.0891	−0.0764	−0.0658
			(0.0308)	(0.0230)	(0.0176)	(0.0141)
$\ln\left(L - L^{\text{mex}}\right)$				−0.181		−0.127
				(0.115)		(0.0468)
Years	1951–1972	1960–1965	1951–1967	1951–1967	1960–1965	1960–1965
N	344	48	97	91	32	32
adj. R^2	0.105	0.129	0.203	0.277	0.253	0.322
Clusters	16	12	9	9	11	11

Observations are state-years. For cotton, mechanization fraction is the fraction of production harvested by machine (USDA, 1974, 218). For sugar beets, mechanization fraction is fraction of production thinned and/or weeded by machine (Rogers and Cohen, 1963, 22, Table 3). Diffs-in-diffs regressions include state-years with zero *braceros*; fixed-effects regressions use logged regressor and thus omit state-years with zero *braceros*.

Figure A7: Mechanization versus *bracero* stock, during program



Observations are state-years. For cotton, mechanization fraction is the fraction of production harvested by machine. For sugar beets, mechanization fraction is fraction of production thinned and/or weeded by machine.

in the states that did not use the program, and this resulted in its termination.

A7 Further characterization of worker stocks

A7.1 Effect of *bracero* exclusion on non-Mexican foreign seasonal farm labor

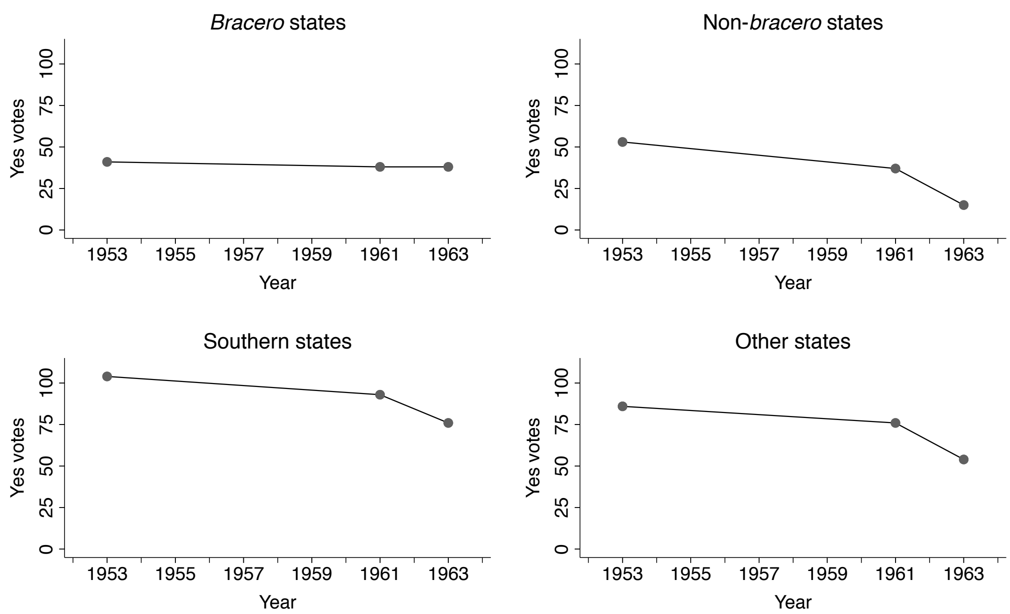
Figure A9 shows that stocks of non-Mexican foreign seasonal agricultural workers remained very low after *bracero* exclusion.

A7.2 Seasonal variation in *bracero* stocks

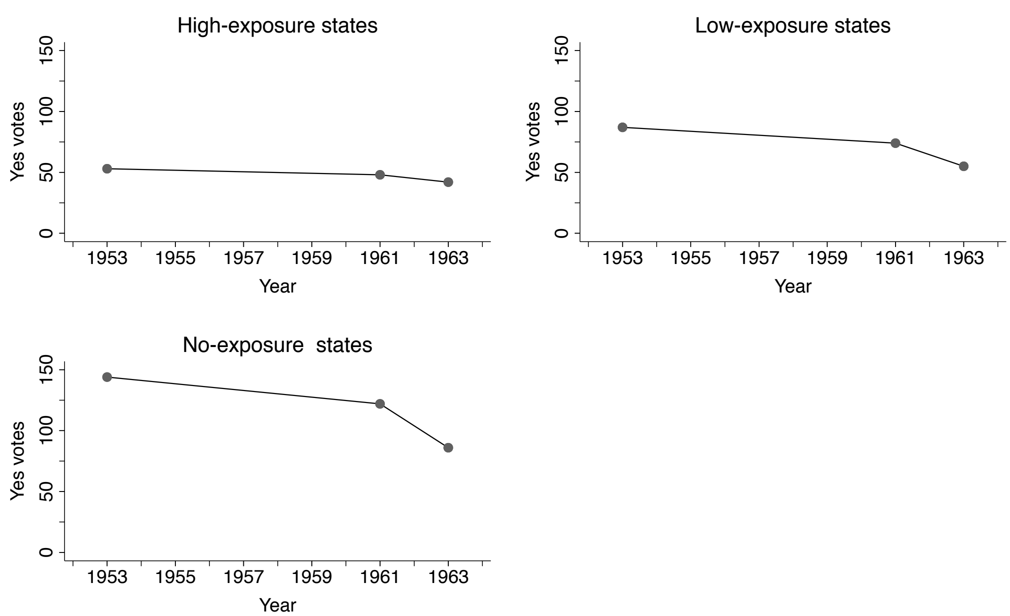
Figure A10 shows the distribution of *bracero* stocks on average over the course of a year, for the entire United States. In the 1950s and 1960s, the stock of *bracero* workers over the course of each year occurred in October. In the 1960s, almost all *braceros* present at any point in the year were present in or after the month of May.

Figure A8: Votes in favor of renewing the *bracero* program in the U.S. House of Representatives, by state group

(a) *Original Alston-Ferrie state categories*

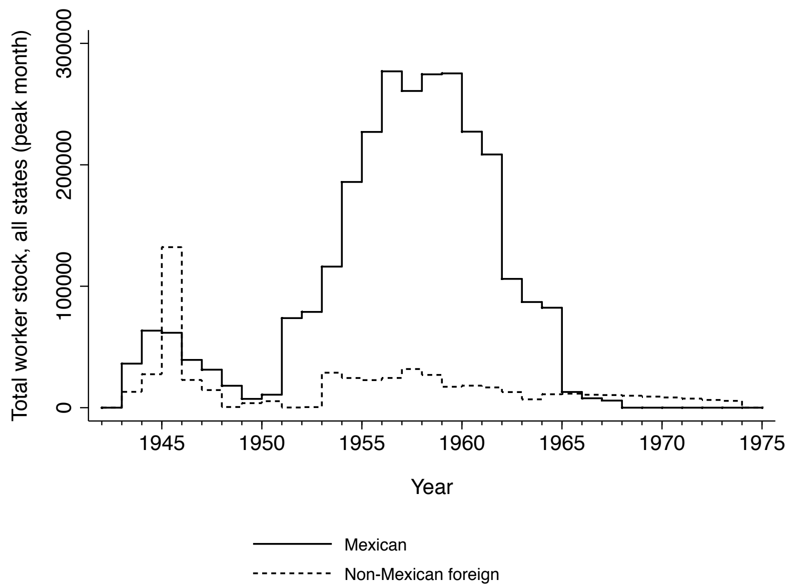


(b) *State categories in this paper*



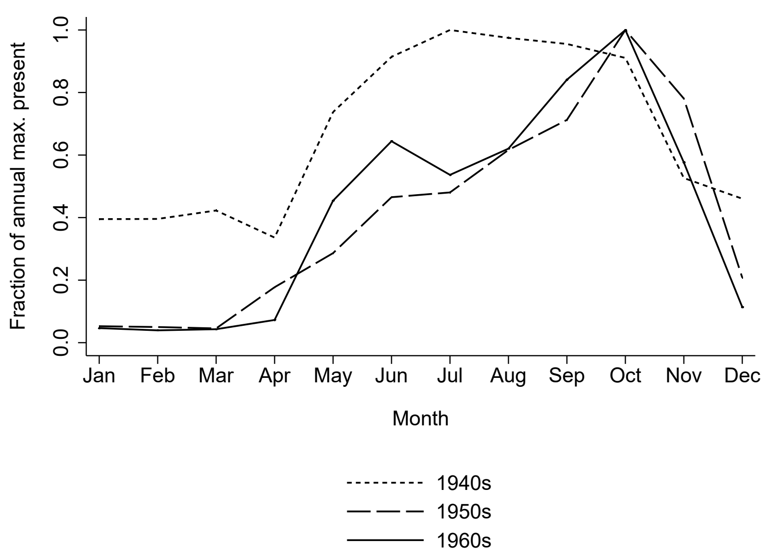
'Yes' vote counts on renewal of Public Law 78 from Alston and Ferrie (2007, Table 5.3, pp. 110–111). Alston and Ferrie categorize 'Bracero' states as those that employed over 10,000 bracero months 1954–1964 (AZ, CA, CO, MI, NM); 'South' is the former Confederacy plus Oklahoma (AL, AR, FL, GA, LA, MS, NC, OK, SC, TN, TX, VA); 'Non-bracero' states are non-South states that employed zero braceros 1954–1964 (AK, CT, HI, MA, MD, ME, NH, NJ, NY, PA, RI, VT).

Figure A9: Mexican versus other foreign seasonal farm workers in the U.S., total



Total across all states, in each year, of that year's peak-month worker stock of each type. 'Non-Mexican foreign' for the purposes of this comparison includes nationals of Jamaica, the Bahamas, other British West Indes, and Canada, as well as U.S. nationals from Puerto Rico.

Figure A10: Fraction of annual maximum monthly stock of *braceros* present in each month, entire U.S.



"1940s" is 1943–1949, "1960s" is 1960–1965. For each decade in each month, we sum the total stock of *bracero* workers present in that month across all the years of the decade in question, then divide that summed stock in each month by the maximum monthly stock. For example, for the 1950s the graph shows for month m the quantity $\left(\sum_{y=1950}^{1959} \sum_{s\in S} b_{s,m,y}\right) / \left(\max_{m} \sum_{y=1950}^{1959} \sum_{s\in S} b_{s,m,y}\right)$, where $b_{s,m,y}$ is the stock of *braceros* in state s in month m in year y, and S is the set of all states. Thus a value of 1 on the vertical axis means that in that month the sum of all *bracero* stocks in that month across the years of that decade is equal to the maximum such sum for any month.

References

Alston, Lee J. and Joseph P. Ferrie, *Southern Paternalism and the American Welfare State: Economics, Politics, and Institutions in the South, 1865–1965*, New York: Cambridge University Press, 2007.

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

Beaudry, Paul, Mark Doms, and Ethan Lewis, "Should the Personal Computer Be considered a Technological Revolution? Evidence from U.S. Metropolitan Areas," *Journal of Political Economy*, 2010, *118* (5), 988–1036.

Bickerton, Maria Elena, "Prospects for a bilateral immigration agreement with Mexico: Lessons from the Bracero Program," *Tex. L. Rev.*, 2000, *79*, 895–919.

BLS, "Wartime Wages, Income, and Wage Regulation in Agriculture: Part 2–Comparative Wages and Wage Regulation," *Monthly Labor Review*, 1946, *63* (2), 195–204.

Borjas, George J and Lawrence F Katz, "The Evolution of the Mexican-Born Workforce in the United States," in George J Borjas, ed., *Mexican Immigration to the United States*, Chicago: University of Chicago Press, 2007, pp. 13–55.

Briggs, Vernon M, *Foreign Labor Programs as an Alternative to Illegal Immigration into the United States: a Dissenting View* Vol. 2, Paper 28, Center for Philosophy and Public Policy. College Park, MD: University of Maryland, 1980.

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

Calavita, Kitty, *Inside the State: The Bracero Program, immigration, and the INS*, New York: Routledge, 1992.

Card, David, "How immigration affects US cities," in Robert P. Inman, ed., *Making Cities Work: Prospects and Policies for Urban America*, Princeton: Princeton University Press, 2009, pp. 158–200.

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

Cardoso, Lawrence A., *"Mexican Emigration to the United States, 1897–1931: Socio-Economic Patterns"*, Tucson, AZ: University of Arizona Press, 1980.

Clark, Victor S., "Mexican Labor in the United States," *Bulletin of the Bureau of Labor*, 1908, *78* (September), 466–522.

Clemens, Michael A, "The Effect of Occupational Visas on Native Employment: Evidence from Labor Supply to Farm Jobs in the Great Recession," IZA Discussion Paper 10492. Bonn: IZA Institute for the Study of Labor 2017.

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

DOL, "Part III, Chapter 4800 — Revision of ES-223, In-Season Farm Labor Report," Manual Transmittal Letter No. 414 1955. Dwight D. Eisenhower Presidential Library, Abilene, KS. U.S. President's Commission on Migratory Labor, Box 11, folder "Labor Dept. Committee on Coordination, Samuel Pierce, Chairman".

_ , *Estimating Current and Expected Farm Employment*, U.S. Department of Labor Bureau of Employment Security, 1956.

Durand, Jorge, Douglas S Massey, and Fernando Charvet, "The changing geography of Mexican immigration to the United States: 1910–1996," *Social Science Quarterly*, 2000, *81* (1), 1–15.

Fan, Jianqing and Irene Gijbels, "Variable bandwidth and local linear regression smoothers," *Annals of Statistics*, 1992, *20* (4), 2008–2036.

Fite, Gilbert C, "Mechanization of cotton production since World War II," *Agricultural History*, 1980, *54* (1), 190–207.

Galarza, Ernesto, *Strangers in Our Fields*, Washington, DC: U.S. Section, Joint United States-Mexico Trade Union Committee, 1956.

— , *Merchants of Labor: The Mexican Bracero Story*, Charlotte: McNally & Loftin, 1964.

Gamio, Manuel, *Mexican Immigration to the United States: A Study of Human Migration and Adjustment*, Chicago: University of Chicago Press, 1930.

Gardner, Bruce, "Minimum wages and the farm labor market," *American Journal of Agricultural Economics*, 1972, *54* (3), 473–476.

Gastelúm Gaxiola, María de los Angeles, *La migración de los trabajadores mexicanos indocumentados a los Estados Unidos*, Vol. 6, Colección Posgrado, México, DF: Universidad Nacional Autónoma de México, 1991.

González Navarro, Moisés, *Población y Sociedad en México (1900–1970)*, Vol. 2, México, DF: Universidad Nacional Autónoma de México, 1974.

Gratton, Brian and Emily Merchant, "Immigration, Repatriation, and Deportation: The Mexican-Origin Population in the United States, 1920–1950," *International Migration Review*, 2013, *47* (4), 944–975.

Grove, Wayne A., "The Mexican Farm Labor Program, 1942–1964: Government-Administered Labor Market Insurance for Farmers," *Agricultural History*, 1996, *70* (2), 302–320.

Hadley, Eleanor M, "A critical analysis of the wetback problem," *Law and Contemporary Problems*, 1956, *21* (2), 334–357.

Harper, Robert G., "Mechanization and the Seasonal Farmworker," *Farm Labor Developments*, 1967, *1* (2, April), 8–20.

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

Heinicke, Craig and Wayne A Grove, "'Machinery Has Completely Taken Over': The Diffusion of the Mechanical Cotton Picker, 1949–1964," *Journal of Interdisciplinary History*, 2008, *39* (1), 65–96.

Herrendorf, Berthold, Christopher Herrington, and Akos Valentinyi, "Sectoral technology and structural transformation," *American Economic Journal: Macroeconomics*, 2015, *7* (4), 104–133.

Hirsch, Hans G, "Effects of change in use of seasonal workers on US-Mexican agricultural trade and balance of payments," Economic Research Service. Washington, DC: US Department of Agriculture 1966.

Hong, Gihoon and John McLaren, "Are Immigrants a Shot in the Arm for the Local Economy?," NBER Working Paper 21123. Cambridge, MA: National Bureau of Economic Research 2015.

Johnson, D Gale and Marilyn Corn Nottenburg, "A Critical Analysis of Farm Employment Estimates," *Journal of the American Statistical Association*, 1951, *46* (254), 191–205.

Jones, Lamar B and G Randolph Rice, "Agricultural Labor in the Southwest: The Post Bracero Years," *Social Science Quarterly*, 1980, *61* (1), 86–94.

— **and James W Christian**, "Some Observations on the Agricultural Labor Market," *Industrial and Labor Relations Review*, 1965, *18* (4), 522–534.

Koziara, Karen S., "The Agricultural Minimum Wage: A Preliminary Look," *Monthly Labor Review*, 1967, *90* (9), 26–29.

Leamer, Edward E, "The Heckscher-Ohlin Model in Theory and Practice," 1995.

Levine, Linda, "The Effects on US Farm Workers of an Agricultural Guest Worker Program," Washington, DC: Congressional Research Service 2006.

Mamer, John W, "The Use of Foreign Labor for Seasonal Farm Work in the United States: Issues Involved and Interest Groups in Conflict," *Journal of Farm Economics*, 1961, *43* (5), 1204–1210.

Martin, Philip L, "Guest workers: Past and present," in "Migration between Mexico and the United States, Binational Study," Vol. 3: Research Reports and Background Materials, Washington, DC: U.S. Commission on Immigration Reform, 1998, pp. 877–896.

— **and Michael S Teitelbaum**, "The Mirage of Mexican Guest Workers," *Foreign Affairs*, 2001, *80* (6), 117–131.

Martin, William E, "Alien Workers in United States Agriculture: Impacts on Production," *Journal of Farm Economics*, 1966, *48* (5), 1137–1145.

Massey, Douglas S and Karen A Pren, "Origins of the new Latino underclass," *Race and Social Problems*, 2012, *4* (1), 5–17.

McBride, John G, *The Vanishing Bracero: Valley Revolution*, San Antonio, TX: The Naylor Co., 1963.

Mervine, E.M. and R.D. Barmington, *Mechanical Thinning of Sugar Beets* Bulletin 476, Fort Collins: Colorado Agricultural Experiment Station, Colorado State College, 1943.

Metzler, William H., Ralph A. Loomis, and Nelson L. LeRay, *The Farm Labor Situation in Selected States, 1965–66*, Washington, DC: Economic Research Service, U.S. Dept. of Agriculture, 1967.

Mitchell, Don, *They Saved the Crops: Labor, landscape, and the struggle over industrial farming in Bracero-era California*, Athens, GA: University of Georgia Press, 2012.

Morgan, Kristi L, "Evaluating guest worker programs in the US: a comparison of the Bracero Program and President Bush's proposed immigration reform plan," *Berkeley La Raza Law Journal*, 2004, *15*, 125–144.

Morgan, L. C. and B. L. Gardner, "Potential for a U.S. guest-worker program in agriculture: Lessons from the Braceros," in B. R. Chiswick, ed., *The Gateway: U.S. Immigration Issues and Policies*, Washington, DC: American Enterprise Institute, 1982, pp. 361–411.

Morris, Austin P, "Agricultural Labor and National Labor Legislation," *California Law Review*, 1966, *54* (5), 1939–1989.

North, David S and Marion F Houstoun, *The Characteristics and Role of Illegal Aliens in the US Labor Market: An Exploratory Study* Report ETA-DOL-20-1-74-21, Employment and Training Administration, Washington, DC: U.S. Department of Labor, 1976.

Peri, Giovanni and Chad Sparber, "Assessing inherent model bias: An application to native displacement in response to immigration," *Journal of Urban Economics*, 2011, *69* (1), 82–91.

Rasmussen, Wayne D, "Technological Change in Western Sugar Beet Production," *Agricultural History*, 1967, *41* (1), 31–36.

Rogers, Lawrence and Irving Cohen, *Technological Changes in Sugar Beet Cultivation: Effect on Seasonal Hired Labor* Bureau of Employment Security, Washington, DC: U.S. Department of Labor, 1963.

Rorabaugh, Guy, "Presidential Address," *Journal of the American Society of Sugar Beet Technologists*, 1964, *13* (1), 1–4.

Scruggs, Otey M, "Texas and the Bracero program, 1942-1947," *Pacific Historical Review*, 1963, *32* (3), 251–264.

Smith, Michael M, "Beyond the borderlands: Mexican labor in the Central Plains, 1900–1930," *Great Plains Quarterly*, 1981, *1* (4), 239–251.

Taylor, Paul Schuster, *Mexican Labor in the United States: Migration Statistics IV* University of California Publications in Economics, Vol. 12, No. 3, pp. 23–50, Berkeley, CA: University of California Press, 1934.

U.S. National Archives, "Department of Agriculture Bureau of Agricultural Economics Organization Authority Record," National Archives Catalog Online.

U.S. Senate, *The migratory farm labor problem in the United States* Report of the Committee on Labor and Public Welfare, United States Sentate, made by its Subcommittee on Migratory Labor, purusant to S. Res. 188. 89th Congress, 2nd Session. August 30., Report 91-83. Washington, DC: Government Printing Office, 1966.

USDA, *Major Statistical Series of the U.S. Department of Agriculture, How They Are Constructed and Used* Vol. 7, Farm Population and Employment, Washington, DC: United States Department of Agriculture, 1969.

USDA, *Sugar Reports* No. 225, February. Agricultural Stabilization and Conservation Service, Washington, DC: United

States Department of Agriculture, 1971.

USDA, *Statistics on Cotton and Related Data, 1920–73*, Washington, DC: United States Department of Agriculture Economic Research Service, 1974.

USDA, *Agricultural Labor Data Sources: An Update* No. 658, August. Agriculture Handbook, Washington, DC: United States Department of Agriculture Economic Research Service, 1986.

Vialet, Joyce and Barbara McClure, *Temporary Worker Programs: Background and Issues,* A report prepared at the request of Senator Edward M. Kennedy, chairman, Committee on the Judiciary, United States Senate, for the use of the Select Commission on Immigration and Refugee Policy, Congressional Research Service. Washington, DC: Government Printing Office, 1980.

Wise, Donald E., "The effect of the bracero on agricultural production in California," *Economic Inquiry*, 1974, *12* (4), 547–558.