The Effect of U.S. Agricultural Subsidies on Farm Expenses and the Agricultural Labor Market*

Belinda Acuña†
Department of Economics
University of California, Santa Barbara

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Abstract

This paper examines the effect of agricultural subsidies on farm labor and capital expenses and on the market for agricultural labor, specifically immigrant agricultural labor. The analysis uses the confidential USDA Agricultural Resource Management Survey, the Current Population Survey, and the National Agricultural Statistics Service Quick Stats database. Farm and state-level data from before and after the enactment of the 1996 Farm Bill is used to identify the effect of subsidies on farm expenses and the labor market. The 1996 Farm Bill separated production decisions and prices from subsidy payments. The farm-level analysis indicates that farm subsidies increase farm labor and capital expenses. Subsidies have a larger impact on labor expenses for farms that produce relatively more labor intensive program commodities such as rice and sorghum. The state-level results indicate that agricultural subsidies have a positive effect on the hours worked by immigrant agricultural labor. These findings suggest that agricultural subsidies increase the immigrant agricultural labor force.

Keywords: Agricultural Policy, Domestic Subsidies, Agriculture Labor Market, Immigrant Labor, Econometric Applications

JEL Classification: J43, J82, Q12, Q18

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†Send direct e-mail to acuna@econ.ucsb.edu

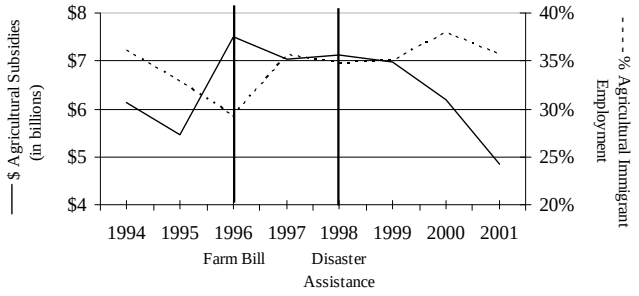
I Introduction

Billions of dollars are spent every year to fund the American agricultural sector, and debates arise about whether farm policy accomplishes its objectives and who the true beneficiaries are of these costly programs.[1] Farm payments are primarily intended as income transfers from taxpayers to farm operators in order to protect farmers from the risks associated with agriculture commodity markets (e.g. volatile prices, natural disasters). Agricultural payments provide incentives for farm operators to expand operations and increase farm labor and capital expenditures. This paper identifies the effect of agricultural subsidies on farm labor and capital expenses by analyzing confidential farm level data before and after a unique farm policy change, the 1996 Farm Bill. The 1996 Farm Bill separated commodity prices and output from the determination of agricultural subsidies.

Figure 1 shows U.S. agricultural subsidies and the percentage of the agricultural labor force that are immigrants for the years 1994 through 2001. Immigrant workers comprise a

Figure 1

U.S. Agricultural Subsidies and Immigrant Labor, 1994 - 2001



Note: Subsidies are in 2007 billions of dollars and do not account for disaster assistance payments.
Subsidies and immigrant labor are in fiscal year totals.
Data sources: Current Population Survey for immigrant labor data and Just and Nelson (1996) for agricultural subsidies data.

large portion of the farm labor force and potentially are also a large component of farm labor expenses.[2] Before the 1996 Farm Bill, the percentage of immigrant employment decreased

[1] The 1996 Farm Bill allocated 35.6 billion dollars for the production flexibility contract (PFC) program to be paid out to farmers over the years 1996 to 2002. In 1998, the farm bill allocated 2.68 billion dollars to corn alone through the PFC program. More recently, the 2002 Farm Act developed programs which paid farmers approximately 20 billion dollars in 2005 (Economic Research Service, USDA 2007).

[2] In 1998, 78 percent of all U.S. farm crop workers were born in Mexico up from 68 percent between 1993

every year and dropped to 29% in 1996. In 1997, the percentage of immigrant labor increased sharply to 36%. The figure suggests that farmers reacted to the policy change in 1997 by perhaps hiring more immigrant workers. In 1998, farmers were also provided disaster assistance payments, but are not included in the subsidy measure.

Agricultural policies have been a part of the agricultural sector since the 1930's and have undergone major changes within the last 15 years. The 1996 Farm Bill provides the main source of identification since it enacted a major change in the determination of subsidy payments. Prior to 1996, farmers were able to influence the subsidies they received since subsidies were based on commodity prices and were closely tied to farm expenditures through production decisions. The 1996 Farm Bill based subsidy payments on an exogenous payment rate and historical acreage making it difficult for farm operators to influence the amount received. The subsidy payment was then characterized as a "lump-sum" transfer since it did not rely on production decisions or market prices (Burfisher and Hopkins, 2003).

The 1995, 1996, and 1997 confidential USDA Agricultural Resource Management Survey (ARMS) is used to examine the effect of agricultural subsidies on farm labor and capital expenses.[3] Commodities are also separated into labor and capital intensive crops and analyzed separately. A pooled cross-section analysis is used which controls for farm commodity, county and time effects. Using the 1996 Farm Bill change, subsidy payments are treated as exogenous since they were determined in the bill.

Farm-level results show that a 1% increase in subsidies per acre received by a farm increases labor expenses by .03% and increases capital expenses by .11%. Evaluated at the means, this indicates that for every $.20 per acre in subsidies a farm receives, farm labor expenses increase by $.015 per acre and capital expenses increase by $.196 per acre. As expected, it is also observed that farm operators of labor intensive crops increase their expenses of labor more than capital and operators of capital intensive crops increase their

and 1995 (Zahniser and Treviño, 2001).

[3] Access to ARMS data was obtained under a confidentiality agreement with USDA NASS and is only available at USDA statistical field offices. The NASS Arizona field office, located in Phoenix, AZ, provided access to ARMS and provided a computer and office space from August 2006 to August 2008 for this research.

expenses of capital more than labor. These results suggest that farm operators either increase the number of workers hired or their wages and also, that operators are either increasing the amount of capital used in the production process or are experiencing capital price increases.

A drawback of the farm-level data is the inability to separate the components of farm labor expenses: wages and employment. Since agricultural subsidies are shown to increase farm labor expenses, it is of interest to analyze whether wages or employment is the driving factor. This analysis uses a panel of U.S. states to analyze wages and employment hours for the total agricultural labor market and then separately for the immigrant and non-immigrant agricultural labor market. Interest in the immigrant labor market is due to the observation that the immigrant labor force increased with subsidies as shown in figure 1. The 1995, 1996, and 1997 ARMS, the Current Population Survey (CPS) and the National Agricultural Statistics Service (NASS) Quick Stats databases are used. Assuming states are independent labor markets, the estimation strategy uses a fixed effects panel framework and also takes advantage of the 1996 farm policy change for identification.

Results for the state-level analysis indicate that subsidies have no effect on wages or on the employment hours of non-immigrant workers. However, results indicate that an additional \$1 per acre in subsidies that a state receives increases agricultural immigrant employment by 315,550 hours. Evaluated at the sample means for subsidies and immigrant employment hours, this indicates that a 1% increase in subsidies per acre that a state receives increases agricultural immigrant employment hours by .63%. These estimates imply that the increase in farm labor expenses is driven by an increase in the hours worked by immigrant laborers and not by increases in wages.

The structure of the paper is as follows: section II reviews the most recent literature, section III describes the background on farm policy, section IV describes the data, section V develops the empirical framework, identification strategy, and discusses the results, section VI conducts an additional analysis based on both the farm and state-level data, and section VII concludes.

II Literature Review

II.1 Agricultural Subsidies

Economic analysis of the effect of agricultural subsidies focuses on the incidence of agricultural policy: the distribution of the benefits and costs of the policy on producers, suppliers of production inputs, or taxpayers (Alston and James, 2002). A large portion of this literature focuses on the price support program. The price support program is intended to increase commodity prices by government intervention in the commodity market.[4] Although this program is still in place today, research based on more recent payment programs, such as payments introduced in the 1996 Farm Bill, is perhaps more relevant. The economic implications of agricultural subsidies as described in the literature are reviewed. The section is concluded with literature on the agriculture immigrant labor market.

Economic theory suggests that agricultural subsidies increase the prices of the inputs used more intensively in the production process. A large portion of the literature examines the incidence of agricultural subsidies on land, and it is strongly asserted that subsidies will increase the price of land in the long run and have little to no effect on other inputs (Choi and Johnson, 1993). Floyd (1965) emphasizes that the amount of the increase in input prices depends on the price elasticity of supply of the factors used. Since land is very inelastic, we should observe subsidies have a larger effect on the price of land than labor and capital, but observe a greater rise in the quantity employed of the other factors. Floyd analyzes the effect of agricultural price supports on the return to labor and capital. He develops a theoretical model of the effects of the price support program where output is not controlled, controlled under acreage limitations, and controlled by quota limitations. His results indicate that an increase in government-induced prices under no output control raises the farm wage rate, but when output is controlled, there is no effect on farm earnings.

Similar to Floyd, Gisser (1969) develops a theoretical model of the farm labor market and

[4]The government intervenes in the market by purchasing commodities at set minimum prices directly from farmers and stores the excess commodities until they can be donated or re-sold.

analyzes whether four specific agriculture support programs affect wages and employment. Of the four programs analyzed, the price support program is the only program still in place today. Gisser uses output and input elasticity parameters to obtain results. His results suggest that the price support program raises farm wages by 2% and increases farm employment by 7%, assuming farm labor supply is elastic. These findings suggest that subsidies have a larger effect on employment than wages which confirms what is indicated by Floyd.

Kirwan (2004) conducts an empirical analysis to examine the incidence of subsidies on the farmland rental rate using farm-level panel data from the 1992 and 1997 USDA NASS Census of Agriculture micro-data files. He is able to use the 1996 Farm Bill as an exogenous policy change to assist in identifying the effect. The author concludes that owners of farmland that are not farm operators only capture about $.20 of the subsidy dollar indicating there are potentially additional subsidy effects. Kirwan conducts additional analyses on the effect of agricultural subsidies on farm expenses. He finds that agricultural subsidies also increase labor, seed, fertilizer, chemical and other capital expenses. This analysis does not attempt to separate the labor expenses variable or to examine the difference between labor and capital intensive farms.

Barkley (1990) develops a theoretical model of the decision to migrate out of agriculture and estimates the model using data from the USDA and Bureau of the Census for the years 1940-1985. The author includes a government payments variable in the regression analysis to capture the effect of government involvement in the farm labor market. The author assumes the government payments variable to be exogenous although prior to 1996, government subsidies were tied to production decisions and prices creating an endogeneity issue in the estimation. Barkley finds no significant effect of the government payments variable on the migration of labor out of agriculture. The author explains the results by indicating that the government payments variable includes different types of programs, such as price support, target price subsidies, and acreage restrictions, which all have counteracting effects on the farm labor force.

II.2 Immigrant Agricultural Labor

There seems to be no research on the effect of agricultural subsidies on immigrant agricultural labor although there is a small media debate on the correlation between subsidies and illegal immigration. The immigrant agricultural labor market accounts for approximately 30% of the total labor market in agriculture. Many immigrant workers in agriculture are also undocumented workers. As much as 25% to 75% of the hired farm labor force is estimated to be undocumented (Effland and Runyan, 1998). In 1998, approximately 57% of workers born in Mexico were undocumented (Zahniser and Treviño, 2001). Taylor and Martin (1997) describe the agricultural sector as having a highly elastic immigrant supply. Agricultural subsidies are potentially being used to increase the amount of hired farm labor instead of increasing earnings.

Taylor and Martin (1997) analyze the impact of immigrants on poverty and welfare in California farmworker communities where the majority of the population is employed in agricultural activities. The Census of 1980 and 1990 are used to examine the relationship between farm employment, immigration, and income using a six equation simultaneous system. The authors explain how a circular relationship between farm employment and immigration exists. Not only does farm employment attract immigrants to rural communities, but immigration generates new farm jobs "by suppressing real earnings for farm workers and discouraging the adoption of labor-saving production practices." Results indicate that an additional 100 farm jobs leads to a 136 person increase in immigrants implying that there is a strong positive relationship between farm employment and immigrant labor.

Although previous work has emphasized the effects of subsidy programs on earnings and employment, recent analysis is sparse. Agricultural policy changes approximately every 5 to 7 years and it is of interest to investigate recent policy effects. Furthermore, no research seems to have been conducted to understand the effects of subsidies on the immigrant labor force. The next section will describe the changing framework of agricultural policy which will be used for identification.

III Agricultural Payments Policy

The U.S. government subsidizes the agriculture sector primarily to stabilize farm income and to compensate for unstable market prices. Subsidies are administered through the Commodity Credit Corporation (CCC) of the U.S. Department of Agriculture (USDA), which requires owners of eligible farms to submit applications for specific payment programs. The program commodities eligible for subsidy payments in the years for this analysis were barley, corn, cotton, oats, rice, sorghum and wheat.

In 1995, subsidies were provided mainly through the deficiency payment program.[5] Deficiency payments were intended to provide farmers with a guaranteed commodity price. The payment received for a particular commodity, j, was determined as the product of a commodity's payment rate, yield, and 85% of the farm's commodity base acres as shown in equation (1):

$$(1) \qquad Subsidy_j = (Payment\ Rate)_j * (Yield)_j * (85\%\ Base\ Acres)_j$$

The payment rate was a per-unit subsidy calculated as the difference between the target price which was a predetermined level set by the 1990 Farm Act (Young and Shields, 1996), and the national average price of the marketing year. When the market price was above the target price, subsidies were zero. A farm's yield was determined as the average commodity yield between 1981 and 1985 to control for productivity changes. A farm's base acreage was determined as the average acreage planted on the farm during the previous five years (Young et al., 2005). Therefore, base acreage in 1995 was the average acres planted from 1990 to 1994. After the first five months of the crop marketing year, 75% of deficiency payments were disbursed based on forecasted commodity prices. The last 25% were disbursed at the

[5]The deficiency payment program required that subsidized farmers be enrolled in the acreage reduction program (ARP). The ARP made it mandatory for farmers to idle a certain percentage of their commodity acres in order to control the supply of the commodity. ARP acres did not receive payments. In addition to ARP, farmers were required to plant at least 75 percent of the commodity for which they received subsidies in order to receive payment (Evans, 1993).

end of the marketing year after commodity prices were known (Pollack and Lynch, 1991).

The 1996 Farm Bill also known as the Federal Agriculture Improvement and Reform (FAIR) Act of 1996, introduced production flexibility contract (PFC) payments in order to separate farm market prices and crop production decisions from government income support. They were intended to allow farmers the flexibility to plant any crop even if it wasn't subsidized. Payments were then associated with the land and not with the particular commodity that was being planted. PFC payments were calculated using the same formula as for deficiency payments with changes to the payment rate and base acres. The payment rate for each commodity was calculated by dividing the U.S. commodity payment level, determined by the FAIR Act, by the total U.S. enrolled base acreage of that commodity to obtain the per-unit subsidy (Young and Shields, 1996).

Under the FAIR Act, base acreage was frozen at 1995 levels to remove the dependency on production. By freezing base acreage at 1995 levels, subsidies for program commodities were based solely on historical production. Unlike under the previous farm bill, farmers were not able to influence future subsidy payments through current production. The FAIR Act provided farmers with an exogenous subsidy payment level and terminated the ARP and the production requirement. PFC payments were disbursed annually no later than September 30th and advance payments were available for disbursement on December 15th or January 15th of the fiscal year (Just, 1996).

After the policy change, the distribution of agricultural subsidies shifted towards states in the Great Plains. Figures 2 and 3 show the distribution of agricultural subsidies across states from before and after the enactment of the bill in 1995 and 1997, respectively. In 1995, the states that received the highest subsidies received between \$150,437,000 and \$778,909,000 and are shown in the darkest shade. The state with the highest subsidy receipts was Iowa followed by Minnesota and Illinois. In 1997, the state with the highest subsidy receipts changed to Kansas with \$464,202,000 followed by Iowa and Minnesota. The northeastern Unites States received the lowest amount of subsidies both before and after the enactment

of the policy.

The identification strategy used in the analysis takes advantage of the 1996 policy change. Since the policy removed dependency of subsidy payments from commodity prices and output, the subsidy amount in 1996 and 1997 only depends on the payment rate. The payment rate is exogenous since it is determined entirely by the FAIR Act and not influenced by current producer behavior. During the previous farm act, farmers had some control over the payment they received through their production decisions. Thus, the effect of agricultural subsidies on expenses and employment was difficult to separate from the effect of production decisions, since production is correlated with expenses and employment. However, beginning with the 1996 farm act, farmers were not able to influence the amount of subsidy payments since they depended only on payment rates and base acres set by legislation and not on market prices or production.

IV Data

This paper uses a variety of datasets in order to analyze the effect of subsidies on expenses and the labor market. The confidential Agricultural Resource Management Survey (ARMS) is used for the farm-level analysis. A confidentiality agreement was obtained through USDA NASS to work with the dataset in the Arizona NASS office. The state-level analysis uses the ARMS dataset along with the Current Population Survey (CPS) and National Agricultural Statistics Service (NASS) Quick Stats[6] to construct a panel of states before and after the 1996 FAIR Act. ARMS is a series of annual personal interviews with farm operators within the continental U.S. and contains specific farm-level data, including government payments, costs, and income data. Institutional farms and those who sell less than $1,000 of agricultural products a year are not included in the ARMS sample.

The ARMS sample used in the farm-level analysis is limited to farms that received pos-

[6] NASS Quick Stats is an online database which provides state and county level data on many agricultural statistics. Specifically, farmland area by state is obtained for the state-level analysis.

itive government payments in 1995, 1996, or 1997 and responded to the ARMS Phase III version 1 form.[7] The sample is further limited to farms that produced at least one of the program commodities for consistency. The government subsidy variable in the ARMS includes conservation reserve payments which are given to idle cropland. These payments are removed from the government subsidies variable in our analysis to arrive at subsidies given for deficiency payments in 1995 and PFC payments in 1996 and 1997.

Table I describes summary statistics of the variables used in the analysis and their descriptions. The data shows that average labor expenses per acre operated increased from \$45.67 to \$55.06, but fell to \$47.14 in 1997. Capital expenses per acre operated increased from \$172.41 to \$191.91, but also fell to \$171.13. Subsidies per acre decreased every year from \$22.52 in 1995 to \$19.64 in 1996, then to \$18.44 in 1997. The change from 1995 to 1996 could be largely due to the change in policy. Farms produce more corn and wheat than any other program crop at 65% and 47% in 1997, respectively.

The ARMS sample used in the state-level analysis is constructed similarly as in the farm-level sample. The government subsidy variable is constructed by aggregating the total subsidies received, without the conservation reserve payments, by all farms in a state divided by the total acres operated of program crops in a state to obtain the subsidy dollar per acre received. The sales per acre variable is constructed similarly as the subsidy variable. The total number of farms in a state is also obtained from the ARMS dataset. All dollar amounts are in constant 2007 dollars.

The CPS[8] is used primarily to obtain state-level average agricultural wages and agricultural employment hours for the total labor market and the immigrant and non-immigrant labor market. The CPS provides detailed information on citizenship status, wages and farm labor characteristics. The sample is limited to individuals between the ages of 15-65 with positive wages who responded to being employed in the agriculture sector (not including

[7]Farms that did not receive government subsidies or that reported receiving a negative amount are excluded from the analysis since they are assumed to behave differently from farms that do receive subsidies.

[8]The CPS is a monthly survey of about 50,000 households in the United States and is conducted by the Bureau of Labor Statistics and the U.S. Census Bureau.

veterinary services, forestry, fishing, hunting, or trapping occupations). Individuals in the CPS are surveyed for 4 consecutive months, not surveyed afterwards for 8 months, and finally, surveyed for an additional 4 months. In each survey month, individuals who report wage information are those in outgoing rotation groups (ORG). Individuals in ORG report wage information in their 4th and 8th interviews which corresponds to the 4th and 16th month, respectively. We take only individuals from ORG which guarantees a yearly sample of unique individuals (BLS and Bureau of the Census, 2002).

In order to obtain larger sample sizes and additional data on agricultural wages by state, I pool across 12 monthly CPS surveys for each year: from August 1995 to July 1996, August 1996 to July 1997, and from August 1997 to July 1998. This is due to the crop marketing year which varies from crop to crop. The average crop marketing year for program crops starts in August and ends in July. Obtaining average agricultural wages under the crop marketing year follows closely the data collection procedure of ARMS, which begins in July of the reference year and ends in the spring of the following year. For each year, agricultural employment hours are aggregated within states and agricultural wages are averaged to obtain total employment hours per state and wages.[9]

Table 2 shows summary statistics of the variables used in the state-level analysis as well as descriptions of the variables. All dollar amounts are in constant 2007 dollars. The data shows that average state agriculture sector wages were higher for non-immigrant agricultural workers than for immigrant agricultural workers for all years. Agriculture sector employment hours for immigrant workers increased by 905,000 hours from 1995 to 1996, but decreased slightly in 1997. Non-immigrant agricultural workers had a different experience: their hours worked decreased every year. Between 1995 and 1997, average state subsidies increased by \$.20 per acre. It is apparent that there is a slight peak of employment hours in the 1996 crop marketing year. This can be compared to figure 1 which shows the strong increase in

[9] A state-level analysis is conducted since the ARMS and CPS samples are not appropriate for analysis of county-level or further disaggregation.

immigrant employment in the 1997 fiscal year.[10]

V Empirical Framework

V.1 Farm-Level Analysis

The ARMS farm-level data is used to estimate the effect of government subsidies on farm labor and capital expenses. Farm labor expenses include amount spent on hired and contract labor and does not include expenses on farm operators or owners. Farm capital expenses include the total dollar amount spent on fertilizer, chemicals, seeds, and depreciation. The farm-level analysis uses a pooled cross section and an instrumental variable estimation for years 1995, 1996, and 1997.

Let expenses, either labor or capital, per acre operated for farm j in time t be denoted by ex_{jt} and government subsidies per acre operated by g_{jt}, then the estimation equation can be characterized by (2) where $\mathbf{X}_{jt}$ is a vector of other factors which also affect expenses, and

$$\log ex_{jt} = \pi_0 + \pi_1 \log g_{jt} + \mathbf{X}'_{jt}\boldsymbol{\phi} + dc_j + dt_1 + dt_2 + \tau_{jt} \tag{2}$$

where dc_j, dt_1 and dt_2 are dummy variables for farm county, year 1996 and year 1997, respectively. The estimation is run for both labor and capital expenses as dependent variables. [11] The vector, $\mathbf{X}_{jt}$, includes log sales per acre, the log number of harvested acres, indicator variables for six program commodities, and an indicator variable denoting whether the farm plants multiple crops. The variables log sales and log number of harvested acres are included to attempt to control for farm size. The indicators for the program commodities are intended to capture any farm differences that attribute to planting a specific program

[10] The 1997 fiscal year includes seven months of the 1996 crop marketing year.

[11] This estimation assumes that labor and capital expenses are determined separately. To incorporate joint determination, the estimation is also run with log capital and log labor expenses as independent variables in the log labor and log capital expenses estimations, respectively. Results for the variable of interest are approximately similar.

crop. The omitted program crop is corn and therefore, the coefficients on the included crops will be compared to corn farms. The multiple crop farm indicator is intended to capture any farm differences having to do with non-specialization. County indicators control for county specific factors that are constant across time such as land and soil characteristics. The time indicators control for factors that remain constant across all farms but change by year , such as aspects of the agricultural political environment. The log-log specification provides elasticity estimates.

The estimation in equation (2) is also conducted for each program crop separately, except not including the crop indicators. This is conducted to determine whether there is a difference in the subsidy effect based on what input the production process uses more intensively. First, the ratio of labor to capital expenses for each commodity is used to determine whether the program crop is labor or capital intensive. Only farms that specialize in the production of that commodity alone are used to determine the ratio in order to remove any biases that may be due to planting multiple crops. Second, the ratio for each crop is compared with that of the other crops. Cotton had the highest labor to capital ratio of .49 followed by rice with .35, sorghum with .29, and oats with .28. These crops are determined as labor intensive since they have higher ratios than barley and wheat with .23 and corn with .12 which are considered capital intensive.

Identification is obtained when government subsidies are exogenous and uncorrelated with the error term, τ_{jt}. To the extent that farms were unaware of the amount of subsidies they were going to receive in 1996 and 1997 and so could not change 1995 base acres in response to that, subsidies are plausibly exogenous. Recall that the 1996 farm act froze base acres at their 1995 levels and set payment rate determination in legislation. Furthermore, policy makers drafted the farm bill during a time of high stable crop prices and after the 1995 WTO Agreement on Agriculture came into effect not providing farmers with enough time to anticipate the drastic changes that were included in the new farm bill.

Subsidies are not exogenous if farms are inherently different from other farms due to

management, crop production decisions and other farm-specific characteristics. Thus, if farms receive subsidies due to farm-specific factors, this can bias our results. Using indicator variables for crops is an attempt to control for the differences in farm characteristics. Under this specification, farms that plant cotton, for example, are assumed different than farms that plant corn.[12]

V.1.1 Results: Farm Labor and Capital Expenses

Table 3 shows the OLS farm-level estimation of the effect of agricultural subsidies on farm labor and capital expenses. All of the reported coefficients are from the log subsidies variable, but regressions include the controls in equation (2). The crop specific estimations also include the controls except without the crop indicator variables. The estimation is first conducted for all of the program crops in the sample followed by specific commodity estimation for labor intensive crops, cotton, oats, rice, and sorghum, and capital intensive crops, barley, corn, and wheat.

The estimation for the sample of all crops in the first row indicates that a 1% increase in agricultural subsidies per acre a farm receives will increase farm labor expenses per acre by .03%[13] and will increase farm capital expenses by .11%. This indicates farms are spending more money on inputs as a result of subsidy receipts with more money spent on capital goods. Evaluated at the sample mean values for subsidies, labor expenses, and capital expenses per acre, this indicates that for every $.20 per acre in subsidies a farm receives, farm labor expenses increase by $.015 per acre and capital expenses increase by $.196 per acre. Since the average number of program crop acres a farm operated in the sample time period was

[12] An instrumental variable (IV) analysis was conducted to attempt to alleviate the bias associated with farm heterogeneity. The 1996, 1997, and 1998 payment rates determined in the 1996 Farm Bill were used as instruments for the 1995, 1996 and 1997 government subsidies variable. Payment rates are exogenous since they were determined under the 1996 FAIR act and were shown to be highly correlated with subsidy payments in the first stage. IV results were identical to the OLS results and are not reported here. This indicates that much of the farm heterogeneity bias is controlled by the farm indicators.

[13] Kirwan (2004) specifically tests the effect of subsidies on farm labor expenses and finds an estimate of .03 percent using OLS log-log estimation similar to this analysis. Under instrumental variable estimation, Kirwan finds a statistically significant effect of .033 percent.

1,024, then an increase of approximately $205 in subsidies given to a farm increases their farm labor expenses by $15.36 and capital expenses by $201. The average program crop farm received $20,191 in subsidies between 1995 and 1997.

Separating the commodities, the labor intensive column shows subsidies affect labor and capital expenses for farms that produce rice and sorghum more than any other farm. Rice and sorghum labor expenses increased by .20% and .26%, respectively and their capital expenses increased by .16% and .14%, respectively due to subsidy receipts. It is expected that labor intensive farms will spend more on labor than on capital due to subsidy receipts and that capital intensive farms will do the opposite. Rice and sorghum are observed to spend more on labor and furthermore, the capital intensive commodities spend more on capital than on labor. Cotton and oats show no significant effect of subsidies on labor expenses but do on capital expenses. This is potentially due to the fact that many farms that produce cotton and oats produce multiple crops and this is capturing most of the effect.

Farmers of corn are the only farms observed to spend less on labor due to subsidy receipts. The corn production process is highly capital intensive and it could be that subsidies provide corn farmers income to invest in more capital that is then being substituted for labor. Crops such as rice, sorghum, barley and wheat potentially use the subsidy income to increase both labor and capital expenses if they are used together as complements in the production process. Farmers of wheat are observed to spend more on labor than on capital indicating perhaps that the group used to define the labor intensity ratio is not appropriate.

The positive and statistically significant coefficient on agricultural subsidies on capital expenses for every commodity indicates that farm operators are either increasing the amount of capital employed or are experiencing higher capital prices. The positive and statistically significant coefficient on agricultural subsidies on labor expenses in the sample for all crops indicates that farm operators are either increasing the amount of labor hours employed or increasing wages. Although it is impossible to separate capital expenses into the price and number employed components given the available data, the next section of the analysis

attempts to separate farm labor expenses using the CPS data at the state-level. The state-level analysis attempts to separate labor expenses for the total agricultural labor market and the immigrant and non-immigrant agricultural labor market to further understand whether subsidies affect the input price or the number of inputs.

V.2 State-Level Analysis

The estimation technique in the state-level analysis is motivated by a fixed effects estimation framework where reduced forms of the agricultural labor market in a state are estimated. Consider the agriculture labor market in a state where agriculture wages are set by the supply and demand for labor. The supply and demand for labor in a state are assumed to be determined by characteristics of the agriculture labor market such as the amount of government subsidies received, sales, the number of farms in a state, and the average wage offered in the non-agriculture sector. In a perfectly competitive agricultural labor market, market-clearing provides the reduced-form equations (3) and (4) where wages are denoted

$$w_{it} = \alpha_1 g_{it} + \mathbf{Z}'_{it}\boldsymbol{\alpha} + s_i + \varepsilon_{1it} \tag{3}$$

$$L_{it} = \beta_1 g_{it} + \mathbf{Z}'_{it}\boldsymbol{\beta} + s_i + \varepsilon_{2it} \tag{4}$$

by w_{it} in state i in time t, and labor is denoted by L_{it} in state i in time t, and represents labor hours. The regressors in the equations are assumed to have an effect on wages and labor hours. These are state government subsidies per acre operated, g_{it}, a vector of controls, $\mathbf{Z}_{it}$, a state specific effect, s_i, and ε_{1it} which denotes the error term.[14] The vector of controls, $\mathbf{Z}_{it}$, includes sales of program crops for each state per acre operated, the total number of

[14] The reduced-form equations are obtained assuming they are derived from structural demand and supply equations whose parameters are not of interest. The reduced form equations do not have to be derived from a competitive labor market structure. Furthermore, the reduced-form equations can also be derived assuming noncompetitive labor markets (Lang 1998).

farms in each state, and the average wage offered in the non-agriculture sector. Sales are included to control for differences in both prices and production in addition to attempt to be comparable to the farm-level analysis. Including sales and the number of farms is also an attempt to control for differences in supply across states and time that potentially influence wages and employment and are also correlated with government subsidies.

OLS estimation of equations (3) and (4) will yield biased estimates if the state specific effect is not controlled for. The state specific effect is potentially correlated with determinants of wages and labor hours not accounted for in the equation which will lead to biased estimates. To solve this problem, fixed effects estimation is used to control for state specific factors that do not change over time which are correlated with the error such as land and soil characteristics, geographically specific commodities, typical weather patterns and other unobserved factors. In order to eliminate the state specific effect, we estimate the equations in (5) and (6) where dt_1 and dt_2 are time indicators for year 1996 and 1997, respectively.

$$w_{it} = \delta_1 g_{it} + \mathbf{Z}'_{it}\boldsymbol{\delta} + \mathbf{s}'_i\boldsymbol{\phi} + dt_1 + dt_2 + \mu_{1it} \tag{5}$$

$$L_{it} = \gamma_1 g_{it} + \mathbf{Z}'_{it}\boldsymbol{\gamma} + \mathbf{s}'_i\boldsymbol{\sigma} + dt_1 + dt_2 + \mu_{2it} \tag{6}$$

The time indicators control for time-varying characteristics that remain constant across states. Regressions are weighted by state farmland area in all specifications.

Estimation of equations (5) and (6) is also conducted for the dependent variables of immigrant and non-immigrant agricultural labor hours and wages. The immigrant labor hours and wages variables may suffer from measurement error since undocumented individuals are possibly undercounted in the CPS dataset. If the measurement error in these variables is correlated with any of the regressors, then this can lead to biased estimates. We will assume that the true level of employment hours is higher than the one that we observe and that

the true level of wages is approximately the same or slightly lower.[15] Furthermore, we will assume this measurement error is uncorrelated with factors that affect agricultural immigrant workers and wages. This difficulty will still lead to unbiased estimates of the effect of subsidies on immigrant labor, but will lead to larger standard errors.

The subsidies received by farmers and states are not random and prior to 1996, were correlated with farmer production decisions and prices since subsidies were determined by production and current market prices. The 1996 FAIR Act separated subsidy payments from commodity production and prices, and subsidies were then determined by payment rates and base acres set in the act. The change in policy allows us to control for the problem that farm operators potentially determine the amount of agricultural subsidies received by choosing how much to plant which is then correlated with their hiring decisions. The years 1995, 1996 and 1997 are used to take advantage of the exogenous change in subsidy payments from the 1996 FAIR Act.[16]

V.2.1 Results: Wages and Employment

Tables 4 and 5 present the fixed effects estimation results from estimating the effect of agricultural subsidies on wages and employment hours for the total agricultural labor market and separately for immigrant and non-immigrant labor. Table 4 shows the estimation for wages as the dependent variable where the first column is for the full sample. The second column is for immigrant agricultural labor, and the third column is for non-immigrant agricultural labor. The subsidies variable is statistically insignificant in all specifications indicating that subsidies have no effect on average agricultural wages. However, an effect is observed in table 5 on the effect of immigrant agricultural labor hours. The subsidies coefficient is shown to be positive and statistically significant indicating that an additional

[15] The true value of immigrant weekly earnings is assumed to be the same or slightly lower since earnings of immigrant farm laborers are typically low and vary slightly from one laborer to another.

[16] An instrumental variable analysis was also conducted in this analysis which used the payment rates and base acres set in the 1996 Farm Bill as instruments. Due to the high correlation between the instrumental variable used and the covariates, estimates are shown to be identical and are not reported.

$1 per acre in subsidies that a state receives increases agricultural immigrant employment by 315,550 hours. Evaluated at the average sample values for subsidies and immigrant employment hours, these results indicate that a 1% increase in subsidies increases immigrant employment hours by .63%. Table 5 also shows that the subsidies coefficient is statistically insignificant for the total labor market and the non-immigrant labor market estimations indicating the only effect of subsidies is observed on the immigrant agricultural labor force. It is possible that we only observe a change in the quantity of labor and not wages since agricultural labor has a highly elastic supply (Floyd, 1965).

The only effect of agricultural subsidies is observed on immigrant agricultural labor. The market for total agricultural labor consists of farm operators, contract labor, and hired labor. Immigrant workers are usually hired and contract farm labor although approximately 7% of immigrant workers are farm operators (Grieco, 2004). Farm operators and owners are usually non-immigrants. Since subsidies are shown to have an effect on immigrant labor hours, farmers potentially are hiring additional labor to expand their production. In addition, it could also be that farm operators are entering the labor market and consequently hiring more immigrant workers for production. Therefore, subsidies create incentives for farm owners to increase the amount of labor hired potentially to increase their production and business practices. This analysis suggests that the increase in farm labor expenses caused by subsidies that was observed in the farm-level analysis is mainly due to increases in the amount of labor hired and not to an increase in wages.

VI Additional Analysis

This section attempts to compare the farm-level analysis to the state-level analysis in two ways: first, we create state-level data from the farm-level variables by taking the average of all farms in a state and second, we take the product of the wage and employment variables from the state-level analysis to get an estimate of state farm labor expenses for total, immigrant

and non-immigrant labor expenses. Let le_{it} be farm labor expenses derived from the farm-level data for state i in time t as shown in equation (8), let g_{it} be the amount of

$$le_{it} = \theta_0 + \theta_1 g_{it} + \mathbf{C}'_{it}\boldsymbol{\pi} + \sigma_{1it} \tag{7}$$

government subsidies per acre operated in state i, and let $\mathbf{C}_{it}$ be a vector of control variables: sales per acre and the number of harvested acres. The regression is estimated for years 1995, 1996, and 1997. For the state-level data, equation (9) shows the estimation equation where $(w * L)_{it}$ is the state farm labor expenses as taken from the CPS state-level data,

$$(w * L)_{it} = \theta_0 + \theta_1 g_{it} + \mathbf{I}'_{it}\boldsymbol{\rho} + \sigma_{2it} \tag{8}$$

g_{it} is the government subsidies variable taken directly from the state-level analysis, and $\mathbf{I}_{it}$ is the vector of controls similar to the ones in equations (5) and (6) which includes sales per acre, number of farms, and non-agriculture sector wages. The regression is also conducted for the product of agricultural immigrant and non-immigrant wages and employment hours for years 1995, 1996, and 1997.

Results for the four sets of regressions are shown in table 6. The first column describes the dependent variable used and from what data it was derived from. Only the subsidy effect is shown in the table. Comparing the elasticities, we observe that the state-level estimate for the total and non-immigrant agricultural labor market expenses and the farm-level estimates of the state aggregates of farm labor expenses are not statistically different from zero. The lack of statistical significance of the two variables may be due to the high level of aggregation. Furthermore, although the coefficient on the farm-level state aggregated data is not statistically significant, it is similar to what was obtained in the farm-level analysis in section V.1.1.

The effect of subsidies on the product of immigrant wages and employment hours is positive and significant with an elasticity of 1.2%. I attempt to compare this estimate to

the one obtained in the farm-level data of .03% by using the state-level averages. Recall that the farm-level results indicated that an additional $.20 in subsidies per acre results in an additional $.02 spent on labor expenses. Using the averages, the state-level results indicate that an additional $.20 in subsidies per acre operated results in an increase of $.28 in immigrant labor expenses. This shows that the state-level analysis results are higher than the farm-level aggregates by approximately $.26 per acre. The difference potentially is due to the fact that there are immigrant workers that are farm operators and not just hired or contract labor. In 2002, approximately 7% of all immigrant workers in agriculture were farm operators (Grieco, 2004). In this case, they are not being captured in the farm-level state-aggregated data which only accounts for hired and contract labor, but are included in the state-level data. Another potential reason is that there could be measurement error present in the immigrant worker variable that is correlated with the error causing the upward bias.

VII Conclusion

This paper analyzed the effect of agricultural subsidies on farm labor and capital expenses using the USDA ARMS database for years 1995, 1996, and 1997. The analysis also used the USDA ARMS, CPS, and NASS Quick Stats databases to examine the effect of agricultural subsidies on agricultural wages for the total agricultural labor market and then separately for the immigrant and non-immigrant agricultural labor market using a panel of states for years 1995, 1996, and 1997. The unique 1996 FAIR Act allowed for identification of the agricultural subsidies effect by separating farm subsidy payments from production decisions and commodity prices. The analysis showed that a 1% increase in subsidies per acre increases farm labor expenses by .03% and increases farm capital expenses by .11%. The effect on both labor and capital expenses is more pronounced for relatively more labor intensive commodities of rice and sorghum. The state-level analysis showed that a 1% increase in subsidies per acre a state receives increases the hours worked by immigrant labor by .63%.

The U.S. government continues to spend billions of dollars a year funding the agricultural sector in order to protect farmers from the high risks of commodity markets. Considering that government payment programs continue to be in place today, it is crucial to understand the effects of these costly policy programs. The effect of subsidies on immigrant labor will potentially assist in new farm policy proposals. New farm policy is enacted approximately every 5 to 7 years with the most recent farm bill in 2008.

Future research should concentrate on examining the effect of other payment programs on the agricultural labor market to see whether they have similar effects. In addition, current estimates of the effect of the price support program on the labor market could be compared to older estimates to see if there have been any changes. It would also be beneficial to conduct a similar analysis on farm-level panel data where farm labor expenses are decomposed into wages and employment in order to obtain larger sample sizes in analyzing the effect of agricultural subsidies on the components separately. In addition, being able to observe the number of immigrant laborers hired per farm would be beneficial.

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Figure 2

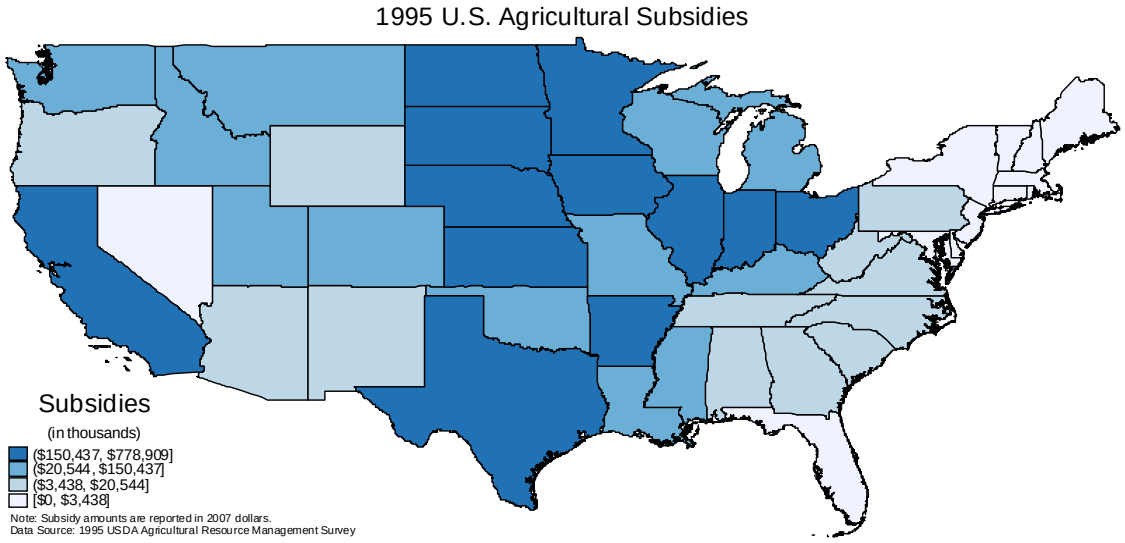

Figure 3

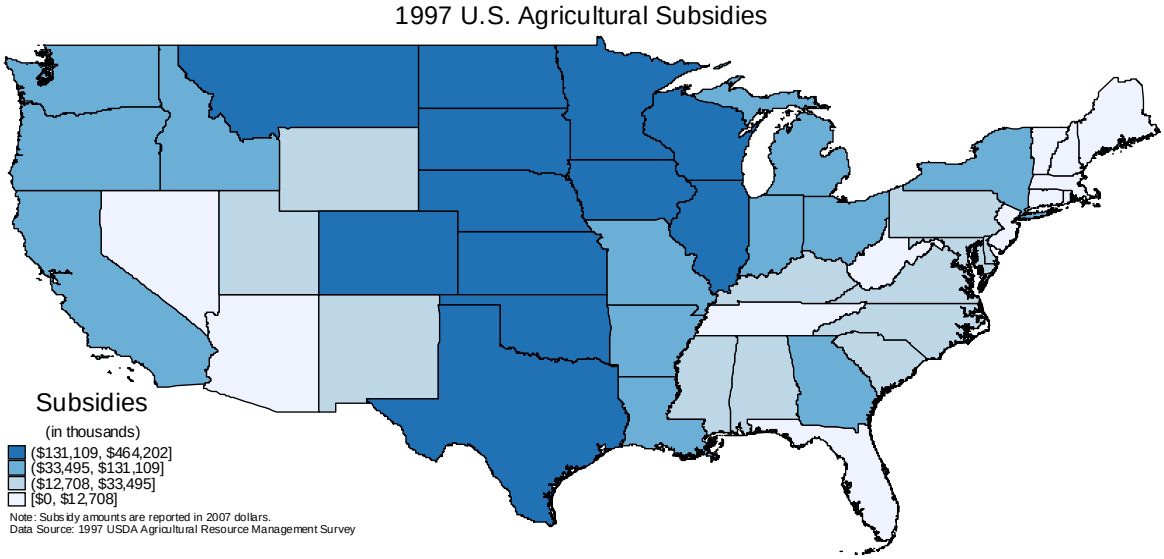

TABLE 1
Summary Statistics and Variable Descriptions
Farm-Level Data

	Average per U.S. farm		
Variables	1995	1996	1997
Labor expenses ($/acre)	$45.67	$55.06	$47.14
-*Labor expenses per acre operated*	(107.55)	(217.51)	(141.99)
Capital expenses ($/acre)	$172.41	$191.91	$171.13
-*Capital expenses per acre operated*	(387.37)	(630.39)	(354.45)
Subsidies ($/acre)	$22.52	$19.64	$18.44
-*Government payments per acre operated*	(68.18)	(21.41)	(17.88)
Sales ($/acre)	$391.21	$433.35	$361.56
-*Sales of all commodites per acre operated*	(952.24)	(1,118.15)	(710.36)
Acres harvested	546.96	573.32	568.16
-*Acres harvested*	(591.94)	(659.93)	(1,041.41)
Acres operated	954.70	1,020.08	1,023.67
-*Acres operated*	(1,390.51)	(1,905.96)	(2,076.47)
Barley farms	.10	.09	.09
-*Proportion of barley farms*	(.30)	(.29)	(.28)
Corn farms	.71	.61	.65
-*Proportion of corn farms*	(.46)	(.49)	(.48)
Cotton farms	.05	.10	.03
-*Proportion of cotton farms*	(.22)	(.29)	(.18)
Oat farms	.12	.13	.17
-*Proportion of oat farms*	(.33)	(.33)	(.37)
Rice farms	.02	.03	.01
-*Proportion of rice farms*	(.15)	(.17)	(.11)
Sorghum farms	.03	.12	.11
-*Proportion of sorghum farms*	(.18)	(.33)	(.31)
Wheat farms	.43	.47	.47
-*Proportion of wheat farms*	(.50)	(.50)	(.50)
Multiple crop farm	.39	.47	.44
-*Proportion of farms that plant multiple crops*	(.49)	(.50)	(.50)
N	2,432	2,755	3,882

Note: Summary statistics are weighted by the sample survey weight. Standard deviations are reported in parentheses. Labor expenses, capital expenses, subsidies, and sales are reported in constant 2007 dollars. Farms included are those which have a positive amount of subsidy payments and produce at least one of the program commodities. Data source is the 1995, 1996, and 1997 ARMS database.

TABLE 2
Summary Statistics and Variable Descriptions
State-Level Data

Variables	Average per U.S. state 1995	1996	1997
Wages			
Agriculture sector wage	$8.80	$8.84	$9.30
-Average wage in agriculture sector	(.81)	(.75)	(1.04)
Agriculture immigrant wage	$6.82	$7.49	$7.10
-Average wage for immigrant employees in agriculture	(5.10)	(3.55)	(4.37)
Agriculture non-immigrant wage	$9.12	$9.08	$9.52
-Average wage for non-immigrant employees in agriculture	(1.14)	(1.11)	(1.24)
Employment hours			
Agriculture employment hours (in thousands)	12,778	13,624	13,507
-Total number of hours worked in agriculture	(23,359)	(22,123)	(21,422)
Agriculture immigrant employment hours (in thousands)	5,651	6,556	6,460
-Total number of hours worked by immigrant employees in agriculture	(19,065)	(17,327)	(15,657)
Agriculture non-immigrant employment hours (in thousands)	7,127	7,068	7,046
-Total number of hours worked by non-immigrant employees in agriculture	(7,033)	(7,025)	(8,049)
Controls			
Subsidies ($/acre)	$11.48	$14.19	$11.68
-Payments per acre operated	(7.90)	(7.96)	(6.40)
Sales ($100/acre)	$7.79	$6.85	$6.82
-Sales of all program crop commodities per acre operated	(20.86)	(12.6)	(14.94)
# of farms (in hundreds)	669.51	623.93	641.63
-Total number of farms in hundreds	(612.33)	(625.38)	(566.50)
Non-agriculture sector wage	$12.53	$12.65	$12.99
-Average wage in non-agriculture sector	(.90)	(.86)	(.94)
Acres operated (in thousands)	15,513	13,271	16,345
-Number of program acres operated	(10,939)	(10,097)	(12,564)
State Labor Expenses			
Total labor expenses ($/acre)	$44.47	$27.43	$30.79
-The product of wages and total employment hours per acre operated	(489.17)	(91.45)	(212.06)
Immigrant labor expenses ($/acre)	$13.31	$13.93	$14.88
-The product of immigrant wages and total immigrant employment hours per acre operated	(56.57)	(41.26)	(56.20)
Non-immigrant labor expenses ($/acre)	$31.04	$13.39	$15.83
-The product of non-immigrant wages and total non-immigrant employment hours per acre operated	(441.72)	(68.80)	(173.56)
N	48	48	48

Note: Summary statistics are weighted by state farmland area. Standard deviations are reported in parentheses. Wages, subsidies, and sales are reported in constant 2007 dollars. Data sources include the 1995, 1996, and 1997 ARMS for the subsidies, sales, # of farms variables, and acres data, the 1995, 1996, and 1997 CPS for wage and employment hours data, and the NASS Quick Stats database for state farmland area data. Alaska and Hawaii are excluded from the analysis.

TABLE 3
OLS Estimation: Effect of Agricultural Subsidies on Labor and Capital Expenses
Farm-Level

		Dependent Variable:	
Sample	*N*	Log labor expenses ($/acre)	Log capital expenses ($/acre)
All crops	9,069	.03**	.11***
		(.02)	(.01)
Labor intensive crops			
Cotton	1,080	.02	.08***
		(.03)	(.02)
Oats	919	.05	.11***
		(.05)	(.02)
Rice	289	.20**	.16***
		(.10)	(.05)
Sorghum	958	.26***	.14***
		(.06)	(.03)
Capital intensive crops			
Barley	1,012	.07*	.11***
		(.04)	(.02)
Corn	5,673	-.04*	.09***
		(.02)	(.01)
Wheat	4,883	.14***	.11***
		(.02)	(.01)

Note: Reported coefficients are those for the log subsidies variable. All regressions include the following controls: log sales, log acres harvested, and an indicator for planting multiple crops. Regressions include county and time fixed effects. Coefficients shown to be significant at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively. Robust standard errors are reported in parentheses.

TABLE 4
Fixed Effects Estimation: Effect of Agricultural Subsidies on Wages, Immigrant Wages, and Non-Immigrant Wages
State-Level

	Dependent Variable:		
	Wage	Immigrant Wage	Non-Immigrant Wage
Subsidies ($/acre)	-.03	-.11	-.04
	(.02)	(.11)	(.03)
Sales ($100/acre)	-.004	.001	.003
	(.003)	(.011)	(.006)
# of Farms	.001	-.004	.002
	(.001)	(.006)	(.001)
Non-Agriculture Sector Wage	-.83*	-4.59	-.75
	(.44)	(2.85)	(.75)
Constant	18.01***	62.45*	17.01*
	(5.13)	(34.05)	(8.84)
State and Time Fixed Effects	Y	Y	Y
R^2	.63	.31	.61
N	144	144	144

Note - Wages, subsidies, and sales are reported in constant 2007 dollars. Coefficients shown to be significant at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively. All regressions are weighted by state farmland area. Robust standard errors are reported in parentheses.

TABLE 5
Fixed Effects Estimation: Effect of Agricultural Subsidies on Total Employment Hours, Immigrant Employment Hours, and Non-Immigrant Employment Hours
State-Level

	Dependent Variable:		
	Employment Hours (in thousands)	Immigrant Employment Hours (in thousands)	Non-Immigrant Employment Hours (in thousands)
Subsidies ($/acre)	314.03	315.55*	-1.52
	(192.56)	(166.94)	(38.46)
Sales ($100/acre)	-2.24	-13.95	11.71**
	(19.92)	(18.10)	(4.78)
# of Farms	-9.7	-7.98	-1.72
	(7.45)	(5.47)	(2.85)
Non-Agriculture Sector Wage	2,835.3	3,214.99	-379.68
	(2,613)	(1,991)	(891.81)
Constant	-28,418	-38,219	9,801
	(29,827)	(23,132)	(10,030)
State and Time Fixed Effects	Y	Y	Y
R^2	.99	.99	.98
N	144	144	144

Note - Wages, subsidies, and sales are reported in constant 2007 dollars. Coefficients shown to be significant at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively. All regressions are weighted by state farmland area. Robust standard errors are reported in parentheses.

TABLE 6
Fixed Effects Estimation: State Agricultural Labor Expenses
Comparison: State-Level and Farm-Level Data

Dependent Variable	Subsidy Effect	Elasticities
State-Level Data		
Wages*Employment hours ($/acre)	.46	.17%
	(3.78)	
Immigrant wages*Immigrant employment hours ($/acre)	1.39*	1.2%
	(.772)	
Non-immigrant wages*Non-immigrant employment hours($/acre)	-.93	-.58%
	(3.38)	
Farm-Level Data: State Aggregate		
Farm labor expenses ($/acre)	.04	.03%
	(.59)	

Note - Reported coefficients are those for the subsidies variable. All regressions are at the state-level and are weighted by state farmland area. The first three regressions include controls for sales, # of farms, non-agriculture sector wages, and state and time fixed effects. The fourth regression is run as a log-log model and includes controls for log sales, log acres harvested, and state and time fixed effects. Coefficients shown to be significant at the 10% level are denoted by *. Robust standard errors are reported in parentheses.