The Impact of Agriculture and Farm Produce Prices on Human Capital Formation: Education Decisions of Young Americans in Agricultural Areas Before and During the Food Crisis 2000-2010

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Abstract

This study estimates the short-run effects of the structure of the local economy on high school dropout rates in agricultural areas in the United States from 2000 to 2010. Repeated cross-sections of census data are matched to state-level agricultural price indices and data on the regional composition of employment. Some authors theorise that human capital and land are substitutes, and increasing returns to land-intensive activities may lower human capital investments. I do not find empirical evidence of this in the rural United States. In fact, I find some evidence that as agriculture becomes more lucrative young people in areas with very high levels of agricultural employment become more likely to stay in school, not less, relative to those in areas with little or no agriculture within each state.

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1 Introduction

Rural under-development is a persistent problem in the United States. Since the 1960s, a greater proportion of residents of rural (non-metro) areas have tended to live in poverty than residents of metro areas (Albrecht and Albrecht, 2000), and the latest 2006-11 American Community Survey data presented in Table 1 confirm that, although improving, this trend has persisted until the present. A number of factors, including racial segregation, have been put forward as explanations for the persistence of rural under-development. However, it is important to note that the predominant industry in a community has a large impact on a range of social outcomes. For example, non-urban areas with a higher proportion of industrial or agricultural employment, as opposed to service employment, perform better on most socioeconomic indictors including income, poverty rates, and female workforce participation (Albrecht, 1998, 59).

Some authors (Galor, Moav, and Vollrath, 2009) find that land and human capital are not complements, and therefore under-investment in human capital in rural areas is a function of the structure of the local economy. In this paper, I investigate the possibility that youths living in rural areas characterized by large agricultural sectors are presented with employment opportunities which encourage them to leave high school before graduation, contributing to a lower high school graduation rate in rural areas and therefore increased levels of poverty. In addition, I investigate how exogenous shifts in returns to farming caused by global food price fluctuations in the last decade affected young people's decisions on whether to stay in high school in these same areas.

Repeated cross-sectional data at the individual level from the 2000 census and 2005-2010 American Community Survey are used. Empirical variation comes from the size of the agricultural sector in each Public Use Microdata Area, the composi-

Table 1: Economic outcomes in Rural and Non-Rural America

Variable[a]	Rural[b]	Urban
Population (2011)	51,112,517	260,469,400
No High School Diploma (2006-2010)	17.5%	14.4%
High School Only (2006-10)	36.8%	27.4%
Bachelor's Degree or Higher (2006-2010)	17.5%	30%
Income (2009)	$40,135	$51,522
Poverty Rate (2010)	16.6%	14.9%

[a] Source: Economic Research Service, USDA (2012b). Data used are from the 2006-10 American Community Surveys.
[b] Rural here means nonmetro area, urban means metro area.

tion of the agricultural sector by state, and random variation in commodity prices that affects each state differently depending on the composition of its agricultural sector. I find evidence for a counter-intuitive source of incentives for young people to stay in school in rural America: increasing agricultural commodity prices are correlated with individuals dropping out of high school at lower rates in areas with large agricultural sectors.

Because higher levels of education are positively correlated with higher income, examining the determinants of investments in human capital is an important area of research which is aimed at explaining the development gap between rural and urban America. My results suggest that not only is the gap in high school graduation rates between city and rural young people small and declining (Jordan, Kostandini, and Mykerezi, 2012), but this dynamic could be supported by persistently high prices for agricultural commodities.

2 Related Literature: Motivating Concerns

An interest in exploring the determinants of high school dropouts in rural America is driven by the more basic concern of learning about the correlates of growth. Human capital is important to economic development. At a macro level, most accounts assign investments in education a large role in explaining economic growth, either indirectly or directly.[1] Indirectly, Acemoglu, Johnson, and Robinson (2001, 2002) include education as one aspect of a broader theory highlighting the importance of institutions in promoting growth. Unless individuals are able to enjoy the fruits of their own labor and investments in productivity, the incentive structure of the economy will not facilitate economic development. Therefore, institutions which guarantee property rights, allow equal access to education and civil liberties, and encourage productivity and investment, are key factors in encouraging positive economic outcomes. Directly, Galor and Weil (2000) show that the interaction between technological change and human capital determines the ability of an economy to transition from a stagnant, Malthusian growth regime to a Post-Malthusian regime where increases in productivity outstrip population growth. As technology advances more quickly, the demand for human capital increases because workers need to learn to be able to take advantage of evolving production possibilities.

Assessing the arguments of both Acemoglu, Johnson, and Robinson (2001, 2002) and Galor and Weil (2000) empirically, Glaeser et al. (2004) ask whether institutions cause growth directly, or are themselves a growth-reinforcing consequence of prior development, which can be attributed to accumulation of human and physical capital. They conclude that human capital is a more fundamental driver of economic growth, having an effect prior to institutional quality, which rises only as a country grows richer.

In turn, empirical research shows that the agricultural sector can have important effects on an economy's tendency to invest in human capital. Galor, Moav, and Vollrath (2009) propose that agricultural economies are less likely to supply

[1]Contrarian perspectives are offered by Sachs (2003) and Diamond (1997), who emphasize the role of geography in explaining long-term economic outcomes.

education to their populations because of a lower complementarity between human capital and land, as compared to the complementarity between human capital, physical capital and technology. Under this view, agricultural economies simply do not see the same returns to education as do industrial economies, because higher levels of education among workers do not give large increases in output in the agricultural sector. Because the mechanism linking agricultural production and underinvestment in education is magnified by the concentration of landownership, this leads to lower levels of public investment in education in countries with higher levels of landholding inequality. Interestingly, it appears that the level of complementarity between labor and land could be shifting, with Foster and Rosenzweig (1996) showing that returns to education increased in India after the introduction of Green Revolution high-yield variety seeds. This suggests that the modern agricultural sector differs in fundamental ways from that of previous eras, perhaps due to its being more capital-intensive, allowing greater returns to education and thus incentives to invest in human capital.

What this macro-level scholarship does for this paper is to underline the link between human capital and development, and suggest an interesting research question: does the agricultural sector systematically give incentives for under-investment in education? The Galor, Moav, and Vollrath (2009) perspective indicates that it does, while Foster and Rosenzweig (1996) would disagree. In this study, I approach this question empirically, using a representative sample of US census data from 2000-2010. I model the likelihood of a student remaining in high school after their state-mandated dropout age, as a function of the share of agricultural employment in their area of residence.

At the micro-level, by looking at the interaction between students' area of residence and farm produce prices, this paper is also assessing how increased prices, and perhaps employment opportunities, in the agricultural sector influence the education decisions of young people. As Eckstein and Wolpin (1999) show, there are diverse reasons for an individual's decision to drop out of school, and aside from getting a job, academic ability, motivation and school quality feature prominently among them. Young people rationally assess their outside options while in school, making decisions on whether to continue their education based on their expected utility of leaving versus staying in order to graduate with a diploma (and enjoy whatever inherent value they see in being there). In cases where they perceive their outside options to be relatively promising—for example, when a lucrative job is on offer—they are more likely to leave school. In their results, Eckstein and Wolpin (1999) show that youths who positively perceive their employment opportunities in jobs which do not 'need' a high school diploma (for example, agriculture, according to Galor, Moav, and Vollrath (2009)) are more likely to quit school.

This micro-level research motivates my interest in agricultural price level shifts in this study. By investigating the effects of exogenous changes in returns to the agricultural sector—the large price spikes during the 'food crisis' of the last decade—on young people's education decisions, I can look at whether these were correlated with changes in students' employment opportunities, and decisions on whether to remain in high school. In an extension of the model analyzing school dropouts by local structure of employment, I include a state-level index of agricultural prices which compares producer prices in an individual's state of residence to their levels in 1999. I can therefore estimate the influence of producer price changes during the period of the global food crisis, in areas with higher levels of agricultural employment.

Finally, in addition to its importance to development, concerns about equality and social justice also demand an investigation into the determinants of high school completion rates. Human capital investments are an important vehicle for the intergenerational transmission of inequality. Bowles and Gintis (2002, 16-17) find that the proportion of intergenerational income correlation directly accounted for by the correlation between parent and offspring schooling is around 0.10, even after controlling for cognitive ability. When accounting for the indirect effect of schooling on cognitive ability, the proportion of the intergenerational income correlation accounted for by schooling rises to 0.12. Therefore, there are important normative grounds for investigating the determinants of investments in human capital, apart from their consequences for growth, because reducing the rate at which students drop out of high school reduces the transmission of inequality from one generation to the next and thus promotes social justice.

3 Related Literature: High School Completion, Employment Structures and Labor Market Opportunities

Undesirably low high school graduation rates have proven a vexing public policy problem since the 1970s, when it became clear that 'dropping out' was not confined to the ranks of minority and disadvantaged youth, and thus over-determined by obvious socio-economic issues. However, empirical research into the causes of dropouts has proven difficult, as the difficulties faced by scholars estimating the national dropout rate have clearly illustrated. Although it is a very important measure of the economic well-being of the country, Heckman and LaFontaine (2010) point out that estimates of the national high school completion rate ranged from 66% to 88% in recent years, with the uncertainty around completion rates for minorities significantly higher.

Early quantitative research quickly turned up a plethora of variables correlated with a student leaving high school before graduation. Using data from the 1979

National Longitudinal Survey of Youth (NLSY), Rumberger (1983) found that social class and family background, for example the income and education levels of a student's parents, had a large effect on a young person's chances for success at high school, explaining many differences across racial groups. Black males in central cities and the South, and whites from households with many children, were also less likely to graduate high school, and young women were much more likely to leave school after childbirth.

More recent studies, such as that by Eckstein and Wolpin (1999) cited above (which used the same data as Rumberger (1983)), have found that a student's academic ability, motivation and consumption value of school over leisure have a significant effect on dropout rates. In addition to these 'permanent' personal traits, family background characteristics play a large role. Students from academic families, where parents have college degrees, are very unlikely to drop out of high school, as are those from wealthier families. Children from families with more siblings are less likely to graduate high school. Jordan, Kostandini, and Mykerezi (2012) find that peer group traits, such as membership in gangs or drug use, can also have an impact on the likelihood of a student completing high school.

These individual and family background traits make a similar difference to dropout rates across America. Jordan, Kostandini, and Mykerezi (2012) use data from the 1979 and 1997 NLSY surveys to estimate the differences in dropout rates across geographic areas categorized by different Beale codes denoting ranges on an urban—rural continuum. They find that graduation rates declined by three percent in the US between the 1980s and the 2000s, but that this decline was spread fairly evenly across geographic areas, and previous findings of large disparities in dropout rates could be accounted for by adopting a more rigorous definition of high school completion. The only significant difference was encountered when looking at the most remote rural areas, where graduation rates were higher than in urban areas in the 1980s but not by the late 1990s.

However, the socioeconomic context in which young people attend school also has a significant effect on their likelihood of high school graduation. When there are 'feedback loops' between family structures, social capital, or local industry structures, and the types of skills acquired by students in an economy, school outcomes can perpetuate themselves in a self-reinforcing system. McGranahan (2004), for example, matches individual-level census data to aggregate employment statistics and finds that in the 1970s high concentrations of agricultural, mining and manufacturing employment were associated with higher dropout rates in the rural South. By the 1980s, this relationship had disappeared for the agricultural and manufacturing industries, and McGranahan hypothesizes that this is due to increased demand for educated workers in these industries due to changes in production processes. However, the relationship was strengthened in the 1980s for the mining industry; it is hypothesized that this was due to the energy boom of the late 1970s, but not empirically tested.

Eckstein and Wolpin (1999) show that students who *perceive* their employment prospects positively are more likely to leave school. Montmarquette, Viennot-Briot, and Dagenais (2007) used data on Canadian high school students to more clearly identify the link between employment opportunities outside of school and dropout rates. They find a significant relationship between a young person's employment opportunities outside of school and their likelihood of graduating with a high school diploma. Female students, those who attend private schools, and those who have more highly educated parents are all more likely to remain in school. However, when the returns to working outside of school are high and jobs are more easily accessible, youths are more likely to drop out. In areas with higher minimum wages, lower unemployment, and lower school-leaving ages, young people are incentivized to leave school early to take up employment, which is made more lucrative and easier to obtain than in other areas. For this reason, Montmarquette, Viennot-Briot, and Dagenais (2007) recommend that youth minimum wages be set below those for adults, and that the school leaving age be increased to 17 or 18, in order to increase high school graduation rates in Canada.

4 Research Design and Data

The purpose of this paper is to identify a causal effect of the structure of the local economy, and changes in price levels in agriculture, on individuals' schooling decisions, with the goal of shedding some light on whether agriculture is likely to encourage underinvestment in human capital. It is important to note that I am estimating only the short-term effects of price changes on an individual's expected returns to schooling and thus decision on whether to remain in high school. Of course, students do not decide to drop out based on short-run information about their expected employment opportunities alone; they maximize their expected life utility and thus take into account all aspects of history known to them that affect alternative-specific utilities or the probability distribution of future utilities (for a formal analysis of this set-up see Eckstein and Wolpin (1999)). Therefore, many students would not choose to leave high school due to a change in prices or wages in the year they pass their state minimum dropout threshold, if they perceived the historic wages in agriculture to be low or if they predicted that wages in the sector would be low in the future.

This is assuming that produce price increases are passed along to workers through increased demand for labor and higher wages. In fact, price changes in agriculture could have unexpected and/or contradictory effects. For example, an expected positive income effect for a high school student considering dropping out of school to take a job could also be a positive income effect for their parents employed in the same sector, who might then be less likely to approve of their child leaving school. Similarly, increases in agricultural prices could lead farmers to hire more labor, increasing demand and thus wages in the sector, but they could also lead them to substitute capital for labor, purchasing new equipment and plant, thus reducing demand for labor and wages in agriculture. All these scenarios are possible outcomes resulting from a change in produce price levels in agriculture, and investigating each would require the estimation of a separate causal mechanism.

Nevertheless, the magnitude of the price shifts for agricultural products since 2007 are large, and have had a dramatic effect on the sector as a whole. For example, in response to increased grain prices, the cost of cropping land in grain-growing areas such as Iowa has leapt to record levels, registering annual increases of up to thirty percent since 2007 (New York Times, 2011; Des Moines Register, 2012). I argue that this justifies research into the broader social consequences of the price spikes associated with the food crisis in agricultural areas, even if it is exploratory in nature and does not conclusively prove the relevant causal relationships. My goal in this paper is, as a first cut, to estimate the effects of the recent agricultural produce price increases on high school students' dropout rates.

4.1 Identification strategy

An ideal base-line scenario for identifying this effect is an experiment in which individuals are randomly assigned to agricultural and non-agricultural areas, and a price-fluctuation treatment (Angrist and Krueger, 1999). However, such a research strategy is quite obviously a practically and ethically dubious undertaking. Without being able to conduct a randomized experiment, I will rely on an identification strategy using observational data and regression analysis to statistically control for observable differences among individuals which are confounded with education attainment. In this way I estimate the answer to the 'what if' counter-factual question: would a given individual be more or less likely to remain in school if they were assigned to live in an agricultural area and agricultural prices changed?

My non-experimental identification strategy also relies on exogenous sources of variation which serve as quasi-experiments to randomly assign treatments to individuals. The shifts in agricultural output prices during the last decade, which were unusually volatile, especially during the global 'food crisis' of 2007-08 (National Agricultural Statistics Service, USDA, 2012). I combine yearly data on commodity prices with the composition of each state's agricultural sector to create a price index which is exogenous to each individual's decision to drop out of high school. As depicted in Table 2, the decade 2000-10 witnessed large fluctuations in prices for agricultural products, although these fluctuations were unequally distributed across product classes.[2] The largest increases were in grains: corn, soy and wheat prices more than doubled compared to 1999 price levels by 2008. Livestock and milk prices were less variable than grain crops, seeing around thirty to fifty percent price increases across the decade covered by this study, but their price spikes are nonetheless significant.

Using observational data to examine the determinants of educational decisions, or investments in human capital, I am interested in whether an individual remains

[2]Data on levels and prices of agricultural inputs are not available at the state- or county-level after 2004. Nationally aggregated data suggest that the level of farm inputs hardly changed from 2000-07, as compared to their 2005 levels (average annual growth rate of 0.14%). However, after the food crisis, from 2007-09 inputs declined dramatically compared to their 2005 levels, at an annual rate of 1.8%, while total factor productivity in the sector increased at an annual rate of 3.68%. Crucially for this study, the declines in input levels were concentrated in labor, which declined at an annual rate of 1.56% (2000-07), then 3.69% (2007-09). Increases in input levels were seen in materials (energy and chemicals) and capital (equipment and buildings) (Economic Research Service, USDA, 2012a).

Table 2: Price indices for agricultural products in the United States

	2000	2005	2006	2007	2008	2009	2010
Corn index	0.99	1.04	1.13	1.51	2.17	2.26	2.01
Soy index	1.04	1.31	1.27	1.47	2.10	2.34	2.19
Wheat index	1.00	1.30	1.44	1.91	2.68	2.57	2.02
Hog index	1.33	1.53	1.48	1.44	1.46	1.39	1.49
Milk index	0.86	1.05	0.97	1.12	1.30	1.08	1.01
Cattle index	1.14	1.46	1.45	1.42	1.36	1.28	1.31

Source: National Agricultural Statistics Service, USDA (2012).
1999 is the base year, when all indices have a value of 1.
Years covered are 'decision years' for individuals in this study.

in high school until graduation or decides to leave school. This being a binary variable—the individual is either in school or not in school when observed—I model the odds of an individual remaining in school via logistic regression.[3] The appropriate logistic regression models take the form,

$$ln\left(\frac{P_i}{1-P_i}\right) = \beta_1 + \beta_2\mathbf{A} + \beta_3\mathbf{X}_\mathrm{i} + u_\mathrm{i}$$

where P_i is the probability that an individual remains in school at the time they are surveyed, $\mathbf{A}$ is a vector of regional independent variables measuring the importance of agriculture in the structure of the local economy and price changes in the agricultural sector, $\mathbf{X}_i$ is a vector of individual-level control variables, and u_i is a stochastic error term. The discussion in Section 3 highlights some of the correlates of students' dropout decisions which I cannot control for due to data constraints, and therefore will be contained in u_i. For example, census data do not include school quality, students' or their parents' cognitive ability or grades; all important correlates of high school dropouts. In order to account for some of this

[3] I also estimate linear probability models via ordinary least squares regression, as robustness tests of my logit results.

heterogeneity, I include state fixed effects to control for state-specific unobservables. I also allow the standard errors in my model to be clustered by state to adjust for the fact that variation in prices affects each state (rather than individual) differently. I also include dummy variables for each individual's age and state of residence as controls.

In my empirical analysis, I specify the independent variables **A** in several different ways to highlight the effects of both the structure of the economy and price changes on individuals' education decisions. In a first specification, I include the share of the workers in an individual's region employed in agriculture and its interaction with the agricultural price index. In a second specification, I include a binary variable indicating whether an individual lives in an agricultural area and its interaction with the agricultural price index. In a third specification, I include binary variables indicating whether an individual lives in an area with very low or very high agricultural employment, and their interactions with the agricultural price index. Finally, I estimate models with indicators for households with more than one thousand dollars of farm income, and more than five thousand dollars of farm income. The results of all models are presented after a discussion of my data sources and variables included in the models.

4.2 Dependent variable

The dependent variable is constructed using a sample of micro-level individual census data (Ruggles et al., 2010) from the 2000 census and 2005-2010 American Community Survey (ACS). These microdata are composed of records on persons, rather than aggregate data for a specific location, and when utilized with the appropriate sample weights are representative of all geographic areas in the United States. They are cross-sectional, meaning that they do not follow the same individuals through time but instead are a representative sample of the American population at each time period. Individuals in the dataset are coded by their geographic location, which allows me to match them to the composition of their local labor market. The dataset includes a large number of observations, and for the years with which I am working, the variables from the census and ACS are equivalent, allowing me to work with data from multiple years.

The dependent variable in this study, *In School*, is coded 1 if an individual between fourteen and eighteen years of age is still in school in the year they are surveyed. I do not restrict the study to individuals who have passed their compulsory school leaving age, but include this as a control variable because students can drop out of school before this age. I analyze all young people between fourteen and eighteen years of age in the dataset and include a dummy variable in each model indicating whether they have passed their state-mandated school leaving age.

In a naive comparison, individuals included in the study are less likely to remain in high school after the statutory minimum leaving age if they live in an agricultural area. As Figure 1 illustrates, a young person living in a *High Ag Area* (see definition below) is around seven percent less likely to be in school directly following their statutory threshold than a young person in another area.

4.3 Independent variables

The independent variables used in this study capture the structure of the local economy where the respondent resides, and the importance of the agricultural sector within it. In addition, I construct an agricultural price index which measures changes in farm output prices, as they affect the respondent's state of residence.

1. *Agricultural area indicators.* In order to isolate the effects of the agricultural sector on individuals' schooling decisions, I need to categorize their areas of res-

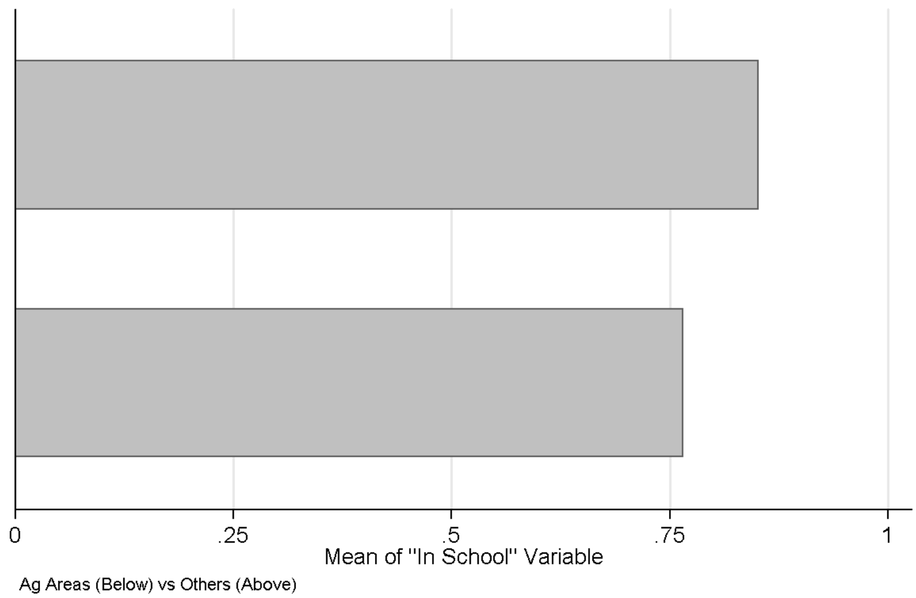

Figure 1: School Attendance in High Ag Areas (Below) vs. Non-Ag Areas (Above)

idence by the share of agriculture in the local economy. I do so using 2010 US census data on the share of population employed in agriculture, aggregated over each Public Use Microdata Area (PUMA) by the American Factfinder online table generator of the US Cenus Bureau. PUMAs are statistical geographic areas determined for the tabulation and dissemination of decennial census data, have a population of around 100,000, are geographically contiguous and are nested wholly within states. They therefore are a well-sized area for characterizing an individual's local economy; they are smaller than states, which are larger than an individual's local labor market, but larger than counties or census tracts, which are very small and therefore do not represent the full extent of the labor market in which an individual is located.

I use the proportion of the workforce employed in agriculture as a continuous predictor. However, I also create dummy variables for agricultural areas. I

Table 3: Agricultural employment in US PUMAs

	Ag. Employment (%)
Minimum	0
Bottom 25%	0.3
Mean	2.3
Top 25%	2.4
Top 5%	8.1
Maximum	34.4

code a PUMA as a *Low Ag Area* if it belongs to the bottom 25% by share of agricultural employment, an *Ag Area* if it belongs to the top 25%, and a *High Ag Area* if it belongs to the top 5%. I then match every individual respondent in my original micro-level dataset to their respective PUMA by its unique identifier number.

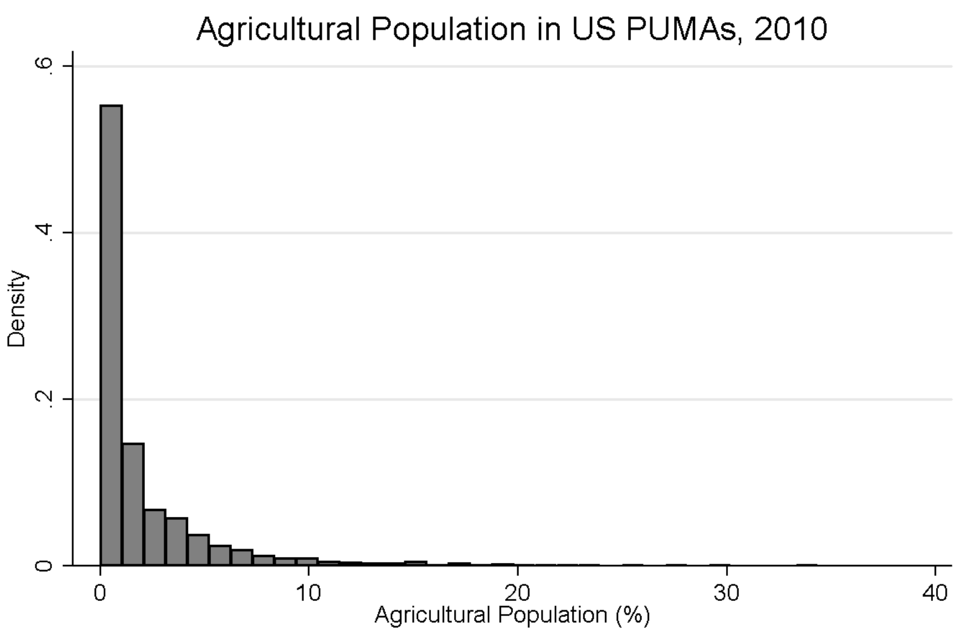

Figure 2: Agricultural Employment aross US PUMAs

As clearly illustrated by Figure 2, the distribution of agricultural employment is very unequal across United States PUMAs. The vast majority of these census areas have very little agricultural employment in their local economies—a trend caused by the fact that PUMAs are defined by population rather than area, and thus the majority of them lie within cities rather than rural areas, where the population is very thinly spread. Even the PUMA at the 95th percentile of agricultural employment has less than ten percent of its total workforce working in the sector. Therefore, I take the natural log of the agricultural workforce as a continuous variable in my subsequent analysis, in order to remove some of this skewness in the data.

2. *Agricultural price index.* I create an agricultural price index for each state and 'decision-year'. To do so, I need to construct a measure which characterizes the particular composition of each state's agricultural sector and thus how price changes in different products affect different states differently. For example, milk production is a very important part of the Wisconsin agricultural sector, comprising almost two-thirds of farm income in the state. By contrast, milk production makes up only approximately three percent of total farm income in Iowa, where corn income is more important, making up more than one third of total farm income. Therefore, changes in milk prices will be a larger factor influencing young people's education decisions in Wisconsin, while corn prices will loom larger in Iowa.

   The importance of this variation by state is illustrated by Figure 3. Iowa has an agricultural sector relatively balanced between grain and livestock production, while Wisconsin's sector is completely dominated by its dairy industry. I therefore take data from the 2007 USDA Economic Research Service Census of Agriculture (National Agricultural Statistical Service, USDA, 2007) on the

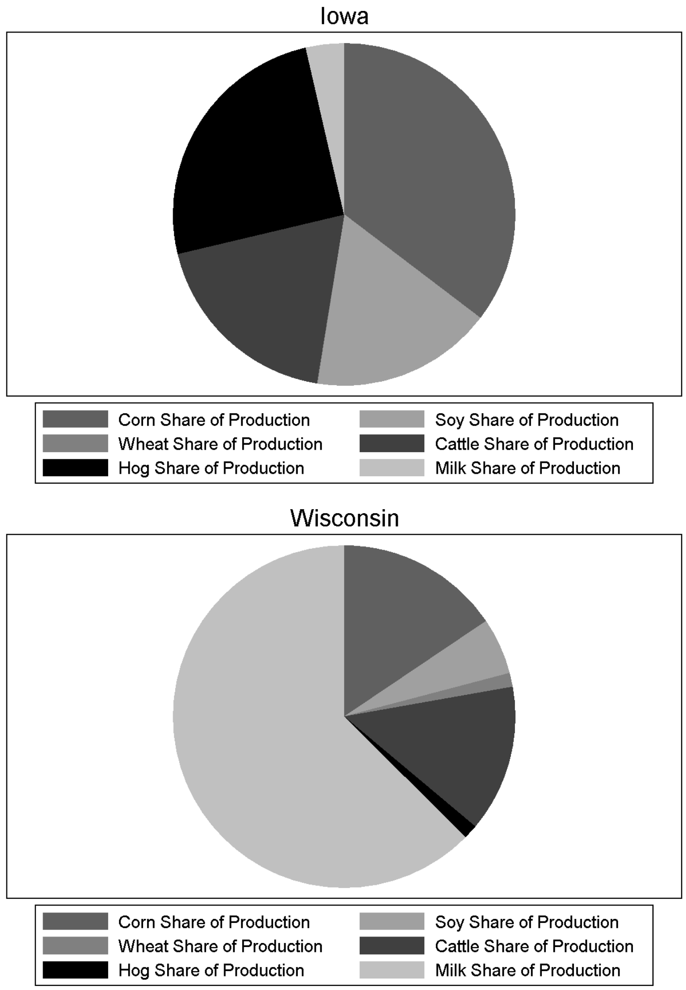

Figure 3: Agricultural Income by Product Category, Iowa and Wisconsin, 2007

value of each state's agricultural production by product category (wheat, corn, soybeans, hogs, cattle and milk).[4] I use this data to find the share of farm income comprised by each product category in each state and combine it with the yearly national product price indices in Table 2. Each state's agricultural price index in decision year t is, finally, a weighted sum of product price indices constructed,

[4]The census of agriculture is carried out only at five-year intervals; I use the 2007 data, because it is closest to the mid-point of the time period covered by this study.

$$AgIndex_{i,t} = \sum_{i=1}^{6}(ProductIndex_{i,t} \times ProductShare_{i,t=2007}),$$

where $\sum_{i=1}^{6} ProductShare_i = 1$.

Due to the differences between states' agricultural sectors, the price indices faced by individuals in each state are different. More importantly, exogenous year-to-year price changes affect states differently. Taking the examples outlined above, Iowa and Wisconsin, it is evident from Figure 4 that the unique composition of each state's agricultural sector, interacted with the variation in national-level price indices from Table 2, results in quite different price indices to be included in the subsequent empirical analysis. The largest price increases during the period included in this study were in grains, and because agriculture in Iowa is more heavily oriented towards grain production (corn and wheat especially, as shown in Figure 3), the increases in the price index are greater there than in Wisconsin, where the large dairy sector did not experience the same growth in producer prices. The greatest variation in the state agricultural index during the period studied was in Illinois, where the index ranged from 1.03 to 2.33 between 2000 and 2010; the least variation was seen in Nevada, where the index ranged from 1.06 to 1.43 during the same period.

4.4 Control variables

A crucial element of my identification strategy is to control for as many observed variables as possible which are confounded with educational outcomes and young people's education decisions. I therefore include the natural log of each individual's

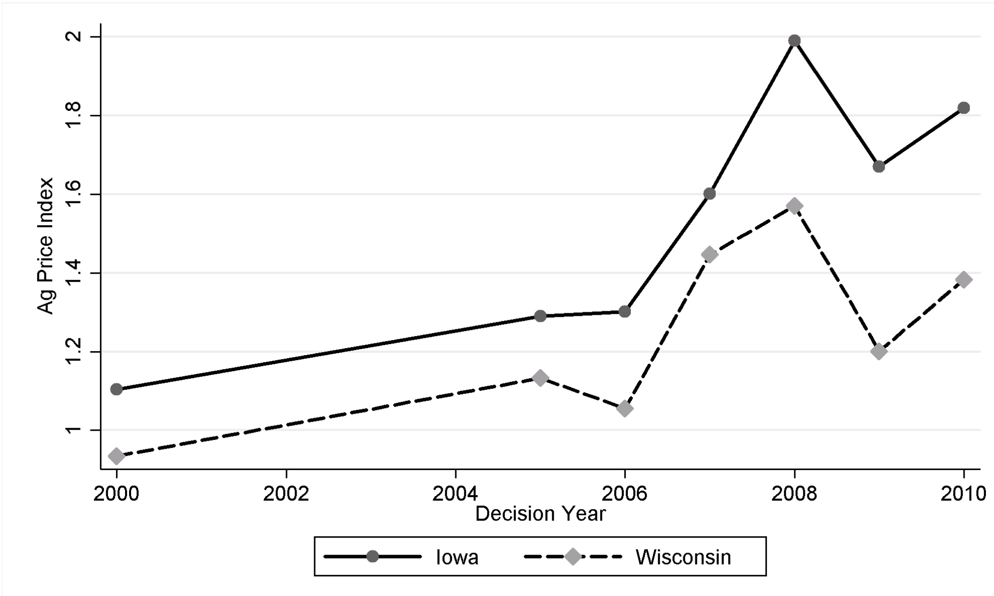

Figure 4: Agricultural Price Indices, Iowa and Wisconsin, 2000-2010

family income, a dummy variable for their sex, seven dummy variables for race, dummy variables for an individual's age, and a dummy variable for each respondent's state of residence. All these individual-level control variables are from the Ruggles et al. (2010) census dataset which also contains my dependent variable.

Because government policy stipulates when young people are legally allowed to leave school, I also control for whether an individual has crossed their state's mandated minimum school leaving-age. I gathered data on state school leaving ages from the Education Commission of the States (2010) in order to identify individuals who have passed their maximum compulsory schooling age, and to control for the potentially confounding influence of government policy on education decisions. To highlight the importance of isolating the influence of state leaving age mandates from that of my economic explanatory variables, I look a little closer at their influence on high school attendance in the raw census data. Individuals who are yet to reach their state-mandated maximum compulsory schooling age are significantly more likely to be in school that those who have passed the age threshold. I estimate a simple logistic regression model taking *In School* as its dependent variable, an indicator of whether an individual has passed their state-mandated dropout age as its independent variable, and include each individual's age as a control. The results, presented in Table 4, show that a student who has not yet passed their maximum compulsory schooling threshold is more likely to be in school than a student who has passed the threshold.

Table 4: Results of logistic regression predicting school dropouts by state threshold

DV: 'In School'	Coef.	Robust Std. Err.	z	95% CI	
Pre-Threshold	0.50	0.15	32.66	0.47	0.53
Age	-0.69	0.003	-219.26	-0.70	-0.69

Model applies individual-level sample weights ("PERWT" in the IPUMS dataset)

I present a short summary of the school leaving age data in Table 5 and a state-by-state description in Table 6. School leaving ages vary across states from sixteen to eighteen. Most states have a leaving age of either sixteen or eighteen, with only around one-fifth of states having a maximum compulsory age of seventeen.

Table 5: School leaving ages in the United States

Maximum compulsory age	Number of states
16	19
17	11
18	20

Source: Education Commission of the States (2010).

I do not include dummy variables for each 'decision-year' in my models. Including these variables would reduce all variation in my price index to the variation in

Table 6: School Leaving Ages by State

State	Max. Compulsory Age	State	Max. Compulsory Age
Alabama	17	Montana	16
Alaska	16	Nebraska	18
Arizona	16	Nevada	18
Arkansas	17	New Hampshire	18
California	18	New Jersey	16
Colorado	17	New Mexico	18
Conneticut	18	New York	16
Delaware	16	North Carolina	16
Florida	16	North Dakota	16
Georgia	16	Ohio	18
Hawaii	18	Oklahoma	18
Idaho	16	Oregon	18
Illinois	17	Pennsylvania	17
Indiana	18	Rhode Island	16
Iowa	16	South Carolina	17
Kansas	18	South Dakota	18
Kentucky	16	Tennessee	17
Louisiana	18	Texas	18
Maine	17	Utah	18
Maryland	16	Vermont	16
Massachusetts	16	Virginia	18
Michigan	18	Washington	18
Minnesota	16	West Virginia	17
Mississippi	17	Wisconsin	18
Missouri	17	Wyoming	16

Source: Education Commission of the States (2010).

Data included in subsequent empirical analyses do not include Alaska or Hawaii.

the composition of the agricultural sector across states—which would in turn be perfectly collinear with the state dummy variables. As a control for general economic conditions which could vary across time and affect the employment opportunities of high school students, I include one annual state-level average unemployment figure from the Bureau of Labor Statistic's Local and Area Unemployment Statistics (aggregated by the USDA Economic Research Service).

5 Empirical Results

Across all models taking *In School* as the dependent variable, the influence of individual-level traits and family characteristics is as found by the previous studies discussed above in Section 3. Minorities are all significantly less likely to remain in school than non-Hispanic Whites, except for Asians who are significantly more likely than non-Hispanic Whites to remain in school. Male students have, on average, lower odds of remaining in school after the age of 14 than their female colleagues. Students from poorer families are less likely to be in school, and as the level of unemployment in their state increases, students become less likely to leave school. This is a similar result to that found by both Eckstein and Wolpin (1999) and Montmarquette, Viennot-Briot, and Dagenais (2007), and illustrates that as the employment opportunities in an individual's state labor market decline, he or she is more likely to derive a higher return from schooling than from working. The influence of state policy on young people's education decisions remains as in Table 4; young people are significantly less likely to be in school after passing their state-mandated minimum school leaving age.

Model (1) is specified including natural log of the percentage of the workforce employed in agriculture and the state-level agricultural price index. It shows that individuals living in PUMAs characterized by higher levels of agricultural employ-

Table 7: Results of Logit Models 1-5

DV: 'In School'	(1)	(2)	(3)	(4)	(5)
Log Ag Pop	-0.12***	-0.13**			
	(-5.25)	(-2.11)			
Ag Price Index	0.028	0.024	0.040	0.0040	0.032
	(0.60)	(0.41)	(0.73)	(0.07)	(0.56)
Log Ag Pop*Ag Index		0.0050			
		(0.13)			
Ag Area			-0.10		
			(-0.90)		
Ag Area*Ag Index			-0.041		
			(-0.57)		
High Ag Area				-0.37***	-0.30**
				(-2.65)	(-2.27)
Hi Ag*Ag Index				0.16	0.13
				(1.47)	(1.25)
Low Ag Area					0.27***
					(3.69)
Lo Ag*Ag Index					-0.083
					(-1.63)
>School Age	-0.15**	-0.15**	-0.14**	-0.13*	-0.15**
	(-2.29)	(-2.29)	(-2.02)	(-1.88)	(-2.24)
Sex	0.22***	0.22***	0.22***	0.23***	0.23***
	(14.98)	(14.98)	(14.98)	(15.06)	(15.04)
Log family income	0.26***	0.26***	0.26***	0.27***	0.26***
	(21.99)	(21.99)	(22.64)	(21.82)	(21.48)
Hispanic	-0.52***	-0.52***	-0.52***	-0.50***	-0.51***
	(-8.15)	(-8.14)	(-8.48)	(-8.15)	(-7.76)
Black	-0.12***	-0.12***	-0.10***	-0.087**	-0.11***
	(-2.89)	(-2.90)	(-2.64)	(-2.53)	(-2.92)
Native Amer.	-0.46***	-0.46***	-0.48***	-0.49***	-0.48***
	(-5.59)	(-5.58)	(-5.73)	(-5.87)	(-5.78)
Asian	0.67***	0.67***	0.68***	0.71***	0.69***
	(11.81)	(11.80)	(12.04)	(13.77)	(12.91)
Pacific Islander	-0.26***	-0.26***	-0.26***	-0.24***	-0.25***
	(-2.95)	(-2.95)	(-2.86)	(-2.73)	(-2.74)
Other Race	-0.16*	-0.16*	-0.15	-0.13	-0.15
	(-1.67)	(-1.66)	(-1.55)	(-1.31)	(-1.54)
Unemployment	0.021***	0.021***	0.021***	0.022***	0.022***
	(3.74)	(3.74)	(3.83)	(4.04)	(4.07)
Pseudo R^2	0.148	0.148	0.148	0.148	0.148
Chi-sq	27509.5	27501.3	27415.9	25409.6	26066.9
Observations	1097105	1097105	1097105	1097105	1097105

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

ment are significantly less likely to stay in school after state dropout thresholds, a finding confirmed by all subsequent models. An eighteen-year-old white male is, on average, 2.6 percentage points more likely to be in school when he lives in a PUMA with the mean level of agricultural employment compared to a PUMA with a level of agricultural employment one standard deviation above the mean. Looking at their effects across all districts on average, increases in the agricultural price index are not significantly correlated with individuals staying in school.

Model (2) is specified including a continuous by continuous interaction of the share of agricultural employment in a PUMA with the state-level agricultural price index. The sign and magnitude of the coefficients on the *Ag Population* and *Ag Price Index* variables are similar to in Model (1), and the coefficient on the interaction term is small, positive and statistically insignificant. The marginal effect of a one-unit increase in the price index, reflecting a moderate level of price increases similar to that experienced in Iowa between 2000 and 2009, is less than one half of one percentage point, and not statistically significant from zero, at levels of agricultural employment up to two standard deviations above the mean.

Model (3) includes a dummy variable for an *Ag Area*, a PUMA with a share of agricultural employment among the top 25% of all PUMAs in the US ($\geq 2.4\%$), and its interaction with the state-level *Ag Index*. It thus compares the effects of agricultural price shifts in agricultural areas to those with very low levels of agricultural employment. In agricultural areas with this level of agricultural employment, young people are not significantly more likely to drop out of school than students in other areas. Movements in the agricultural price index also have no significant effect on dropout rates; the coefficients on the *Ag Index* variable and its interaction with the *Ag Area* dummy variable are small an insignificant. The marginal effect of a one-unit increase in the price index is very small and statistically insignificant.

The lack of statistically significant differences in dropout rates depending on the agricultural price index in Models (2) and (3) is unsurprising, due to the very low levels of agricultural employment in US PUMAs overall, and my method of categorizing PUMAs as *Ag Areas* dependent on their relative levels of employment in agriculture. It is unlikely that changes in agricultural prices should have a significantly different impact on students' education decisions in areas where only around three percent of the workforce is employed in the agricultural sector, compared to other areas, because still only a small fraction of their local labor market will be affected by shifts in farm produce prices. In addition, the changes in the price index used in the predicted probability calculations above are only moderate compared to the variation seen in some states such as Illinois. The marginal effects calculations use a price variation similar to that seen in Iowa 2000-2009, in order to maintain the plausibility of the tests, which would be compromised if I examined only extreme values on the price index which not all states experienced.

Model (4) includes a dummy variable for *High Ag Areas*, the top five percent of PUMAs by agricultural employment ($\geq 8.1\%$) and its interaction with its state *Ag Index* variable. It therefore compares the effects of agricultural price increases in areas with high levels of agricultural employment to their effects in all other areas. Like those of Models (1) and (2), the results of Model (4) indicate that students in PUMAs with high levels of agricultural employment were significantly more likely to drop out of high school than those in areas with lower levels of agricultural employment. However, shifts in agricultural prices are not correlated with dropouts. The coefficients on the *Ag Index* variable and its interaction with the *Hig Ag Area* dummy variable are insignificant at the $p < 0.10$ level. Holding all other variables at their modes and means, the marginal effect of a one-unit increase in the *Ag Index* in a *High Ag Area* is an increase in the probability of a student remaining in school of around three percentage points, but statistically insignificant at the $p < 0.05$ level.

Model (5) includes dummy variables for areas with very low (*Low Ag Area*) and very high (*High Ag Area*) levels of agricultural employment, and their respective interactions with the state-level *Ag Index*. It therefore explicitly compares the effects of agricultural price increases in PUMAs with relatively high levels of employment in agriculture ($\geq 8.1\%$) to those with almost no agricultural employment ($< 0.3\%$), rather than comparing *High Ag Areas* to all other PUMAs. The results indicate significant differences in the likelihood of an individual remaining in school between the two types of areas: students from *High Ag Areas* are significantly less likely to remain in school than those from *Low Ag Areas* and areas with middling levels of agricultural employment.

As a further test of the relationship between the price index and students' dropout decisions I estimate two more models ((1) and (2) in Table 8) identical to Model (4) in Table 7, but setting the thresholds of the dummy variables at the higher and more substantively important levels of ten and twenty percent. The signs of the coefficients on all variables in Model (1) are identical to their counterparts in Table 7: Agricultural areas are associated with higher likelihoods of dropping out, while increases in the price index are associated with lower likelihoods of dropping out in agricultural areas. In Model (1) the correlation between the agricultural price index and dropouts is significant at the $p < 0.10$ level, and the marginal effect of a one-unit increase in the index is a four percentage point increase in the likelihood of a young person being in school, in a high-ag area (agricultural employment $\geq 10\%$). In Model (2), neither residence in an area with very high levels of agricultural employment nor shifts in the agricultural price index are significantly correlated with high school dropouts.

Table 8: Robustness tests: Logit models setting ag area indicators at 10% and 20% (1,2), and including farm households (3,4)

DV: 'In School'	(1)	(2)	(3)	(4)
Ag Area (1/10)	-0.49***			
	(-3.20)			
Ag Price Index	0.0034	0.0084	0.019	0.018
	(0.06)	(0.15)	(0.32)	(0.31)
Ag Area*Ag Index	0.23*			
	(1.89)			
High Ag Area (1/5)		-0.24		
		(-1.56)		
High Ag Area*Ag Ind		-0.17		
		(-1.40)		
Farm Hhold			-0.038	
			(-0.05)	
Farm HH*Ag Ind			-0.16	
			(-0.36)	
Farm Hhold 2				-0.28
				(-0.30)
Farm HH2*Ag Ind				-0.13
				(-0.25)
> School Age	-0.13*	-0.13*	-0.13*	-0.13*
	(-1.84)	(-1.81)	(-1.79)	(-1.78)
Sex	0.23***	0.23***	0.23***	0.23***
	(15.07)	(15.09)	(14.94)	(14.94)
Log family income	0.27***	0.27***	0.27***	0.27***
	(21.89)	(22.07)	(22.17)	(22.18)
Hispanic	-0.50***	-0.50***	-0.51***	-0.51***
	(-8.29)	(-8.35)	(-8.36)	(-8.35)
Black	-0.086**	-0.083**	-0.084**	-0.084**
	(-2.51)	(-2.44)	(-2.39)	(-2.42)
Native Amer.	-0.49***	-0.50***	-0.51***	-0.51***
	(-5.85)	(-6.07)	(-6.10)	(-6.11)
Asian	0.71***	0.71***	0.71***	0.71***
	(13.93)	(13.94)	(13.44)	(13.47)
Pacific Islander	-0.24***	-0.24***	-0.24***	-0.24***
	(-2.71)	(-2.68)	(-2.65)	(-2.66)
Other Race	-0.13	-0.12	-0.13	-0.13
	(-1.32)	(-1.29)	(-1.31)	(-1.31)
Unemployment	0.022***	0.022***	0.022***	0.022***
	(4.12)	(4.24)	(4.11)	(4.07)
Pseudo R^2	0.148	0.148	0.148	0.148
Chi-sq	24790.4	37185.1	24247.9	25080.2
Observations	1097105	1097105	1097105	1097105

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

I also show the results of two further models in Table 8. In Model (3), I include a dummy variable indicating the individuals in the dataset who live in farm households with more than one thousand dollars of agricultural produce annually. In Model (4) I include a dummy variable indicating the individuals who live in a household producing more than five thousand dollars of agricultural produce annually. This could give a clearer identification of the link between produce prices and dropout rates, as the families of the respondents are directly affected by the price shifts in the *Ag Index*. However, the results of Models (3) and (4) are inconclusive. The coefficients on the *Farm Household* variables, and their interactions with the *Ag Index* are very small compared to their equivalents in previous models, and are not statistically significant at the $p < 0.10$ level. Although the coefficients on the *Ag Index* variables are negative, rather than positive in the previous models, they is small and not statistically significant, leading me to discount the importance of these results rather than cast doubt on the results of the other models.

Finally, as robustness tests, I estimate the same models as shown in Tables 7 and 8, but as linear probability models using ordinary least squares regressions. The results from these models are shown in Tables 9 and 10 and confirm the findings outlined above. All models indicate that individuals living in areas characterized by higher levels of agricultural employment are significantly less likely to remain in school than individuals living in other areas. All models, except Model (3) in Table 10 which includes an indicator for households with more than one thousand dollars in farm income, indicate that increases in the state agricultural price index are associated with significantly lower levels of high school dropouts in areas with higher levels of agricultural employment.

Table 9: Robustness tests: Linear probability models

DV: 'In School'	(1)	(2)	(3)	(4)	(5)
Log Ag Pop	-0.0080***	-0.017***			
	(-204.52)	(-85.80)			
Ag Price Index	0.0027***	-0.0021***	0.0014***	0.00071***	0.0037***
	(27.97)	(-14.63)	(12.80)	(7.17)	(31.14)
Log Ag Pop*Ag Index		0.0064***			
		(46.60)			
Ag Area			-0.018***		
			(-54.93)		
Ag Area*Ag Index			0.0054***		
			(24.25)		
High Ag Area				-0.045***	-0.039***
				(-67.06)	(-57.98)
Hi Ag*Ag Index				0.023***	0.020***
				(49.71)	(43.24)
Low Ag Area					0.021***
					(67.21)
Lo Ag*Ag Index					-0.0088***
					(-41.38)
> School Age	-0.0080***	-0.0081***	-0.0070***	-0.0069***	-0.0080***
	(-98.29)	(-99.19)	(-85.70)	(-84.36)	(-97.74)
Sex	0.015***	0.015***	0.015***	0.015***	0.015***
	(283.39)	(283.39)	(283.63)	(284.25)	(283.92)
Log family income	0.024***	0.024***	0.024***	0.024***	0.024***
	(1293.77)	(1293.58)	(1301.87)	(1310.56)	(1302.29)
Hispanic	-0.041***	-0.041***	-0.041***	-0.040***	-0.040***
	(-369.93)	(-368.78)	(-368.67)	(-357.29)	(-362.62)
Black	-0.0050***	-0.0050***	-0.0041***	-0.0032***	-0.0044***
	(-68.07)	(-67.51)	(-55.37)	(-43.88)	(-59.94)
Native Amer.	-0.042***	-0.042***	-0.043***	-0.044***	-0.043***
	(-156.75)	(-157.09)	(-162.43)	(-164.69)	(-161.74)
Asian	0.034***	0.033***	0.035***	0.036***	0.035***
	(236.72)	(236.39)	(244.34)	(254.98)	(244.34)
Pacific Islander	-0.020***	-0.020***	-0.020***	-0.019***	-0.019***
	(-27.49)	(-27.56)	(-27.17)	(-26.09)	(-26.15)
Other Race	-0.0091***	-0.0091***	-0.0082***	-0.0069***	-0.0082***
	(-18.56)	(-18.60)	(-16.77)	(-14.05)	(-16.86)
Unemployment	0.0012***	0.0012***	0.0012***	0.0013***	0.0013***
	(110.57)	(113.67)	(110.78)	(119.51)	(121.17)
Observations	95596517	95596517	95596517	95596517	95596517

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Robustness tests: Linear probability models

DV: 'In School'	(1)	(2)	(3)	(4)
Ag Area (1/10)	-0.057***			
	(-65.35)			
Ag Price Index	0.00083***	0.0014***	0.0021***	0.0020***
	(8.51)	(14.15)	(21.11)	(20.23)
Ag Area*Ag Index	0.031***			
	(49.94)			
High Ag Area (1/5)		-0.052***		
		(-17.87)		
High Ag Area*Ag Ind		0.0090***		
		(3.92)		
Farm Hhold			-0.014***	
			(-10.16)	
Farm HH*Ag Ind			-0.0042***	
			(-4.67)	
Farm Hhold 2				-0.048***
				(-29.09)
Farm HH2*Ag Ind				0.0082***
				(7.58)
> School Age	-0.0067***	-0.0065***	-0.0063***	-0.0062***
	(-82.61)	(-79.35)	(-76.92)	(-76.72)
Sex	0.015***	0.015***	0.015***	0.015***
	(284.35)	(284.43)	(284.41)	(284.39)
Log family income	0.024***	0.024***	0.024***	0.024***
	(1313.08)	(1316.87)	(1318.47)	(1318.25)
Hispanic	-0.040***	-0.040***	-0.040***	-0.040***
	(-358.26)	(-359.14)	(-362.50)	(-362.88)
Black	-0.0031***	-0.0029***	-0.0030***	-0.0030***
	(-42.67)	(-40.01)	(-41.18)	(-41.67)
Native Amer.	-0.044***	-0.045***	-0.045***	-0.045***
	(-165.07)	(-167.48)	(-168.79)	(-169.02)
Asian	0.036***	0.036***	0.036***	0.036***
	(255.12)	(256.37)	(255.99)	(255.88)
Pacific Islander	-0.019***	-0.019***	-0.019***	-0.019***
	(-26.00)	(-25.73)	(-25.66)	(-25.72)
Other Race	-0.0069***	-0.0067***	-0.0068***	-0.0069***
	(-14.17)	(-13.68)	(-14.00)	(-14.15)
Unemployment	0.0013***	0.0013***	0.0012***	0.0012***
	(120.35)	(120.95)	(115.44)	(114.78)
Observations	95596517	95596517	95596517	95596517

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6 Discussion and Conclusion

This study estimates the short-run effects of the global food crisis on dropout rates in agricultural areas in the United States. I find no evidence that land-intensive activities inhibit human capital investments. In fact, I find weak evidence that the opposite might be true after controlling for individual characteristics, respondents' age relative to their state's minimum school age threshold, other regional characteristics and state fixed effects . As farming becomes more lucrative, youth in relatively agriculture-intensive areas are *more* likely to remain in high school not less.

The likelihood of a student dropping out of high school is not significantly correlated with agricultural prices in the vast majority of the United States, where agriculture plays only a very slight role in the local economy. However, in areas where a comparatively large share—more than ten percent—of the workforce is employed in agriculture, students' probability of dropping out was more than four percent lower, on average, when agricultural prices were high. Higher farm prices from 2000-2010 were thus able to mitigate the disadvantage which these youths faced in dropout rates compared to comparable youths in non-agricultural areas.

This is a finding of some substantive significance. Rural youths are around three percent less likely than urban youths to graduate high school in the US on average (see Table 1), and therefore a four percent shift in the likelihood of a student remaining in school made a significant difference in negating this difference. Higher agricultural prices during the global food crisis appear to have helped rural America, not only through greater incomes for farmers, but through greater investments in human capital by young people. These will contribute to economic development and mitigate socio-economic inequality after farm prices decline; or, given the sustained high levels of global food prices since 2010, higher graduation rates at rural high schools could become the norm, leading to some convergence in income levels between rural and urban America.

In this study, I have not attempted to trace the precise causal mechanism linking higher farm prices to lower dropout rates in agricultural areas, but tried to isolate an average relationship between agricultural prices and education decisions. However, in the course of my research, one mechanism linking farm prices and school dropouts stood out as especially plausible and worthy of further investigation. Although state or county-level data are not yet available, national data from the Economic Research Service, USDA (2012a) indicate that labor inputs in US agriculture declined considerably after 2007, while capital inputs of equipment and buildings increased. This suggests that as produce prices spiked during the food crisis, US farmers substituted capital for labor, causing decreased demand for workers and lower wages in agriculture, lower employment opportunities for youths in agricultural areas, increased relative utility to remaining in school, and thus the decreased dropout rates which I find in my analysis above. An empirical investigation which utilizes state- or county-level data on farm labor inputs, or an instrumental variable such as geographically coded data on purchases of tractors and combines, could isolate this mechanism linking increased farm prices and dropout rates in agricultural areas.

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