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Georgeanne M. Artz, Kevin Kimle, Peter Orazem

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Department of Economics
Ames, Iowa, 50011-1070

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Does the Jack of All Trades Hold the Winning Hand?: Comparing the role of specialized versus general skills in the returns to an agricultural degree

Georgeanne M. Artz, Visiting Assistant Professor, Economics, Iowa State University, gartz@iastate.edu

Kevin L. Kimle, Rastetter Chair of Agricultural Entrepreneurship, Iowa State University, kimle@iastate.edu

Peter F. Orazem, University Professor, Economics, Iowa State University, pfo@iastate.edu

Abstract

This paper examines the roles of specialized versus general skills in explaining variation in the returns to an agriculture degree across majors inside and outside the agricultural industry. The focus on returns by sector of employment is motivated by the finding that most agricultural majors are employed in non-agricultural jobs. A sample of alumni graduating from a large Midwestern Public University between 1982 and 2006 shows that alumni with majors more specialized in agriculture earned a premium from working in the agriculture industry, but this advantage has diminished over time. More generally trained agriculture majors earn more outside than inside agriculture, and their advantage has increased over time. During sectoral downturns in the agriculture economy, more specialized majors suffer large pay disadvantages compared to more generally trained agriculture majors and majors in other colleges. These findings suggest that greater levels of specialization may limit a graduate's ability to adjust to changing economic circumstances. Agriculture degree programs could benefit from curriculum innovations focused on developing more generalized skills.

JEL codes: J43, J31, A2

Key Words: Earnings, Agricultural sector, College Major, Business cycle, Curriculum, Specific Skills, General Skills, Urban, Rural

Does the Jack of All Trades Hold the Winning Hand?: Comparing the role of specialized versus general skills in the returns to an agricultural degree

Agribusiness firms are increasingly hiring non-agriculture college graduates. Goecker et al. (2005) estimated that the number of agricultural graduates qualified for management/business positions with agribusiness firms represents only 60 percent of the job openings. Agribusiness firms turn to graduates of allied fields such as business to fill the remaining 40 percent of their job openings. The reason may be an undersupply of agriculture graduates relative to demand, or alternatively, that non-agriculture graduates have skills that are not being developed as fully in traditional agriculture programs. The former suggests a need for increased recruitment into traditional agriculture majors, while the latter suggests a need for changes in curricula and course content to improve the competencies of agricultural graduates.

Some clues suggest that agricultural firms seek non-agriculture graduates because they desire a different mix of skills. In a 1992 National Research Council report, *Agriculture and the undergraduate,* a former corporate executive, Robert Goodman, wrote, "Today, those of us who hire research technicians in the private sector find young people with the skills and experience we need as often as not among graduates of programs in chemistry, life sciences, and chemical engineering, and we must absorb the cost of teaching them about agriculture on the job. This is not bad, because in my experience such people are quickly attracted to the importance and the intrinsic interest of agricultural research and development. Both of these observations raise the question of the relevance of having an undergraduate curriculum in agriculture." (p. 44).

Corroborating evidence is found in recent surveys of potential employers of agricultural college graduates that emphasize the importance of general qualifications such as oral communications skills and ability to work in a team setting over more technical or specialized knowledge of agriculture (Boland and Akridge, 2004; Onianwa, Wheelock, Mojica, and Singh, 2005; Norwood and Henneberry, 2006; Briggeman, Henneberry and Norwood, 2007). This suggests that non-agriculture degree holders can compete effectively for agriculture industry jobs.

However, other evidence points to firms outside agriculture bidding for the services of agriculture majors. Carnevale, Strohl and Melton (2011) report that 87 percent of college graduates with degrees in agriculture or natural resources have jobs outside agriculture, suggesting that agricultural firms use non-agriculture graduates because agriculture graduates are being lured to other sectors for higher wages, better benefits, or more urban environments. The greater placement of agriculture majors outside agriculture may be a measure of the strength of the curriculum and not a weakness.

Past studies of returns to agriculture majors have been limited by samples that focused primarily or exclusively on College of Agriculture alumni. These studies confirm the importance of advanced degrees and work experience for higher salaries among these alumni, while documenting a significant but narrowing gender gap (Broder and Deprey, 1985; Preston, Broder, and Almero, 1990; Barkley, 1992; Zekeri, 1992; Barkley, Stock and Sylvius, 1999; Barkley, and Biele , 2001; Qenani-Petrela and McGarry Wolf, 2007). Harris, et al. (2005) find comparable results studying salaries earned by agribusiness management graduates. What these studies do not provide is a frame of reference to the returns to other college majors.

A handful of studies have examined relative pay in the agriculture industry compared to jobs outside agriculture, many or most looking at entry-level salaries. Some report an income penalty for alumni in agriculture industry jobs. Zekeri (1992) finds former agriculture students in agriculture-related positions earned roughly 5 percent less than their peers in non-agricultural jobs. Qenani-Petrela and McGarry Wolf (2007) report a 12.4 percent earnings gap between agriculture and other sectors of the economy. Barkley and Biele (2001) find a 33 percent premium for non-agricultural employment relative to agribusiness jobs in a sample of Kansas State University agribusiness and agricultural economics alumni, apparently reversing the findings of no difference in salary of Kansas State alumni in an earlier study (Barkley, Stock and Sylvius, 1999). Preston et al. (1990) also found no difference in salaries between agriculture and non-agricultural industries for Virginia Tech alumni.

A plausible explanation for the mixed findings regarding the salary discount in agriculture is that ag-related jobs are disproportionately located in rural areas. The rural-urban wage gap is well documented: Kusmin, Gibbs and Parker (2008) report that college graduates earn 23 percent less in nonmetropolitan areas even after controlling for personal characteristics. Differences in the ability to control for job location across studies may be one reason for such large discrepancies in measured pay differentials across agriculture and non-agriculture sectors. A second possibility is that some agricultural majors provide more sector-specific training than do others. That suggests that the skills of some agricultural majors will be highly valued in agriculture but discounted heavily in nonagricultural sectors, even as other majors may provide skills that receive a premium in non-agricultural firms.

This study uses a large random sample of graduates of a Midwestern public University to explore the returns by major in the agricultural and non-agricultural sectors. The strength of the study is its ability to identify the value of agricultural sector-specific skills versus general skills developed by major. This data set reflects the incomes of graduates over a greater than twenty year time period, an important distinction from past work that looked at only starting salaries, a much more narrow data set. Compared to previous studies, this data set also has better controls for academic success within the major, family background, and curricular diversity, increasing the confidence that the results reflect returns to the major and not differences in abilities of individuals across majors. The study has the added advantage that it incorporates the salaries earned by non-agricultural graduates inside and outside the agriculture industry as a reference, and so we gauge earnings of agriculture majors against the universe of all majors in the university.

The results are compelling. Most agriculture majors work outside the agriculture industry. There are substantial returns to agriculture majors working in agriculture, but only when the firms are located in urban areas. Some majors, most notably Animal Science and Agricultural Education and Studies, appear to have substantial sector-specific skills as measured by large pay gaps between jobs inside and outside agriculture. Others, most notably Agricultural Business, earn a wage premium outside agriculture consistent with the development of skills that are broadly valued across sectors. Importantly, differences in GPA of majors across the two sectors vary only by small amounts, suggesting that sectoral wage differences are due to the skills developed in the major and not to differences in the abilities of individuals across the agriculture and non-agriculture firms. Our findings would support curricular reform that would focus on developing more general skills in majors that have traditionally focused narrowly on agriculture.

Data

We first establish the stylized facts regarding average earnings by agricultural majors by sector and location. Where possible, we also will show that our results, which are based on a specific university's alumni, are consistent with national data on earnings by agricultural majors. Of course, our use of a specialized sample from a single university will allow us to add many additional controls into the analysis that would be impossible with available national survey data.

Our analysis uses a survey of Iowa State University alumni who graduated between 1982 and 2006. Data were collected using a 2007 stratified random sample survey of 25,025 Iowa State University (ISU) alumni graduating between 1982 and 2006 (Jolly, Yu, Orazem, & Kimle 2010). Sample surveys were mailed to 24 percent of the 84,917 alumni who received bachelor's degrees over that period.[1] Respondents could choose to complete the survey on-line or return the questionnaire by mail. We received 5,416 usable surveys for a response rate of 21.6 percent. The survey asked respondents a variety of questions about their careers subsequent to graduation in addition to individual demographics and family background. Survey responses were matched to student records containing information about majors, coursework, and extracurricular activities while at ISU. We projected the reported zip codes of alumni's current residency to county FIPS codes and use the Economic Research Service's rural-urban continuum codes (RUCC) to define rural or urban status of their current locations. Counties with RUCC 6-9 are defined as rural. The 2003 codes were used to define 2007 rural status.

Among alumni working in agricultural industry jobs in 2007, one-third held degrees from a college other than the College of Agriculture and Life Sciences (CALS). Furthermore, among CALS alumni, only 21 percent were employed in agriculture in 2007; the vast majority of CALS alumni reported holding jobs in non-agricultural industries. Of the jobs in agriculture, 60 percent were located in urban, not rural, areas.

Table 1 reports summary information on salaries earned by agriculture and non-agriculture graduates in agriculture and non-agriculture firms by urban and rural location. On average, non-agriculture majors earn about $13,000 more than agriculture majors. In urban areas, there is no significant difference in average income between agriculture and non-agriculture sectors. However, agriculture majors earn a substantial premium over non-agriculture majors in urban agricultural firms, while non-agricultural majors receive a significant premium over agriculture majors in non-agricultural sectors.

The pattern is markedly different in rural markets. Salaries for all majors are over $18,000 less in rural markets. Salaries in rural agricultural firms are even lower, averaging $30,000 less compared to their urban counterparts. However, there is no premium paid to agriculture majors in rural agriculture firms. Still, non-agricultural majors receive a $15,000 premium in rural non-agriculture sectors. Clearly urban versus rural residence is a key factor in assessing the returns to agriculture majors overall and relative to other college majors.

Table 2 displays average earnings in agricultural and non-agricultural industries by more specific groupings of majors within the College of Agriculture and Life Sciences[2]. The range of salaries is remarkable. Within agriculture, the highest average salaries go to Animal Science majors whose pay more than doubles the average in Agricultural Engineering and Plant Science. Outside of agriculture, the top salaries in Agriculture Business are more than double those in Agriculture Engineering and Natural Resources.

Equally remarkable differences exist in the probability of finding employment in the agriculture industry. Less than 4 percent of Food Science majors work in agriculture, barely more than the proportion of non-agriculture majors. Meanwhile, over one-quarter of Plant Science and Agriculture Enginnering majors take jobs in the agriculture sector. Average earnings fall as the fraction employed in agriculture increases with the simple correlation of -0.37, suggesting that agricultural firms do have trouble competing for college talent at least on average.

There are substantial differences across majors in the average paid inside and outside of the agriculture industry. The majors in table 2 are listed in order of the size of the premium paid for working in agriculture. The premium approaches 100 percent in animal science and exceeds 50 percent in Natural Resources. However alumni in other majors earn a premium for working outside agriculture, the largest a 51 percent premium among Agricultural Business majors. Identifying the source of such dramatic variation in returns and employment across majors and sectors is critical for anyone interested in curriculum development or career advising in agriculture.

While this study includes only graduates from one university, we can compare the characteristics of Iowa State graduates with the universe of agriculture degree holders. Carnevale, Strohl and Melton (2011) analyzed median earnings and industry of employment for college graduates by major using 2009 American Community Survey data compiled by the U.S. Census. The two samples are not quite comparable as the Census data only included terminal bachelor's degree recipients while the ISU data also includes holders of graduate degrees. Nevertheless, the sample distributions for ISU agriculture majors match the universe reasonably well. The main difference is that ISU agriculture graduates are more likely to be employed in the agriculture industry (21 percent versus 13 percent) compared to the universe of agriculture degree recipients. Comparing earnings and employment within more narrowly defined majors (e.g. agricultural economics or plant science) showed a great deal of consistency in relative employment rates in agriculture and in relative pay levels by major. The ISU majors whose relative salaries were higher than those in the national population were the highest ranked agricultural departments at ISU.

Conceptual Framework

One explanation for differences in returns across industries is that salaries are determined in part by the level of general versus industry-specific human capital an individual possesses. In particular, if a portion of one's salary is determined by the level of human capital specific to one's firm, occupation or industry, we would expect workers to incur a penalty when switching into jobs that require less, or different, specific human capital (Poletaev and Robinson, 2008)[3].

We frame our analysis using Neal's (1998) model of training choice. In Neal's two-period model, workers acquire firm-specific training in the first period. In period two, they decide whether to stay in their current position or switch jobs. In the context of our data, individuals choose a major and receive training in college during the first period. That training will have both general and agriculture sector-specific components. In the second period, students graduate and choose employment either in the agriculture industry or in a non-agricultural industry.

To make this precise, let individual i choose major j, where $j=\{A,N\}$. Agriculture majors are indicated by A and non-agriculture majors are indicated by N. While in the major, she expects to receive general training skill, α_j, which is equally valued in all sectors, as well as a major-specific skill, δ_{jk}, which is productive only in sector k. Her actual skill level upon completion of the major can deviate from her anticipated skills. In particular, she will discover her suitability to the major. This is measured by a random skill shock ε_{ij}^{C} which reflects the additional sector-specific human capital attributable to the quality of the match between her individual abilities and interests and the skills required in the major. These shocks are drawn from an *i.i.d.* symmetric distribution $G(\varepsilon^{C})$ with $E(\varepsilon^{c}) = 0$.

In the second period, individuals choose their sector of employment, k, where $k=\{A,N\}$.The individual's sectoral income, Y_{ik}, reflects both general and sector-specific training.

Income for individuals who 'switch' and choose employment in sectors not related to their college major will only be rewarded for their general skills. Let D_{ij}^{k} be a dummy variable equal to 1 if j=k and 0 otherwise. The output price attached to sector-specific productivity is given by P_k. Individual earnings will also reflect the quality of the match between their sector-specific training and the specific skill requirements on the job, ε_{ik}^{W}. Accounting for the various sources of skills, income of major j in sector k is:

$$Y_{ijk} = \alpha_j + D_{ij}^{k} P_k \delta_{jk} + P_k\left(\varepsilon_{ij}^{C} + \varepsilon_{ik}^{W}\right) \qquad (1)$$

Risk neutral individuals will pick the sector with the highest earnings such that $Y_{ik} > Y_{il}\ \forall k \neq l$. Because the sector-specific training will have no value outside of agriculture by definition, the observed difference in earnings between the agricultural and non-agricultural sectors is

$$\rho = E\left[P_A\left(\delta_{ijA} + \varepsilon_{iA}^{C} + \varepsilon_{iA}^{W}\right) \middle| \left(\delta_{ijA} + \varepsilon_{iA}^{C} + \varepsilon_{iA}^{W}\right) > 0\right] \qquad (2)$$

An estimate of ρ will be the coefficient on the dummy variable D_{ij}^{A} in a regression of form (1). This is the average gain from picking the agricultural sector relative to the non-agriculture sector. In experimental terms, this is the treatment effect on the treated where the treatment is obtaining employment in the agriculture industry. Importantly, this will differ from the value of sector-specific training for the population as a whole because of nonrandom sorting across sectors. Because $\delta_{iA} > 0$ by assumption, the individuals in the agriculture sector will have unobserved sector skills $(\varepsilon_{iA}^{C} + \varepsilon_{iA}^{W}) > -\delta_{iA}$ whose truncated mean will be above zero, as shown in figure 1. Hence, the measured value of sector-specific skills in agriculture, ρ, will be an upper-bound of the true value of sector-specific skills in the industry.

Our analysis has assumed implicitly that the general skills α_i are identical across sectors so that sector choice is unrelated to the general component of skills. If α_i is correlated with the unobserved sector-specific skills, then our measure of ρ will be subject to an additional source of selection bias associated with nonrandom sorting across sectors on general skills. One solution to this is to parameterize the general training measure by $\alpha_i = X_i'\beta$ where X_i is a vector of human capital measures reflecting academic performance, family background and socio-economic status, and work experience since leaving college. To the extent that the sorting across sectors is attributable to these observable factors across sectors, inclusion of X_i as a proxy for general skills will correct for nonrandom sorting on ability.

One issue we can lay to rest is whether the differences in earnings across agriculture and non-agriculture jobs are driven by differences in academic success. Agriculture majors employed in agriculture had average GPAs of 3.04 compared to 2.96 for those employed in other sectors. While the difference is statistically significant, it is numerically small. In 3 of 8 majors, average GPA is higher outside agriculture which is counter to the concern that employees in the agriculture sector are disproportionately drawn from the upper-tail of the graduates in the agriculture major. What's more, in half of the majors, the sector with the higher average earnings is the one with the lower GPA although the differences in GPA are small in each instance.[4] Thus, while all of our analysis will incorporate measures of academic success, there is no systematic pattern that suggests that the earnings gap between sectors is driven by differences in academic success.

Empirical Specification

The empirical specification follows from equation (1). Our dependent variable, ln (Y_{ijk}), is the natural log of the 2007 salary of ISU alumni *i* in major *j* and sector *k*. The survey instrument collected salary information using categorical variables. For this analysis, we use the midpoint of each category to approximate actual salary.

$$\ln(Y_{ijk}) = (\alpha_N + \delta_{NN}) + X_i'\beta + D_{iN}^A(-\delta_{NN}) + D_{iA}^A(-\alpha_N - \delta_{NN} + \alpha_A + \delta_{AA})$$
$$+D_{iA}^N(-\alpha_N - \delta_{NN} + \alpha_A) + \varepsilon_{ijk} \quad (3)$$

In our application of (3), we further subdivide the agriculture degree dummy variables into D_{iAj}^A and $D_{iAj}^N; j = 1, \dots 8$, where the 8 subgroups are the 8 agriculture majors listed in table 2.

The error term in (3) is $\varepsilon_{ijk} = \varepsilon_{ij}^C + \varepsilon_{ik}^W$; the sum of individual-specific productivities in the major and in the job match that are not correlated with the vector of individual attributes X_i. If $E(\varepsilon_{ijk} | X_i) = 0$, we can derive exact measures of major-specific human capital. If that assumption is violated, we can sign the expected bias in our estimate of ρ.

To see that, note that specification (3) treats the earnings of non-agriculture majors employed in the non-agricultural sector as the base. Relative to them, non-agriculture majors employed in agriculture will sacrifice their major specific capital δ_{NN}, which means we can directly estimate the value of major-specific human capital for non-agriculture majors as the negative of the coefficient on D_{iN}^A. The coefficient for agriculture majors in the non-agricultural sector will measure the general value of their training α_A net of the value of a non-agriculture major in the same sector. Finally, the coefficient on agriculture majors in the agriculture sector will include both general and sector specific value of the agriculture major net of the base value. The relative size of the coefficients on D_{iA}^A and D_{iA}^N yields an estimate of the major-specific human capital for agriculture majors, δ_{AA}. If $E(\varepsilon_{ijk}) = 0$, then ρ=δ_{AA}. If our vector of individual attributes X_i does not sufficiently control for the nonrandom assignment across sectors, then as shown in figure 1, the measured return from choosing the agriculture sector ρ>δ_{AA}, an upper bound measure of the true major-specific human capital.

We also make use of an alternative specification that further decomposes the returns into urban and rural components. That specification takes the form

$$\ln(Y_{ijkl}) = (\alpha_{NU} + \delta_{NNU}) + X_i'\beta + D_{iNU}^{A}(-\delta_{NNU}) + D_{iNR}^{A}(-\delta_{NNU} - \alpha_{NU} + \alpha_{NR}) + D_{iNR}^{N}(-\delta_{NNU} - \alpha_{NU} + \alpha_{NR} + \delta_{NNR}) + \sum_{l=R}^{U} D_{iAl}^{A}(-\alpha_{NU} - \delta_{NNU} + \alpha_{Al} + \delta_{AAl}) + \sum_{l=R}^{U} D_{iAl}^{N}(-\alpha_{NU} - \delta_{NNU} + \alpha_{Al}) + \varepsilon_{ijkl}. \quad (4)$$

where the value of a non-agricultural degree in the non-agricultural sector in the urban market, $(\alpha_{NU} + \delta_{NNU})$, is the constant term in the regression. Specification (4) will allow us to examine whether the major-specific skills differ in value across urban and rural markets. We could only estimate specification (4) with the aggregate agriculture major. We do not have a sufficient number of observations to generate precise estimates of urban and rural returns by detailed agriculture major and sector.

The vector of human capital measures, X_i , includes measures of college experience, post baccalaureate education and career experiences, demographic and family background variables.

College experience variables. These measures control for breadth of the curriculum and academic success. Variables include cumulative grade point average, length of time in school, whether the alumni had a double major, and the degree of specialization in the major.[5]

Career variables. Post-baccalaureate career experience measures include the number of years since earning the first bachelor's degree (experience), whether the alumnus/alumna holds a graduate degree, the number of jobs held since graduation, whether the individual has ever started a for-profit business, and current employment status (full-time or part-time and whether self-employed or not). A term interacting gender with part-time work is also included to control for likely differences in work experience related to the length of the part-time spell by gender.[6]

Demographic and family background variables. We include race and gender as explanatory variables in addition to a set of family-related variables. These include father's education, number of siblings, whether the individual's family operated a farm business or other type of business and the individual's high school rank. We also include a series of dummy variables controlling for year of graduation and, in specification (3), rural residence.

Regression Results

Table 3 presents the estimates of the observed differences in earnings between the agricultural and non-agricultural sectors (ρ) by major and location, conditional on observable human capital measures in percentage terms[7]. The estimated premium/penalty from working in agriculture by degree (and location if applicable) is provided along with the results of the corresponding test of equality across industries. Panel A gives the key coefficients from estimation of specification (4) that compares returns for Iowa State College of Agriculture and Life Sciences (CALS) alumni as a whole relative to all other ISU alumni by urban and rural location and by sector. Estimates are relative to a base of urban non-agricultural major in the non-agricultural sector. Panel B provides the key estimates by detailed CALS major relative to the base category, non-agricultural degree in a non-agricultural job as in specification (3). Complete regression results are provided in appendix tables A4 and A5. The signs of the additional controls are generally as expected and consistent with previous studies.

The results in Panel A demonstrate an urban-rural gap in returns to an agriculture major of over 20 percent in agriculture jobs and just under 10 percent in non-agriculture jobs. Non-agriculture majors also are paid more in urban markets but the urban-rural gaps are half the size found for agriculture majors. Estimates of major-specific human capital in agriculture, ρ are significant and positive in every case. Non-agriculture degree recipients earn a premium of 20 percent or more from working outside agriculture in both urban and rural markets. Agriculture degree recipients earn a premium from working in the agriculture sector of 15.6 percent in urban markets and 3.5 percent in rural markets.

Panel B of table 3 displays the results of this analysis using the detailed CALS majors. Positive estimates of major-specific human capital are found in 5 of 7 agriculture majors. Of these, four are statistically significant: Natural Resources, Animal Science, Other Agriculture and Agricultural Education and Studies. Two of the agriculture majors have negative estimated major-specific capital, meaning that majors earn more outside agriculture. The 7 percent premium earned by Agricultural Economics/Agribusiness majors outside agriculture is consistent with, albeit smaller than, the 33 percent premium reported for Agribusiness majors at Kansas State (Barkley and Biele, 2001). Non-agriculture majors earn a 7.5 percent premium for working outside agriculture. These estimates imply that degrees that command sizeable premiums in agriculture industry jobs such as Animal Science or Agricultural Education and Studies focus their curricula on material that only earns a return if the graduate is employed in agriculture. However, the majority of degree recipients in those majors find work outside agriculture and are penalized for their more specialized training. In contrast, the Agricultural Economics/Agribusiness degree has a greater emphasis on general skills that are valued both in and outside of agriculture. To illustrate the magnitude of the estimated penalty or premium from degree-industry match, we compute the predicted salary across majors and industries for a given alumnus: a white, male, 1985 alumnus, non-entrepreneur working full-time in an urban location, with average values for the remaining family background, college experience and career measures. Table 4 displays these results sorted in ascending order according to the size of the premium for working in agriculture. An Agricultural Economics/Agribusiness major would earn about $7,000 a year less working in rather than out of agriculture, almost the same gap estimated for non-agriculture majors. Meanwhile, there is a large premium to working in agriculture for Animal Science majors (roughly $32,000 a year), Agricultural Education and Studies majors (nearly $17,000 a year) and Other Agriculture majors (about $15,000 a year).

Cohort Effects

Graduating into a recessed labor market can cause long-term reductions in returns to college (Khan, 2010). That is particularly true when the recession atypically affects specific sectors. In the case of agriculture, the 1982 recession resulted in sharp reductions in farmland prices and the failure or forced consolidation of rural banks, dragging out the recovery in Iowa for several years after the national economy had rebounded. In contrast, the 1992 recession barely affected Iowa and was followed by the longest expansion in the history of the United States. The 2001 recession mainly affected the national non-agricultural market for college graduates.

We can explore how market conditions affect earnings by major by adding cohort effects to the earnings function as follows. We divide our alumni into 3 cohorts C_1: 1982-1986 (the approximate length of the agricultural recession); C_2: 1987-2001 (a period of general economic expansion); and C_3: 2002-2006 (a period of weak growth focused on jobs outside agriculture). By interacting these cohort dummy variables with major and sector of employment, we can assess whether major-specific returns in agricultural and non-agricultural sectors vary across sector-specific business cycles. In addition, we should find that majors with the largest sector-specific human capital, ρ, were hurt most when they graduated into a recessed agricultural market but may have been hurt less in recessions that hit non-agricultural sectors more. The specification used to investigate these hypotheses is

$$\ln\left(Y_{ijt}^k\right) = \alpha_0 + (\alpha_{N1} + \delta_{NN1}) + X_i'\beta + \sum_{t=2}^{3} C_{it} D_{iNt}^N(-\alpha_{N1} - \delta_{NN1} + \alpha_{Nt} + \delta_{NNt}) +$$

$$\sum_{t=1}^{3} C_{it} D_{iNt}^A(-\delta_{NNt}) + \sum_{t=1}^{3} C_{it} D_{iAt}^A(-\alpha_{N1} - \delta_{NN1} + \alpha_{At} + \delta_{AAt}) +$$

$$\sum_{t=1}^{3} C_{it} D_{iAt}^N(-\alpha_{N1} - \delta_{NN1} + \alpha_{At}) + \sum_{t=1}^{3} \gamma_{Nt} C_{it}(D_{iAt}^N + D_{iNt}^N)\, \rho_j +$$

$$\sum_{t=1}^{3} \gamma_{At} C_{it}(D_{iAt}^A + D_{iNt}^A)\, \rho_j + \varepsilon_{ijkt}. \qquad (5)$$

In this formulation, we use the estimated ρ in table 3 as an estimate of the degree to which the major specializes in skills unique to the agriculture industry. The more specialized agriculture majors are those in table 3 with positive estimates of ρ, while more general agriculture majors, Food Science and Agricultural Economics/Agribusiness, as well as non-agriculture majors, have negative estimates of ρ. Using the returns to non-agriculture majors in non-agricultural jobs in period 1 $(\alpha_{N1} + \delta_{NN1})$ as the frame of reference, we can show how returns to the agriculture and non-agriculture majors changed across the three time periods. We can then use the estimates of γ_{Nt} and γ_{At} to show how more or less specialization in agriculture affected returns in the non-agriculture and agriculture sectors, respectively.

Table 5 reports our findings. Non-agricultural degree holders from the 1982-1986 graduation cohort working in the agriculture industry earned about 20 percent less than their peers working outside of agriculture. Agriculture majors graduating during this period earned roughly 17 percent more working in agriculture relative to jobs outside agriculture. Surprisingly, the agriculture majors earned about 10 percent less in agriculture jobs than did their non-agriculture major counterparts. More specialized agriculture majors who found jobs in agriculture gained 1.8 percent higher earnings for every percentage increase in ρ, but those who took the more plentiful jobs outside agriculture in that era lost 0.5 percent in earnings for every percentage increase in ρ.

Our finding of large costs to graduating in a recession are in line with recent studies of large earnings loss associated with recessions. Khan (2010) found that a man who graduated in December 1982 when the unemployment rate was 10.2% earned 23% less than an observationally equivalent graduate entering the labor market 18 months earlier when the economy was at full employment. The earnings disadvantages compared to graduates in normal times persisted and were still between 4-5% 12 years after graduation. For a typical worker, lost earnings from graduating in a bust market were on the order of $100,000 less over 18 years. Similar costs of recessions are reported by Davis and von Wachter (2011) who found that the present value of lost earnings from job loss in a recession cost 19% compared to workers who retain jobs.

Alumni graduating with agriculture degrees during the national expansionary period between 1987 and 2001 earned relatively about 40 percent more working in agriculture than did the 1982-86 agriculture graduates. However, non-agriculture majors earned much more on average, even when working in the agriculture sector. The 36 percent premium over base earned by non-agriculture majors in agriculture jobs is even larger than the premium earned in agriculture jobs. The return from specialization in the agriculture sector is half that in the 1982-86 period at 0.9 percent increased earnings per percent increase in ρ. Working outside agriculture still penalized more specialized agriculture training.

For the 2002-2006 cohort, returns to an agriculture degree are much better than in the earlier periods and actually dominate returns to a non-agriculture degree in both sectors. However, the estimated return to specialization actually turns negative in both sectors. This suggests that recent graduates with more specialized majors incurred an earnings penalty even when working in agriculture, while graduates of the more general agricultural programs earned a premium both in agricultural jobs and in jobs outside agriculture. A plausible explanation for the rising value of general skills is offered by Lazear's (2005) "Jack-of-all-Trades" model of entrepreneurship. He shows theoretically and empirically that firm owners are broadly trained while their employees are specialists. If the labor market is increasingly valuing managerial skills involving decisions spanning many academic disciplines, then we would expect to find rising relative returns to majors offering broader training.

Conclusions and Implications

This paper examines the relative returns to an agricultural degree from working in or outside of the agricultural industry. Contrary to popular perception, we find most agricultural majors are employed in non-agricultural industries. Furthermore, we find sizeable differences in earnings across majors from working in agriculture. Agricultural Economics/Agribusiness majors actually earn significantly more in non-agriculture fields, suggesting that this major develops more generally-valued skills, while graduates of Animal Science and Agricultural Education and Studies programs, for example, earn large premiums working in agriculture, apparently reflecting substantial sector-specific skills.

We also find large negative effects on earnings for alumni graduating during economic downturns. The negative cohort effects for more specialized agriculture majors graduating during the 1980s agriculture recession suggests that having a narrowly focused major may be risky in that it makes it more difficult to adjust to changing economic circumstances. Significant shifts in industry dynamics, apart from economic distress, may also represent a risk to having a more narrowly focused major.

Taken together, these findings have important implications for curriculum decisions in agricultural degree programs. While teaching more specialized, industry-specific knowledge and skills can reward students who land jobs in agriculture, it can hurt the majority of majors who find work in other sectors. Returns to development of specialized skills and knowledge while obtaining an undergraduate degree vary considerably. In fact, this paper shows that there are inherent risks in specialization of undergraduate studies, whether those risks arise from career changes, sector-specific changes or shocks, or economic circumstances.

Our findings support the current momentum toward developing more general skills in agricultural economics and agribusiness degree programs such as communications and business (Larson 1996). This analysis suggests there is ample justification for continued emphasis on development of generalized skills for any major or program of study. Examples of such innovations include writing intensive exercises across the curriculum; experiential learning using case studies, simulations, interaction with industry professionals, and projects from private companies; and incorporating oral reports and group projects with more traditional forms of instruction. Such curricular innovations will be most challenging in academic programs populated with individuals who have experienced success from specialization but whose students face changing labor market demands for more generalized skills and knowledge.

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[1] We sampled the alumni graduating between 1982 and 2006 at 24% sampling rate except that graduates in 1982 and 1992 are fully sampled. Oversampling in 1982 and 1992 was to allow additional evaluation of entrepreneurial decisions in boom and bust years.

[2] See appendix table A1 for specific degree programs included in each major category.

[3] In this analysis we presume the specificity resides at the industry or sector level (rather than the firm or occupation level).

[4] The results are reported in appendix table A2.

[5] This measure developed by Lazear (2005) is constructed as the credits taken in the major minus the largest number of credits earned in a department outside the major.

[6] Incidence of part-time employment as a fraction of all employed for workers over 20 is 25% for women but only 11% of men. U.S. Bureau of Labor Statistics: http://www.bls.gov/web/empsit/cpseea06.htm

[7] With the log-linear regression specification, the percentage change in personal income resulting from a categorical variable is $g^{*} = \exp(\beta_k - 0.5\sigma_k^2) - 1$ (Kennedy, 1981), β_k is the estimated coefficient for the *kth* dummy variable and σ_k^2 is the variance of β_k.

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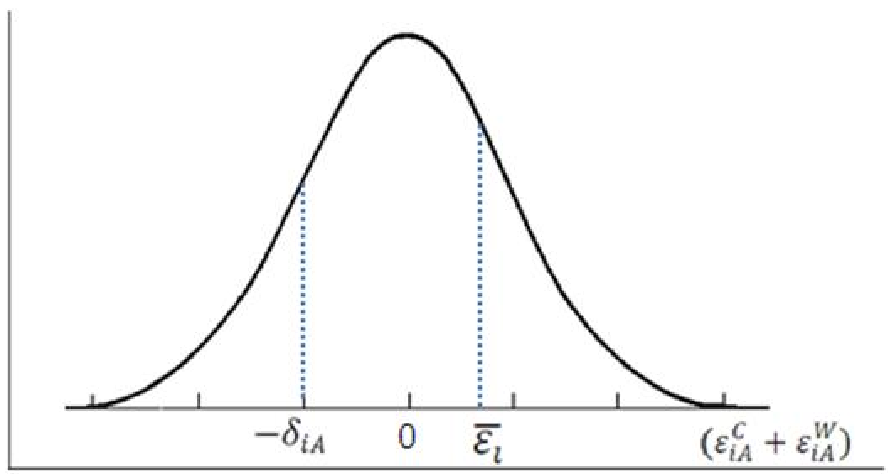
Figure 1: The effect of nonrandom sorting into the agricultural sector on average unobserved sector-specific human capital



Notes: δ_{iA} is the level of sector-specific training individual i expected to attain as they entered the major and $\overline{\varepsilon_i}$ is the conditional mean of $(\varepsilon_{iA}^C + \varepsilon_{iA}^W)$ for those selecting work in agriculture.

Table 1. Average Income of ISU Alumni by Degree, Industry of Employment and Job Location, 2007

	Non-Agricultural Degree		Agricultural Degree		All Degrees	
Industry of Current Job	Urban	Rural	Urban	Rural	Urban	Rural
Non-Agriculture	$84,717	$69,320	$69,985	$53,558	$83,521	$66,099
Agriculture	$74,056	$54,199	$90,087	$53,880	$84,143	$53,967
All Jobs	$84,586	$68,849	$73,877	$53,639	$83,539	$65,059

Table 2. Average Salary and Employment Status by Major and Industry

Major	Obs.	Industry: Agricultural	Industry: Non-Agricultural	Industry: Total	% Employed In Agriculture	Earnings Ratio (Ag/Non-Ag)
Animal Science	2,403	$116,721	$60,910	$74,622	23.1%	1.92
Natural Resources	1,557	$75,314	$47,659	$50,692	11.3%	1.58
Other Agriculture Degree	683	$73,883	$61,052	$63,823	37.0%	1.21
Agricultural Education / Studies	1,945	$68,587	$61,793	$63,474	23.8%	1.11
Food Science/ Biological Science	970	$65,000	$70,087	$69,855	3.6%	0.93
Agricultural Engineering	663	$46,957	$53,347	$51,573	27.8%	0.88
Plant Science	1,810	$51,222	$63,511	$59,644	30.7%	0.81
Non-Agricultural degree	76,338	$68,846	$87,577	$87,270	1.6%	0.79
Ag Econ/Agribusiness	1,953	$71,141	$107,062	$100,254	18.5%	0.66
All Alumni, Currently Employed	87,611	$72,940	$85,550	$85,002	4.3%	0.85

Note: Authors' calculations based on weighted averages of responses by employed 1982-2006 ISU graduates to the *Iowa State University Alumni Survey*.

Table 3. Estimated Percent Difference in Income by Major and Industry of Employment

Major		Industry: Agricultural	Industry: Non-Agricultural	*P*	Test of Equality Across Industry (prob > F)
A: College & Location					
Non-Agricultural degree	Urban	-19.9** (2.40)	--- base	-19.9[a]	0.015**
	Rural	-31.2*** (12.83)	-4.7*** (38.73)	-26.5[a]	0.000***
Agricultural degree	Urban	-2.3 (1.47)	-17.9*** (24.05)	15.6	0.000***
	Rural	-23.8*** (14.95)	-27.3*** (29.31)	3.5	0.023**
B: Detailed Major					
Non-Agricultural degree		-7.50*** (4.69)	--- base	-7.5[a]	0.000***
Food/Biological Science		-30.5*** (3.81)	-18.5*** (9.85)	-12.0	0.109
Natural Resources		-23.7*** (5.97)	-31.6*** (22.98)	7.9	0.022**
Ag Econ/Agribusiness		1.7 (0.56)	8.7*** (5.60)	-7.0	0.042**
Animal Science		15.2*** (5.91)	-16.1*** (9.78)	31.3	0.000***
Agricultural Education /Studies		0.8 (0.32)	-15.5*** (10.64)	16.3	0.000***
Agricultural Engineering		-18.2*** (4.62)	-22.6*** (9.78)	4.4	0.280
Plant Science		-18.9*** (8.16)	-20.5*** (13.50)	1.6	0.496
Other Agriculture Degree		24.80*** (4.91)	10.50*** (3.53)	14.3	0.021**

Note: Complete regression results are reported in appendix table A5 and include controls for individual ability, family background, graduation cohort, demographics and career experience. t-statistics in parentheses. Asterisks denote significance at the 10 percent (*), 5 percent (**) and 1-percent (***) levels.

[a] The measure of major-specific human capital for non-ag majors in the non-agriculture sector is +19.9. We report the estimate as the implied loss incurred by non-agriculture major who accept employment in the agriculture sector to be consistent with the estimated ρ for the agriculture majors.

Table 4. Estimated Salary of Sample Alumnus by Major and Industry

	Industry		
	Agriculture	Non-Agriculture	Difference
Major			
Food & Biological Sciences	$71,863	$83,872	-$12,009
Non-Agriculture	$95,234	$102,928	-$7,695
Ag Econ/Agribusiness	$104,674	$111,908	-$7,235
Plant Science	$83,553	$81,844	$1,709
Ag Engineering	$84,263	$79,737	$4,526
Natural Resources	$78,648	$70,461	$8,187
Other Agriculture	$128,631	$113,748	$14,882
Ag Education/Ag Studies	$103,817	$87,035	$16,782
Animal Science	$118,591	$86,409	$32,181

Note: Salaries predicted across majors and industries for a given alumnus using regression results in appendix table A5. Alumni assumed to be a white, male, 1985 alumnus, non-entrepreneur working full-time in an urban location, with average values for the remaining family background, college experience and career measures.

Table 5. Estimated Percent Difference in Income and Returns to Agriculture Major-Specific Capital by Cohort, Major and Industry of Employment

	Agriculture Industry			Non-Agriculture Industry		
Cohort	Non-Agriculture Degree	Agriculture Degree	ρ	Non-Agriculture Degree	Agriculture Degree	Ρ
1982-1986	-20.64%	-30.44%	1.78%	---	-13.71%	-0.54%
	(5.61)	(10.07)	(10.74)		(6.82)	(5.39)
1987-2001	36.02%	9.40%	0.94%	25.88%	4.92%	-0.14%
	(11.71)	(3.71)	(8.42)	(32.62)	(3.37)	(2.43)
2002-2006	6.60%	24.92%	-0.51%	10.25%	14.68%	-0.28%
	(1.75)	(7.28)	(2.81)	(24.04)	(6.63)	(2.94)

Note: t-statistics in parentheses. Estimates based on an earnings regression with additional controls for individual ability, family background, demographics and career experience.. See text for details.

Appendix

Table A1. Classification of CALS majors

Major Grouping	Majors Included
Ag Econ/Agribusiness	Agricultural business & Agricultural economics
Ag Engineering	Industrial Technology; Agricultural Systems Technology; Agricultural Mechanization & Agricultural and Biosystems Engineering
Natural Resources	Environmental Science; Entomology; Fisheries & Wildlife Biology; Forestry; Natural Resource Ecology and Management & Animal Ecology
Food and Biological Sciences	Genetics; Agricultural Biochemistry; Microbiology; Microbiology, Biochemistry, Biophysics and Molecular Biology (Ag) & Agricultural Microbiology
Animal Science	Dairy Science; Animal Science & Zoology
Plant Sciences	Food Science (Ag); Food Science and Human Nutrition (Ag); Food Science and Technology; Food Technology and Science; Food Technology; Dietetics(Ag); Agronomy; Horticulture & Plant Pathology
Ag Education/Ag Studies	Farm Operations; Agricultural Education; Agricultural Studies; Agricultural Education and Studies & Agricultural Special
Other Ag	Public Service and Administration in Agriculture; Sociology (Ag); Agricultural Journalism & Professional Agriculture

Table A2. Comparison of Mean GPA across Major and Industry

	Total		Agriculture Industry		Non-Agriculture Industry		Difference in Means Test
Major	n	Mean	n	Mean	n	Mean	Ag v. Non-Ag Job by Major
Agricultural Economics	1,953	2.87	362	3.04	1,591	2.84	6.09***
Agricultural Engineering	663	2.76	184	2.81	479	2.74	1.51
Animal Science	2,403	2.95	555	3.05	1,848	2.92	5.72***
Plant Science	1,810	3.06	555	3.09	1,255	3.05	1.20
Natural Resources	1,557	3.07	176	3.04	1,381	3.07	-0.72
Other Agriculture	683	3.13	253	3.11	430	3.15	-0.99
Agricultural Educ./Studies	1,945	3.01	462	3.08	1,483	2.98	4.12***
Food Science /Biological Science	970	3.12	35	2.77	935	3.13	-5.36***
All CALS Alumni	11,229	2.98	2,559	3.04	8,670	2.96	7.58***
All Alumni	86,998	3.06	3781	3.09	83217	3.05	4.07***

Table A3. Major/Industry/Location Match Variables

Dummy Variable	Major	Industry	Location	Observations
AAR	Agriculture	Agriculture	Rural	1,096
AAU	Agriculture	Agriculture	Urban	1,463
ANR	Agriculture	Non-Agriculture	Rural	3,153
ANU	Agriculture	Non-Agriculture	Urban	5,561
NAR	Non-Agriculture	Agriculture	Rural	420
NAU	Non-Agriculture	Agriculture	Urban	863
NNR	Non-Agriculture	Non-Agriculture	Rural	12,070
NNU	Non-Agriculture	Non-Agriculture	Urban	63,016

Table A4. ISU Alumni Salary Regression Results

Variable	Est. Coefficient	t-stat	Est. % Δ
Constant (NNU)	3.091***	(89.25)	
AAR	-0.272***	(-14.95)	-23.8%
AAU	-0.023	(-1.47)	-2.3%
ANR	-0.319***	(-29.31)	-27.3%
ANU	-0.197***	(-24.05)	-17.9%
NAR	-0.373***	(-12.83)	-31.2%
NAU	-0.048**	(-2.40)	-19.9%
NNR	-0.222***	(-38.73)	-4.7%
Individual Characteristics			
Male	0.343***	(78.90)	40.9%
Black	-0.062**	(-4.04)	-6.0%
Asian	0.195***	(11.77)	21.6%
Native American	-0.240***	(-3.97)	-21.5%
Hispanic	0.022	(1.13)	2.2%
Race unknown	-0.107***	(-5.51)	-10.2%
Family & HS background			
Father's education	0.021***	(17.27)	2.1%
Number siblings	-0.007***	(-5.70)	-0.7%
Farm business	0.023**	(3.58)	2.3%
Parent business	0.053***	(12.02)	5.5%
High School Rank	0.001***	(12.05)	
ISU curriculum			
GPA	0.058***	(14.85)	5.8%
Specialization	-0.007***	(-23.58)	-0.7%
Length in school	-0.037***	(-8.28)	-3.7%
Double major	0.032***	(3.91)	3.3%
1987-1991	0.240***	(26.13)	27.1%
1992-1996	0.298***	(19.87)	34.7%
1997-2001	0.329***	(15.31)	38.9%
2002-2006	0.269***	(9.58)	30.8%
Post Baccalaureate Measures			
Experience	0.048***	(34.79)	4.8%
Graduate degree	0.132***	(31.98)	14.1%
Number of jobs	-0.022***	(-26.78)	-2.2%
Entrepreneur	0.047***	(7.69)	4.9%
Employed part-time	-0.650***	(-49.85)	-47.8%
Self-Employed full time	-0.075***	(-7.79)	-7.3%
Self-Employed part time	-0.370***	(-26.61)	-30.9%
Woman*part time	-0.297***	(-20.68)	-25.7%
observations	83359		
R-squared	0.4274		

Table A5. ISU Alumni Salary Regression Results with Detailed Major Categories

Variable	Est. Coefficient	t-stat	Est. % Δ
Constant	3.087***	(89.34)	
Non-Ag Degree, Ag Job	-0.078***	(4.69)	-7.5%
Ag Economics, Ag Job	0.017	(0.56)	1.7%
Ag Economics, Non-Ag Job	0.084***	(5.60)	8.7%
Ag Engineering, Ag Job	-0.200***	(4.62)	-18.2%
Ag Engineering, Non-Ag Job	-0.255***	(9.78)	-22.6%
Animal Science, Ag Job	0.142***	(5.91)	15.2%
Animal Science, Non-Ag Job	-0.175***	(12.25)	-16.1%
Plant Science, Ag Job	-0.209***	(8.16)	-18.9%
Plant Science, Non-Ag Job	-0.229***	(13.50)	-20.5%
Natural Resources, Ag Job	-0.269***	(5.97)	-23.7%
Natural Resources, Non-Ag Job	-0.379***	(22.98)	-31.6%
Other Ag, Ag Job	0.223***	(4.91)	24.8%
Other Ag, Non-Ag Job	0.100***	(3.53)	10.5%
Ag Educ, Ag Job	0.009	(0.32)	0.8%
Ag Educ, Non-Ag Job	-0.168***	(10.64)	-15.5%
Food/Bio. Sci, Ag Job	-0.359***	(3.81)	-30.5%
Food/Bio. Sci, Non-Ag Job	-0.205***	(9.85)	-18.5%
Individual Characteristics			
Male	0.343***	(78.70)	40.9%
Black	-0.066**	(-4.32)	-6.4%
Asian	0.188***	(11.38)	20.7%
Native American	-0.245***	(-4.07)	-21.9%
Hispanic	0.025	(1.29)	2.5%
Race unknown	-0.111***	(-5.74)	10.5%
Family & HS background			
Father's education	0.021***	(17.42)	2.1%
Number siblings	-0.008***	(-6.87)	-0.8%
Farm business	0.005	(0.81)	0.5%
Parent business	0.051***	(11.60)	5.3%
High School Rank	0.001***	(11.85)	0.1%
ISU curriculum			
GPA	0.061***	(15.79)	6.3%
Specialization	-0.006***	(-22.58)	-0.6%
Length in school	-0.036***	(-8.02)	-3.5%
Double major	0.028***	(3.42)	2.9%
1987-1991	0.247***	(26.37)	28.0%
1992-1996	0.282***	(18.80)	32.6%
1997-2001	0.319***	(14.90)	37.6%
2002-2006	0.242***	(8.64)	27.3%
Post Baccalaureate Measures			

Experience	0.048***	(34.75)	4.9%
Graduate degree	0.128***	(30.92)	13.6%
Number of jobs	-0.022***	(-26.59)	-2.2%
Entrepreneur	0.041***	(6.62)	4.2%
Employed part-time	-0.653***	(-50.22)	-48.0%
Self-Employed full time	-0.076***	(-7.84)	-7.3%
Self-Employed part time	-0.375***	(-27.03)	-31.6%
Woman*part time	-0.294***	(-20.57)	-25.5%
Rural	-0.207***	(40.65)	-18.7%
observations	83359		
R-squared	0.4274		