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

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This paper examines the roles of specialized versus general skills in explaining variation in the returns to an agriculture degree among graduates working both inside and outside the agricultural industry. The focus on returns by sector of employment is motivated by our finding that most agricultural graduates are employed in non-agricultural jobs. In that study, 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. Agricultural graduates with more general training earn more outside than inside agriculture. Higher-ability graduates in more industry-focused curricula tend to sort into the agricultural industry, while higher-ability graduates in broader curricula tend to choose jobs outside of agriculture. All graduates are more likely to accept agricultural employment when the farm economy is strong, but agricultural graduates who enter agricultural jobs when the farm economy is weak suffer lifetime earnings reductions. 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 that focus on developing more generalized skills.

Key words: earnings, agricultural sector, college major, business cycle, curriculum, specific skills, general skills, urban, rural.

JEL codes: A2, J31, J43.

Agriculture is the # 1 most useless college degree, according to an on-line article published recently by Yahoo[1]; animal science and horticulture degrees ranked 4th and 5th on this list. These degrees are useless, Loose contends, because they are "so specific they can't be applied in a variety of fields, or [are] linked to careers with virtually little to no projected job growth." As an example, the story characterizes an animal science degree as, "so specific that trying to apply it to anything else means a tough time convincing people it gives you any useful skills for jobs outside animal science".[1] In response, the Dean of the College of Food, Agricultural and Natural Resource Sciences at the University of Minnesota stated that, "animal scientists work in the medical, pharmaceutical, food safety, and finance fields, just to name a few... about half continue to graduate school where they study veterinary medicine, public health and biology".[2]

Issues regarding the specificity of skills imparted by agricultural curricula relative to the needs of employers are not new. Indeed, some commentators have argued, contrary to Loose's contention, that agricultural curricula are insufficiently focused on the skills required by employers in the agriculture industry. As a result, agribusiness firms have increasingly hired non-agricultural college graduates. In a 1992 National Research Council report titled

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[1] Loose, T. 2012. College Majors That Are Useless, Yahoo!Education, January. http://education.yahoo.net/articles/most_useless_degrees.htm.

[2] Levine, A.S. 2012. Yahoo's 'College Majors That Are Useless'…Really? The HuffingtonPost, January 20. http://www.huffingtonpost.com/allen-s-levine/useless-college-majors_b_1217401.html.

Amer. J. Agr. Econ. 96(1): 193–212; doi: 10.1093/ajae/aat063
Published online September 9, 2013

Agriculture and the Undergraduate, a former corporate executive 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 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," (Goodman 1992).

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 agricultural knowledge (Boland and Akridge 2004; Onianwa Wheelock, Mojica, and Singh 2005; Norwood and Henneberry 2006; Briggeman, Henneberry, and Norwood 2007). This suggests that non-agricultural degree holders can effectively compete for agricultural industry jobs.

However, other evidence indicates that firms outside of agriculture bid for the services of agricultural graduates.[3] For example, report that 87% of college graduates with degrees in agriculture or natural resources have jobs outside of agriculture, suggesting that agricultural firms use non-agricultural graduates because agricultural graduates are being lured to other sectors for higher wages, better benefits, or more urban environments. An interesting counterpoint is that the greater placement of agricultural graduates outside of agriculture may be a measure of the strength of the curriculum and not a weakness.

We extend the analysis of the returns to agricultural graduates by addressing the following questions:

1) What are the returns to agricultural curricula compared to other curricula?
2) Are agricultural graduates confined to a narrowing pool of jobs in the agricultural industry or do they find employment outside agriculture?
3) Are the returns higher inside or outside the agricultural industry?
4) Are agricultural curricula so specific that graduates' skills are severely discounted outside agriculture?
5) Does the sorting of agricultural graduates inside and outside of the industry correspond to the industry specificity of the major?

Past studies of returns to agricultural majors have been limited by samples that focused primarily or exclusively on agricultural alumni. These studies confirm the importance of advanced degrees and work experience for higher salaries among these alumni, and also document 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 Biere 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 comparison to the returns to other college majors.

A handful of studies have examined relative pay in the agricultural industry compared to jobs outside agriculture, and some report an income penalty for alumni in agricultural industry jobs. For example, Zekeri (1992) finds that former agricultural students in agriculture-related positions earned roughly 5% less than their peers in non-agricultural jobs. Qenani-Petrela and McGarry Wolf (2007) report a 12.4% earnings gap between agriculture and other sectors of the economy. Moreover, Barkley and Biere (2001) find a 33% premium for non-agricultural employment relative to agribusiness jobs in a sample of Kansas State University agribusiness and agricultural economics alumni graduating between 1990 and 1997. However, earlier studies that included all agricultural graduates from Kansas State indicate no salary premium for non-agricultural employment (Barkley 1992; Barkley, Stock, and Sylvius 1999). Preston et al. (1990) also found no difference in salaries between agricultural and non-agricultural industries for Virginia Tech alumni.

A plausible explanation for the mixed findings regarding the lower salary in agriculture is that agriculture-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

[3] Carnevale, A.P., J. Strohl, and M. Melton. 2011. What's It Worth: The Economic Value of College Majors. Center on Education and the Workforce. Georgetown University. Available online at: http://cew.georgetown.edu/whatsitworth/.

earn 23% 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 agricultural and non-agricultural sectors. A second possibility is that some agricultural majors provide more sector-specific training than others. This 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 from Iowa State 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 25-year time period and includes a rich set of controls for academic success within the major, family background, and curricular diversity, which increases confidence that the results reflect returns to the major and not differences in individuals' abilities across majors. The study has the added advantage that it incorporates the salaries earned by non-agricultural graduates inside and outside the agricultural industry as a reference, so we gauge the earnings of agricultural majors against other majors in the university.

The results of our study are compelling. Most agricultural majors work outside the agricultural industry. There are substantial returns to agricultural majors working in agriculture, but only when the firms are located in urban areas. Some majors, most notably animal science and agricultural education and agricultural studies, appear to have substantial sector-specific skills, as evidenced by large pay gaps between jobs inside and outside agriculture. Other majors, most notably agricultural business, earn a wage premium outside agriculture consistent with the development of skills that are broadly valued across sectors. Higher ability graduates in more industry-focused curricula tend to sort into the agricultural industry, while higher ability graduates in broader curricula tend to work outside of agriculture. All majors are more likely to accept agricultural employment when the farm economy is strong, but agricultural graduates who enter agricultural jobs when the farm economy is weak suffer lifetime earnings reductions.

Data

We first establish the stylized facts regarding average earnings by agricultural majors by sector and location. Where possible, we will also show that our results, which are based on a specific university's alumni, are consistent with national data on earnings by agricultural majors.

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, and Kimle 2010). Sample surveys were mailed to 24% of the 84,917 alumni who received bachelor's degrees over that period. Respondents could choose to complete the survey online or return the questionnaire by mail. We received 5,416 usable surveys for a response rate of 21.6%. All reported survey results in this study are weighted to reflect the distribution of graduates by year and college across the range of almost 85,000 alumni.

The survey asked respondents a variety of questions about their careers after 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 USDA Economic Research Service's (ERS) rural-urban continuum codes (RUCC) to define the rural or urban status their current locations (USDA, ERS 2004). 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% were employed in agriculture in 2007. Of the jobs in agriculture, 60% were located in urban, not rural, areas.

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

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

		Industry				
Major	Obs.	Agricultural	Non-agricultural	Total	% Employed in Agriculture	Earnings Ration (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 responses by employed 1982-2006 ISU graduates to the *Iowa State University Alumni Survey*.

agricultural and non-agricultural graduates. However, agricultural graduates earn a substantial premium over non-agricultural graduates in urban agricultural firms, while non-agricultural graduates receive a significant premium over agricultural graduates in non-agricultural sectors.

The pattern is markedly different in rural markets. Salaries for all majors are over $18,000 less in rural markets, and salaries in rural agricultural firms are even lower, averaging $30,000 less compared to their urban counterparts. There is no premium paid to agricultural graduates in rural agricultural firms. Still, non-agricultural graduates receive a $15,000 premium in rural non-agricultural sectors. Clearly urban versus rural residence is a key factor in assessing the returns to agricultural 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 CALS.[4] The range of salaries is remarkable. In agriculture, the highest average salaries go to animal science graduates, whose pay is more than double the average of agricultural engineering and plant science graduates. Outside of agriculture, the top salaries in agricultural business are more than double those in agricultural engineering and natural resources.

[4] See the supplementary appendix for specific degree programs included in each major category.

Equally remarkable differences exist in the probability of being employed in the agricultural industry. Less than 4% of food science graduates work in agriculture, barely more than the proportion of non-agriculture graduates. Meanwhile, over one-quarter of plant science and agricultural engineering graduates take jobs in the agricultural sector. Average earnings fall as the fraction employed in agriculture increases with the simple correlation −0.37, suggesting that agricultural firms do have trouble competing for college talent, at least on average.

There are substantial differences across graduates in the average salary paid inside and outside of the agricultural industry. The graduates in table 2 are listed in order of the size of the premium paid for working in agriculture. The premium approaches 100% in animal science and exceeds 50% in natural resources. However, alumni in other majors earn a premium for working outside agriculture, the largest being a 50% premium among agricultural business alumni. 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, our broad statistics correspond with national averages reasonably well. For example,[3] 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 agricultural graduates match overall graduates reasonably well. The main difference is that ISU agricultural graduates are more likely to be employed in the agricultural industry (21% versus 13%) compared to agricultural degree recipients from other universities. 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 graduates 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 partially determined by the level of general versus industry-specific human capital an individual possesses. In particular, if salaries are partially determined by firm-specific, industry-specific, or occupation-specific human capital, then workers incur a penalty when they switch into jobs that do not require those specific skills (Poletaev and Robinson 2008).[5] Skills developed in a college major may also be specific to a particular industry, and so graduates finding employment in other industries will sacrifice their potential returns from major-specific human capital.

We frame our analysis using an adaptation of 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 our context, individuals choose a major and receive training in college during the first period. Training will have both general and agriculture sector-specific components. In the second period, students graduate and choose employment either in the agricultural industry or in a non-agricultural industry.

To make this precise, let individual i choose a major where $j = \{A, N\}$. Agricultural graduates are indicated by A and non-agricultural graduates are indicated by N. While in the major, the graduate expects to receive a 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. The graduate's actual skill level upon completion of the major can deviate from her anticipated skills. In particular, she will discover her suitability to the work related to the major. This is measured by ϵ_{ij}^C, the additional sector-specific human capital attributable to the quality of the match between her individual abilities, character and interests, and the curricular skills required in the major field of work. These match productivities are drawn from an *IID* symmetric distribution $G(\epsilon_{ij}^C)$ with $E(\epsilon_{ij}^C) = \bar{\epsilon}$.

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

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

training. Income for individuals who "switch" and choose employment in sectors not related to their college major will be fully rewarded for their general skills, but their major-specific skills will be discounted. For ease of exposition, we assume that the major-specific skills that apply to all alumni in the major, δ_{jk}, are fully depreciated outside the major industry, but that the match-specific skills that incorporate individual talents, character, ambition, and other personal abilities may retain some value outside the major industry. Match skills specific to major j are discounted in industry k at the rate $\theta_j^k, \theta_j^k \in [0, 1]$. Those match skills retain all their value in the major industry so that $\theta_A^A = \theta_N^N = 1$.

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. Accounting for the various sources of skills, income of major j in sector k is:

$$(1) \qquad Y_{ijk} = \alpha_j + D_{ij}^k P_k \delta_{jk} + \theta_j^k P_k \epsilon_{ij}^C.$$

Thus, an agriculture major receives $Y_{iAA} = \alpha_A + P_A\delta_{AA} + P_A\epsilon_{iA}^C$ when working in the agricultural sector, but $Y_{iAA} = \alpha_A + \theta_A^N P_N \epsilon_{iA}^C$ when working in a non-agricultural sector. Similarly, a non-agricultural graduate working in agriculture receives $Y_{iNA} = \alpha_N + \theta_N^A P_A \epsilon_{iN}^C$, and $Y_{iNN} = \alpha_N + P_N\delta_{NN} + P_N\epsilon_{iN}^C$ when working in a non-agricultural sector.

Risk-neutral individuals will pick the sector with the highest earnings such that $Y_{ik} > Y_{il} \forall k \neq l$. In particular, an agricultural major will pick the agricultural sector when

$$(2) \qquad P_A\delta_{AA} + P_A\epsilon_{iA}^C > \theta_A^N P_N \epsilon_{iA}^C \text{ or } P_A\delta_{AA} + (P_A - \theta_A^N P_N)\epsilon_{iA}^C > 0.$$

Therefore, an agricultural major will opt for the agricultural job when the returns in the agricultural sector are high relative to the nonagricultural sector ($P_A > P_N \geq \theta_A^N P_N$), or when net farm income is high.[6] Alternatively, if returns are higher in the non-agricultural sector ($P_N > P_A$), the agricultural graduate will still accept employment in the agricultural sector when the return to major-specific skills in the agricultural sector ($P_A\delta_{AA}$) exceeds the net return from match-specific human capital in the non-agricultural sector, $(P_A - \theta_A^N P_N)\epsilon_{iA}^C$. This is more likely when θ_A^N is low, meaning that agricultural graduates' match-specific skills are not easily transferrable to the non-agricultural sector.

The observed return to agricultural graduates employed in agriculture relative to non- agriculture will be

$$(3) \qquad \rho = [P_A\delta_{AA} + (P_A - \theta_A^N P_N)\epsilon_{iA}^C] | [(P_A\delta_{AA} + (P_A - \theta_A^N P_N)\epsilon_{iA}^C) > 0].$$

This is the average gain from picking the agricultural sector relative to the non-agricultural sector for those graduates who select the agriculture sector. In experimental terms, this is the treatment effect on the treated, where the treatment is obtaining employment in the agricultural industry. Importantly, this will differ from the value of sector-specific training for the population as a whole because of non-random sorting across sectors. In particular, as illustrated in figure 1, the observed and population returns will only be identical when $\rho = P_A\delta_{AA}$, that is, when the expected match capital for those in the agricultural jobs $E(\epsilon_{ij}^C) = \bar{\epsilon} = 0$. When the expectation is non-zero, the observed return will depend on the sign of the relative returns in the agricultural and non-agricultural sectors and on the degree to which match-specific capital is discounted in

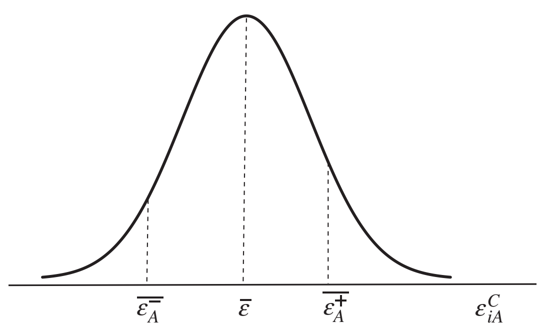

Figure 1. The effect of nonrandom sorting into the agricultural sector on average unobserved sector-specific human capital

Notes: Variable ϵ_{iA}^C is the agricultural sector-specific human capital that results from the quality of the match between individual abilities and skills developed in a given agricultural major; $\bar{\epsilon}$ is the mean level of ϵ_{iA}^C in the population of graduates in that major; $E(\epsilon_{iA}^C | (P_A - \theta_A^N P_N) > 0) = \bar{\epsilon}_A^+$ is the conditional mean of ϵ_{iA}^C for those selecting an agricultural job in a major whose skills are discounted heavily in nonagricultural jobs; $E(\epsilon_{iA}^C | (P_A - \theta_A^N P_N) < 0) = \bar{\epsilon}_A^-$ is the conditional mean of ϵ_{iA}^C in a major whose skills retain much of their value in nonagricultural jobs.

[6] Using data from the USDA Economic Research Service, we estimate that 77% of real net farm income is real net value added, which rises with increased prices and/or productivity relative to real input prices.

the nonagricultural jobs, and the estimated ρ will reflect the incentives to sort into or out of agricultural jobs.

When $(P_A - \theta_A^N P_N) > 0$, those sorting into the agricultural sector will have atypically large match capital draws, and so $E(\epsilon_{iA}^C | (P_A - \theta_A^N P_N) > 0) = \overline{\epsilon_A^+} > \bar{\epsilon} > 0$. In markets when agricultural returns are atypically strong, or in majors whose skills are heavily discounted outside agriculture, those choosing agricultural jobs will be drawn from the upper tail of the distribution of match-specific skills. These graduates' observed returns in agriculture will be larger than the returns that would have been observed had everyone in that major selected a job in agriculture. However, when $(P_A - \theta_A^N P_N) < 0$ so that nonagricultural returns are high or agricultural match-specific skills retain their value outside agriculture, graduates with the largest match-specific skills will be better off taking nonagricultural jobs. The expected match-specific capital for graduates taking agricultural jobs will be $E(\epsilon_{iA}^C | (P_A - \theta_A^N P_N) < 0) = \overline{\epsilon_A^-} < \bar{\epsilon}$. Consequently, estimated returns to selecting an agricultural career will understate the expected returns for the population of graduates as a whole in markets when agricultural returns are weak or where major-specific skills are not heavily discounted in non-major jobs.

A key implication of figure 1 is that the best students in a given agricultural major will not necessarily take jobs in agriculture. We can test this expectation indirectly by sorting by grade point average, presuming that both observed and unobserved major-specific skills are positively correlated with academic performance in the major. Agricultural graduates 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 curricula, average GPA is higher for those taking jobs outside of agriculture.[7] Below we will examine whether the sorting into and out of agricultural jobs appears consistent with our estimates of major-specific human capital.

Thus far, our analysis has treated the general skills, α_i, as 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 non-random sorting across sectors on general skills. To allow for variation in general skills by sector, we 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, including X_i as a proxy for general skills will correct for non-random sorting on ability.

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.[8] Given the nature of these data, ad hoc least squares estimation may not provide consistent estimates (Stewart 1983). Instead, we implement an interval-censored regression with robust standard errors to model earnings (Clay and Powe11 2001)

$$
\begin{aligned}
(4)\quad \ln(Y_{ijk}) = {} & (\alpha_N + P_N(\delta_{NN} + \epsilon_{iN}^C)) + X_i'\beta \\
& + D_{iN}^A(-P_N\delta_{NN} \\
& + (\theta_N^A P_A - P_N)\epsilon_{iN}^C) \\
& + D_{iA}^A(-\alpha_N - P_N(\delta_{NN} + \epsilon_{iN}^C) \\
& + \alpha_A + P_A(\delta_{AA} + \epsilon_{iA}^C)) \\
& + D_{iA}^N(-\alpha_N - P_N(\delta_{NN} + \epsilon_{iN}^C) \\
& + \alpha_A + \theta_A^N P_N \epsilon_{iA}^C) + \xi_{ijk'}
\end{aligned}
$$

where ξ_{ijk} is assumed to be a random error uncorrelated with observed background attributes, X_i, choice of major, or sector of employment. In our application of (4), we further subdivide the agricultural degree dummy variables into D_{iAj}^A and $D_{iAj}^N; j = 1, \ldots 8$, where the 8 subgroups are the 8 agricultural curricula listed in table 2. We also estimate a

[7] See the supplementary appendix for detailed data on GPA by major and industry of employment.

[8] The survey brackets for personal income are: Less than $25,000; $25,000 to $39,999; $40,000 to $59,999; $60,000 to $74,999; $75,000 to $99,999; $100,000 to $149,999; $150,000 to $249,999; $250,000 to $500,000; and More than $500,000.

variant of (4) with separate returns for urban and rural residents to examine whether the major-specific skills differ in value across urban and rural markets.[9] In the urban-rural variant, we only report results for a single aggregated agricultural major because thin samples led to unreasonable estimates for some graduates in rural markets.

In our estimation of specification (4), the sector-specific returns P_N and P_A become part of the coefficient. We relax this restriction later by incorporating interactions with an index of net farm income to measure the relative strength of the agricultural industry compared to other sectors at the time of graduation. We focus on income rather than just price because relative productivity as well as relative price may change over time, and both will affect the relative value of time in and out of agriculture.[10]

The vector of human capital measures, X_i, includes measures of college experience, post baccalaureate education and career experiences, and 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 alumnus had a double major, and the degree of specialization in the major.[11]

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 (Corcoran, Duncan, and Ponza 1983).[12]

Demographic 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 (4), 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 the vector of observable human capital X_i. We report the main parameters of interest to conserve space. Complete regression results are provided in a supplementary appendix. The signs of the additional controls are generally as expected and consistent with previous studies.

Applying specification (4) separately by urban and rural location, panel A provides the estimated returns by major, industry and residence relative to a base salary for nonagricultural graduates employed outside agriculture in urban markets. All reported coefficients are converted into percentage differences from the base salary.[13] Returns to an agricultural major are highest in urban markets, with a 24% urban salary premium in agricultural jobs and a 12% urban salary premium in non-agricultural jobs. Urban premia for non-agricultural graduates are larger, 32% in agricultural jobs and 20% for non-agricultural jobs.

The estimated major-specific human capital in agriculture, ρ, is 12.9% in urban markets. The estimated ρ in rural markets is only 1% and is not statistically significant.

[9] As is common with earnings functions, we are treating schooling decisions, in this case choice of one of 9 majors, as exogenous, as well as the decisions regarding urban or rural location or sector of employment. As a practical matter, it is not feasible to develop sufficient credible instruments to identify major, location, and sector choices. The literature on returns to schooling has shown that various methods used to correct for potential endogeneity of schooling decisions results in estimated returns to schooling that are broadly consistent with least-squares estimates (Card 1999).

[10] The relative value of time working in agriculture versus other sectors changes over time due both to changes in relative prices and to changes in relative productivity across the two sectors. Our measure of net farm income is a combination of both relative price and productivity, and thus a measure of the relative profitability of the agricultural sector at the time of graduation.

[11] 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.

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

[13] 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.

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

Major		Industry: Agricultural	Industry: Non-agricultural	ρ	Test of Equality Across Industry (prob > F)
A: College & Location					
Non-agricultural degree	Urban	−0.62	–base	−0.62	0.768
		(0.30)			
	Rural	−32.66***	−19.9***	−14.1[a]	0.000***
		(12.96)	(36.59)		
Agricultural degree	Urban	−4.03**	−16.9***	12.9	0.000***
		(2.57)	(21.89)		
	Rural	−27.6***	−28.54***	0.9	0.530
		(17.79)	(30.05)		
B: Detailed Major					
Non-agricultural degree		−6.8***	— base	−6.8[a]	0.000***
		(4.49)			
Food/Biological Science		−24.3***	−13.5***	−10.8	0.000**
		(42.15)	(8.16)		
Natural Resources		−23.3***	−32.5***	9.2	0.001***
		(7.68)	(26.16)		
Ag Econ/Agribusiness		3.3	10.1***	−6.7	0.023**
		(1.32)	(6.41)		
Animal Science		16.5***	−18.1***	34.6	0.000***
		(5.77)	(12.73)		
Agricultural Education /Studies		−1.5	−14.1***	12.6	0.000***
		(0.56)	(10.98)		
Agricultural Engineering		−18.8***	−22.6***	3.8	0.174
		(8.86)	(9.48)		
Plant Science		−28.2***	−20.2***	−8.0	0.001***
		(11.75)	(14.05)		
Other Agriculture degree		0.3	8.5**	−8.2	0.198
		(0.08)	(2.53)		

Notes: Complete regression results are reported in a supplementary appendix and include controls for individual ability, family background, economic conditions, demographics, and career experience. The z-statistics in are parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) levels.
[a]The measure of major-specific human capital for non-ag majors in the non-agriculture sector is +6.8. We report the estimate as the implied loss incurred by non-agriculture majors who accept employment in the agriculture sector to be consistent with the estimated ρ for the agriculture majors.

For non-agricultural graduates, major-specific human capital applies to jobs outside agriculture. The estimated ρ for non-agricultural graduates is 0.6% and statistically insignificant in urban markets, and 14.1% in rural markets. On average, there is a wage premium paid for getting a job more closely aligned with the major, but the range of 0–14% suggests that the premium is surprisingly small.

Further insights follow from applying specification (4), allowing for separate impacts by agricultural major. Panel B provides the key estimates relative to the base category, a non-agricultural degree in a non-agricultural As before, positive values of ρ imply higher returns in agricultural than in non-agricultural jobs, while negative values imply higher wages for the graduate outside of agriculture. In 4 of 8 agricultural curricula, ρ is positive. Of these, three are statistically significant, suggesting the existence of major-specific human capital: animal science, natural resources, and agricultural education and studies. The three agricultural curricula with negative and significant estimated ρ are agricultural business and food/biological science and plant science, meaning that graduates earn more in non-agricultural jobs. The 6.7% premium earned by agricultural economics/agribusiness graduates outside agriculture is consistent with, albeit smaller than, the 33% premium reported for agribusiness graduates at Kansas State (Barkley and Biere 2001). Non-agricultural graduates earn 6.8% more in nonagricultural jobs, suggesting a modest-sized but statistically significant level of major-specific human capital in non-agricultural curricula.

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

	Industry		
Major	Agricultural	Non-agricultural	Difference
Food & Biological Sciences	\$80,507	\$91,929	−\$11,422
Other Agriculture	\$106,706	\$115,312	−\$8,607
Plant Science	\$76,306	\$84,806	−\$8,500
Ag Econ/Agribusiness	\$109,822	\$117,034	−\$7,212
Non-Agriculture	\$60,791	\$65,203	−\$4,412
Ag Engineering	\$86,317	\$82,252	\$4,065
Natural Resources	\$81,546	\$71,729	\$9,817
Ag Education/Ag Studies	\$104,738	\$91,288	\$13,451
Animal Science	\$123,832	\$87,113	\$36,719

Note: Salaries predicted across majors and industries based on complete regression results available in a supplementary appendix.

The literal interpretation of these estimates is that agricultural degrees commanding a sizeable premium in the agricultural industry such as animal science or agricultural education and studies focus their curricula on material that only earns a return in agricultural jobs. However, the majority of degree recipients in those graduates 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 inside and outside of agriculture. To illustrate the magnitude of the estimated penalty or premium from degree-industry match, we compute the predicted salary across graduates and industries. 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 agriculture rather than outside it. This is larger than the gap found for non-agricultural graduates. On the other hand, an animal science major earns roughly \$37,000 per year more in an agricultural job than outside agriculture. The annual salary gaps favoring agricultural jobs are \$13,000 for an agricultural education and studies major, and \$10,000 for natural resources graduates. These gaps are not small. Over a 40-year work career, the present value of earning \$13,000 per year is almost \$230,000 at a 5% discount rate.

Business Cycle Effects

As illustrated in figure 1, the observed ρ will vary with the relative strengths of the agricultural and non-agricultural labor markets. Past studies have already shown that graduating into a recessed labor market causes long-term reductions in returns to college (Khan 2010). The returns to graduates that focus narrowly on skills required for one sector would be particularly vulnerable if the recession atypically affected the targeted sector. 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 farm recovery in Iowa and other Midwest states 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 (Nickerson et al. 2012).

Armed with historical information on the relative strength of the agricultural and agricultural sectors, we can explore how stronger or weaker market conditions affected the earnings for the various graduates. One approach is to add cohort effects into the earnings function. We divide our alumni into 3 cohorts: C_1, 1982-1986 (agricultural recession but expansion outside of agriculture); C_2, 1987-2001 (a period of general economic expansion across both sectors); and C_3, 2002-2006 (a period of weak job growth outside of agriculture but strong demand for agriculture products). 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 expect that graduates with the largest sector-specific human capital, ρ, would be hurt most when they graduated into a recessed agricultural market, but should have been hurt less in recessions that hit non-agricultural sectors more. The

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

	Agriculture Major		Non-agriculture Major		ρ	
Cohort	Agriculture Industry	Non-agriculture Industry	Agriculture Industry	Non-agriculture Industry	Agriculture Industry	Non-agriculture Industry
1982-1986	−32.41%	−18.51%	−36.89%	–	1.71%	−0.94%
	(10.98)	(12.39)	(12.65)		(10.21)	(9.07)
1987-2001	4.66%	0.86%	27.89%	24.66%	0.80%	−0.26%
	(2.11)	(0.65)	(10.00)	(22.51)	(7.60)	(4.89)
2002-2006	9.72%	8.60%	6.52%	10.61%	−0.63%	−0.54%
	(4.46)	(4.82)	(2.76)	(7.25)	(6.72)	(8.32)

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

specification used to investigate these hypotheses is

$$(5)\quad \ln(Y_{ijt}^{k}) = \alpha_0 + (\alpha_{N1} + \delta_{NN1}) + X_i'\beta + \sum_{t=2}^{3} C_{it} D_{iNt}^{N}(-\alpha_{N1} - \delta_{NN1} + \alpha_{Nt} + \delta_{NNt}) + \sum_{t=1}^{3} C_{it} D_{iNt}^{A} \times (-\delta_{NNt}) + \sum_{t=1}^{3} C_{it} D_{iAt}^{A} \times (-\alpha_{N1} - \delta_{NN1} + \alpha_{At} + \delta_{AAt}) + \sum_{t=1}^{3} C_{it} D_{iAt}^{N}(-\alpha_{N1} - \delta_{NN1} + \alpha_{At}) + \sum_{t=1}^{3} \gamma_{Nt} C_{it}(D_{iAt}^{N} + D_{iNt}^{N})\widehat{\rho_j} + \sum_{t=1}^{3} \gamma_{At} C_{it}(D_{iAt}^{A} + D_{iNt}^{A})\widehat{\rho_j} + \xi_{ijkt}.$$

In this formulation, we use the estimated ρ_j in table 3 as an estimate of the degree to which the major specializes in skills unique to the agricultural industry. The more specialized agricultural curricula are those in table 3 with positive estimates of ρ_j, while more general agricultural curricula food science and agricultural economics/agribusiness, as well as agricultural curricula have negative estimates of ρ_j. Using the returns to non-agricultural graduates in non-agricultural work in period 1 ($\alpha_{N1} + P_N(\delta_{NN1} + \epsilon_{iN1}^{C})$) as the frame of reference, we can show how returns to the agricultural and non-agricultural curricula 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-agricultural and agricultural sectors, respectively. In this estimation, the sector-specific returns P_N and P_A become part of the coefficient; thus, the cohort effects may be confounded with general trends for the agricultural and non-agricultural sectors. We relax this restriction in the subsequent estimation by incorporating interactions with an index of net farm income to measure the relative strength of the agricultural industry compared to other sectors at the time of graduation.

Table 5 reports our findings. Non-agricultural degree holders from the 1982-1986 graduation cohort working in the agricultural industry earned about 37% less than their peers working outside of agriculture. Agricultural degree holders graduating during this period had higher earnings if they took jobs outside agriculture, as they earned 19% less than non-agricultural graduates in non-agricultural jobs, but 14% more than agricultural graduates working in agriculture. More specialized agricultural graduates who found jobs in agriculture gained 1.7% higher earnings for every percentage increase in ρ, but those more specialized graduates who took the more plentiful jobs outside agriculture in that era lost 0.9% in earnings for every percentage increase in ρ.

Alumni graduating with agricultural degrees during the national expansion period between 1987 and 2001 earned 37% more working in agriculture jobs than did the 1982-86 agricultural graduates. However, non-agricultural

Table 6. Estimated Salary of Sample Alumnus by Industry, Degree Specificity and Economic Condition at Time of Graduation

	Specialized Ag Degree			General Ag Degree		
	Agriculture Industry	Non-agriculture Industry	Difference	Agriculture Industry	Non-agriculture Industry	Difference
Poor Farm Economy	$113,972	$80,176	$33,796	$101,077	$107,715	$−6,637
Good Farm Economy	135,821	$95,546	$40,275	$120,454	$128,363	$−7,910
	$−21,848	$−15,370		$−19,376	$−20,649	

Notes: Salaries predicted for a given alumnus using complete regression results available in a supplementary appendix. Alumni assumed to be a white, male alumnus with 22 years of experience (1985 graduate), a non-entrepreneur working full-time in an urban location, with average values for the remaining family background, college experience, and career measures.

graduates earned much more on average, even when working in the agricultural sector. The 28% premium over base earned by non-agricultural graduates in agricultural jobs is much larger than the 4.7% premium earned by agricultural graduates. The return from specialization in the agricultural sector is half that in the 1982-86 period at 0.8% increased earnings per percentage increase in ρ. Working outside agriculture still penalized more specialized agricultural training.

For the 2002-2006 cohort, returns to an agricultural degree are much better than in the earlier periods and dominate returns to a non-agricultural degree in the agricultural sector. 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 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. Lazear shows theoretically and empirically that firm owners are broadly trained, while their employees are specialists. If the labor market increasingly values managerial skills involving decisions spanning many academic disciplines, then we would expect to find rising relative returns to graduates offering broader training (Orazem, Yu, and Jolly 2010).

An alternative specification that more explicitly incorporates a measure of sector-specific returns interacts our continuous measure of net farm income with major and sector of employment. Complete regressions results are available in a supplementary appendix. To illustrate the magnitude of the estimated penalty or premium from graduating in a recessed economy, we use the same approach applied in table 4. We compute the predicted salary across graduates and industries, but vary the market conditions at the time of graduation. In particular, we chose the best (2006) and worst (1985) years for farm income included in the timeframe of our data. We compare the effect of specialization by comparing the results for an alumnus holding the most specialized agricultural degree—animal science—with the more general degree, agricultural economics/agribusiness. These results are reported in table 6.

Graduating into a recessed agricultural market has large, long-term effects on earnings of agricultural graduates regardless of sector or employment. Evaluated at 22 years of job experience, simulated annual earnings for graduates of more general agricultural graduates are $19,000 less in the agricultural sector and $20,000 less outside agriculture than an identical alumnus graduating in a strong farm economy year. For more specialized graduates, the annual penalty from graduating into a weak farm economy is $22,000 in agriculture and $15,000 outside of agriculture.

Our finding of large costs related to graduating in a recession are in line with recent studies of large earnings losses 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.

Non-Random Sorting into Agriculture Industry Jobs

We now return to the issue of nonrandom sorting by agricultural graduates into jobs into and outside of agriculture. Our theoretical model predicts that an individual's incentive to choose a job in agriculture increases when the level of major-specific skills (δ_{AA}) is large; when relative returns for agricultural commodities are high, when match-specific capital (ϵ_{iA}^{C}) is large, and when match-specific capital is discounted more heavily in nonagricultural jobs (θ_{A}^{N}). Furthermore, the upper-tail of the skill distribution of a major will sort atypically into agricultural jobs when the major has a high value of θ_{A}^{N}. Although we do not observe δ_{AA}, θ_{A}^{N}, or ϵ_{iA}^{C} directly, our estimate of ρ represents a combination of these effects such that $\frac{\partial \rho}{\partial \delta_{AA}} > 0$, $\frac{\partial \rho}{\partial \theta_{A}^{N}} > 0$, and $\frac{\partial \rho}{\partial \epsilon_{iA}^{C}} > 0$. Consequently, we can test indirectly for the sorting effects by examining how job choices are affected by ρ.

The hypotheses regarding $Pr(AA)$, the probability an agricultural major selects agricultural employment are:

1) The probability of selecting agricultural employment rises with the level of major-specific human capital: $\frac{\partial Pr(AA)}{\partial \rho} > 0$.
2) The probability of selecting agricultural employment rises with relative agricultural returns: $\frac{\partial Pr(AA)}{\partial P_A} > 0$.
3) Assuming that grade point average (GPA) is a legitimate measure of match- specific skill in a major, ϵ_{iA}^{C}, then the probability of selecting agricultural employment rises with GPA in markets with a higher level of major-specific human capital: $\frac{\partial Pr(AA)}{\partial \rho}\frac{\partial \rho}{\partial GPA} > 0$.

Table 7 displays these results, which are consistent with our expectations. Graduates with higher levels of ρ are more likely to be employed in the agricultural industry, and higher-ability (higher GPA) students in these more specialized majors are more likely to be employed in agriculture. We observe a positive effect of a strong farm economy on the probability of having an agriculture job.

Table 7. Probit Estimation Results of the Probability of Choosing Employment in the Agriculture Industry

Variables	Coefficient (standard error)
ρ	0.018***
	(0.004)
$\rho xGPA$	0.005***
	(0.001)
P_A; ln (real farm income)	0.120***
	(0.030)
Observations	87,520
Pseudo R-squared	0.071

Notes: Complete regression includes controls for individual ability, family background, and demographics.
Standard errors are in parentheses. Asterisks denote significance at the 10% (*), 5% (**), and 1% (***) levels.

Conclusions and Implications

This article examines the question of whether agricultural degrees are in fact "useless" by comparing the relative returns to an agricultural degree from working inside or outside of the agricultural industry. The premise of claim that degrees in agriculture are worthless is twofold: first, that the skills and knowledge learned in the degree are not readily transferable to other fields, and second, that there is little or no job growth in the field. What Loose is missing is that most agricultural graduates are employed in non- agricultural industries. We do find sizeable differences in earnings across graduates from working in agriculture relative to not, but in many cases agricultural graduates earn more working outside of the field than in it. Agricultural economics/agribusiness graduates earn significantly more in non-agricultural fields, suggesting that this major develops more generally-valued skills, while graduates of animal science and agricultural education and studies programs earn large premiums working in agriculture. These differences in relative wages inside and outside agriculture are consistent with a model that assumes earnings depend on general skills learned in college and on major-specific human capital.

We also find large negative effects on earnings for alumni graduating during economic downturns. The negative cohort effects for more specialized agricultural alumni who graduated during the 1980s agricultural 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.

Patterns of sorting into and out of agricultural jobs by success in the major are consistent with our findings of relative returns to major-specific capital and the quality of the match between individuals' unobserved abilities and the skills required in the major. The higher ability graduates of majors that are more narrowly focused on the agricultural industry tend to take jobs in agriculture, while higher-ability graduates in broader curricula tend to choose jobs outside of agriculture. However, the majority of graduates across all agricultural graduates, both narrow and broad, take jobs outside of agriculture. This suggests that broader curricula that will not be as heavily discounted outside of agriculture would benefit the majority of future graduates.

Returns to specialized skills and knowledge developed while obtaining an undergraduate degree vary considerably. While teaching more specialized, industry-specific knowledge and skills can reward the minority of students who land jobs in agriculture, it can hurt the majority of graduates who find work in other sectors. Our findings support the current momentum toward developing more general skills in agricultural graduates that will not be as heavily discounted outside of agriculture, for example communication and business skills (Larson 1996). In fact, this article shows that there are inherent risks in the specialization of undergraduate studies, whether those risks arise from career changes, sector-specific changes or shocks, or economic circumstances. This does not mean that specialized knowledge of agriculture is not useful, but rather that it is most valuable and flexible when combined with an understanding of the rest of the world around it.

Future work using these data could more concretely guide curricular reform. The most likely research strategy would be to modify the approach used by Poletaev and Robinson (2008), who examined the earnings changes of workers reemployed following a job loss due to plant closings or large layoffs. For each worker, the authors defined the old and new job as a collection of skill requirements, and found that the larger the change in required skills from an old to a new job, the greater the earnings loss. One could similarly decompose graduates into a vector of required general and applied skills, and then examine how those skills are rewarded inside and outside of agriculture. Skills that are heavily discounted outside of agriculture are major-specific and curricula that heavily weight those skills may want to explore adding other skills that are more highly rewarded outside the industry. To our knowledge, this has never been done for any set of college graduates, but our findings suggest that much could be learned from the exercise.

Supplementary Material

Supplementary material is available at the American Journal of Agricultural Economics online at www.oxfordjournals.org/our_journals/ajae.

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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	z-stat	Est. %Δ
Constant (NNU)	10.368***	(165.51)	
AAR	−0.323***	(16.46)	−27.6%
AAU	−0.041***	(2.72)	−4.0%
ANR	−0.336***	(29.25)	−28.5%
ANU	−0.185***	(23.28)	−16.9%
NAR	−0.395***	(13.59)	−32.7%
NAU	−0.006	(0.35)	−0.62%
NNR	−0.205***	(33.99)	−18.5%
Individual Characteristics			
Male	0.306***	(73.38)	35.8%
Black	−0.037**	(3.43)	−3.7%
Asian	0.188***	(11.42)	20.7%
Native American	−0.229***	(4.81)	−20.5%
Hispanic	0.048**	(2.74)	4.9%
Race unknown	−0.097***	(5.43)	−9.2%
Family & HS background			
Fathers	0.018***	(14.22)	1.8%
Number siblings	−0.001	(0.96)	−0.1%
Farm business	0.029**	(4.52)	2.9%
Parent business	0.044***	(9.56)	4.5%
High School Rank	0.001***	(11.18)	0.1%
ISU curriculum			
GPA	0.047***	(11.89)	4.7%
Specialization	−0.006***	(20.38)	−0.6%
Length in school	−0.039***	(8.73)	−39.1%
Double major	0.040***	(4.55)	4.0%
1987-1991	0.252***	(23.96)	28.7%
1992-1996	0.321***	(20.41)	37.9%
1997-2001	0.320***	(14.14)	37.7%
2002-2006	0.265***	(9.07)	30.3%
Post Baccalaureate Measures			
Experience	0.042***	(28.05)	4.2%
Graduate degree	0.108***	(25.61)	11.4%
Number of jobs	−0.021***	(21.59)	−2.1%
Entrepreneur	0.073***	(10.42)	7.6%
Employed part-time	−0.629***	(36.21)	−46.7%
Self-Employed full time	−0.084***	(6.23)	−8.0%
Self-Employed part time	−0.430***	(21.61)	−35.0%
Woman*part time	−0.226***	(12.48)	−21.0%
ln (Farm Income)	−0.077***	(6.75)	−7.7%
observations	85,819		
Wald $\chi 2$ (35)	40,480		

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

Variable	Est. Coefficient	z-stat	Est. %Δ
Constant	9.847***	(230.53)	
Non-Ag Degree, Ag Job	−0.070***	(4.49)	−6.8%
Ag Economics, Ag Job	0.033	(1.35)	3.3%
Ag Economics, Non-Ag Job	0.096***	(6.41)	10.1%
Ag Engineering, Ag Job	−0.208***	(8.86)	−18.8%
Ag Engineering, Non-Ag Job	−0.256***	(9.48)	−22.6.4%
Animal Science, Ag Job	0.153***	(5.77)	16.5%
Animal Science, Non-Ag Job	−0.199***	(12.73)	−18.1%
Plant Science, Ag Job	−0.331***	(11.75)	−28.2%
Plant Science, Non-Ag Job	−0.226***	(14.05)	−20.2%
Natural Resources, Ag Job	−0.265***	(7.68)	−23.3%
Natural Resources, Non-Ag Job	−0.393**	(26.16)	−32.5%
Other Ag, Ag Job	0.004	(0.08)	0.3%
Other Ag, Non-Ag Job	0.082**	(2.53)	8.5%
Ag Educ, Ag Job	−0.015	(0.56)	−1.5%
Ag Educ, Non-Ag Job	−0.152***	(10.98)	−14.1%
Food/Bio. Sci, Ag Job	−0.278***	(42.15)	−24.3%
Food/Bio. Sci, Non-Ag Job	−0.145***	(8.16)	−13.5%
Individual Characteristics			
Male	0.314***	(74.0)	36.9%
Black	−0.014	(1.32)	−1.4%
Asian	0.185**	(10.80)	20.3%
Native American	−0.245***	(5.38)	−21.8%
Hispanic	0.052***	(2.83)	5.3%
Race unknown	−0.116***	(6.27)	−11.0%
Family & HS background			
Fathers education	0.018***	(14.17)	1.8%
Number siblings	−0.005***	(4.09)	−0.5%
Farm business	−0.002	(0.28)	0.2%
Parent business	0.043***	(9.37)	4.4%
High School Rank	0.001***	(7.85)	0.1%
ISU curriculum			
GPA	0.056***	(14.38)	5.6%
Specialization	−0.006***	(20.75)	−0.6%
Length in school	−0.034***	(7.64)	−3.4%
Double major	0.014	(1.58)	1.4%
Post Baccalaureate Measures			
Experience	0.035***	(92.80)	3.6%
Graduate degree	0.109***	(25.90)	11.5%
Number of jobs	−0.018***	(18.98)	−1.8%
Entrepreneur	0.061***	(8.63)	6.3%
Employed part-time	−0.660***	(37.58)	−48.3%
Self-Employed full time	−0.068***	(5.05)	−6.6%
Self-Employed part time	−0.442***	(22.15)	−35.7%
Woman*part time	−0.211***	(11.00)	−19.0%
Rural	−0.202***	(38.08)	−18.3%
ln (Farm Income)	0.135***	(14.32)	13.5%
observations	85, 819		
Wald χ2 (42)	38, 687		

Table A6. ISU Alumni Salary Regression Results with Net Farm Income Interactions

Variable	Est. Coefficient	z-stat	Est. %Δ
Constant (NN)	9.973**	(224.18)	
Ag Degree, Ag Job (AA)	−0.267	(1.39)	28.2%
Ag Degree, Non-Ag Job (AN)	−1.040***	(11.02)	−64.8%
Non-Ag Degree, Ag Job (NA)	−1.980***	(7.34)	−86.7%
AA * ln(farm income)	0.008**	(0.17)	−0.93%
AN * ln(farm income)	0.336***	(14.51)	39.9%
NA * ln(farm income)	0.583***	(8.82)	78.8%
NN * ln(farm income)	0.103***	(10.31)	10.9%
AA * ln(farm income)*ρ_j	0.002***	(9.52)	0.21%
AN * ln(farm income)*ρ_j	−0.001***	(8.72)	−0.10%
Individual Characteristics			
Male	0.315***	(74.65)	37.0%
Black	−0.010**	(−0.97)	−1.0%
Asian	0.191**	(11.16)	21.1%
Native American	−0.226***	(4.90)	−20.3%
Hispanic	0.058***	(3.18)	5.9%
Race unknown	−0.102***	(5.59)	−9.7%
Family & HS background			
Fathers education	0.018***	(13.90)	1.8%
Number siblings	−0.00***	(2.98)	−0.4%
Farm business	0.022***	(3.41)	2.2%
Parent business	0.045***	(9.78)	4.7%
High School Rank	0.001***	(8.05)	0.1%
ISU curriculum			
GPA	0.055***	(14.00)	5.7%
Specialization	−0.006***	(22.32)	−0.6%
Length in school	−0.033***	(7.25)	−3.2%
Double major	0.018**	(2.05)	1.8%
Post Baccalaureate Measures			
Experience	0.035***	(92.31)	3.6%
Graduate degree	0.111***	(26.23)	11.7%
Number of jobs	−0.019***	(18.70)	−1.8%
Entrepreneur	0.067***	(9.39)	6.8%
Employed part-time	−0.656***	(37.18)	−48.1%
Self-Employed full time	−0.064***	(4.75)	−6.2%
Self-Employed part time	−0.434***	(21.41)	−35.25%
Woman*part time	−0.223***	(11.10)	−19.2%
Rural	−0.203***	(38.29)	−18.4%
observations	85,819		
Wald $\chi 2$ (42	36,276		