CALCULATING RETURNS TO DEGREE USING STUDENT LONGITUDINAL DATA SYSTEMS

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Abstract

Human capital theory shows educated workers are more productive in the workforce and subsequently earn more. Hundreds of studies have shown this by estimating the rate of return to education. However, these studies use national surveys and are limited to nationwide estimates. The emergence of Student Longitudinal Data System (SLDS) has permitted states and institutions to track students throughout education and even into the workforce. While several studies use SLDS data to calculate average wages of college alumni, none have calculated the rate of return. This paper develops a framework to calculate the net present value and rate of return for higher education using SLDS data. We apply the framework to estimate the economic value of completing a degree at an Iowa community college. We estimate the returns for all community colleges, by award type, and individual programs. Our results show returns are six percent for those completing a community college degree.

Keywords: wages, returns to degree, rate of return, community colleges, Iowa, student longitudinal data system, human capital theory, economics of education

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1 Introduction

What is the economic value of increasing educational attainment? Years of Census data has shown higher educational attainment garners higher wages in the workforce. Dozens of other studies have also shown that mean and median wages increase with further educational attainment. Human capital theory (e.g., Becker, 1964) provides a theoretical foundation for the relationship between education and earnings. Educated workers are more skilled, more adaptable to changes, and more productive. A worker's productivity, in turn, is tied to wages. Firms will not pay workers more than the additional productivity (marginal productivity) they provide to the firm, thereby providing a maximum potential wage.

Several studies in the 1990s and 2000s used administrative education and workforce records to track students from education into the workforce. Some report mean and median wages to evaluate the effectiveness of individual programs or colleges (e.g., Friedlander 1993a, 1993b) while other studies measure the performance of a system of colleges (e.g., Sanchez, Laanan & Wiseley, 1999; Laanan, Starobin, Compton, Eggleston, & Duree, 2007). More recently, states have used student longitudinal data systems (SLDS) to systematically track average wages of higher education alumni. Florida's Education & Training Placement Information Program (FETPIP) annual reports contain average wages of former Bachelor's, Master's, and Ph.D. recipients. For the most part, these studies show increasing educational attainment will increase the level and growth of wages.

The emergence of SLDS has led to dozens of studies on earnings of college graduates. Many SLDS tie administrative educational records to unemployment insurance (UI) records, which are maintained to meet local and federal reporting requirements. Administrative educational records began to arise in higher education in the early 1990s to implement state and federal legislation. These databases are maintained by state educational agencies and typically collect data on student populations, in contrast to national datasets that rely on sampling methods. UI records are maintained by workforce development offices to track salaries and employment in order to administer unemployment benefit programs.

Several pieces of federal legislation have mandated states implement SLDS to track the outcomes of students. Most notably, the State Fiscal Stabilization Fund of the American Recovery and

Reinvestment Act (ARRA) and the America COMPETES Act (20 USC 9871 § 6401(e)(2)) requires states to implement an SLDS from preschool through postsecondary education. Similarly, applicants to the Race to the Top were also bound by the requirements listed in the American COMPETES Act.

The Carl D. Perkins Career and Technical Education Act requires states to track CTE participants into the workforce to report wages of recent secondary and postsecondary participants (20 USC 2301 § 6401(e)(2)). As a result, states have implemented contracts to permit data exchanges between educational administrative records and unemployment insurance records. Many states have been aided by SLDS grants issued by the U.S. Department of Education. Since 2009, $373 million in grants has been allocated to states to build an SLDS. Iowa passed legislation in 2007 which funded an initiative to join education data and unemployment insurance records to track workforce outcomes.

Most of the studies using administrative records or SLDS data study the labor market outcomes of community college students. There is substantial evidence that community college graduates will earn higher wages than students who leave community college before completing a degree (Sanchez, Laanan & Wiseley, 1999; Gracie, 1998; Yang and Brown, 1998; Vanderheyden, 1994; Seppanen, 1998; Carvell, Graham & Piland, 1998; Friedlander 1993a, 1993b; and Laanan, 1998). A recent study of Iowa's graduates from 2002 concluded community college graduates earn approximately $4,000 more than students who left before completing a degree (Laanan et al., 2007). The Associate's of Applied Science—which is oriented toward immediate employment upon graduation—also seemed to be the most lucrative community college degree, earning over $3,000 more, on average, than other Associate's degrees. Several other studies have also found a similar link between community college education and wages. Studies of California records conclude that wages for community college awardees were higher and grew faster than all students (Sanchez et al., 1999; Friedlander, 1993b).

Past studies have either tracked mean or median wages over time (Yang and Brown, 1998; Vanderheyden, 1994; Seppanen, 1998; and Carvell et al., 1998). Some studies include mean/median wages and a lengthy discussion on wage growth (Gracie, 1998; Laanan, 1998). However, these studies do not include the additional cost students must bear to obtain additional credentials, thus, missing the core concepts from human capital theory. While the empirical evidence does indicate community college graduates earn more, it is still unclear if those additional earnings have compensated the cost of earning a degree.

Three costs must be considered for students choosing to stay in school: (1) the direct cost of schooling (e.g., tuition); (2) the opportunity cost of forgone wages; and (3) the time cost of deferring higher wages to a later period. These costs can be substantial. We estimate the direct and opportunity cost for the final year of education in Iowa community colleges was $4,500.[1]

This study will use three interrelated measures of value: (1) present value; (2) net present value; and (3) internal rate of return. These measures have traditionally been used to measure the value of educational attainment (Becker, 1964; Heckman, Lochner, & Petra, 2008). These measures are single values that incorporate a flow of wages over time, which will permit a focused analysis. Additionally, the latter two measures will incorporate the three types of costs defined above, which allows us to interprete the results as "returns to degree."

Since we use administrative records, we can derive estimates for numerous combinations. We will derive estimates of the returns to education at the statewide level and also estimate program-level returns. Section 2 will outline a simple version of human capital theory and related research; section 3 will describe the method that will be used; section 3 will describe the data set in more detail for Iowa; section 5 will summarize the results of present value, net present value, and internal rate of return; section 6 will compare the methodology from this paper with methodologies used in other papers; section 7 will conclude.

2 Human Capital Theory & Empirical Evidence

Human capital theory links additional schooling to higher wages. Educated workers will be better trained to handle their job. Subsequently, they will be more productive, better-able to make local decisions and innovations that increase their productivity (e.g., Hayek, 1945). For instance, educated farmers are more

[1] Average tuition (direct costs) is calculated by dividing total revenues from tuition and fees by enrollment (Iowa Department of Education, 2003, 2009). Opportunity cost is the difference in median wages between completers and leavers (see Table 1).

likely to adapt to changing conditions and incorporate new technology in their fields (Huffman, 1974). Consequently, those farmers have larger profits compared to farmers with less education.

Consider a firm that wants to maximize profits. For simplicity we will assume the firm does not have any machines (machine capital) so total profits for a competitive firm can be written:

$$\pi = pq - wE$$

Where π denotes total profits, *p* is the price of the good sold (which is determined by the market), *q* is the number of units sold, *w* is the prevailing wage determined by the market, and *E* is the number of employees. The first term, *pq* represents total revenue and in this formulation *wE* denotes total cost. We assumed this firm was in a competitive market (e.g., many other sellers and many buyers) so the price *p* and wage *w* is determined by the market. The firm chooses an output, *q*, and the number of employees, *E*, to maximize profits.

The additional cost from hiring one more worker is the wage of the employee, *w*, which is known as the marginal cost (MC) for the firm. The marginal revenue (MR) from selling another item is *p*. A well-known proof in economics is a profit maximizing firm should set output *q* where MR = MC (Colander, 2007, chapter 11 or any microeconomics textbook), which in this instance is $p=w$.

Now consider the marginal product (MP) of a worker, that is, the additional output *q* that is gained from hiring an additional employee. Dividing the marginal product into one gives the number of workers needed to produce one additional unit. We can rewrite the marginal cost as:

$$MC = w \times \frac{1}{MP}$$

so if hiring one additional worker allows the firm to produce one additional unit, then marginal cost is equal to the wage of that worker. But suppose the new worker is more productive and is able to produce two units, then the marginal cost of one new employee has declined. We can rewrite the profit maximizing point as:

$$MR = MC \Leftrightarrow p = MC \Leftrightarrow p = w \times \frac{1}{MP}$$

and after rearranging,

$$w = p \times MP$$

The right side of the term is the value of the marginal product. As productivity increases the firm can afford to pay a productive worker more, up until that wage equals w. Education, which increases worker productivity because it equips them with the appropriate skill, will increase the maximum wage a firm would pay.

Thus, by completing education and gaining skills for the workforce, students can increase their wages for a lifetime. However, gaining additional education is void of costs. Completers must forgo earnings and incur direct costs in return for higher wages. Figure 1 sketches the theoretical income stream for someone completing a degree compared to someone leaving early. While leavers earn more, completers pay tuition and forgo earnings. Direct costs (e.g., tuition) are relatively minimal at community colleges. In Iowa, community college students spent an average of $1,600 (adjusted to 2008 levels) on tuition in fiscal year 2002.[2] The substantial cost of education is forgone earnings. We estimate students forgo approximately $3,000 in additional income by remaining in school an additional year. Nevertheless, human capital theory suggests that higher education will be rewarded with higher wages that compensate for direct costs, opportunity costs, and time costs.

[FIGURE 1 ABOUT HERE]

Literally hundreds of studies have established this link, known as rate of return or returns to education for all forms of education in the United States and internationally (e.g., Card, 1999; Grubb, 1993; Leslie & Brinkman, 1988; Psacharopoulos, 1994; Psacharopoulos & Patrinos, 2002; Leslie & Brinkman, 1988; and Heckman, et al., 2008). Each year of education is usually associated with a 10 percent increase in wages (Card, 1999; Psacharopoulos & Patrinos, 2002). The return on bachelor's degrees, compared to a high school diploma, is typically between 15 and 20 percent (Heckman et al., 2008).

Similarly, the average community college entrant who does not complete a degree earns approximately 9 to 13 percent more than a high school graduate. Earning an associate's degree, however,

[2] Average tuition expense is total revenue from tuition and fees divided by enrollment. See Iowa Department of Education (2004, 2009).

increases the earnings gap to between 15 and 27 percent (Leigh & Gill, 1997; Kane & Rouse, 1995, 1999). Based on these results, the imputed return to completing a college degree compared to leaving is between 6 and 14 percent. Robison and Christophersen (2004) used Census data and estimated the returns to completing an Iowa community college degree to a high school diploma was 8.5 percent.

Moreover, returns to degree are higher for those in terminal, career-oriented programs (e.g., Associate's of Applied Science) compared to a transfer program (e.g., Associate's of Arts) (Leigh & Gill, 1997; Kane & Rouse, 1995; Gill & Leigh, 2001).

These studies implemented a form of the Mincer (1972) specification, where log of earnings were regressed on educational attainment (e.g., years of schooling or highest degree completed) and years of work experience.[3] These estimates, however, were based on national surveys that contain responses from students with a diverse educational background from very little education to postgraduates.

While many administrative data sets contain a large amount of information, the ability to track high school graduates and dropouts is limited. Therefore, we analyze the rate of return by comparing income of completers and leavers. We compare wages of completers and leavers using three calculations predominately drawn from Becker's (1964) analysis: (1) present value; (2) net present value; and (3) internal rate of return.

3 Method

SLDS data is limited in a number of respects which limits the direct replication of the methodology used in other studies. First, SLDS data typically does not contain worker experience which is necessary to conduct analysis with the Mincer specification (see Heckman, Lochner, & Todd, 2005 for a review). Second, most SLDS data does not link elementary or high school records to workforce outcomes. Typically, states and institutions can only follow college alumni into the workforce. Thus, we cannot compare the wages of college graduates versus high school graduates, which is a common practice in human capital literature.

[3] This measure, although called the "Mincer specification," was first proposed by Becker and Chiswick (1966).

This paper adapts a framework developed by Friedlander (1993a, 1993b) and Sanchez et al. (1999), which compares the wages of “completers” and “leavers”, and merges it with the early literature from human capital theory. Completers and leavers are staggered so leavers have spent a year in the workforce while completers finish their last year in college. As a result, the differences in wages can be inferred to as the returns to degree for completing the final year of community college.

This is a common scenario in education. Suppose a student has already completed some postsecondary schooling. The student is waiting to register for a final year of classes in order to complete a degree, but must weigh a degree versus entering the labor force. Should the student continue to enroll for a final year, and incur the respective costs, or seek a job in the labor force? By entering the labor force the student will have an additional year of earnings with no tuition costs, but lacks an additional year of training and college degree. The student who stays must pay more money and forgo earnings, but will have the benefit of slightly more training and a degree.

Friedlander (1993a, 1993b) and Sanchez et al. (1999) only track students who appear in all four quarters as a proxy for “full-time” employment. We deviate from this method and include students who work in any quarter. Since UI records contain unseasonalized employment data, it does not capture the seasonal changes in employment associated with the economy.

Figure 2 shows seasonalized and unseasonalized unemployment counts for Iowa. By definition, seasonalized unemployment is relatively stable and through the center of the unseasonalized trend. There are large disparities in seasonalized and unseasonalized unemployment during the first quarter of each year, after post-holiday decline in sales and the beginning of cold weather.

[FIGURE 2 ABOUT HERE]

Unemployment insurance records will mimic the patterns of unseasonal unemployment. Thus, considering students who only work four quarters will eliminate many who are only seasonally unemployed. At the same time, community colleges produce many workers in sectors with high seasonal unemployment, such as manufacturing and construction (Schenk & Matsuyama, 2009).

3.1 Calculating Returns

The present value of earnings is able to reflect the dollar-value of a degree over time. Present value calculations are particularly helpful since they discount money earned at a later date as money promised at a later date is often less valuable than it is at present. There are a couple of reasons for the devaluation. First, students forgo immediate uses of money, and therefore, incur an opportunity cost. A dollar earned today can be invested and earn interest, which compounds and grows exponentially. When a dollar is promised for next year, the value is lower since the investor must forgo the annual interest. For instance, investing a dollar in a bank account which earns 3 percent APR will increase your wealth to $1.03 next year. Forgoing that investment cannot be made up by promising a dollar next year, instead, one must be promised $1.03 to compensate for the opportunity cost.

Second, studies in neuroeconomics suggest that human brains naturally discount money over time (Camerer, Loewenstein, & Prelec, 2005; McClure, Ericson, Laibson, Loewenstein, & Cohen, 2007). There is a psychological component to having immediate satisfaction instead of having to wait. This tends to be a tug-of-war between the primal part of the brain which demand immediacy versus the recently developed subfrontal cortex which can rationalize patience.[4]

Equation (1) incorporates discounting and is called the present value of earnings:

$$V(Y) = \sum_{t=1}^{T} \frac{Y_{j,t}}{(1+i)^t} \quad (1)$$

where Y is the income stream of the j^{th} student between initial time period, $t=1$, until the end. The discount rate, i, is the percentage the value of money declines each year.

A more appealing approach would be to include the costs of schooling, including the cost of tuition and foregone earnings. We've intentionally limited the period of investment into a single year—the last year for completers—so costs can be incorporated by differencing the stream of income from completing a degree, Y_j, and income for students who left early, X_j. Additionally, the cost of tuition, c, is

[4] McClure et al. (2007) provides substantial evidence that the brain mimics a hyperbolic discount function instead of the exponential discount expressed in this paper. We use the exponential discount function to maintain consistency with the literature in human capital theory. Moreover, the exponential discount function is appropriate if students who leave early invest their additional wages.

subtracted for the student finishing the degree. Thus, the net present value for the completer can be written:

$$V(X,Y) = \sum_{t=1}^{T} \frac{Y_{j,t} - X_{j,t}}{(1+i)^t} - c. \qquad (2)$$

We are able to interpret the results of equation 2 as the monetary value of completing a degree versus leaving early. Positive values indicate the degree is worthwhile, even when considering the tuition costs that must be paid and forgone income in order to earn the degree. Negative values, on the other hand, indicate the degree is not monetarily worthwhile. By extension, the amount, which is expressed in dollars, can be interpreted as the compensating differential that could change a student's decision.

For example, consider a student who is attempting to decide whether to complete her degree or leave to the job market in the Health Sciences. Suppose the student knew the net present value of an Associate's degree over four years was $19,000. Under these circumstances, it would be beneficial for the student to enroll in school to complete her degree. Moreover, if the student was offered $19,000 to leave the program, the student would find this to be a fair offer.

Net present value is based on a dollar value and must presume a discount rate. A preferable interpretation would be expressed as percentages, which can be compared across various geographic areas, including multiple countries. The internal rate of return is the discount rate, *r*, which equates the net present value of earnings to zero. That is, internal rate of return which satisfies:

$$\sum_{t=1}^{T} \frac{Y_{j,t} - X_{j,t}}{(1+r)^t} - c = 0. \qquad (3)$$

Researchers can compare the internal rate of return to interest rates to make decisions on further educational investment (Hirshleifer, 1970). When the rate of return in equation 3 exceeds interest rates, then further education is justified. If the rate of return is below market rates, then further education cannot be justified on economic grounds.

3.2 Computational Method

Estimating equations 1 and 2 is straightforward once wage data is available and we choose our discount rate, but it is computationally expensive with thousands of students. Moreover, equation 3 cannot be easily solved through analytic methods. We can rewrite equation 3 as a polynomial of root *T*.

$$\left(Y_{j,1} - X_{j,1}\right)(1+r)^{-1} + \left(Y_{j,2} - X_{j,2}\right)(1+r)^{-2} + \cdots + \left(Y_{j,T} - X_{j,T}\right)(1+r)^{-T} - c = 0$$

Writing it this way, it becomes clear the solution to equation 3 is actually finding the root of the polynomial. The root could be solved for each individual student, but again, would be computationally expensive.

In fact, solving equations 2 and 3 is much more efficient through matrix algebra. Equation 2 can be solved in a minimal amount of time while equation 3 can be estimated faster than solving each polynomial individually. Switching to matrix notation, we can write student wages as:

$$\boldsymbol{Y} = \begin{pmatrix} y_{1,1} & y_{1,2} & \cdots & y_{1,T} \\ y_{2,1} & y_{2,2} & \cdots & y_{2,T} \\ \vdots & \vdots & \ddots & \vdots \\ y_{n,1} & y_{n,2} & \cdots & y_{n,T} \end{pmatrix}$$

$$\boldsymbol{X} = \begin{pmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,T} \\ x_{2,1} & x_{2,2} & \cdots & x_{2,T} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m,1} & x_{m,2} & \cdots & x_{m,T} \end{pmatrix}$$

where ***Y*** and ***X*** is a matrix of individual wages for completers and leavers, respectively.

The matrices ***Y*** and ***X*** are similar to the layout of two spreadsheets, where each row is an individual student and each column is wages for a given year. The notation above indicates there are *n* leavers and *m* completers over years 1,…,*T*. A vector (e.g., column) of discount rates, $\vec{d}$, can be written:

$\vec{d} = \{1/(1+r)^1 \quad \cdots \quad 1/(1+r)^T\}$.

Thus, if we assume an interest rate *r*, equation 2 can be computed by:

$$\boldsymbol{F} = (\boldsymbol{Y} - \boldsymbol{X}) \times \vec{d} - c,$$

which will yield an *n*-element vector.[5] Each element is the net present value of completing the final year of community college. In this paper we assume the interest rate is three percent.

We estimate equation 3 using Newton-Rhapson for a system of equations. Letting $f(r) = \sum_{t=1}^{T} \frac{Y_j - X_j}{(1+r)^t} - c = 0$ where $f_i \in \boldsymbol{F}$ we formulate the Jacobian matrix:

$$\boldsymbol{J}(r) = \begin{pmatrix} \frac{\partial f_1}{\partial r} \\ \vdots \\ \frac{\partial f_n}{\partial r} \end{pmatrix}.$$

That is, each element in $\boldsymbol{J}$ is the change in the net present value as we change the interest (discount) rate. That is, how sensitive are the net present value estimates if the discount rate was to change? Our objective is to find a value, a_0, so $\boldsymbol{F}(a_0) = 0$. The value, $a_0 - 1$, is the internal rate of return.

Using Newton's theorem, we can guess a value, a_k, to solve the root of $\boldsymbol{F}$. It is highly unlikely that estimate will be correct on the first try, but we can use $\boldsymbol{F}$(r) and $\boldsymbol{J}$(r) to recursively solve it through multiple iterations. Namely, $F(a_k)$ can be used to estimate a_{k+1}, which will ultimately converge to the answer, a_0. After the initial guess, the next guess can be written:

$$a_{k+1} = a_k - [\boldsymbol{J}(a_0)]^{-1}\boldsymbol{F}(a_k).$$

The iterations are terminated when $\boldsymbol{F}(a_{k+1}) \approx 0$. For this paper, we consider $\boldsymbol{F}(a_{k+1})$ sufficiently close to zero when

$$\frac{\sqrt{\sum_{i=1}^{n}(a_{k+1} - a_k)^2}}{\sqrt{\sum_{i=1}^{n} a_{k+1}{}^2}} < 0.001.;$$

which is called the norm of the vector. Again, this will produce an *n*-element vector and each element is the rate of return. Several initial estimates, a_k, should be used since there may be multiple roots. For this paper, we used the initial guesses of 0.03 (e.g., 3 percent), 0.1, 1, and 50. Each initial guess converged to the same answer. The vector is then merged with the education data to derive rates of return by any element in the administrative educational records.

[5] We can only subtract $\boldsymbol{X}$ when $n=m$. In this case it did not. Instead, we substitute $\boldsymbol{X}$ with an n x T matrix of median wages for leavers. Alternatively, researchers can match similar students based on observable characteristics (e.g., sociodemographics) or by their propensity to graduate. Several papers discuss matching procedures, including Titus() and Becker() among others.

4 Data

The Iowa Department of Education and Iowa Workforce Development maintain the Training and Employment Outcomes System (TEOS). TEOS is created through multiple steps by combining the Iowa Community College MIS—an administrative database of student enrollment and awards at Iowa's 15 community colleges—and UI records. First, we used Iowa's Community College MIS to track of cohort of students who obtained a degree in the 2001-02 academic year and students who left community college in the 2000-01 academic year. We culled potential students from the MIS and matched them with the National Student Clearinghouse—a subscription-based database of enrollment at over 3,000 postsecondary institutions (Romano & Wisniewski, 2005; Schoenecker & Reeves, 2008). We omitted any student who was found in those records since they did not fully transition to the workforce. The remaining students were then matched with UI records.

UI records were obtained from Iowa Workforce Development and we matched all known wages for each quarter between the 3rd quarter of 2001 through the 4th quarter of 2008. Wages were aggregated by the fiscal year, between the 3rd and 2nd quarter. Iowa's UI records do not contain wages for federal employees, members of the armed forces, the self-employed, proprietors, unpaid family workers, church employees, and railroad workers covered by the railroad unemployment insurance system, as well as students employed in a college or university as part of a financial aid package. In addition, our records only include wages earned in Iowa and does not include surrounding states.

Amounts were adjusted for inflation to July 2008 levels using the Consumer Price Index for Urban Consumer (CPI-U). As we previously mentioned, we included anyone who worked at least one quarter during the fiscal year. However, we omitted anyone who did not work at least part of any year between 2003 and 2008 since we did not know if they were unemployed or were no longer residents. In addition, we omitted leavers who were not found in the 2002 wage files. We did keep completers who did not work in 2002 since they may have opted out of the labor market while completing their degree.

After the various stages of matched, 19,423 records were in the final analysis. Sixty-six percent of the cohort was classified as leavers and 6,551 students are listed as completers.

5 Results

Table 1 shows the median wages and wage growth for the cohort. In the first year out of school, leavers had the advantage of higher wages while completers finished their degree. Nevertheless, as expected, wages grew rapidly for completers. Completers' wages overtook leavers' wages within two years of graduation.

[TABLE 1 ABOUT HERE]

Wages for completers were $29,592 by 2008, almost $2,000 higher than leavers. The descriptive data shows the impact of the 2007-08 recession. Wages for both completers and leavers fell over three percent as the economy deteriorated in 2008. TEOS only includes working individuals and is inflation adjusted, so the drop in wages is a reduction in real wages for employees. Similar drops in wages were also present by degree type.

Associate's of Applied Science was the most lucrative award, earning over $37,000 by 2008. Diploma recipients also saw tremendous growth in wages by the last year of analysis. On average, their wages grew an average of 59 percent each year, accumulating a total 223 percent increase over that period. Nevertheless, all award types had annual increases averaging over 38 percent. Even leavers had atypical wage increases of 59 percent each year.

5.1 Human Capital Measures

The above analysis is akin to the analysis found in Friedlander (1993a, 1993b), Sanchez et al. (1999), Gracie (1998) and other publications using UI records. Table 2 shows the present value, net present value, and internal rate of return comparing completers and leavers in the 2002 cohort, respectively. Our subsequent analysis will focus on each of the human capital measures.

The present value is available for both leavers and completers since it independently summarizes the earnings for each group. The present value summarizes gross income for leavers and completers. In 2002, completers value the next 6 years of income to be $152,511, while leavers value their income at $149,379. Since the present value for completers is higher, it also indicates the value of completing a degree is higher than entering into the workforce early. Nevertheless, from a policy perspective, present value offers very little than a gleam of the relative value for completing a degree.

[TABLE 2 ABOUT HERE]

We turn to net present value for a more informative figure. Net present value is only available for completers since it directly compares the income stream for the two groups. The net present value for completers is $1,994, which indicates there is an economic return to completing a degree.

The net present value can also be interpreted as the compensating differential—the amount where students will change their decision regarding graduation. For instance, our results indicate completers will gain $1,994 by completing a degree. Thus, many students will stay to finish their degree and benefit from higher earnings. However, students will find it fair to accept $1,994 instead of graduating and enter the workforce for seven years.

We find the net present value for diplomas is $-3,168. Colleges could subsidize diploma program participants by that amount so students will find it economically viable to stay in school.

Finally, the most informative indicator is the rate of return. Again the indicator is only available for completers. Over the seven-year period, the investment in education returned six percent. That is, for each dollar invested, community college awards returned 6 cents.

We can also compare the internal rate of return to results from other studies and other form of investments. Several studies indicated the returns to community college degrees were between 6 and 14 percent (Leigh & Gill, 1997; Kane & Rouse, 1995, 1999; Robison & Christopherson, 2004). Our results indicate returns to degree were at the bottom of those estimates, but it is important to note that those studies analyzed students for 10 to 15 years after graduation.

5.2 Returns by Programs

Since the wage analysis is tied to the Community College MIS, our analysis can be done through various elements collected in the system. Namely, we can provide estimates to the rate of return by college programs. Other studies, which utilize national data sets, are limited in their analysis by other academic criteria.

We chose to conduct the analysis by Iowa's 16 career clusters for a variety of reasons. First, 16 areas is likely the maximum number of areas we can easily summarize without providing overwhelming information. Second, we are less likely to censor information due to limited cell sizes. Lastly, the Iowa Department of Education has begun to report other information, such an enrollment, through the 16 clusters. Table 3 provides descriptive wages statistics for the 2002 cohort. As we saw before, wages were initially low for community college completers, but grew rapidly after graduation. Also, there was a decline in median wages for almost every cluster.

[TABLE 3 ABOUT HERE]

Table 4 provides the human capital measures. Nine of the 16 clusters had positive returns. Science, Technology, Engineering, and Mathematics, Manufacturing, and Finance had the largest returns, followed by law, IT, health sciences, and construction.

[TABLE 4 ABOUT HERE]

Similar to the discussion above, net present value provides us an interesting interpretation. A student in the health sciences, who is studying for the final year of courses, could rationally be convinced to leave school in exchange for $21,860. In many instances students would only find it fair to be compensated in order to remain for the final year.

Returns to degree were quite large in several career clusters. Law, STEM, and finance had the largest returns. These returns reflect the demand and supply for particular skill sets in the current economy. Several estimates for the rate of return were not solvable. Technically, there must be at least one positive flow of income in order for the internal rate of return to have a solution. In some cases, leavers always had a higher wage. Thus, in these extreme cases, the negative returns could not be directly solved.

Rates of returns may be low due to demand for any skill set and not individual awards. In particular, professional licensure and certifications can be obtained without completing a formal degree.

Occupational licensing has been estimated to increase wages approximately 15 percent in the United States (Kleiner and Krueger, 2008).

6 Comparing Methodologies

Present value, net present value, and internal rate of return are based on similar formulations. We also explored evaluating programs based on wage levels and wage growth. No matter what methodology is employed, researchers and policy makers will tend to use it to rank outcomes of various programs. So does the extra effort in producing human capital estimates yield results qualitatively different from simpler methods?

Table 5 shows the ranking of returns on career clusters using 2008 wage levels, annual wage growth, cumulative wage growth, present value, net present value, and internal rate of return. The government career cluster ranked highest in 2008 wages for completers and the largest cumulative change in wages.

We evaluate the relationship between descriptive measures—2008 wage levels, annual wage growth, and cumulative wage growth—and human capital measures—present value, net present value, and internal rate of return—by calculating the Spearman correlation coefficient across the rankings. Since there are no tied ranks, we can measure the correlation between x_i and y_i using $\rho = \frac{6\Sigma(x_i - y_i)^2}{n(n^2-1)}$. Like the traditional Pearson correlation coefficient, the Spearman correlation coefficient is bounded between -1 and 1, where -1 is perfect negative correlation, 1 is perfect positive correlation, and 0 indicated perfectly uncorrelated variables.

[TABLE 5 ABOUT HERE]

Table 6 shows the Spearman coefficients for all measures. Wage levels are, with the exception of annual change, positively correlated with all measures at a statistically significant level. However, other descriptive measures are not correlated with human capital measures. Nevertheless, human capital measures tend to be correlated with other human capital measures at statistically significant levels (e.g., rate of return and present value). Therefore, we can reasonably conclude that there is a difference in outcomes as a result of using human capital measures compared to descriptive measures.

[TABLE 6 ABOUT HERE]

7 Discussion

The results of this paper largely confirms the labor market outcomes for Iowa community college graduates is comparable to those nationwide. Completing a community college degree in Iowa returns 6 percent over a 6-year period, which is within the 6 to 14 percent range estimated by other scholars (Leigh & Gill, 1997; Kane & Rouse, 1995, 1999; Robison & Christopherson, 2004). Specifically, the pay-off amounts to almost two-thousand dollars in profit for the student. Our findings also suggest career-oriented programs have the highest immediate returns, namely, a degree in a CTE field (Associate's of Applied Science) returned almost 56 percent. These finding mirror studies by Grubb (1993), Leigh & Gill (1997), Gill & Leigh (2001), and Kane & Rouse (1995) which found similar differences between vocational and transfer programs.

This paper also presented findings by program major, which has not been extensively covered in the literature. Iowa's economy is highly dependent on manufacturing and finance with a growing emphasis on renewable energy. Thus, it is not surprising to see STEM, finance, manufacturing, health, and construction with the highest returns. Law had the highest returns, but the reason is still unclear. Other states may see very different results based on the structure of their economy. Perhaps even more helpful would be following the trends for the rate of return over a period of time to see changes in the demand and supply for workers. Iowa will be doing that as it has begun to track a cohort of students from 2006 into the workforce, where we can compare the labor market outcomes with the 2002 cohort studied here.

Net present value and rate of return estimates can be a valuable marking, accountability, and planning tool for higher education. First, net present value provides a single dollar value which can be used to entice students to remain in higher education as opposed to leaving the workforce. While student undoubtly consider wages before they leave school, they may have imperfect information the role of schooling has on their future earnings. At the same time, higher education can use net present value to provide scholarships or adjust tuition to keep students in school. Some programs, such as STEM, provide lucrative returns in the workforce while human service graduates earn very little. The latter majors have suppressed earnings because they work for non-profit or state organizations with limited budgets, yet, they provide a social service that is valueable. More student may be inclined to enter the market if they were offered a lower tuition or scholarship that was financed by higher tuitions in a program that provides substantial wage returns. The net present value provides colleges the bounds for such programs.

Net present value and returns to degree also provide an effective accountability measure for several pragmatic reasons. First, both are a single number that represent the flow of wages over several years. Average wages can be complex since there is an average wage for every year in the analysis, so the rate of return can actually be easier to explain. Rate of return has the added benefit of being expressed as a percent, which means it can be compared equally between majors, institutions, states, and to national estimates.

Currently, colleges use a variety of accountability measures, the most prominent being persistent rate, graduate rate, and time-to-degree. It’s likely there is codependence between the rate of return and the aforementioned measures. Students typically consider the costs and benefits of persisting or graduating for higher education. Thus, a low or negative rate of return may encourage students to leave early—lowering persistence and graduation rates—as oppose to incurring further costs from education. A high rate of return will encourage students to remain in school in order to gain those benefits in the labor market. Thus, researchers may see a positive correlation between graduate/persistence rate and rate of return.

Conversely, difficult programs are more likely to constrain the labor supply because only few make it through a program. The limited labor supply means workers are more valuable and are paid more in the workforce. In this scenario, a graduation/persistence rate may be negatively correlated with rate of return. This paper does not deal with this issue, but several other studies have explored the role labor market expectations play in student decisions (Roy, 1951; Ben-Porath, 1967; Orazem and Mattila, 1991; Dellas & Koubi, 2003).

Nevertheless, it is important to keep some perspective on why returns may fluctuate. Goldin and Katz (2009) show returns to education have increased since the 1970s for two reasons: a disproportional increase in employer demands for educated labor and technical skill complementarily. The former is simply firms wanting educated employees because they are more productive and profitable to the firm. The latter is a result of increasing technology in the workforce. Many jobs require the use of some advanced technology, which often requires some education. Increasingly, employees need to have at least a college education to work with modern technology, thereby, increasing the demand for educated workers.

Obviously, colleges need to maintain quality programs to firms find value in hiring college graduates. Yet, a recession or new technology could decrease the demand for college graduates, thus, eliminating returns to degree to no fault of the college. Indeed, Goldin and Katz found the returns to education declined between the 1940s and 1960s because of falling relative demand for educated workers. Local factors, such as a recently closed business, may suppress returns in the short-run.

Third, the recent increase in college tuition has been notable for researchers and policy makers. Thus, an appropriate analysis should include the wages and the costs of education. As tuition rises, the economic value of the degree (measured by net present value or rate of return) will erode unless wages increase as well.

Finally, politicians and policy analysts can use these human capital metrics to evaluate education's effect on the distribution of income. A third of the growth in wage inequality has originated from education and its impact on wages (Lemieux, 2006). Our analysis demonstrates the spread between those who complete a degree and those do not. But wage inequality is not only caused by the have and have-nots in education, there is also a increasing inequality within educated groups. Again, our analysis shows the value of education can differ markedly depending on the student's major.

Despite the richness of SLDS data, there are still several limitations. First, this study only looks at wages 6 years after graduation. Many studies (e.g., Kane & Rouse, 1995) analyze wages between 10 and 15 years after graduation, when wages and career choices stabilize. Thus, our estimates for this cohort are likely understated compared to national estimates.

UI also records do not contain wages for all graduates and for all workers. These limitations are present in all UI studies and have no immediate recourse. Also, our UI records did not contain wages from surrounding states. Ten community colleges share a contiguous border with another state. It is possible many of these individuals hold gainful employment across Iowa's border, and therefore, are not included in this analysis. Unfortunately, our data is limited to community college completers and leavers. As of yet, there is no way to link UI records to high school graduates and dropouts. Thus, we lose the ability to measure the value of community colleges compared to students with only a high school diploma.

Further analysis can obviously explore the returns to underrepresented populations and financial aid status. But as SLDS support continues to grow, other states and institutions should look toward the metrics presented in this paper. Numerous non-profit organizations and think-tanks are striving for a common set of outcome metrics across states, including workforce metrics. Average and median wages are difficult to compare across the United States due to cost-of-living differences. Rate of return can provide a common base of comparison while providing other worthwhile information to institutions and states.

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Figure 1: Theoretical Wages of Higher Education Leavers and Completers

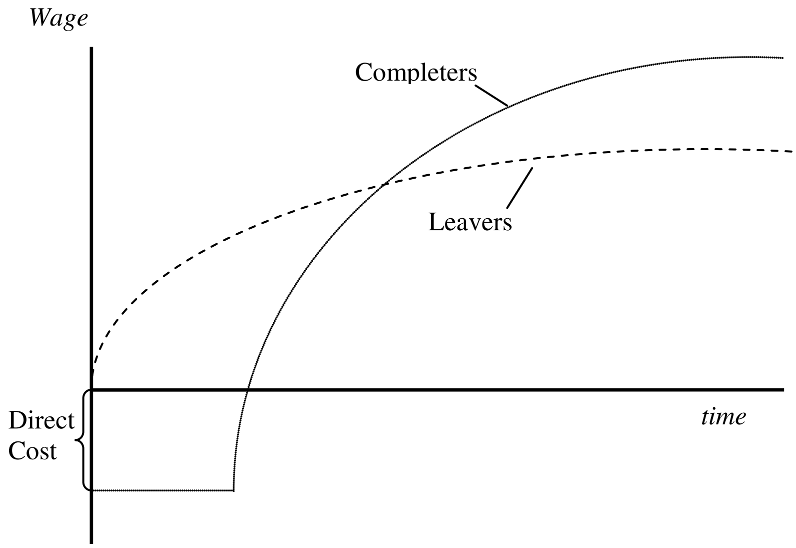
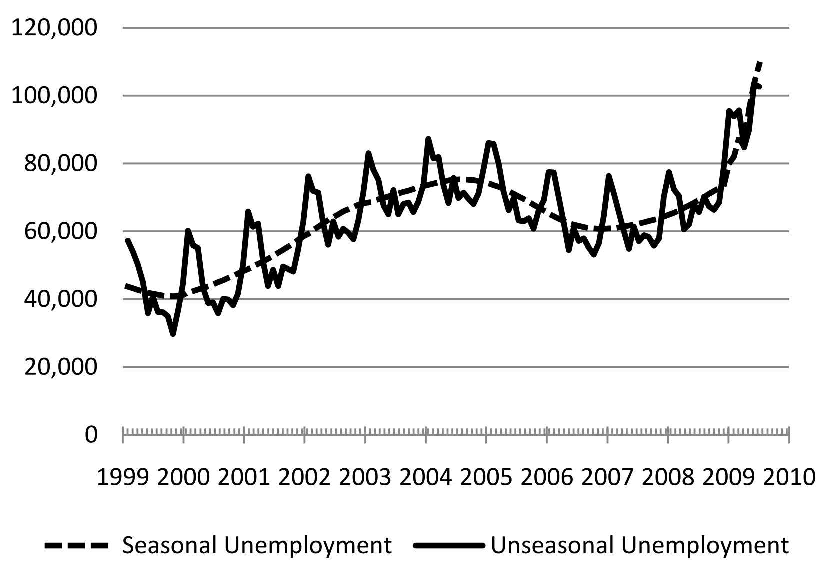


Figure 2: Seasonal and Unseasonalized Unemployed Workers in Iowa: 1999-2009



Source: Bureau of Labor Services, Local Area Unemployment Statistics.

Table 1: Descriptive Earnings of 2002 Cohort

	Wages by Fiscal Year							Annual Return
	2002	2003	2004	2005	2006	2007	2008	
Leavers	$14,762.93	$21,621.20	$24,373.32	$25,859.47	$27,469.05	$28,680.69	$27,674.79	23.3%
Completers	12,223.73	20,801.54	24,696.88	27,140.48	29,126.06	30,554.49	29,591.87	34.3%
AA	13,399.14	19,910.76	22,752.47	24,852.72	27,054.91	29,420.72	28,712.73	28.9%
AS	12,938.61	22,469.24	26,593.80	28,325.04	30,320.24	31,725.65	29,922.71	32.2%
AGS	14,089.16	24,197.09	31,553.75	34,151.34	34,214.02	33,105.44	33,681.25	33.7%
AAA	10,752.22	18,264.41	20,586.75	24,573.26	22,671.36	25,995.08	25,650.14	33.6%
AAS	12,432.91	28,392.90	32,961.85	35,324.68	36,965.78	38,030.62	37,120.56	44.0%
Diploma	9,004.27	19,969.01	26,246.94	27,306.67	28,734.45	29,873.41	29,110.69	47.9%
Certificate	12,638.55	18,812.02	20,807.91	20,570.19	22,284.21	22,690.79	23,651.30	23.2%
Other	23,985.19	26,108.54	28,929.05	28,087.44	27,805.02	26,623.43	25,717.65	2.4%

Note: Wages are adjusted for inflation to July 2008 using the Consumer Price Index for All Urban Consumers (CPI-U). Wages are measured for the fiscal year between June and July of the noted year. Compound Average Annual Return is the geometric mean of between 2002 and 2008.

Table 2: Returns to Education, 2002 Cohort

	Present Value	Net Present Value	Rate of Return
Leavers	$149,379.50		NA
Completers	152,510.80	$1,993.74	6.0%
AA	144,140.10	-9,285.52	-4.4%
AS	162,314.20	9,342.89	18.1%
AGS	177,480.40	24,966.23	12.4%
AAA	127,086.90	-26,985.52	[1]
AAS	194,924.20	41,962.11	55.7%
Diploma	150,507.60	-3,168.83	-0.7%
Certificate	119,264.90	-33,249.19	[1]
Other	174,105.90	20,714.31	46.1%

Note: [1] denotes rate of return calculations did not converge. In all cases, returns were "infinity negative."

Table 3: Descriptive Summary of Earnings by Career Cluster

Career Cluster	Status	Wages by Fiscal Year						
		2002	2003	2004	2005	2006	2007	2008
Agriculture	Leavers	$11,970	$19,149	$25,327	$25,904	$28,131	$29,939	$29,413
	Completers	11,139	21,844	25,321	27,385	29,498	32,142	30,094
Construction	Leavers	13,085	22,688	27,266	29,294	32,775	33,458	31,068
	Completers	10,258	23,446	28,608	31,869	34,304	36,633	35,439
Arts/Comm.	Leavers	8,791	14,407	17,000	18,202	19,604	21,130	21,592
	Completers	11,817	17,964	21,992	25,590	25,685	26,305	25,564
Business	Leavers	14,072	19,772	22,038	22,852	24,565	25,223	24,266
	Completers	12,071	19,445	21,955	23,456	23,984	24,953	24,589
Education	Leavers	15,097	21,672	24,212	25,761	27,622	28,747	27,777
	Completers	13,062	16,648	19,146	22,876	25,632	27,634	26,753
Finance	Leavers	23,045	31,504	32,102	32,440	32,942	33,226	32,817
	Completers	23,683	29,404	35,494	30,764	32,921	32,492	36,963
Government	Leavers	41,393	40,248	47,414	46,825	50,146	39,362	42,188
	Completers	4,104	20,686	23,940	25,026	30,305	19,965	35,310
Health	Leavers	15,090	21,757	23,489	24,671	25,256	25,926	25,043
	Completers	11,805	25,872	31,363	31,827	33,786	33,346	32,369
Hospitality	Leavers	11,213	16,266	18,067	20,234	22,256	22,003	21,435
	Completers	15,349	18,034	22,922	22,489	22,530	25,572	23,789
Human	Leavers	12,783	16,355	17,767	18,562	19,097	20,392	19,472
Services	Completers	9,404	14,061	15,125	18,211	18,739	20,059	18,784
IT	Leavers	17,933	27,183	29,737	31,507	33,105	34,536	30,677
	Completers	13,244	22,348	28,091	30,984	33,203	35,124	33,124
Law	Leavers	14,985	21,193	24,683	27,056	29,516	31,501	31,097
	Completers	15,239	24,309	29,982	32,800	36,963	38,463	37,234
Manufacturing	Leavers	13,595	25,226	29,973	33,585	35,539	36,097	36,013
	Completers	12,229	24,793	32,268	35,129	37,302	38,092	37,287
Marketing	Leavers	14,654	21,050	24,376	26,896	28,536	28,588	27,972
	Completers	17,986	23,819	26,249	29,475	29,874	30,227	27,549
STEM	Leavers	14,971	29,149	34,029	37,064	39,009	39,871	38,318
	Completers	11,258	27,578	33,422	37,491	39,040	40,782	38,802
Transportation	Leavers	11,736	20,418	25,681	26,987	28,949	31,336	31,117
	Completers	12,074	21,548	25,422	28,827	31,368	32,740	32,987

Note: Wages are adjusted for inflation to July 2008 using the Consumer Price Index for All Urban Consumers (CPI-U). Wages are measured for the fiscal year between June and July of the noted year. Compound Average Annual Return is the geometric mean of between 2002 and 2008.

Table 4: Returns to Education by Career Cluster

Career Cluster	Status	Present Value	Net Present Value	Rate of Return
Agriculture	Leavers	$ 146,826	NA	NA
	Completers	152,479	-$913	4.6%
Construction	Leavers	168,296	NA	NA
	Completers	178,379	24,563	30.8%
Arts/Comm	Leavers	108,841	NA	NA
	Completers	133,251	-20,702	[1]
Business	Leavers	134,267	NA	NA
	Completers	129,951	-23,407	[1]
Education	Leavers	149,704	NA	NA
	Completers	130,916	-22,168	[1]
Finance	Leavers	196,622	NA	NA
	Completers	188,842	35,450	46.0%
Government	Leavers	273,643	NA	NA
	Completers	139,199	-13,315	-17.6%
Health	Leavers	142,981	NA	NA
	Completers	175,182	21,860	32.9%
Hospitality	Leavers	117,100	NA	NA
	Completers	120,798	-33,237	[1]
Human Services	Leavers	109,084	NA	NA
	Completers	101,990	-50,902	[1]
IT	Leavers	177,361	NA	NA
	Completers	176,109	22,391	26.7%
Law	Leavers	156,162	NA	NA
	Completers	182,249	29,763	53.0%
Manufacturing	Leavers	182,968	NA	NA
	Completers	189,234	35,364	37.8%
Marketing	Leavers	150,765	NA	NA
	Completers	158,456	4,883	12.9%
STEM	Leavers	208,228	NA	NA
	Completers	206,531	53,578	49.1%
Transportation	Leavers	154,049	NA	NA
	Completers	158,568	5,947	12.9%

Note: [1] denotes rate of return calculations did not converge. In all cases, returns were "infinity negative."

Table 5: Ranks of Career Clusters by Method

	2008 Wages	Cumulative Change	Annual Change	Present Value	Net Present Value	Rate of Return
Agriculture	9	7	10	10	10	10
Construction	7	2	15	5	5	6
Arts/Comm	14	10	7	12	12	13
Business	13	12	5	14	14	14
Education	11	11	6	13	13	13
Finance	4	14	3	3	2	3
Government	1	1	16	11	11	11
Health	12	5	12	7	7	5
Hospitality	15	15	2	15	15	15
Human Services	16	13	4	16	16	16
IT	8	8	9	6	6	7
Law	6	9	8	4	4	1
Manufacturing	3	4	13	2	3	4
Marketing	10	16	1	9	9	8
STEM	2	3	14	1	1	2
Transportation	5	6	11	8	8	9

Table 5: Spearman Correlation Coefficients by Method

	Wage Levels (2008)	Cumulative Change	Annual Change	Present Value	Net Present Value	Rate of Return
Wage Levels (2008)	1.00*** (0.00)					
Cumulative Change	0.63** (0.01)	1.00*** (0.00)				
Annual Change	-0.63** (0.01)	-1.00*** (0.00)	1.00*** (0.00)			
Present Value	0.76*** (0.00)	0.48 (0.06)	-0.48 (0.06)	1.00*** (0.00)		
Net Present Value	0.76*** (0.00)	0.45 (0.08)	-0.45 (0.08)	1.00*** (0.00)	1.00*** (0.00)	
Rate of Return	0.70*** (0.00)	0.40 (0.12)	-0.40 (0.12)	0.97*** (0.00)	0.97*** (0.00)	1.00*** (0.00)

Note: P-values are shown in parenthesis. 5 percent significance is denotes by *, 2.5 percent **, 1 percent, ***.