Accounting for Investments in Formal Education*

Katharine G. Abraham

University of Maryland and NBER

February 19, 2010
Revised April 14, 2010

* This paper was prepared for discussion at the Bureau of Economic Analysis Advisory Committee meeting to be held May 7, 2010.

Investment in human capital may take many forms. The time that parents spend with their children during the early childhood years can be thought of as an investment in the development of the children's cognitive, emotional and social abilities. Formal education, from the primary grades through college and postgraduate studies, represents a further investment in the development of students' capacities. After leaving school, individuals may engage in structured training or less formal learning on the job. More broadly, medical care, diet, and exercise may be considered forms of investment in human capital. While few would quarrel with the idea that all of these investments may have significant value, measuring that value poses significant challenges. My goal in the present paper is to describe and critique alternative approaches to the measurement of investment in formal education.

The first section of the paper sketches a framework for an education satellite account in which both the costs of education and the returns to education would be tallied. Section II discusses measurement of the costs of education and Section III addresses a variety of issues that may arise in attempting to value education based on the projected returns to additional years of schooling. The construction of real output measures for formal education is discussed briefly in Section IV. Concluding observations are offered in Section V.

I. A Framework for Accounting for Investment in Education

Work on the measurement of investments in human capital generally and investments in formal education specifically has a long history, dating back at least to

Machlup (1962) and Schultz (1961). Non-human investment goods typically are valued based on their selling prices, but in modern societies the human capital embodied in human beings cannot be bought and sold. Scholars have adopted one of two competing approaches to quantify the value of investments in human capital. In one strand of the literature, perhaps best exemplified by Kendrick (1976), investment in human capital is estimated based on the costs of that investment; in the second strand of the literature, developed most notably in an important series of papers by Jorgenson and Fraumeni (1989, 1992a, 1992b), the same investment is measured using information on the future stream of earnings that the investment can be expected to provide.

These competing approaches parallel the two approaches to the measurement of output that are embedded in the double-entry bookkeeping of the national income and product accounts, in that the former is based on the costs of producing formal education (corresponding to the income side of the national accounts) and the latter on the value of the resulting output (corresponding to the production side of the national accounts). In the national accounts, the compensation paid to the factors of production responsible for national output should equal the dollar value of sales for final demand, meaning that the two estimates provide a check on each other. In principle, albeit with some complications, a similar double-entry bookkeeping structure could be applied to the development of satellite accounts designed to track activities, such as investment in human capital, that have a non-market dimension. In the case of formal education, this implies a need for measures both of the cost of formal education (inputs) and of the present value of the return to that education (output).

Inputs to formal education include market inputs such as teacher time, books and supplies, and fixed educational capital. The costs of these market inputs to formal education are already incorporated in the existing national accounts. In addition, investment in formal education requires a substantial amount of non-market time – primarily student time but also the time of parents and other unpaid adults – that is not reflected in the existing accounts. Measurement of the full cost of formal education thus requires data on the non-market time allocated to education, together with an appropriate valuation for that time.

From an output perspective, the value of education consists of enhanced capacities that yield future returns. These returns may take the form of increased workplace productivity that is manifested in higher earnings, but also may take the form of increased productivity in non-market activities. Because human assets are not bought and sold, the only feasible approach to valuing the output of education is to attempt to calculate the present value of the stream of returns to those assets.

In practice, estimates of human capital investment based on valuation of future returns to education generally have been much larger than estimates based on the costs of that education. This raises the question of whether, even in concept, we should expect the two measurement strategies to produce similar results. In contrast to the market accounts, where money spent on purchases for final demand must flow into someone's pocket as income, there is no conceptual identity between returns and costs for investments in education. If individuals were risk-neutral decision-makers bearing the full cost of investment in their own human capital, we would expect the marginal costs of investment in formal education to equal to the expected present value of the marginal

returns, though even in this case, we would not necessary expect the expected present value of the aggregate returns to education to equal the total cost of inputs to education. Making things more complicated, from the individual's perspective, investments in human capital are risky and risk-averse individuals are likely to invest less in education than would be socially desirable. Liquidity constraints that limit the amount individuals can borrow to finance investments in their own education may have a similar effect. In either case, these considerations would lead one to expect the average rate of return on investments in education to exceed the rate of return on diversifiable assets. On the other hand, at least in the developed world, investments in education are highly subsidized. Students and their families bear little if any of the direct costs of education at the elementary and secondary level and, even at the post-secondary level, tuition paid typically does not cover the full cost of the educational services provided. The existence of these subsidies may offset the dampening effects of risk and liquidity constraints on educational investments. From an accounting perspective, one way to think about any excess of returns over costs associated with investments in formal education is to treat these excess returns as "profits" accruing to the household sector, somewhat analogous to the profits accruing to the business sector in the conventional accounts.

While this all makes conceptual sense, the very large size of some measures of the residual returns to households in connection with their investments in formal education raises concerns about potential measurement problems. On the input side of the ledger, existing measures may fail to account for all of the relevant costs of investment in formal education. More importantly, on the output side, there are a number of reasons to think that existing estimates may overstate the returns to formal education. Understanding the

reasons for discrepancies between cost-based and return-based estimates of investment in formal education will be an important part of developing any useful human capital satellite account. I return to these issues later in the paper.

A full accounting structure for an education satellite account will require not only estimates of the nominal value of each year's investments in education, but also estimates of prices and/or quantities so that the real value of these investments can be tracked over time. Knowing any two out of three of the elements in the V = p * Q identity, where V is nominal output, p the price of output and Q quantity or real output, allows the third to be identified. For expenditure-side estimates of output in the conventional accounts for market goods and services, it is most common to start with some measure of nominal output (V) and then use information on prices (p) to derive real output (Q). In the case of non-market goods and services, however, data on prices are not commonly available. Absent data on prices, the more typical strategy in the non-market context is to combine measures of nominal value with indicators that can be used to track real quantities over time, and then to derive the trend in prices implicitly based on the ratio between the nominal value and real quantity measures.

II. Input-Based Measurement of Investment in Education

In the existing national income and product accounts, the output of the education sector is measured using information on the cost of the market inputs required to produce that output. The largest share of market costs is accounted for by teacher and staff salaries, but expenditures for materials as well as capital costs also are included in the existing accounts. There are clearly issues concerning the measurement of some of these

items, including how to capture the cost of capital services (Abraham and Mackie 2005) and, for higher education, how to separate education expenditures from research and other types of expenditures. A larger issue with the existing measures, however, is their exclusion of the large amount of student time devoted to education, as well as smaller amounts of parent and volunteer time.

The largest share of non-market inputs to education is the time that students devote to their own schooling. Information on school enrollments, attendance rates and academic calendars together with assumptions about the amount of time students spend on homework outside of class can be used to produce reasonable estimates of the amount of time that students invest. Better data on time use should be valuable for refining these estimates and for estimating the time devoted by parents and other unpaid adults to children's education. The American Time Use Survey (ATUS) should be helpful in this regard. Since 2003, the ATUS has collected information on time use and individual characteristics for a sizable sample of people age 15 and older. Together with information on school enrollment status, the survey provides detailed information on the time students devote to their own education and the time unpaid adults devote to activities related to the education of both household and non-household children. The ATUS does have some limitations, the most significant being that it collects no information about time use for individuals younger than 15 years of age. Another potentially important limitation is that the ATUS does not collect information on secondary activities; a parent who reported cooking a meal while supervising their child's homework, for example, would be recorded simply as cooking a meal. Another limitation is that the way in which voluntary activities are coded groups volunteering in

the classroom together with a broader set of volunteer activities, though given the modest total amount of time devoted to the broader class of volunteer activities this cannot be terribly important. Finally, college students living in dormitories almost certainly are under-represented in the survey, though this should be significant only to the extent that students living in dormitories allocate their time differently than other college students.[1]

Valuing the time that students, parents and other adults devote to formal education is arguably more problematic. The two options commonly proposed in the literature for valuing the time devoted to nonmarket activities are either to use the opportunity costs of the individual's time or to use the replacement cost for hiring someone else to perform the tasks in question. Activities related to one's own education – such as attending classes or studying – cannot be performed by another person. Time spent in these activities, therefore, should be valued at the opportunity cost of the student's time. Time that parents and other adult volunteers devote to activities related to children's education more appropriately should be valued at a replacement wage – the market wage that would be paid to a person hired to perform the task in question. This could be either the wage of a generalist, such as the average wage for housekeepers, or the wage of a specialist, such as the average wage paid to hired tutors.

While it is apparent that the time older students spent in own education has an opportunity cost, even younger children could in principle perform tasks that have some value in the market. Compulsory schooling and child labor laws may prevent younger children from working for pay, but there is still a foregone output cost associated with

[1] In principle, college students living in dormitories should be treated as resident in their parents' home and thus eligible for selection into the ATUS at that address, but in practice they seem likely to be overlooked when the household is rostered and, if rostered, difficult to contact.

having these students in school rather than at work. Assigning a dollar value to this opportunity costs is more difficult, though it cannot be a very high figure and setting the opportunity cost of young children's time to zero may be a sensible approximation.

In thinking about the appropriate opportunity cost to assign to time students spend in school, it frequently has been noted that education may have both a consumption dimension and an investment dimension. To the extent that education is more enjoyable than market work, a portion of the opportunity cost associated with time devoted to formal education properly should be allocated to consumption rather than to investment. Alternatively, to the extent that students find the process of education to be more unpleasant than working, the time devoted to education may carry a cost that exceeds the foregone market wage. In practice, I must acknowledge, determining the appropriate adjustment would be difficult, and few past efforts to estimate the costs of education have even attempted to account for the amenity value or disamenity value of time devoted to education rather than to market work. If education has a large unobserved disamenity value, cost-based estimates of investment in education that do not account for this in valuing the time that students devote to their schooling will be understated. .

Similar considerations may come into play with regard to the replacement wage for valuing the time devoted by parents and other volunteers to helping with children's education. A parent who helps a child with homework, for example, may have either higher or lower productivity in that activity as compared to someone hired to do the same job. To the extent that such activities are partly consumption for the parent and only partly focused on the child's learning, one might expect parents' productivity to be lower than that of those who perform the same work for pay. While one ideally would want to

adjust in some fashion for differences in productivity between parents or other volunteers and those who perform similar tasks for pay in valuing the time unpaid adults devote to children's education (see Abraham and Mackie 2005, 2006), in practice an unadjusted replacement wage may be the best feasible measure.

In the United States, data from the Current Population Survey (CPS) typically are used to determine market pay rates for valuing nonmarket time. One limitation of the CPS data is that they capture only wages and salaries and not the value of additional compensation such as paid vacation, health insurance and pension benefits. According to BLS data on employee compensation, wages and salaries account for about two-thirds of the typical compensation package.[2] This means that using just potential wage or salary earnings to value time devoted to education may lead the costs of education to be understated. Unfortunately, existing data sources include only limited information about the value of benefits received broken out by worker characteristics. There should be a way, however, to use this information to strengthen estimates of the value of time devoted to education.

Note that I have not included as part of the cost of investment in formal education the costs of rearing children – the time parents spend caring for young children, food, clothing, shelter and so on. For a measure of total investment in human capital, the costs of raising human beings to the point where they can be productive would need to be included on the cost side of the ledger. On the returns side of the ledger, consistent with the valuation of marketable physical assets, the present value of the future returns to total investments in human capital should be measured net of necessary subsistence

[2] Employer Costs for Employee Compensation (ECEC) data for September 2009 show total compensation averaged $39.83 per hour, of which wages and salaries accounted for $26.24 and other benefits for $13.60.

expenditures, defined in some as-yet-to-be determined fashion. Similarly, as discussed by Rosen (1989), the present value of the stock of human capital assets should be measured net of maintenance costs. In the context of valuing the flow of investment in formal education, however, necessary subsistence can be taken as given – a person's basic needs must be met regardless of their educational attainment and there is no reason to expect necessary subsistence to rise with the level of education. Neither the incremental cost of obtaining additional formal education nor the incremental returns to additional formal education should be affected by these necessary rearing and maintenance costs.

III. Using Expected Returns to Measure Investment in Education

A second method of measuring investment in education is to use the incremental earnings approach pioneered by Jorgenson and Fraumeni (hereafter J-F) for the United States (1989, 1992a, 1992b) and subsequently applied to data for a growing number of other countries (see, for example, Gu and Wong, 2008, for Canada and Wei, 2004, 2006, 2007, and 2008, for Australia). The basic idea behind the J-F methodology is that an individual's human capital has a worth equal to the expected present value of their future market and non-market labor incomes. The value of an investment in formal education, then, is equal to the increase in this present value attributable to acquiring the specified increment of formal education. While it seems clear in principle that some variant of the J-F methodology is the only feasible output-based method for valuing investments in formal education, there are legitimate questions about existing implementations of this methodology. The very large size of the estimates typically yielded by the J-F

methodology relative to corresponding cost-based estimates may serve as a caution against taking first-generation J-F estimates at face value.

The Jorgenson and Fraumeni Methodology

The details of the J-F methodology have been laid out in a number of other papers; here, I sketch the J-F approach briefly to provide the necessary background for a discussion of various concerns that have been voiced about it. To determine the value of investments in formal education, J-F begin by calculating the present value of lifetime earnings for the oldest individuals in their data set and working backwards. Suppose that the oldest group is age 75. Assuming for simplicity that no one over the age of 75 is employed, the present value of market income for this group is just equal to market income at age 75. For a 75-year old in year y of sex s and education level e, this can be written:

$$mi_{y,s,75,e} = ymi_{y,s,75,e}$$

where mi is the present value of lifetime market earnings and ymi is market earnings in the current year. Now consider the lifetime earnings of a person age 74. This equals current earnings as of age 74 plus the expected value of future earnings as of age 75, which can be written:

$$mi_{y,s,74,e} = ymi_{y,s,74,e} + (1+\rho)^{-1} sr_{y,s,75} (1+g) mi_{y,s,75,e}$$

where ρ is the annual discount rate, sr is the probability of survival for a person of the indicated sex and age, and g is the yearly rate of growth in labor income. One can work backwards in the same fashion to younger age groups. Similar expressions also can be written down for non-market labor income. The value of non-market time is assumed to

be equal to the value of market time less the marginal tax rate on labor income. J-F assume that, except for 10 hours per day devoted to personal maintenance activities and (at younger ages) 1300 hours per year devoted to education by people who are in school, individuals not engaged in market work engage in productive non-market activities.

In the J-F calculations, persons age 35 through 75 do not enroll in school. Between ages 5 and 34, however, individuals may choose to acquire additional education. Expected future earnings in these age groups incorporate not only the returns to the level of education already obtained but also the returns to additional schooling the individual can be expected to acquire. For example, in describing how future labor income would be projected for a person with either the highest or the next-highest number of years of education, Jorgenson and Fraumeni (1992b) explain:

> For an individual of a given age and sex enrolled in the highest level of formal schooling, which is the 17th year of school or higher, lifetime labor income is the discounted value of labor incomes for a person with 17 years or more of education. For an individual enrolled in the 16th year of school, lifetime labor income includes the discounted value of labor incomes for a person with 17 years of formal education or more, multiplied by the probability of enrolling in the 17th year of school, given enrollment in the 16th year... It also includes the discounted value of labor incomes for a person with 16 years of education, multiplied by one minus this probability, which is the likelihood of terminating formal schooling at 16 years. (p. 309)

More generally, expected market income for a person with s years of schooling equals:

$$mi_{y,s,a,e} = ymi_{y,s,a,e} + (1+\rho)^{-1} sr_{y,s,a+1}(1+g)\left[senr_{y,s,a,e} mi_{y,s,a+1,e+1} + (1-senr_{y,s,a,e}) mi_{y,s,a+1,e}\right]$$

where senr is the probability of enrolling to complete an additional year of schooling. Again, non-market labor income can be specified similarly.

For any individual, the value of investing in an additional year of schooling (moving from educational level e to e+1) at any age a is equal to the difference between the expected value of labor income for a person who does and does not acquire that extra

schooling. For example, the investment in human capital for an individual who enrolls in and completes the 17th year of schooling is calculated as the difference between the expected present value of future labor income for a person of a given age and sex with 17 years of education and the corresponding value for a person of the same age and sex with 16 years of education.

To calculate the total investment in formal education in a given year, data on the number of people by age, sex, level of education and school enrollment status are required. Earnings by age, sex and years of education are taken from current cross-sectional data. Assumptions about discount rates and the annual growth of labor income have varied somewhat across studies, but typical figures are in the range of 4 to 5 percent a year for ρ and 1 to 2 percent per year for g.

Critiques of the Jorgenson and Fraumeni Methodology

While few would argue in concept with the idea that the value of investments in formal education must reflect the future returns attributable to that investment, questions have been raised about some of the particulars of the J-F calculations. Some of these questions reflect discomfort with the idea of using earnings as proxy for productivity or the idea of using cross-sectional earnings differentials to draw conclusions about the value of future earnings streams for individuals who acquire different amounts of education. Many of the questions, however, seem to be related in some fashion to an underlying discomfort with the magnitude of the J-F estimates relative to cost-based estimates of the value of the same investments.

Several possible explanations for the large size of the J-F estimates relative to cost-based estimates suggest themselves. One factor is the likely difference between the discount rate individuals use in making education decisions versus the lower discount rate used in the J-F calculations to value future labor income. Further, the J-F estimates of the returns to education build in assumed future productivity growth that may not properly be attributable to the education decisions individuals have made. Another contributing factor may be that, because of heterogeneity across individuals, the projected earnings of highly-educated people had they not continued in school in a given year might be higher than assumed in the J-F calculations, meaning that the true return to the incremental years of schooling acquired by these individuals may be lower. In addition, some of what J-F count as returns to education may actually represent returns to other human capital investments, for example, parental investments in young children or on-the-job training that occurs subsequent to the completion of formal schooling. Finally, the J-F estimates would not be so large if only the returns to market work were captured; the calculations in J-F (1989, 1992a, 1992b) assume, however, that people realize returns to past education for 14 hours/day, 7 days a week, exclusive of time in school, whether or not the person is engaged in market work. I discuss each of these concerns in turn.

Use of Wages as Proxy for Productivity. Implicit in the J-F methodology is that differences in market wages reflect differences in individuals' productivity. As already noted with reference to estimates of the costs of investment in education, in addition to receiving higher wages and salaries, more highly educated workers also tend to receive more generous benefits packages. Although data on the value of benefits received broken out by worker characteristics are limited, it seems reasonable to think that they could be

used to refine estimates of the returns to education based on wage rates exclusive of benefits.

A more fundamental question is whether higher compensation should be assumed to reflect higher productivity. In the case of both education and experience, it is easy enough to accept this presumption, though alternative interpretations could be advanced. In the case of differences in earnings by sex, however, the assumption that the higher average pay earned by men necessarily reflects their higher productivity compared to women with the same years of education and experience seems more questionable.

One argument for including sex as a factor in the J-F earnings projections is that, in their data, experience cannot be observed directly but must be proxied using information on age and years spent in school. Because women tend to be less attached to the labor force than men, women with any given number of years of proxy experience will tend to have fewer years of actual experience than observationally similar men, though this has become less true over time. Women and men also differ in life expectancy at any given age. I do not in any case have a good alternative to the standard assumption that compensation reflects productivity to propose, but merely note this point about the nature of the J-F estimates.

Use of Synthetic Cohort Data to Proxy for Future Earnings Expectations. A somewhat different criticism of the J-F estimates is that the synthetic earnings profiles observed in cross-sectional data may do a poor job of capturing the earnings that individuals will actually realize over their lifetimes. For example, the extra earnings that someone who is 25 can expect to realize when they are 55 if they acquire a 15th year of schooling today may differ from the earnings premium earned by today's 55 year olds

who acquired a 15th year of schooling thirty years ago. Among the factors that might affect the size of the realized versus the projected earnings premium are secular changes in the supply of people who attain different levels of education, long-term changes in the relative demand for more versus less educated workers or purely cyclical factors. While it is true that all of these supply and demand factors might affect the future returns to education, it nonetheless seems appropriate to use current earnings differentials to identify the current value of having different amounts of education. This is, after all, the information that individuals making schooling decisions are most easily able to observe and that, except perhaps for the most sophisticated, on which their estimates of the potential payoff to schooling are likely to be based. Changes in relative earnings by age and education level from one year to the next then may be treated as revaluations of the stock of human capital (see Christian 2009), similar to the revaluations of non-human physical capital that occur if changes in supply or demand make existing assets more or less valuable.

A somewhat different question is whether attaining a given number of years of education represents the same amount of investment today as in the past. Changes in the length of the school year, the length of the school day, class sizes or the quality of instruction all could mean that any given number of years of schooling represents something different today than was the case in the past. If, say, the quality of instruction in the junior year of high school has risen, one might expect the returns to completing that year of school to be higher for today's high school sophomores than would have been the case for students in previous decades. Similarly, changes in the mix of subjects taught could be important. A shift from science and engineering to "softer" disciplines

among those receiving college degrees, for example, could affect the returns one would expect to earning a college degree. In principle, it might be possible to account for these sorts of changes in calculating the expected returns to education for today's students; in practice, this undoubtedly would be difficult.

Choice of Discount Rate. Another factor that has a significant effect on the J-F estimates is the choice of discount rate. Because an individual's investment in formal education cannot be diversified, such investments are risky from the individual perspective and a relatively high rate of return may be needed to induce individuals to remain in school. From the perspective of the society as a whole, however, investments in formal education are diversified across individuals and thus considerably less risky, meaning that future returns to these investment should be discounted at a lower rate. The discount factor used in empirical implementations of the J-F methodology for calculating the present value of future returns represents the time value of money or risk-free rate of return. If individuals act to equate the (marginal) benefits and (marginal) costs of their investments in education, using a lower discount rate than applied by the individual to value future returns will produce estimated returns to education that exceed the estimated costs.

To make this point more concrete, consider an individual who makes an investment in human capital that cost $1,000, including any foregone labor income, and has an expected yield of $100 per year for 40 years. The anticipated internal rate of return on this investment would be approximately 9.8 percent, roughly in line with estimates of the rate of return to education prevailing in the literature. Using a discount rate of 4 percent per year to convert the expected stream of returns to a discounted

present value, however, would imply a value for the asset of $1,979. In this example, the social value of the investment using the J-F approach ($1,979) considerably exceeds its cost ($1,000).

One possible method of recognizing this sort of discrepancy in a satellite account for formal education would be to construct an entry on the cost side of the accounting ledger that equals the difference between the expected value of the future returns to formal education evaluated using the social discount rate ($1,979 in my example, assuming a value for ρ of 4.0 percent) and the expected value calculated using a discount rate that represents a reasonable individual rate of return. This entry could be thought of as compensation for the risk that individuals assume when they make non-diversifiable investments in formal education.

Treatment of Aggregate Productivity Growth. Another important element of the J-F calculations is the assumed annual rate of growth in labor income. In calculating the return to education, real earnings at each level of education are assumed to grow by g percent per year. Because the base earnings to which this growth rate is applied are larger for those with more education, building earnings growth into the calculations raises the value of educational investments. One can ask, however, whether this treatment is appropriate. To the extent that earnings growth reflects productivity improvements made possible by investments in physical capital or knowledge capital (e.g., research and development spending), these added returns should not be attributed to the initial investment in education.[3]

[3] I have heard this point attributed to William Nordhaus, but have not been able to find a discussion of it in his published work..

How much difference does the incorporation of projected growth in earnings make in calculating the returns to education? This question would be best answered through a more careful sensitivity analysis of existing estimates, but some simple calculations may be illustrative. Recall the previous example of an investment in formal education that yields a return of $100 per year for 40 years. Discounted at 4 percent per year, that level stream of returns has a present value of $1,979. Had it instead been assumed that the $100 return would grow by 1 percent per year over the 40 years, the present value of the investment would be $2,323, or about 17 percent more. The larger the assumed growth rate for earnings, of course, the larger the estimates that allow for growth relative to those that do not.[4]

Counterfactual Earnings for Those Who Pursue Additional Education. Another issue with regard to the J-F estimates of the returns to formal education concerns the appropriate set of assumptions about what would have happened to these people had they not continued with their schooling. There are two ways in which assumptions about the appropriate counterfactual for calculating the return to obtaining an additional year of schooling could go wrong. First, it could be the case that more highly-educated individuals would have had higher earnings than less-educated individuals even without the additional schooling they acquired. Second, as noted by Christian (2009), even if a highly-educated person had not gone on in a particular year to acquire additional schooling, the odds of their doing so in some subsequent year could be higher than the odds for the average person of the same age and educational attainment. In either case,

[4]Note that, to a first approximation, *raising* the assumed rate of growth in earnings will have the same effect as *lowering* the assumed discount rate by the same amount.

the usual J-F calculations may yield too large an estimate of the returns to formal education.

The former issue is familiar from the literature on the returns to schooling. If high ability individuals find continuing in school less onerous than low ability individuals, education may serve the function of signaling high ability rather than of enhancing students' capacities (Spence 1973). To the extent that this explains the higher earnings of more educated individuals, the J-F methodology may overstate the social return to education, which generally is assumed to arise because education raises individuals' productivity (Conrad 1992). While a concern in principle, the extensive literature on returns to education (see, for example, Card 2000) suggests that any pure ability bias in estimates of the return to schooling may not be large.

The second problem relates to the assumption made in the J-F formulation about how continuing in school affects the odds of later acquiring additional schooling. To illustrate, consider how the J-F calculations treat a 17-year-old who already has 11 years of schooling and then either completes or does not complete the 12th year of schooling. To determine the present value of completing the 12th year of schooling, the projected future earnings for an 18-year-old who has done so are compared to the projected future earnings of someone age 18 with 11 years of schooling. The projected future earnings of the latter individual include some probability of completing the 12th year of schooling at a later age, but because an 18-year-old with just 11 years of schooling has fallen off the educational track, the probability of their continuing in school is relatively low. Christian (2009) suggests that, had the 18 year old with 12 years of education not finished that last year of schooling, a better counterfactual might be that the probability of their doing so is

the same as for a 17 year old with 11 years of schooling – a person who is still on track educationally – rather than that for an 18 year old with 11 years of schooling.

Christian (2009) shows that assumptions about future enrollments have a significant effect on the estimated returns to formal education. Under the standard J-F counterfactual, in 2005, the market component of gross investment in education had a value of $16 trillion. Under the alternative assumption that, had a person who acquires a year of education not done so, their odds of doing so subsequently would have been the same as for a person with the same initial education who is a year younger – that is, as for a person who had not fallen off track educationally – the market component of gross investment in education in 2005 equaled just $3.1 trillion.[5]

Confounding Returns to Other Human Capital Investments. Another factor that may cause the J-F estimates of investment in formal education to be overstated is the confounding of returns that properly should be attributed to other types of human capital investment with the returns to formal education. Parental investments in their children may be the clearest case. Suppose that the children whose parents invest more in them at young ages (e.g., reading to them, providing a range of stimulating experiences, offering access to books in the home, and so on) also tend to acquire more years of schooling and, holding educational attainment constant, to have higher wages later in life. The costs of this parental investment generally are not reflected in cost-based measures of investment in education, which include only the value of time parents spend in activitiese directly related to their children's formal education. The returns to early childhood parental

[5] Christian (2009) chooses to focus on the net return to education – comparing the projected earnings of a person of age a+1 and e+1 years of schooling to those of a person of age a with e years of schooling – rather than the gross returns. In effect, however, as can be seen in Figure 5 of his paper, this is almost equivalent to making the second of the counterfactual assumptions just discussed.

investments, however, would be captured in the higher average earnings of more educated as compared to less educated individuals, and thus wrongly attributed to the education they received. Without further study, unfortunately, it would be difficult to say how important this factor might be.

Any correlation between years of education and the amount of on-the-job-training later in life also could affect the estimated returns to education. The argument here is slightly more complicated than that for early life parental investments. If it were the case that individuals discounted future returns to on-the-job training at a rate equal to the time value of money and invested up to the point where costs (in the form of foregone earnings during the training period) equaled returns (in the form of higher earnings following the training), larger investments in on-the-job training by more highly educated people would not affect estimates of the returns to education. If, however, individuals see investments in on-the-job training as risky and apply a higher discount rate in deciding whether such investments are worthwhile, the returns to on-the-job training evaluated at the risk-free discount rate will exceed the costs. To the extent that highly-educated people are more likely to invest in on-the-job training, this would lead the estimated returns to formal education to be overstated.

To assess the size of any resulting bias in estimates of investment in formal education from this latter source, one would need to know the amount of time that individuals devote to on-the-job training, broken out by age, sex and level of education. Unfortunately, because so much on-the-job training is informal rather than formal, this is apt to be difficult to determine. If it could be measured, given the discount rates applied by individuals in making decisions about on-the-job training and the time value of

money, it would be possible to back out the excess return to on-the-job training that otherwise would be counted as part of the return to formal education.

Valuation of Non-Market Time. A final reason for the large size of the J-F estimates of the return to education is the decision to value non-market as well as market time in the calculation of these returns. There is a growing body of evidence that education has significant benefits that extend beyond its positive effect on individuals' market productivity. The private benefits attributable to education may include better health and improved longevity; in addition, there also may be significant externalities associated with education, such as a more-informed electorate and lower crime rates (Abraham and Mackie 2005). The J-F methodology focuses exclusively on the private benefits of education and assumes that these benefits can be associated with the time that individuals devote to their daily activities. Except for time devoted to necessary personal maintenance activities (assumed to require 10 hours per day) and time devoted to further schooling (assumed to require 1,300 hours per year while in school), individuals are assumed to realize returns to non-market time that equal the person's wage rate net of taxes on labor income. Defined in this way, the non-market returns to education are very large, reflecting the fact that a majority of the average adult's discretionary time is spent in activities other than market work. In the calculations reported in J-F (1992b, p. 333), for example, non-market returns account for roughly 60 to 65 percent of the total value of investment in education in most years.

One objection to valuing non-market hours as prescribed in the J-F methodology is that individuals may not in fact be able to choose their hours of work freely. Many jobs are a package deal, with job-holders typically expected to work a fixed number of

hours in exchange for a specified level of compensation. This may be true whether they are paid a salary or an hourly wage rate. If an individual does not have the option of working more hours at their average wage rate, the value of the marginal non-market hour may lie below the value of the marginal market hour even after adjustment for taxes (Rosen 1989). In this case, the value that the J-F methodology assigns to non-market time will be too large.

Moreover, market wage rates are used in the J-F calculations to value non-market time even for individuals who are not in the labor force. This creates a different problem. One would expect that, among those with the same age, sex and education, labor force participation is apt to be positively correlated with expected wages. Valuing the non-market time of those who are out of the labor force at the wage rate earned by working people with the same observable characteristics seems likely to overstate the value of that time.

A frequent source of unease about the J-F approach to the valuation of nonmarket time is the sense that education is unlikely to raise the value of non-market time in the same way that it raises market productivity (see, for example, Abraham and Mackie 2005). Graduate work in economics, for example, might make a person knowledgeable about econometric methods and for that reason a more valuable employee in the right type of job, but it is unclear how possessing these skills would add to productivity in home production or to the likely enjoyment of leisure activities. More generally, while there are many home activities in which more educated individuals seem likely to enjoy a productivity advantage – for example, making healthy food choices or reading to children – there are many other activities in which there is no reason to think this should be the

case – for example, cleaning the bathroom or doing the laundry. This suggests that, in principle, education should be allowed to raise the productivity of time devoted to different sorts of activities by different amounts, perhaps including some activities for which education does not raise productivity at all. In practice, unfortunately, it is not obvious how one would come up with the appropriate adjustment factors.

Considering the possible effect of additional education on the enjoyment associated with leisure activities raises further issues. Does it really make sense, for example, to think that a highly-educated baseball fan derives more enjoyment from watching a World Series game on television than a less-educated baseball fan? Even if a highly-educated individual allocates her time differently than a less-educated individual, does it make sense to say that the more-educated individual derives greater enjoyment from attending a symphony performance than the less-educated individual derives from attending a football game? These are questions that may be inherently unanswerable and assuming that all the discretionary time of highly-educated people should be valued at a uniformly high rate for the purpose of estimating the returns to education has struck many as difficult to defend.

In thinking about the types of non-market activities for which it should be assumed that there is a return to education, one might also appeal to existing conventions about the production boundary for national economic accounting. With few exceptions, the production boundary for the current national accounts encompasses only market output. There have been many proposals for satellite accounts that would encompass only non-market output, but these typically would extend the production boundary only to encompass services that could in principle have been purchased from 3rd party

suppliers. For example, it has been suggested that satellite accounts for home production should encompass cooking, cleaning, and home repairs, but generally not the enjoyment associated with watching television. In this context, incorporating any added enjoyment that education may allow an individual to derive from his or her activities seems at odds with the general philosophy underlying the national accounts. While the original J-F estimates incorporated both market and non-market returns to education, J-F-type estimates constructed for other countries typically have been restricted to the market returns.

IV. Real Output Trends

In addition to nominal measures of the costs and returns to investment in formal education, a full accounting for investment in formal education also requires real measures on both the input and the output side of the accounts. One option is to produce real estimates by identifying price deflator(s) to use in conjunction with either the cost-based or the returns-based nominal estimates. In the literature on the measurement of educational output, however, a more common approach is to construct quantity indexes that can serve to track real input or real output trends.

Price Deflators for Formal Education. In the existing accounts, the nominal output of the education sector is measured using information on the costs of the inputs used to product educational output. For inputs incorporated in these accounts, associated price deflators already have been identified. The major non-market inputs not currently measured are student time, parent time and the time of other unpaid adults. Nominal measures of the value of nonmarket time inputs start with measures of the hours devoted

to educational activities that then are valued using either an opportunity wage or a replacement wage. Price deflators for these inputs thus are not required. The opportunity costs and replacement costs attached to different time inputs could be used to weight the hours of different types of education time for the purpose of constructing an index of real inputs to education.

On the output side, it is less clear what an appropriate deflator for nominal measures based on the stream of future labor income might be. Wei (2004) argues that, because the extra money that more educated workers earn largely will flow to consumption, a Consumer Price Index (CPI) is a suitable deflator. More commonly, however, researchers have turned to quantity indicators to identify the trend in the real output of formal education, using that information together with data on nominal spending to back out the implicit trend in the price of educational output.

Output Quantity Indicators. The simplest output quantity indicators for estimates of investment in education track the number of students who are enrolled in school each year. In the existing accounts, the nominal output of education is measured using the cost of inputs to education. Different types of students may require different amounts of these inputs and it has been suggested that an education quantity index should be formed based on data disaggregated by relevant student characteristics. For starters, this might include level of education (e.g., elementary, secondary or post-secondary). In addition, as discussed by Fraumeni, Reinsdorf, Robinson and Williams (2008), it may be important to differentiate along the lines of other student characteristics such as regular versus special education or native versus non-native English speaker.

For a measure of educational output based on the J-F methodology, the value of an additional year of education depends on the student's age, sex and grade level. A quantity index thus should rest on student counts disaggregated along these dimensions. Different quantity index formulas then will attach different values to the schooling these students acquire. A Laspeyres quantity index, for example, would value the increments to education acquired by students in each age/sex/grade level cell using the base period returns for an individual of the given age and sex of acquiring the specified year of schooling.

A significant challenge in applying the indicator approach is adjusting for changes in the quality of the education that students receive. Looking at changes in the quantity or quality of the inputs used to educate students is one way to do this. The idea behind this approach is that there is a production function for education in which output depends on the inputs to the process. Based on research by education specialists, factors that might affect the quality of the education students receive include class size and teacher qualifications such as degrees earned, whether the teacher has been trained in the subject being taught and years of teaching experience (see Christian and Fraumeni 2005, Fraumeni, Reinsdorf, Robinson and Williams 2008). While it seems plausible that all of these things might affect the quality of education, evidence on the nature and magnitude of these effects is unfortunately sparse. In an expanded accounting structure that recognized inputs of unpaid time as well as market inputs to education, one also might ideally want to adjust for changes in the quality of parent and volunteer time. If the average parent has become more educated, for example, one might expect the

productivity of the time they spend in school-related activities that benefit their children to have risen.

As an alternative to looking at the inputs to students' education and attempting to adjust for changes in the quality of those inputs, one might instead look at outcome measures such as average test scores or the share of students who are promoted to the next grade level or who graduate. The idea here is that higher quality education should lead to better student outcomes. Compared to looking at the quality of educational inputs, outcome measures have the advantage of reflecting, albeit imperfectly, what students actually know, though there are some obvious problems of data availability and comparability of the measures over time. Perhaps more importantly, these outcomes may not be attributable purely to what students learned in school, but may also reflect family and environmental influences.

In practice, the quality-adjusted quantity indexes that researchers have constructed typically have accounted for relatively little of the nominal growth in the per-student cost of education, implicitly attributing most of that nominal growth to higher prices. This may be correct, but it also may be that the quality-adjusted quantity indexes have simply done a poor job of capturing actual improvements in the quality of education.

V. Conclusion

In this paper, I have argued for a double-entry approach to accounting for investments in formal education. In contrast to the two sides of accounts that are focused on market activity, cost-side and output-side estimates of investment in formal education will not necessarily give the same answer even in principle. If the two approaches give

very different answers, however, it seems important to understand the reason(s) for this large discrepancy.

The largest part of the paper has been devoted to a discussion of the Jorgenson and Fraumeni methodology for estimating the return to investments in education based on future streams of labor income. This discussion has been primarily at a conceptual level and has given short shrift to the many difficult nuts-and-bolts issues that complicate the preparation of estimates in practice (e.g., data on school enrollment or educational attainment that are not broken out by single year of education). I have argued that there are a number of reasons to believe that existing J-F estimates of the returns to education may overstate the returns to formal education. Among the major challenges for future efforts to refine these estimates, I would include refining the counterfactual assumption about future schooling for those who invest in education; measuring other investments in human capital and finding ways to account for any confounding effects of those investments on estimated returns to education; refining estimates of the non-market returns to education; and developing methods to account for changes in the quality of education over time. In principle, I agree with Jorgenson and Fraumeni that the only feasible option for developing output-based estimates of investment in human capital is to make use of estimated future returns. While I have questions about some of the particulars of the J-F calculations and for that reason am somewhat skeptical of the first-generation J-F estimates that have been produced to date, these estimates make clear that investments in formal education are significant in magnitude and provide a good foundation for future work in this important area.

References

Abraham, Katharine G. and Christopher Mackie, eds.. 2005. *Beyond the Market: Designing Nonmarket Accounts for the United States*. Washington, DC: National Academies Press.

----------. 2006. "A Framework for Nonmarket Accounting" In *A New Architecture for the U.S. National Accounts*, eds. D. Jorgenson, S. Landefeld and W. Nordhaus. Chicago: University of Chicago Press, 161-192.

Card, David. 2000. "Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems." National Bureau of Economic Research Working Paper 7769. June.

Conrad, Klaus. 1992. "Comment on 'Investment in Education and U.S. Economic Growth,' by Jorgenson and Fraumeni." *Scandinavian Journal of Economics*, Vol. 94, Supplement, S71-S74.

Christian, Michael S. 2009. "Human Capital Accounting in the United States: 1994 to 2006." Wisconsin Center for Education Research. Unpublished working paper.

Christian, Michael and Barbara M. Fraumeni. 2005. "Measuring the Education Function of Government." Unpublished. Bureau of Economic Analysis.

Fraumeni, Barbara M., Marshall B. Reinsdorf, Brooks B. Robinson and Matthew P. Williams. 2008. "Price and Real Output Measures for the Education Function of Government: Exploratory Estimates for Primary and Secondary Education." National Bureau of Economic Research Working Paper No. 14099. July.

Gu, Wulong and Ambrose Wong. 2008. "Human Development and Its Contribution to the Wealth Accounts in Canada." Paper prepared for the OECD Workshop on the Measurement of Human Capital, Fondazione Giovanni Angelli, Turin. November 3-4.

Jorgenson, Dale W. and Barbara M. Fraumeni. 1989. "The Accumulation of Human and Nonhuman Capital." In *The Measurement of Saving, Investment and Wealth*, eds. Robert E. Lipsey and Helen Stone Tice. Chicago: University of Chicago Press, 227-281.

----------. 1992a. "Investment in Education and U.S. Economic Growth." *Scandinavian Journal of Economics*, Vol. 94, Supplement, S51-S70.

----------. 1992b. "The Output of the Education Sector." In *Output Measurement in the Service Sector*, Zvi Griliches, ed. Chicago: University of Chicago Press, 303-338.

Kendrick, John W. 1976. *The Formation and Stocks of Total Capital*. New York: Columbia University Press.

Machlup, F. 1962. *The Production and Distribution of Knowledge in the United States*. Princeton: Princeton University Press.

Rosen, Sherwin. 1989. "Comment on 'The Accumulation of Human and Nonhuman Capital,' by Jorgenson and Fraumeni." In *The Measurement of Saving, Investment and Wealth*, eds. Robert E. Lipsey and Helen Stone Tice. Chicago: University of Chicago Press, 281-285.

Rothschild, Michael. 1992. "Comment on 'The Output of the Education Sector,' by Jorgenson and Fraumeni." In *Output Measurement in the Service Sector*, ed. Zvi Griliches. Chicago: University of Chicago Press, 339-341.

Schultz, T.W. 1961. "Investment in Human Capital." *American Economic Review*, March, 1-17.

Spence, Michael. 1973. "Job Market Signaling." *Quarterly Journal of Economics*, 355–374

Wei, Hui. 2004. "Measuring the Stock of Human Capital for Australia." Working Paper No. 2004/1, Australian Bureau of Statistics. February.

----------. 2006. "Measuring Option Values and the Economic Benefits of Completing Secondary Education." Paper Prepared for the Methodology Advisory Committee, Australian Bureau of Statistics. November 17.

----------. 2007. "Measuring Australia's Human Capital Development: The Role of Post-School Education and the Impact of Population Ageing." *Statistical Journal of the IAOS*, 183-191.

----------. 2008. "Developments in the Estimation of the Value of Human Capital for Australia." Paper prepared for the OECD Workshop on the Measurement of Human Capital, Fondazione Giovanni Angelli, Turin. November 3-4.