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SESSION III

Measuring the education output of government Using a human capital approach: What might estimates show?

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INTRODUCTION

1. Most European statistical agencies are developing new measures of government output to comply with the European System of Accounts (ESA). ESA 1995 [Eurostat 1995] calls for direct volume measures for most government output, including education, instead of input-based measures.

2. Difficulties with implementing direct volume measures by the Office for National Statistics of the United Kingdom led to the Atkinson Review [Atkinson, 2005]. A number of conference sessions, full conferences, and consultations have been held over the past couple of years to develop and improve the direct volume measures for government output with considerable time devoted to the topic by both statistical agencies and private researchers. These efforts are likely

[1] This paper has been prepared at the invitation of the secretariat.

to continue well into the future as there are significant measurement problems associated with developing the new output estimates.

3. This paper concludes that a human capital approach to measuring the education output of government is highly likely to be fruitful. Growth rates from the human capital approach would be used to estimate the volume of government education output. The discussion in this paper will center on feasibility and whether a human capital approach is likely to provide estimates that are significantly different from approaches primarily driven by enrollment growth rates.

4. Last summer Dale Jorgenson, Barbara Fraumeni, and Michael Christian began a research project to extend and revise the Jorgenson-Fraumeni (J-F) investment in education estimates for the United States (1992a, 1992b). A preliminary report on the first stages of this project was presented at an OECD/ONS/Government of Norway workshop in London in the Fall.[2]

5. The original J-F project was a massive project which took some 5-10 years to complete. The length of time was in part due to the time involved in conceptualizing and implementing new methodology, but it was also due to the size of the data collection effort. A number of investigators were involved in preparing inputs to the estimates, most notably Chinloy, Gollop and Ho, who constructed a labor data base on wages, hours worked, and employees by age and education categories. The J-F human capital estimates were constructed by single year of age and education. Realistically such an effort cannot be supported on an on-going basis.

6. Accordingly, the J-F-C project is asking the question: Can robust estimates be constructed with a blend of categorical data from the labor data base maintained by Ho and information on enrollment and population by single year of age and grade enrolled or highest education level completed?

7. Even this less ambitious project entails producing a large data set; the largest J-F-C database has over 120,000 observations spread out over 45 years with about 25 variables associated with each observation. However, the Ho labor data base, the main foundation for the J-F-C project, is the data base constructed for the EU-KLEMS data base, which was released for public use on March 15th.[3] The public release does not release the full Ho labor database for a variety of reasons, but nonetheless the full set of data could possibly continue to be used by at least some researchers. The databases for other countries probably are less encompassing, but each could represent a starting point for construction of a human capital set of accounts.

8. If a human capital approach is to be adopted by statistical agencies, it must require relatively few resources and little time to update the government output time series. Initial development costs might be higher than other approaches, but with luck the efforts of private researchers such as J-F-C would significantly reduce start-up costs.

9. The original J-F human capital research on investment in education produced results from 1948-1986. The current J-F-C project will produce results from 1960 (the start of the Ho data

[2] See Fraumeni, 2006. The posted paper at http://www.oecd.org/dataoecd/1/60/37460216.pdf outlined the human capital methodology, which is described in the appendix to this paper. The verbal presentation focused on the subject of this paper.

[3] See the homepage of the EU KLEMS project at http://www.euklems.net/ for further information.

underlying EU-KLEMS) to a recent year, say 2005. Initially as was true for J-F, J-F-C will focus on the aggregate output of both private and public education. Eventually a subproject will focus on how to isolate the impact of public education on lifetime earnings in order to measure government education output. This is an important step that needs to be taken, but one that logically follows demonstration of the feasibility of constructing the human capital set of accounts with substantially less data than the original J-F project in an amount of time that is manageable for a statistical agency.

I. GENERAL METHODOLOGY

10. Government education output is frequently measured by the number of students attending public schools. Quality adjustments may be made, for example to reflect test scores, and other distinctions may be made, for example for the cost of different programs by discipline. These adjustments tend to be very small or relatively ad-hoc because of the lack of data to implement more refined approaches.[4]

11. The J-F human capital approach quantifies the impact of education on lifetime income to determine investment in education, which is by definition the output of education. The Atkinson Report recognized the potential merit of this approach, calling for the consideration of "an adjustment to reflect the value of education for future earnings" [Atkinson, Recommendation 9.3 p. 135].

12. J-F estimated the impact of formal education on lifetime income for the non-institutional population of the United States. The first step was to estimate expected lifetime income for all individuals by year of birth, calendar year of estimate, sex, single years of age from birth (0) through 75+, and single year of education from 1st grade through completing at least one year of graduate school. Investment in education is the incremental effect on lifetime income of completing one more year of education and is registered at the point the additional year of education is completed. All paid and unpaid activities are valued except for maintenance, which includes sleep and personal care. Unpaid non-market activities, except for investment in education and investment in new births, are valued using an opportunity cost approach. Total opportunity cost for these unpaid activities is time multiplied by the market wage that could have been earned by an individual in the same age, sex, and education category by year. Market time is directly valued by the wages earned.

13. Expectations about years lived, enrollment, and labor force patterns including hours worked, and relative wages come from information about older individuals alive in a particular year. For example, the probability that someone completes another year of school in 1981 who is a sixteen-year-old male high-school sophomore in 1980 comes from the completion rate of seventeen-year-old male high-school juniors in 1980. Similarly, the probability that a forty-year old female in 1980 with a college degree will work (and how many hours) in 1981 comes from forty-one year old females in 1980 with a college degree. Accordingly, only contemporaneous information is needed with one exception. Future wages must be determined using a real rate of growth of wages.

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[4] For an example of quality-adjustment of enrollment numbers, see Christian 2006.

14. All future income is discounted. Finally, lifetime incomes are calculated by a backwards recursion, starting with age 74, which is the oldest age before retirement.

15. The Appendix gives equations for the specific methodology employed by J-F-C, which parallels the J-F methodology. The differences in methodology compared to the J-F methodology relate to the use of categorical, rather than single year of age or education, data to significantly reduce data demands.

II. ANALYSIS OF EXPECTED RESULTS

16. In the United States investment in education volume growth rates will be driven by two distinct trends. These trends occur in two sub periods which are approximately the same as the two sub periods analyzed in this paper. The first sub period: 1960-1986, is the later period covered in the original J-F study. The second sub period: 1987-2004, included years which are to be added to the original J-F study by the J-F-C study.[5]

17. Because in most cases adjustments to enrollments or other quantity indicators are small, the actual J-F growth rate results and the expected J-F-C growth rate results are compared to enrollment growth rates. Using enrollments as a proxy for education output assumes that every grade of education contributes the same to education output and that education output (per grade) has not changed over time.

18. The following table compares the annual growth rate for enrollments to the annual growth rates from J-F in constant dollars (volumes).

Table 1

Growth Rates	**Enrollments**	**Investment in Education (constant$)**
1960-1986 (J-F)	**.6%**	**2.7%**
1986-2004 (J-F-C)	**1.2%**	**?**

A question mark appears in the J-F-C row as the project has not yet been completed. Use of J-F investment in education growth rates would make a very significant difference in the education output series. Although the growth rates would be different if only market lifetime income were estimated; the magnitude of the differences with enrollment growth rates would be in the same ballpark.

19. Looking at the trends in 1960-1986 versus 1986-2004 gives a strong indication of what number might replace the '?' when the J-F-C project is completed. The trend stories, which are illustrated in the next table, both relate to college.

[5] These periods were chosen because they could be analyzed without completing the J-F-C project and because the break year: 1986, corresponds roughly to the trend break year.

Table 2		
Growth Rates	**Enrollment Growth Rates**	**Wage Gap College to Other Levels**
1960-1986 J-F	**4.6% (.6%)**	**Decreases often, but also increases**
1986-2004 J-F-C	**1.8% (1.2%)**	**Increases substantially**

The top enrollment growth rate numbers are annual growth rates for college enrollments. The growth rates below are the overall enrollment growth rates repeated from the table above.

20. In the first period: 1960-1986, the college enrollment growth rate is almost eight times the overall school enrollment growth rate. In the later period: 1986-2004, although the college enrollment growth rate is still significantly higher than the overall school enrollment growth rate, the magnitude of the difference is much smaller than in the earlier period. Clearly, the driver of the investment in education growth rates is the high growth rates in college enrollments. College-educated individuals earn significantly higher lifetime income than those with less education because of the higher wages they receive. Accordingly, high college enrollment growth rates impact on investment in education in two ways: through higher wages and through higher overall enrollment rates.

21. The last column of the table looks at the trends in the wage gap between college educated individuals and those with less education. The average wage per hour data used to estimate the wage gap trends comes from the Ho labor database. In the first period: 1960-1986, the trends in wage gaps are mixed; in some cases the gap is narrowing, in other cases it is increasing. [6] In the second period: 1986-2004, the gap is always increasing.

22. Accordingly, my expectation is that the investment in education growth rates will continue to be substantially higher than the overall school enrollment growth rates, but that the reason for the difference will change. The main 'driver' of the difference will be the increasing wage gap rather than the substantially higher college enrollment rates.

III. OTHER ISSUES

23. The other issues that need to be confronted to complete a simplified system to measure government education output are of two types. First, what problems do categorical data represent? Second, what has to be done to make the switch from all formal education output to government only education output?

24. Two education categories seem to be problematic. First, since students commonly spend a

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[6] As can be seen from the Appendix, the education categories changed in 1992. For descriptive purposes, using the categories for 1992 and before, two reference points were used: more than college and a college degree. These were compared to the wages per hour of those with less education: college degree in one comparison; plus always those with college, but without a college degree; a high-school degree; high-school, but without a high-school degree; and up to eight years of primary school completed.

number of years in graduate education, some further research has to be conducted to handle the category of more than college. How many years of graduate education do students complete? How long does it take them to complete each year? To some extent a similar problem occurs at the undergraduate level as the evidence is that more students are taking more than 4 years to complete 4 years of college.

25. Second, wages paid to individuals who have not completed more than eight years of primary education may depend upon whether they have been educated to the point that they can read, write, and perform basic arithmetic. If the numbers of individuals who have less than eight years of education completed is very small, this issue could be ignored.

26. To make the switch from estimating the output of all formal education to just government provided education, the most important issue is attribution to government schools or to other inputs. Trends in time students and parents spend in the education process should be removed from investment in education growth rates.[7] Social capital impacts should also be excluded, which include neighborhood, cultural, and family influences.

IV. CONCLUSION

27. Evidence presented in this paper shows that using a human capital approach to estimating government education output growth rates for the United States could have a significant impact on government education output estimates. To the extent that enrollment and wage gap patterns for other countries show similar trends, similar results would be expected. A human capital approach is superior to a simple enrollment approach as it captures a number of factors not reflected in counts. Education is one of the largest government expenditure categories; accordingly it is important to pay particular attention to its measurement. Education not only benefits the individual being educated; it also leads to higher rates of growth for the economy as a whole due to the higher productivity of a skilled workforce.

[7] It is certainly possible that schools inspire students to involve themselves to a greater extent in learning; accordingly the division between school and individual inputs is unclear.

APPENDIX

1. The following text describes in more detail the methodology being employed for the estimates being developed. The format of the description is similar to the format of the appendix to Jorgenson-Fraumeni (1992b).

DIMENSIONS OF THE DATA

2. Years: 1960-2004
By Sex: Male and Female

3. Categories:

Age
1 16-17
2 18-24
3 25-34
4 35-44
5 45-54
6 55-64
7 65-74
8 75+

Education (1960-1992) based on years of school
1 Less than HS
2 Some high school
3 High school grad
4 Some college
5 College grad
6 More than college

Education (1992-2000) based on highest level achieved
1 8th grade or less
2 grades 9-12 no diploma
3 high school grad
4 some college no degree, associate degree
5 BA, BS
6 More than BA or BS

4. When the variable is enrollment or investment in education, the education categories refer to level of enrollment instead of years enrolled or highest level achieved.

Level of enrollment for all years	
1	Grade 1-8
2	High school years 1-3
3	High school year 4
4	College year 1-3
5	College year 4
6	Graduate school

5. In the following equations, when the variables are categorical as opposed to by single year of age and education, capital letters are used. For example, a variable with an “A” dimension is an age category variable; a variable with an “a” dimension is a by single year of age variable. Enrollment is referred to as “ENR” when it is an enrollment category variable; it is referred to as “enr” when it is a by single year of education level enrolled variable. Otherwise education is referred to by “E” (categorical) or “e” by single number of years in school or by single year of highest level of education achieved.

6. The single years of age are for a = 0,1,2,…75, 75+. The single years of education are:

Education = e	Enrollment or Investment in Education
1	Not enrolled
2	Grade 1
3	Grade 2
4	Grade 3
5	Grade 4
6	Grade 5
7	Grade 6
8	Grade 7
9	Grade 8
10	High school 1
11	High school 2
12	High school 3
13	High school 4
14	College 1
15	College 2
16	College 3
17	College 4
18	College 5+

VARIABLES

7. The input variables required for estimates of the output of the educational sector by year,

unless otherwise indicated, are denoted as follows. Variables are in current (nominal) dollars, are per person in the population unless otherwise noted, and are categorical unless otherwise noted by small letter dimensions and description.

Cmp(s,A,E) – hourly compensation, gross of taxes on labor income.
Emp(s,A,E) – number of employees.
Hrs(s,A,E) – hours worked per week.
Pop(s,a,e) – population by single year of age and education.
R – (1 + real rate of growth on labor income)/(1 + discount rate)
Senr(s,a,enr) – enrollments by single year of age and single year of level enrolled.
Sr(birthyear, s,a) – probability of survival, specific to the year of birth
Tax – Average tax rate on labor income
Taxam – Average marginal tax rate on labor income

8. Intermediate stage variables estimated from the above variables include:
Hrstot(s,A,E) – hours worked per week summed across all employees in the category.
Pop(s,A,E) – population.
Senr(s,A,ENR) – enrollments.
Ymi(s,a,e) – yearly market income by single year of age and education.
Ymi(s,A,E) – yearly market income.
Ymitot(s,A,E) – yearly market income summed across all employees in the category.
Ynmi(s,a.e) – yearly non-market income by single year of age and education.
Ynmi(s,A,E) – yearly non-market income.

Output variables include:
Life(s,a,e) – lifetime income by single year of age and education.
Mi(s,a,e) – market lifetime income by single year of age and education.
Nmi(s,a,e) – non-market lifetime income by single year of age and education
Si(s,a,enr) – Investment in education by single year of age and single year of level enrolled.

LIFE STAGES EQUATIONS

9. There are five stages of life in the J-F human capital model of investment in education. Since calculations proceed by starting with those aged 75, the stages of life are being listed in reverse.

Stage 5: retirement, age 75+
ymi(s,a,e)=ynmi(s,a,e)=mi(s,a,e)=nmi(s,a,e) = 0

Stage 4: work only, age 35-74
ymi(s,a,e)=ymitot(s,A,E)/pop(s,A,E)*(1-tax)
ynmi(s,a,e)=[14*7*52-hrstot(s,A,E))/pop(s,A,E)]
cmp(s,A,E)(1-taxam)
mi(s,a,e)=ymi(s,a,e)+sr(s,older)*mi(s,older,e)*R
nmi(s,a,e)=ynmi(s,a,e)+sr(s,older)*nmi(s,older,e)*R

Stage 3: work and school, age 16-34

ymi(s,a,e)=ymitot(s,A,E)/pop(s,A,E)*(1-tax)
ynmi(s,a,e)=[14*7*52-hrstot(s,A,E)/pop(s,A,E)-1300*senr(s,A,ENR)]*cmp(s,A,E)
*(1-taxam)
mi(s,a,e)=ymi(s,a,e)+[senr(s,a,enr)*sr(s,older)*mi(s,older,school)
+(1-senr(s,a,enr))*sr(s,older)*mi(s,older,e)]*R
nmi(s,a,e)=ynmi(s,a,e)+[senr(s,a,enr)*sr(s,older)*nmi(s,older,school)
+(1-senr(s,a,enr))*sr(s,older)*nmi(s,older,e)]*R

Stage 2: school only, age 5-15
ymi(s,a,e)=ynmi(s,a,e)=0
mi(s,a,e)=[senr(s,a,enr)*sr(s,older)*mi(s,older,school)+(1-senr(s,a,enr))*sr(s,older)*mi(s,older,e)]*R
nmi(s,a,e)=[senr(s,a,enr)*sr(s,older)*nmi(s,older,school)+(1-senr(s,a,enr))*sr(s,older)*nmi(s,older,e)]*R

Stage 1: no school or work, age 0-4
ymi(s,a,e)=ynmi(s,a,e)=0
mi(s,a,e)= sr(s,older)*mi(s,older,e)*R
nmi(s,a,e)= sr(s,older)*nmi(s,older,e)*R

SUMMARY ESTIMATES

10. life(s,a,e)=mi(s,a,e)+nmi(s,a,e), where life is lifetime income, both market and non-market, per capital, total population
si(s,a,e)=senr(s,a,enr)*(life(s,older,e)-life(s,older,e-1))
If you are enrolled in a particular grade, and complete it when you are one year older, you get the lifetime income of someone who is one year older and who has completed that grade.

11. Volume (constant$) variables for each of the output variables are estimated with a translog (Divisia/Tornqvist) index.

Weights in nominal $s	Quantities
Si	Enrolled students
Mi	Population
Nmi	Population
Life	Population

A variety of other volume (constant$) indexes could be constructed, such as for yearly market income and depreciation of human capital.

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