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The Contribution of Post-Secondary Education to Human Capital Stocks in Canada and the United States

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INTRODUCTION AND MOTIVATION

- There is a growing difference in average real wages between Canada and the United States

- Differences in average wages produced by:
    - Differences in the price of human capital
    - Differences in the average quantity of human capital

- Post-Secondary education contributes to quantity of human capital
    - How can this contribution be quantified?
    - How can post-secondary systems be evaluated?

- Quantifying the post-secondary contribution to the human capital stock of a country depends on being able to measure human capital
    - Fraction post-secondary often used as a proxy for a country's human capital stock in international comparisons (OECD)
    - Major problems arise with the use of this measure
    - Identification and Aggregation

ALTERNATIVE QUESTIONS TO ASK ABOUT A COUNTRY'S POST-SECONDARY EDUCATION SYSTEM

- Rates of Return Questions:
  - What are the rates of return obtained by individuals who invested in post-secondary education?
  - What is the rate of return obtained by the marginal investor?
  - Are rates of return higher in other countries? If so, does this imply an inefficient post-secondary system?

- Human Capital Stock Questions:
  - What is the difference in the human capital stock of individuals with and without post-secondary education?
  - Given a country's education system and endogenous choice of education level, how much of the total human capital stock was produced by the post-secondary system?
  - Is this contribution higher in other countries? If so, does this imply an inefficient post-secondary system?

- Efficiency of Human Capital Production Questions:
  - How much output is obtained from given inputs in the production functions that characterize the various levels of post-secondary education?
  - Is this more or less than the output obtained from post-secondary education from the same inputs in other countries? If less, does this imply an inefficient post-secondary system?

WAGES AND THE PRICE OF HUMAN CAPITAL

- The hourly wage is the product of a price and a quantity: $w_{it} = \lambda_t E_{it}$

- The hourly wage is observed: its two components are not. ***This is the fundamental under-identification property of human capital models***.

- Homogeneous human capital model (standard efficiency units model): single price, λ; single type of capital E.

  If selection and technical change in human capital production are assumed to be zero, relative wages between "types" are constant because of a single price.

  With technical change and selection relative wages can change and will reflect technological change and selection effects.

- Heterogeneous human capital model: two prices; two types of capital:

$$w^a = \lambda^a E^a \quad \text{and} \quad w^b = \lambda^b E^b$$

  If selection and technical change in human capital production are assumed to be zero, changes relative wage changes identify changes in relative prices.

  With technical change and selection relative wage changes *do not* identify prices.

  Heterogeneous models in the skill premium literature implicitly assume E^a/E^b constant - no technical change or selection.

- Any change in relative wages is consistent with either model because of the fundamental under-identification.

AN AMENDED HOMOGENEOUS HUMAN CAPITAL MODEL FOR INTERNATIONAL COMPARISONS

- Our homogeneous human capital model amended to include selection and technological change in human capital production provides:
    - Simplicity and ease of aggregation: a major advantage for comparing human capital stocks across time or countries.
- If human capital is homogeneous, the total stock is well defined.
- If human capital is heterogeneous:
    - the total stock is not well defined. (Is a total stock of raw materials well defined if the raw materials are Apples and Oranges?) How then could it be compared across countries using a single measure?
    - if the types are identifiable by, say, education level, there is nothing to be gained by arbitrarily aggregating the different types. Since the types are different factors of production, from a production function point of view the types can no more be sensibly added than adding kilowatts of electricity and hours of "unskilled" labour. There is no common unit for the addition.
    - meaningful cross country comparisons could only be made within human capital types. Total values could be computed, but these would depend on prices as well as quantities.
- Previous objections to the standard homogeneous human capital model may be overcome in the new framework. Evidence in favour of a single price as a good approximation.

IDENTIFYING THE PRICE AND QUANTITY
OF HUMAN CAPITAL

A. Standard Unit Method

- Find a suitable time invariant "standard unit", i.e. an observable worker type with a time invariant number of efficiency units:
    - observing the wage for the standard unit at different points in time identifies the price series.
    - dividing any worker's wage by this price identifies the quantity.
- Identical in principle with the solution to identification of an appropriate price and quantity for computer inputs.
- Motivation for the computer case - the typical "box" on an employee's desk 5 years ago could do much less and yet cost much more. The true input could not be measured by either counting the "boxes" or using the price of the box.
- The computer input problem faces the same identification problem as for the human capital input but solves it simply by the fact that the number of "standard units" in any box is directly observable.
- In the human capital case the number of standard units in any "box" (i.e. worker of any given type) is not directly observable. The solution is to find an observable worker type with time invariant units.
- Primary problem: This worker type should have only the time invariant initial endowment; not exposed to technical change in human capital production functions. Choice of type involves tradeoffs.

IDENTIFYING THE PRICE AND QUANTITY (CONT.)

B. Flat Spot Method

- Based on the presumed existence of a "flat spot" in a cohort's life-cycle human capital profile. (Proposed in Heckman, Lochner and Taber, 1998).

- Motivated by the fact that optimal human capital investment models have some point towards the end of the working life-cycle where optimal investment is zero.

- If there is a period of years over which this occurs and in which depreciation is zero, observing changes in average wages for a cohort over this period will identify human capital price changes.

- Method can be used with homogeneous or heterogeneous models.

- Primary Problems:

    - The flat spots, if they exist, are unknown.

    - Theoretical considerations suggest that any flat spot that exists is likely to be different for different cohorts and for different schooling groups.

    - Cumulative bias potential.

EVIDENCE FOR A SINGLE PRICE

United States

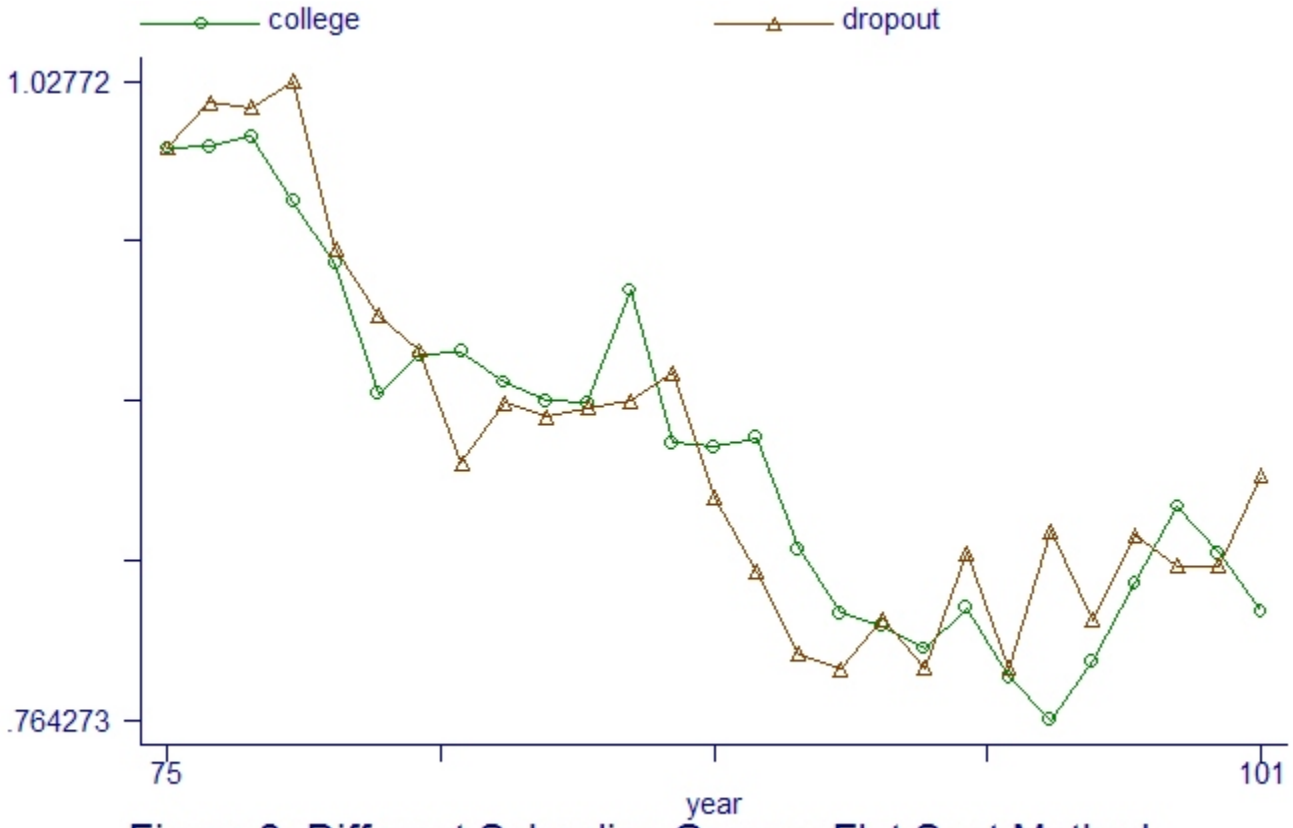

Figure 3: Different Schooling Groups: Flat Spot Method

Canada

	Flat Spot (Dropouts)		Flat spot (University)	
Year	Age 47-56	Age 48-57	Age 52-61	Age 50-59
1980	1.0000	1.0000	1.0000	1.0000
1985	0.9660	0.9476	0.9320	0.9745
1990	0.9123	0.8792	0.8590	0.8775
1995	0.8515	0.8126	0.8287	0.8285

IDENTIFICATION ISSUES IN ASSESSING THE CONTRIBUTION OF POST-SECONDARY SYSTEMS

- **Within a country at a point in time**
    - To identify the difference in efficiency units supplied by the average worker with any observed education status requires the single price assumption
- **Within a country over time**
    - To identify the difference in efficiency units supplied by the average worker with any observed education status at different points in time requires the single price assumption and the difference in the price between the two points
- **Across countries at a point in time**
    - To identify the difference in efficiency units supplied by the average worker with any observed education status across countries at a point in time requires the single price assumption and a group in each country where the ratio of their human capital is known.
- **Across countries over time**
    - To identify the difference in efficiency units supplied by the average worker with any observed education status across countries at points in time requires the single price assumption, the difference in the price for each country between the two points and a group in each country at each point in time where the ratio of their human capital is known.

CONTRIBUTION OF THE POST-SECONDARY SECTORS IN CANADA AND THE UNITED STATES

- Single price assumption implies that the contribution of the post-secondary sector to the total efficiency units of human capital is equal to the contribution of the post-secondary sector to total earnings when the market for human capital is competitive

- TABLE 1:

    - Canada has higher fraction of its working population with post-secondary education than the United States. (Mirrors OECD studies for the total population.)

    - Larger fraction of the working population (about 4 percentage points) not reflected in the relative fractions of efficiency units

- TABLE 2:

    - In 1980 the average Canadian worker with post-secondary education supplied 36.27% more efficiency units of human capital than the average Canadian worker without post-secondary education, vs 52.15% in the United States.

    - In both countries the difference between post-secondary and non-post-secondary increases, but the difference across countries remains.

    - The relative ranking of the fraction of a population with post-secondary education may therefore be a misleading indicator of the relative ranking of human capital stocks for Canada and the United States.

DISAGGREGATION OF THE TOTAL POST-SECONDARY SECTOR

- TABLE 3:
    - The Fraction of the working population with a BA or higher is much higher in the United States than in Canada
    - The Fraction of the post-secondary sector population with a BA or higher is much higher in the United States than in Canada - consistent with larger difference in average efficiency units between post-secondary and non-post-secondary in the US
- TABLE 5:

  The difference in efficiency units supplied by the average worker with non-university post-secondary education compared to the average worker with no post-secondary education is about the same in both countries - in strong contrast to the much larger difference for the United States when all post-secondary workers are used.

- TABLE 6:

  The difference in efficiency units supplied by the average worker with a BA degree or higher compared to the average worker with no post-secondary education is higher in the United States - but by a much smaller percentage than when all post-secondary workers are used.

- Essential to take this difference in the make up of the post-secondary sector into account for international comparisons

HUMAN CAPITAL PRODUCTION IN THE NON-UNIVERSITY SECTOR

- The choice of going to university or remaining a high school graduate has been extensively studied - the choice of undertaking post-secondary education in the non-university sector has been relatively neglected

- Canada has a very large fraction of its workers with a post-secondary education that used the non-university sector - why?

- Who gets non-university post-secondary education and how do they differ from those who get university education?

- Is this non-university post-secondary education a substitute for on-the-job training, or university training, or high school training?

CANADA'S NON-UNIVERSITY POST-SECONDARY SECTOR

- TABLE 7:
    - In 1996 over one quarter of high school dropouts have post-secondary education from the non-university sector.
    - These workers' earnings are about the same as high school graduates with no post-secondary education.
    - Despite a post-secondary education, their average efficiency units are about equivalent to those of a high school graduate
- This evidence does not imply that the post-secondary education of this group did not increase the group's human capital compared to what it would have been without it.
- Average efficiency units for this group being equivalent to a high school graduate does imply a potentially serious over-estimate of Canada's human capital by conventional estimates if the share of the group in total non-university post-secondary education is large.
- The share of these dropouts in the total non-university post-secondary education group is about 40% for males and 33% for females
    - Over a third of Canada's large non-university post-secondary education group has only a high school graduate equivalence in human capital terms

AVERAGE EFFICIENCY UNITS FOR THOSE WITH NON-UNIVERSITY POST-SECONDARY EDUCATION

A DISAGGREGATED ANALYSIS FOR CANADA

- TABLE 8:
    - Within dropouts, in 1995 males with post-secondary education earned on average 17.50% more than males without. For females the gap was 29.35%.
    - Within high school graduates the male gap is 12.06% and the female gap is 12.28%.
    - The "within" differences are very large compared to no difference when dropouts with post-secondary education were compared with high school graduates with no post-secondary education.
    - The pattern of "within" differences being substantial continues to hold for all grade levels.
- Appropriate comparison (abstracting from selection bias) for those with non-university post-secondary education: (Appropriate choice modeling)
    - All individuals with university education were high school graduates, hence the comparison of earnings between university and high school graduates is appropriate in principle.
    - A large fraction of individuals with non-university post-secondary education were not high school graduates, hence the comparison between their earnings and high school graduates is inappropriate in principle.

CANADA - UNITED STATES COMPARISONS
TOTAL POST-SECONDARY SYSTEM

- Workers with post-secondary education had, in 1980, 52.15% higher earnings than those without in the United States and 36.27% in Canada.
    - Under the single price assumption this implies that the average worker with post-secondary education has 52.15% more efficiency units than those without in the US and 36.27% in Canada.
    - Without this identifying assumption, it implies a 52.15% difference in value for the US compared to 36.27% in Canada.
    - Under the single price assumption this does not imply higher average efficiency units for US workers with post-secondary education than for Canada since the efficiency units of the average worker with no post-secondary education in the two countries could be different.
    - Assuming the same initial endowment of human capital in the two countries, the same correlation between initial endowment and schooling level, (i.e. the same selection mechanism into post-secondary education), and the same elementary and secondary systems, average efficiency units of workers without post-secondary education would be the same in the two countries if the fraction in post-secondary was the same.
    - The fraction in post-secondary differs by only 4 percent points, and that is in favour of Canada, so that under the above assumptions the US post-secondary system has generated more efficiency units per post-secondary educated worker.

CANADA - UNITED STATES COMPARISONS
UNIVERSITY AND NON-UNIVERSITY POST-SECONDARY

- Workers with non-university post-secondary education had, in 1980, 18.26% higher earnings than those with no post-secondary education in the United States and 21.32% in Canada.

- Workers with university post-secondary education had, in 1980, 97.38% higher earnings than those with no post-secondary education in the United States and 86.18% in Canada

- Under the single price assumption these are also the relative differences in efficiency units within countries.

- Under the same scenario used to permit an international comparison of the total post-secondary system, this suggests relatively small differences in the efficiency units per worker within post-secondary categories across countries in 1980.

- Over time the relatively small differences remain for the non-university sector, at least until 1995.

- Over time for the university sector, the US workers have increasingly higher average efficiency units compared to those in Canada.

CONCLUSIONS AND FUTURE WORK

- Use of the fraction with a post-secondary is likely to give a misleading estimate of relative human capital in Canada and the United States
- Under a basic scenario of cross country equivalence below post-secondary, the contribution made by the post-secondary sector to the stock of human capital is larger in the United States than it is in Canada
- The primary reason for the difference in contribution is the much larger share of university education in total post-secondary education in the United States
- Smaller contributions do not necessarily imply inefficiencies:
    - It is important to distinguish between rates of return, average human capital stock differences and differences in human capital production functions
- What does the restriction on the upper range of "quality" in universities do to Canada's human capital stock?
- Can cohort information identify technological change in the production of human capital at the post-secondary level?
- Develop better methods of international comparison based on "initial endowment" groups.
- Understand why Canada has a much larger non-university post-secondary sector? Are post-secondary investments across sectors efficient?
- Use of our estimated price series to understand Canada-US differences over time

Table 1

Fraction of Efficiency Units Supplied by Individuals with Post-Secondary Education Canada and the United States: 1975-2000

	Fraction of Efficiency Units		Fraction of Population	
	Canada	United States	Canada	United States
1975		.4586		.3583
Males		.4696		.3753
Females		.4290		.3368
1980	.5144	.5001	.4374	.3967
Males	.5038	.5104	.4287	.4078
Females	.5404	.4760	.4487	.3837
1985	.5652	.5636	.4870	.4441
Males	.5535	.5705	.4763	.4475
Females	.5901	.5495	.4999	.4403
1990	.5951	.6036	.5124	.4774
Males	.5794	.6023	.4959	.4692
Females	.6245	.6059	.5309	.4862
1995	.6520	.6641	.5688	.5288
Males	.6314	.6586	.5441	.5135
Females	.6872	.6736	.5960	.5451
2000		.6969		.5503
Males		.6911		.5307
Females		.7069		.5771

Table 2

Percentage Difference in Per-Person Efficiency Units Between Individuals with and without Post-Secondary Education; Canada and the United States: 1975-2000

	Canada	United States
1975		.5174
Males		.4739
Females		.4797
1980	.3627	.5215
Males	.3530	.5138
Females	.4449	.4589
1985	.3691	.6162
Males	.3631	.6397
Females	.4397	.5504
1990	.3988	.6670
Males	.3994	.7133
Females	.4695	.6251
1995	.4200	.7616
Males	.4354	.8274
Females	.4888	.7223
2000		.8788
Males		.9783
Females		.8119

Table 3
Fraction of the Working Population with and without Post-Secondary Education that have a BA or Higher; Canada and the United States: 1975-2000

	Fraction of Working Population with BA		Fraction of Post-Secondary with BA	
	Canada	United States	Canada	United States
1975		.1523		.4252
Males		.1682		.4483
Females		.1322		.3925
1980	.1008	.1699	.2305	.4283
Males	.1108	.1862	.2584	.4566
Females	.0879	.1509	.1960	.3934
1985	.1208	.2002	.2479	.4508
Males	.1275	.2147	.2678	.4797
Females	.1126	.1841	.2252	.4180
1990	.1372	.2192	.2678	.4591
Males	.1416	.2261	.2856	.4818
Females	.1323	.2118	.2492	.4355
1995	.1646	.2397	.2893	.4532
Males	.1623	.2428	.2984	.4728
Females	.1670	.2364	.2803	.4337
2000		.2604		.4732
Males		.2590		.4881
Females		.2619		.4587

Table 4

Percentage Difference in Per-Person Efficiency Units Between Individuals with and without a BA Degree or Higher; Canada and the United States: 1975-2000

	Canada	United States
1975		.9666
Males		.8073
Females		.9064
1980	.7241	.8800
Males	.6208	.8343
Females	1.0045	.7413
1985	.7384	.9904
Males	.6816	.9672
Females	.8818	.8787
1990	.7132	1.0114
Males	.6640	1.0106
Females	.7875	.9564
1995	.7055	1.0818
Males	.6889	1.1210
Females	.6755	.9929
2000		1.1926
Males		1.2865
Females		1.0493

Table 5

Percentage Difference in Per-Person Efficiency Units Between Non-University Post-Secondary vs. those with no Post-Secondary; Canada and the United States: 1975-2000

	Canada	United States
1975		.1652
Males		.1486
Females		.1582
1980	.2132	.1826
Males	.2161	.1723
Females	.3070	.2105
1985	.1997	.2063
Males	.1980	.2196
Females	.2821	.2209
1990	.2230	.2395
Males	.2303	.2751
Females	.2934	.2421
1995	.2274	.2996
Males	.2468	.3357
Females	.2863	.3186
2000		.3368
Males		.3804
Females		.3536

Table 6
Percentage Difference in Per-Person Efficiency Units Between University and No Post-Secondary Education; Canada and the United States: 1975-2000

	Canada	United States
1975		.9935
Males		.8741
Females		.9775
1980	.8618	.9738
Males	.7460	.9203
Females	1.0102	.8418
1985	.8830	1.1156
Males	.8147	1.0953
Females	.9820	1.0091
1990	.8794	1.1707
Males	.8222	1.1844
Females	1.0001	1.1213
1995	.8932	1.3189
Males	.8789	1.3756
Females	1.0089	1.2496
2000		1.4821
Males		1.6055
Females		1.3527

Table 7

High School Graduation and Non-University Post-Secondary Education: Canada 1991-96

	Dropouts with Post-Secondary Education			High School Graduates with no Post-Secondary Education		
	Fraction of All Dropouts	Average Earnings	Average Earnings Full Time	Fraction of All High School Graduates	Average Earnings	Average Earnings Full Time
1991						
Males	.2413	24739	25415	.2657	25538	26081
Females	.2281	14222	16324	.3293	13980	16191
1996						
Males	.2724	23455	24374	.2345	23320	24107
Females	.2691	14521	16952	.2981	13949	16355

Note: Age restriction is 30-55.

Table 8
Differences in Average Earnings Without Post-Secondary Education and With Non-University Post-Secondary Education by High School Graduation and Highest Grade Attended

	1980		1985		1990		1995	
	N-U PS	NO PS	N-U PS	NO PS	N-U PS	NO PS	N-U PS	NO PS
HS GRAD								
Male					27617	25538	26132	23320
Female					15520	13980	15662	13949
DROPOUT								
Male					24739	21229	23435	19945
Female					14222	11340	14521	11226
GRADE 5-8								
Male	24918	21370	22340	19625	21747	18927	19548	17226
Female	10457	9276	11428	9114	10656	9409	10320	9387
GRADE 9								
Male	25874	23425	23327	21448	22116	20580	20701	18526
Female	11624	10033	12578	9622	11574	9976	11067	9534
GRADE 10								
Male	26547	24491	24517	22727	23037	21381	21042	20110
Female	11944	10664	12094	10561	12207	11065	12095	10824
GRADE 11								
Male	27544	26250	25548	23909	25084	22905	23091	21107
Female	13676	11975	13411	11797	13918	12348	13997	12276
GRADE 12								
Male	29345	28146	27082	26016	27321	25322	26147	23680
Female	14213	12675	14484	13114	15314	13964	15434	13942
GRADE 13								
Male	31125	29617	29452	27059	28156	26123	26426	23005
Female	15031	14267	15803	14689	16594	15074	16955	14512