The Market for College Graduates and the Worldwide Boom in Higher Education of Women[*]

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The worldwide boom in higher education since 1970 has been truly remarkable. Given the great breadth of benefits that college education provides, and the fact that these benefits appear to be rising over time, a worldwide rise in college education may not be surprising—but the different responses of men and women to the rising benefits of college *are* surprising. In the United States and throughout the world, the boom in higher education has been primarily a boom in higher education of women, so much so that in most countries, more women than men now attend college. Figure 1 plots the gender difference (women minus men) in the fraction of 30- to 34-year-olds with college attainment against per capita GDP. A positive gender difference was a novelty in 1970, essentially reserved for a few of the wealthiest countries. Today, a larger fraction of women than men had completed higher education in 67 of 120 of the countries, including countries from every populated continent and 17 with below-median per capita GDP.

In order to illuminate the worldwide boom in higher education, and in particular higher education of women, we present a model of the optimal investment in college by an individual. The determinants include not only the lifetime earnings gain from going to college, but also the effects of college on health, on marital prospects, and productivity of investments in children and other aspects of household production. The incentive to go to college also depends on the costs of college, which includes forgone earnings and tuition, as well as—importantly—the ease or difficulty of performing well in college.

We then move from the individual to equilibrium in the market for college-educated men and women. The demand for college graduates clearly has been growing over time, and so has the supply of men and women that go to college. In recent decades, demand has grown faster

than supply, so that the college earnings premium has grown quite substantially. We argue that women have overtaken men in going to and graduating from college because the elasticity of supply of women with respect to the college earnings premium exceeds that of men, and perhaps because the net benefits from going to college are now greater for the average female high school graduate than the average male.

FIGURE 1A: GENDER DIFFERENCE AMONG 30-34 YEAR-OLDS
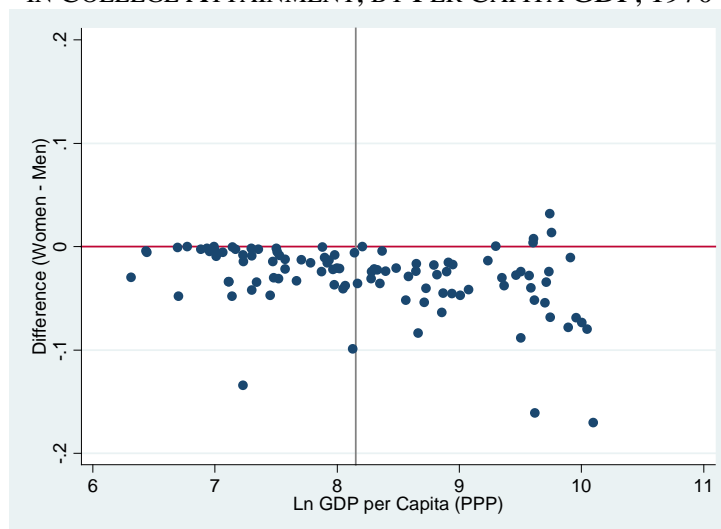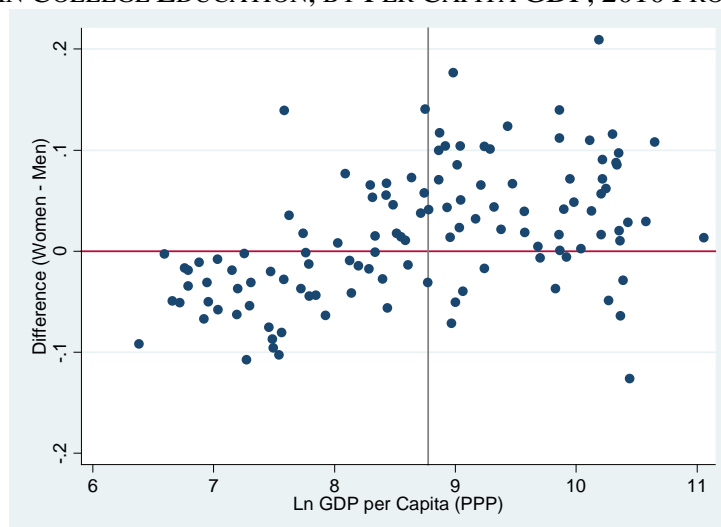IN COLLEGE ATTAINMENT, BY PER CAPITA GDP, 1970

FIGURE 1B: GENDER DIFFERENCE AMONG 30-34 YEAR-OLDS
IN COLLEGE EDUCATION, BY PER CAPITA GDP, 2010 PROJ.

I.   Optimal Investment by an Individual

This section considers the optimal investment in college education, S, by different individuals. The production of S is determined by

1) $S = F(h, H, A_c, A_n)$

where h is the time spent at college, A_c and A_n measure cognitive and non-cognitive abilities, and H measures the stock of human capital prior to any investment in S. H, A_c, and A_n are parameters when investing in college that varies among individuals depending on their earlier education and their abilities. The output of S is increasing in all these predetermined inputs into the production of S, so that F_h, F_H, F_c, and F_n are all >0. We assume that around the optimal level of h, $F_{hh} < 0$. The cost of the time spent on S depends on the earnings forgone per hour of h. Investments in college take place in the initial period only, and produce benefits in a single future period. College education S has many future benefits that compensate for the investment costs. We divide these benefits into raising earnings, improving survival rates, raising the utility from consumption, and improving marital prospects. Raising utility from consumption includes the effects of college education on quality of health, investments in children, management of financial assets, adjustment to shocks, and on other forms of consumption.

Each individual chooses an investment in college education that maximizes his discounted expected utility, given by

2) $V = U_1(x_1, l_1; H) + p(S; H)\beta U_2(x_2, l_2, S; H)$,

where β is his discount rate. The coefficient p is his probability of surviving to the end of period 2, where p is assumed to depend positively on his human capital, as measured by both S and H. The variable x measures the consumption of goods, and l measures household time. Utility is assumed to be increasing and concave in x, l, H, and S.

Utility is maximized subject to resource constraints, and these constraints are crucial to the analysis. To simplify the discussion we assume there is full annuity insurance, so that

expected discounted consumption, including spending on S, would equal expected discounted income. Subject to this equality, individuals can borrow and lend at the interest rate r. The full wealth budget constraint over the two periods is then

$$3) \quad x_1 + \frac{px_2}{1+r} + w_1 l_1 + \frac{pw_2(S,H)l_2}{1+r} + T + w_1 h = w_1 + \frac{pw_2(S,H)}{1+r} + \frac{pM(S)}{1+r} = W,$$

where W is expected full wealth, w refers to hourly earnings, and the total time in each period is normalized to 1. The LHS shows how full wealth is spent, where T is tuition and fees (we assume for simplicity here that T is fixed, independent of h), and w_1h is the earnings forgone from being in college.

Since college education raises hourly earnings in the second period, the derivative $w_{2s} > 0$. This derivative measures the hourly earnings returns per unit of college education, and may vary with the amount of college education. College education also raises the likelihood of marrying persons with greater education and other attractive characteristics. The expected gain from marriage in the second period is treated as an increment to expected wealth, $p(S)M(S)$. Since the gain from marriage is generally greater for those with a college education, $M_s > 0$.

Individuals maximize the value of their discounted utility V in eq. 2, subject to the full wealth constraint in eq. 3. We are mainly interested in the FOCs for investments in college education (S). If e_2 is hours worked in period 2, the FOC for S can be expressed as

$$4) \quad \frac{pe_2w_{2s}}{1+r} + \frac{p\beta U_{2s}}{U_{1x}} + \frac{\beta p_s U_2}{U_{1x}} + \frac{pM_s + p_s M}{1+r} + \frac{p_s[e_2w_2 - x_2]}{1+r} = \frac{w_1}{F_h}$$

The RHS of eq.4 gives the marginal cost of producing an additional unit of a college education, S. The numerator equals the hourly earnings forgone when spending an additional hour at college, and the denominator equals the marginal product of this time. The marginal cost of producing an additional unit of college also depends negatively on cognitive and non-cognitive abilities, and past investments in schooling and other human capital because of the

complementarity among the inputs used to produce college human capital. By raising the marginal cost of *S*, lower cognitive or non-cognitive abilities reduce the optimal investment in college education, partly by lowering grades and other measures of performance in college.

The first term on the LHS of eq. 4 gives the discounted expected increase in earnings from greater college education. This measure of the "rate of return" to college education increased greatly in the United States and many other countries during the past 30 years. The second term on the LHS of eq. 4 gives the effect of greater college education on the expected increase in utility from future consumption. The third term on the LHS of eq. 4 measures the increase in expected utility due to the effect of greater education on the probability of survival.

The fourth term on the LHS of eq. 4 measures the effect of a college education on benefits in the marriage market. These benefits include the effects of college education on the probability of marriage, and the effects of marriage on utility and earnings. The fifth term in eq. 4 measures the benefit from an increased probability of survival in the future if future earnings exceed future consumption. This is a benefit since an increase in the probability of survival when future earnings exceed future consumption raises possible consumption in the initial period.

What do we know about these costs and benefits of college education? The benefits of college appear to be quite large—in terms of wages, life expectancy, the propensity to marry and to stay married, and so on. As we report in Becker, Hubbard, and Murphy (forthcoming) ("BHM"), the benefits of a college education have been rising over time, across all of the categories for which we have data. These benefits, however, are greater for men, although the gap between men and women in benefits to college has fallen over time. As for costs, a large body of evidence (cited in BHM) suggests that women have, on average, higher non-cognitive

ability than men, but less variance in non-cognitive ability. As we show in Part II, non-cognitive

abilities (which lower the cost of college) are crucial to explaining trends in college attendance.

II. Equilibrium Returns and Number of Men and Women Going to College

To better understand why women are now much more likely to graduate from college

than men, college decisions of individual men and women need to be placed within the context

of market equilibrium for college graduates. To do this, we assume that the economy's demand

for the effective number of college graduates is negatively related to the hourly earnings of

college graduates relative to high school graduates. The effective number of graduates equals the

number of male graduates plus the equivalent number of female graduates, where female

graduates would be converted into male graduates at the ratio of their average hourly earnings to

that of males. The demand equation is

5) $\quad C = C_m + aC_f = D\left(R = \frac{w_c}{w_h}, P\right),$

where C is the effective number of college graduates demanded, a is the conversion rate of

female graduates (C_f) into male graduates (C_m), and P represent technological progress and other

forces that shift demand for college graduates. Demand is negatively related to the wage ratio, R.

The supply of college graduates of gender g is positively related to the common benefit R from
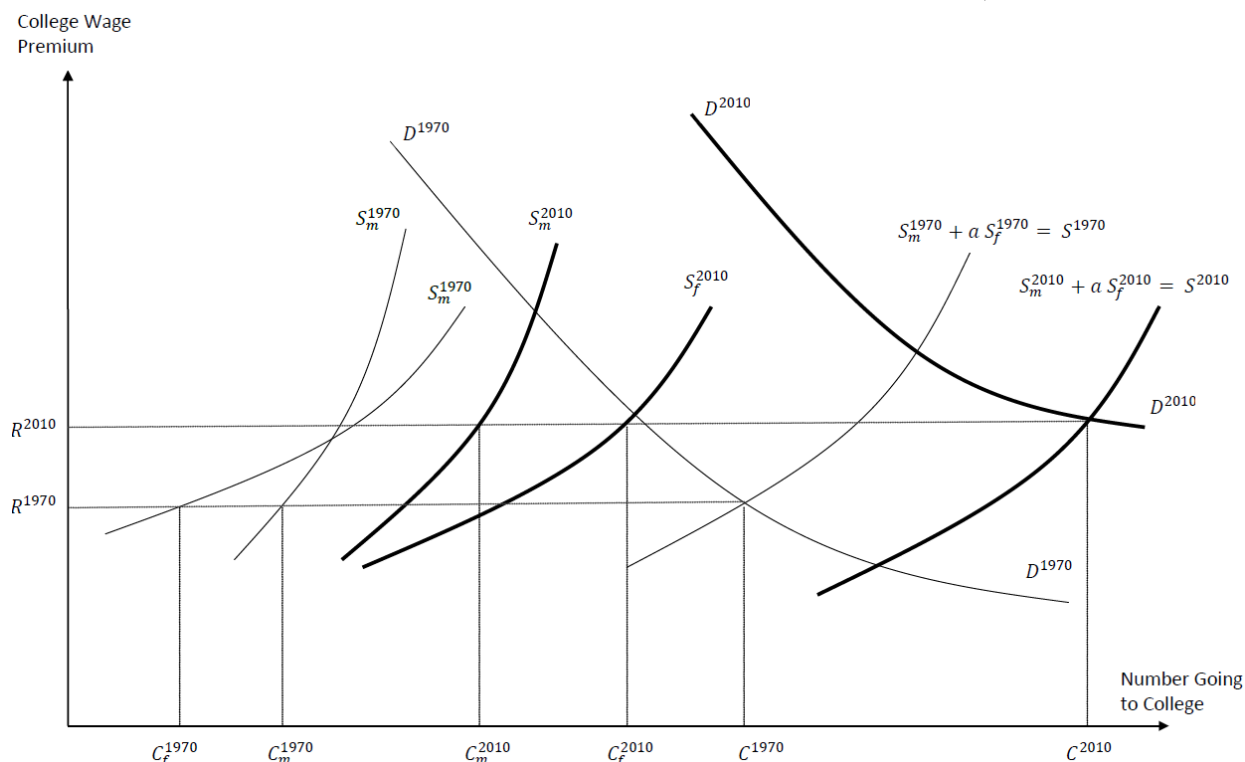
going to college:

6) $\quad C_g = S_g\left(R, N_g, A_{cg}, A_{ng}\right)$

where N_m and N_f are to the non-monetary returns from college to men and women, and A_{cm}, A_{nm},

A_{cf}, and A_{nf} refer to the distributions of cognitive and non-cognitive abilities among men and

women. Equilibrium in the market for college graduates requires aggregate demand to equal

aggregate supply of effective college graduates, as in

7) $\quad D\left(R = \frac{w_c}{w_h}, P\right) = S_m\left(R, N_m, A_{cm}, A_{nm}\right) + a\, S_f\left(R, N_f, A_{cf}, A_{nf}\right) = S$

Given P, the N's ,and the A's, equality between D and S determines the equilibrium monetary benefit from going to college, R, and the number of persons of each gender that go to college, C_m and C_f. Figure 2 compares the equilibrium number of male and female college graduates and the equilibrium return, R for the period before the mid-1970s with the period since the mid-1990s.

FIGURE 2: SUPPLY OF AND DEMAND FOR COLLEGE-EDUCATED WORKERS, 1970 AND 2010

At the 1970 equilibrium return R, the number of women going to college is significantly below that of men: $C_m > C_f$. Even though it appears that non-cognitive abilities have long been on the average higher for women than men, that was more than offset in earlier decades by sufficiently greater non-monetary returns to college men compared to college women in the form of greater marital propensities, greater labor force participation, greater health benefits, and perhaps greater other benefits as well.

During the past 30 years monetary returns to college have risen substantially in the US and many other countries. Since the fraction of high school graduates who go to college has also

risen, quite sharply in many countries, the rise in returns combined with increased supply would indicate that the demand for college graduates shifted outward.

If the supply curves of men and women to college were stable, the increase in demand for college graduates would increase the number of both sexes that go to college by increasing the labor market return from college. Given the increase in labor market returns from college, the percent increase in college attendance of each gender would be positively related to the supply elasticity of that gender. These supply elasticities are negatively related to the degree of heterogeneity among men and women in abilities, both cognitive and non-cognitive, and in non-monetary returns. The supply curve of each gender would be the cumulative distribution of the benefits, net of full costs, for all members of each gender. Those persons with low costs of attending college would be willing to go to college even with low monetary benefits, while those with the highest costs would require high monetary benefits to induce them to go to college.

The evidence we present in BHM indicates that the variability in non-cognitive abilities, and perhaps also in cognitive abilities, is greater for men than for women. This implies that the elasticity of supply to college is greater for women than for men, so that the increased demand for college graduates (even holding supply curves constant) would induce a greater increase in the number of women going to college than in the number of men going. Further, the supply curves have not remained constant as monetary returns increased since various non-monetary benefits of a college education also increased, such as the effects of going to college on the propensity to marry and stay married. Moreover, as we argue in BHM, the gap between the non-monetary benefits from college of men and women narrowed. Even though men on average appear to still get larger non-monetary benefits from college than women do, the narrowing in the gender non-monetary benefit gap could have shifted the supply curve of women to the right

of that of men. The reason is that the average level of non-cognitive skills is greater for women than for men, so that the average full cost of going to college would be smaller for women.

This new equilibrium is shown in Figure 2, where the supply curves of women and men shift from 1970 to 2010. Note that the supply curve for women shifts more, due to a greater shift in non-monetary benefits to college for women. As the figure shows, even if demand did not shift outward, these shifts in supply would have induced the fraction of women going to college to surpass the fraction of men going. However, given that the elasticity of the supply of women going to college also exceeds that of men, the outward shift in demand would produce an even greater positive gap between the proportion of women and men who go to college.

III.   Conclusion

Differences in gender means and distributions of abilities, especially non-cognitive abilities, affect the supply of college-educated women compared to college-educated men since the full cost of college is lower for abler persons. It appears that the average non-cognitive abilities of women are higher than the average for men, as measured by average grades in school and standardized test scores, and that the inequality in non-cognitive abilities is lower for women, as measured by the variances in these grades and test scores. Lower inequality of non-cognitive abilities among women than men imply that elasticities of supply to college would be greater for women than men, since heterogeneity in costs of college attendance would be lower for women. Further, greater average non-cognitive abilities of women than men implies that the supply of women to college would be greater than that of men when their benefits were the same. Together, these gender differences explain how the increased demand for college graduates that occurred in most countries during past 30 years would have increased the supply of women by more than the supply of men, leading to women's college attendance surpassing that of men.

References

Becker, Gary S., William H.J. Hubbard, and Kevin M. Murphy. 2010. "Explaining the Worldwide Boom in the Higher Education of Women." Unpublished.

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