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Initiative de recherche sur les compétences

Population Aging and Human Capital Investment by Youth

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Abstract

This paper examines the link between population aging and the human capital investments of youth. The study proceeds in three steps. First, we estimate an updated version of the Card and Lemieux (2001a) model for Canada using data from the 1981, 1986, 1991, 1996 and 2001 Censuses. The results are used to forecast the impact of population aging on the returns to education of young workers. Second, we review existing empirical studies of the determinants of human capital investments of youth. Theoretical models have long argued that the return to education is one of the important factors in the decision of youth to acquire more education. We show in a new empirical model of enrollment supply and demand that higher education policies and demographic factors actually play a more important role in these decisions. The final step of the paper is to combine the estimates of the updated Card and Lemieux model with existing estimates of the elasticity of human capital investments with respect to cohort size, returns to education, and policy variables that have been obtained. This shows the expected effect of aging on human capital investments of youth under various scenarios.

Résumé

Les auteurs examinent le lien entre le vieillissement de la population et les investissements en capital humain des jeunes. Ils ont procédé par étape. Premièrement, ils ont estimé une version actualisée du modèle de Card et Lemieux (2001a) pour le Canada en utilisant des données tirées des recensements de 1981, 1986, 1991, 1996 et 2001. Les résultats ont servi à prévoir l'impact du vieillissement de la population sur le rendement des études des jeunes travailleurs. Deuxièmement, ils ont examiné les études empiriques des déterminants des investissements en capital humain des jeunes. Depuis longtemps, les modèles théoriques indiquent que le rendement des études est l'un des facteurs importants dans la décision des jeunes de poursuivre leurs études. Dans un nouveau modèle empirique de l'offre et de la demande dans le domaine des inscriptions, les auteurs montrent que les politiques relatives à l'enseignement supérieur et les facteurs démographiques jouent, en fait, un rôle plus important dans ces décisions. Enfin, les auteurs ont jumelé les estimations du modèle actualisé de Card et Lemieux aux estimations actuelles de l'élasticité des investissements en capital humain pour ce qui est de la taille des cohortes, du rendement des études et des variables politiques qui ont été obtenues. Cela montre l'effet escompté du vieillissement de la population sur les investissements en capital humain des jeunes selon diverses hypothèses.

1. Introduction and Background

Demographic change and human capital investment has long as long been topic of interest in labour economics. In his seminal work on the "overeducated American", Freeman (1976) shows that the entry of the large and highly educated baby-boom generation depressed the college wage premium (return to education) during the 1970s. Another seminal study by Welch (1979) shows that the large increase in the number of young workers in the 1970s also had an adverse impact on the level of their wages. More recently, Card and Lemieux (2001a) have developed a general framework in which different age and education groups are modelled as imperfect substitutes for each other. For Canada, the U.S. and the U.K., they find that different age groups are close (elasticity of substitution in the 4-5 range), but not perfect substitutes for each other. Like Katz and Murphy (1992) and Murphy, Riddell and Romer (1998), Card and Lemieux also find that the elasticity of substitution between high school and university-educated workers is in the 1-2 range.

The results of Katz and Murphy (1992) and Murphy, Riddell and Romer (1998) have been widely used to help understand how secular changes in the level of education of the workforce affect relative wages in the presence of skilled-biased demand change. These studies also provide a natural framework for forecasting return to education under various assumptions about technological change and human capital investments of future generations of workers. Like Mérette (2002), however, these studies assume that age groups are perfect substitutes for each other, which is inconsistent with the well know results of Welch (1979). By contrast, the Card and Lemieux (2001a)'s model allows for Welch-type cohort effects. This model can thus be used to forecast how upcoming changes in age and education level of the population will affect the relative wages of all age and education groups. This is crucial for understanding what will be the effect of aging on the education wage premium among young (and older) workers.

Recent research has also shown an important connection between demographic shocks and human capital investments. For instance, Beaudry, Lemieux and Parent (2000), Card and Lemieux (2001b), Fortin (2005a, b) and Bound and Turner (2002) all show that large cohort of youth tend to have a lower level of education than smaller cohorts. This evidence suggests that the level of human capital investment is not solely determined by the demand side (how many youth want to get educated given the prevailing return to education). Supply factors, such as the number of college and university seats available also appears to matter. This is explored in more detail by Fortin (2005a) who concludes that, far from being solely determined by demand factors (return to education), human capital investments of youth are strongly affected by public policies (seats available and state/province appropriation, tuition, etc.)

Our study makes three main contributions to the literature. We first update the results of Card and Lemieux (2001a) for Canada using the 2001 census. Card and Lemieux's study stopped with the 1996 census but, as documented by Boudarbat, Lemieux and Riddell (2003), there has been a significant increase in the returns to education between 1996 and 2001. One interesting hypothesis to test is whether the stagnation in the level of education of young workers in the 1990s (Fortin, 2005b) and other related factors could account for these developments. We find strong support for this hypothesis. These new estimates of the Card and Lemieux model are then used to predict the effect of aging on the return to education of young workers. One robust finding is that returns are expected to grow substantially for men, but remain relatively unchanged for women.

In the second part of the paper, we expand on the above discussion of how demographic and policy factors also affect the human capital investments of youth. Ultimately, the point we make is that even if aging of the population leads to an increase in the return to education, this is unlikely to result in much larger investments of youth in human capital unless higher education policies are there to support these investments.

The third and last part of the paper combines the findings of part one and two to conclude how aging is expected to affect the human capital investments of youth, and how policies should be developed or modified to support these investments. To do so, we combine our updated estimates of the Card and Lemieux (2001a) model with some new estimates of the elasticity of human capital investments with respect to cohort size, returns to education, and policy variables.

2. Labour Supply and Demand by Age and Education Groups

2a. Model

The model borrows heavily on Card and Lemieux (2001a). The starting point is that although existing research on the rising return to higher education has emphasized the role of supply variation, most previous studies have focused on the average return to schooling, rather than differences by age or cohort (e.g. Freeman, 1976; Freeman and Needels, 1993; Katz and Murphy, 1992). These studies analyse the evolution of the return to schooling under the assumption that different age groups with the same level of education are perfect substitutes in production. This assumption means that the aggregate supply of each "type" of education can be obtained by simply summing the total numbers of workers in each education category.[1] A further simplification – which we will also invoke – is that there are only two education groups: "university equivalent" workers, and "high school equivalent" workers.[2] Under these assumptions, all education-related wage differentials in the labour market in any given year are proportional to the average university-high school wage gap in that year. Moreover, the university wage premiums for different age groups will expand or contract proportionally over time, a prediction that is clearly inconsistent with recent movements in Canada (see below).

A natural way of relaxing the hypothesis of perfect substitution across age groups is to assume that the aggregate production function depends on two CES sub-aggregates of high-school and university labour:

(1) $H_t = [\Sigma_j (\alpha_j H_{jt}^{\eta})]^{1/\eta}$,

and

(2) $C_t = [\Sigma_j (\beta_j C_{jt}^{\eta})]^{1/\eta}$,

where $-\infty < \eta \leq 1$ parametrizes the partial elasticity of substitution σ_A between different age groups j with the same level of education ($\eta = 1\text{-}1/\sigma_A$), and α_j and β_j are relative efficiency parameters (assumed to be fixed over time). Note that we use the variable "C" to refer to university labour, following the tradition in the literature (since university is called college in the United States). In principle η could be different for the two education groups, although we ignore this possibility to simplify the model.[3] In the limiting case of perfect substitutability

[1]In practice, different age groups may be allowed to supply different efficiency units of labour, in which case a weighted average of the supply of workers in each age group is appropriate, with a weight equal to the relative wage of the group (Katz and Murphy, 1992).

[2]Following the literature (e.g. Johnson, 1997) we assume that workers with exactly a high school degree supply 1 high school equivalent; workers with exactly an undergraduate university degree supply 1 college equivalent; workers with less than high school education supply some fraction of a high school equivalent; workers with an advanced degree supply more than 1 college equivalent; and workers with education qualifications between a high school and college degree supply α high school equivalents and $(1\text{-}\alpha)$ college equivalents. More details are provided in the data appendix.

[3]Welch (1979) relaxes this assumption in his study on the impact of cohort size on the relative wages of different age groups. Card and Lemieux (2001a) present evidence, however, that η is relatively similar for high school and university workers.

across age groups, η is equal to 1 and total high-school (or university) labour input is just a weighted sum of the quantity of labour supplied by each age group.

Aggregate output in period t, y_t, is a function of high school labour, university labour, and the technological efficiency parameters θ_{ht} and θ_{ct}:

(3) $y_t = f(H_t, C_t; \theta_{ht}, \theta_{ct})$.

Following the existing literature, we assume that the aggregate production function is also CES:

(4) $y_t = (\theta_{ht} H_t^{\rho} + \theta_{ct} C_t^{\rho})^{1/\rho}$,

where $-\infty < \rho \leq 1$ parameterizes the elasticity of substitution σ_E between the two education groups (ρ=1-1/σ_E). In this setting, the marginal product of labour for a given age-education group depends on both the group's own supply of labour and on the aggregate supply of labour in its education category. In particular, the marginal product of high school workers in age group j is:

$$(5) \qquad \partial y_t / \partial H_{jt} = \partial y_t / \partial H_t \times \partial H_t / \partial H_{jt}$$

$$= \theta_{ht} H_t^{\rho-1} \Psi_t \times \alpha_j H_{jt}^{\eta-1} H_t^{1-\eta}$$

$$= \theta_{ht} H_t^{\rho-\eta} \Psi_t \times \alpha_j H_{jt}^{\eta-1}$$

where

$$\Psi_t = (\theta_{ht} H_t^{\rho} + \theta_{ct} C_t^{\rho})^{1/\rho - 1}.$$

Similarly, the marginal product of university workers in age group j is:

$$(6) \qquad \partial y_t / \partial C_{jt} = \theta_{ct} C_t^{\rho-\eta} \Psi_t \times \beta_j C_{jt}^{\eta-1}.$$

Efficient utilization of different skill groups requires that relative wages are equated to relative marginal products. Assuming this is true, equations (5) and (6) imply that the ratio of the wage rate of university workers in age group j (w^c_{jt}) to the wage of high-school workers in the same age group (w^h_{jt}) satisfies the following equation:

$$(7) \qquad \log(w^c_{jt}/w^h_{jt}) = \log(\theta_{ct}/\theta_{ht}) + (\rho-\eta)\log(C_t/H_t) + \log(\beta_j/\alpha_j) + (\eta-1)\log(C_{jt}/H_{jt}).$$

If relative employment ratios are taken as exogenous, equation (7) leads to a simple model for the observed university-high school wage gap of workers in age group j in year t:

$$(8a) \quad r_{jt} \equiv \log(w^c_{jt}/w^h_{jt})$$

$$= \log(\theta_{ct}/\theta_{ht}) + \log(\beta_j/\alpha_j) + [(1/\sigma_A)-(1/\sigma_E)]\log(C_t/H_t) - (1/\sigma_A)\log(C_{jt}/H_{jt}) + e_{jt}$$

where e_{jt} reflects sampling variation in the measured gap and/or any other sources of variation in age-specific wage premiums. For some purposes it is convenient to re-arrange this expression in an alternative form:

(8b) $r_{jt} = \log(\theta_{ct}/\theta_{ht}) + \log(\beta_j/\alpha_j) - (1/\sigma_E)\log(C_t/H_t) - (1/\sigma_A)[\log(C_{jt}/H_{jt})-\log(C_t/H_t)] + e_{jt},$

According to this model, the university-high school gap for a given age group depends on both the *aggregate* relative supply of university labour (C_t/H_t) in period t, and on the *age-group specific* relative supply of university labour (C_{jt}/H_{jt}). The model nests the more conventional specification (used by Freeman (1976), Katz and Murphy (1992), and others) which assumes perfect substitution across age groups with the same level of education ($\sigma_A = +\infty$). Since $1/\sigma_A = 0$ when age groups are perfect substitutes, in the limiting case the university-high school wage gap for any specific age group depends only with the aggregate relative supply of university workers and the relative technology shock $\theta_{ct}/\theta_{ht.}$ More generally, the university-high school wage gap for a given age group also depends on the age group-specific relative supply of university labour. Changes over time in the relative supply of highly educated workers in different age groups would be expected to shift the age profile of the university-high school wage gap, with an effect that varies with the magnitude of $1/\sigma_A$.

A closely related observation is that when $\log(C_{jt}/H_{jt})-\log(C_t/H_t)$ varies over time, observed data on age-group specific relative returns to education will contain significant *cohort effects*, in addition to components that vary by age and year. This is because the relative supply of highly-educated labour in a cohort is roughly constant over time, apart from age effects that reflect rising educational attainment over the lifecycle. Formally, suppose that the log supply ratio for workers who are age j in year t consists of a cohort effect for the group, λ_{t-j} (dated by their year of birth), and an age effect φ_j that is common across cohorts:

(9) $\log(C_{jt}/H_{jt}) = \lambda_{t-j} + \varphi_j$.

In this case equation (8a) implies

(10) $r_{jt} = \log(\theta_{ct}/\theta_{ht}) + \log(\beta_j/\alpha_j)-(1/\sigma_A)\varphi_j + [(1/\sigma_A)-(1/\sigma_E)]\log(C_t/H_t) - (1/\sigma_A)\lambda_{t-j} + e_{jt}$.

According to this equation, the observed university-high school wage gaps for a set of age groups j=1,..J in a sample period t=1,..T will depend on a set of year-specific factors that are common across age groups ($\log(\theta_{ct}/\theta_{ht}) + [(1/\sigma_A)-(1/\sigma_E)]\log(C_t/H_t)$), a set of age-group specific factors that are common across years ($\log(\beta_j/\alpha_j)-(1/\sigma_A)\varphi_j$), and a set of cohort-specific factors ($(1/\sigma_A)\lambda_{t-j}$). This implies that the observed university wage premiums will be decomposable into year, age, and cohort effects. The cohort effects will be ignorable if $(1/\sigma_A)$ is approximately 0 (i.e. if different age groups are perfect substitutes in production) or if λ_{t-j} is a linear function of birth year (in which case the cohort effects can be written as a linear combination of age and year effects).[4]

2b. Implementation

At first glance, it is not clear how to estimate this model. On the one hand, it is possible to estimate the effect of age-group specific relative supplies of highly educated labour on age-group specific returns to university. On the other hand, assuming that data on age group-specific wages and supplies of labour for university and high school equivalent workers are available, a problem still arises in attempting to estimate equation (8a) or (8b) because the aggregate supplies of the two types of labour (C_t and H_t) depend on the elasticity of substitution across age groups. Inspection of equation (8a), however, suggests a simple two-step estimation procedure that provides a method for identifying both σ_A and σ_E. In the first step, σ_A is estimated from a regression of age-group specific university wage gaps on age-group specific relative supplies of university educated labour, age effects (which absorb the relative productivity effect $\log(\beta_j/\alpha_j)$), and time effects (which absorb the combined relative technology shock and any effect of aggregate relative supply):

(11) $r_{jt} = b_j + d_t - (1/\sigma_A)\log(C_{jt}/H_{jt}) + e_{jt}$,

where b_j and d_t are the age and year effects, respectively. Given an estimate of $1/\sigma_A$, the relative efficiency parameters α_j and β_j are easily computed by noting that equations (5) and (6), together with the assumption of equality between wages and marginal products, imply:

(12a) $\log(w^h_{jt}) - (\eta-1)H_{jt} = \log(\theta_{ht} H_t^{\rho-\eta} \Psi_t) + \log(\alpha_j)$ (for all j and t) ,

and

(12b) $\log(w^c_{jt}) - (\eta-1)C_{jt} = \log(\theta_{ct} C_t^{\rho-\eta} \Psi_t) + \log(\beta_j)$ (for all j and t) .

The left-hand sides of these equations can be computed directly using the first-step estimate of $1/\sigma_A$ ($-1/\sigma_A= \eta-1$), while the leading terms on the right hand sides can be absorbed by a set of year dummies. Thus, the age-group specific productivity factors ($\log(\alpha_j)$ and $\log(\beta_j)$) can be estimated as age effects in regression models based on equations (11) and (12) that also include

[4]The latter condition will also imply that $\log(C_{jt}/H_{jt})-\log(C_t/H_t)$ is approximately constant over time.

unrestricted year dummies. Given estimates of the α_j's and β_j's, and of η, it is then straightforward to construct estimates of the aggregate supplies of university and high school labour in each year (C_t and H_t). With these estimates in hand, and some assumption about the time series path of the relative productivity term $\log(\theta_{ct}/\theta_{ht})$, equation (8b) can be estimated directly. In our implementation below we follow the existing literature and assume that $\log(\theta_{ct}/\theta_{ht})$ can be represented as a linear trend.

The second step of our procedure is directly analogous to the estimation method used by Freeman (1976) and Katz and Murphy (1992) to recover the elasticity of substitution between education groups. The key difference is that our estimates of the aggregate supplies of different education groups incorporate a non-zero estimate of $1/\sigma_A$. A less important difference is that we estimate our models over a set of age-group specific university wage premiums, rather than over a set of aggregate premiums for all age groups. Finally, our second stage models include both the aggregate relative supply index ($\log(C_t/H_t)$) and the deviation between the age-group specific relative supply of university workers and the aggregate supply index (i.e. $\log(C_{jt}/H_{jt})-\log(C_t/H_t)$). The coefficient associated with this variable provides another estimate of $1/\sigma_A$ which in principle should be similar to the estimate obtained from the first stage.

2c. Results: Descriptive Statistics

Table 1 shows the university-high school wage gaps by age groups for 1980 to 2000 based on the Canadian Census of 1981, 1986, 1991, 1996 and 2001. As explained in Boudarbat, Lemieux, and Riddell (2003), the Census is by far the best data source available to estimate our model because of large sample sizes and consistent questions (over time) about education and earnings. More detailed on the data are provided in the Data Appendix. The numbers for 1980 to 1995 for men reproduce those from the Card and Lemieux (2001a) study while those for 2000 have been updated using the recently released 2001 Canadian Census. The numbers for women are also computed using the 1981 to 2001 Census. The university-high school wage gaps are also shown in Figure 1a (men) and 1b (women).

There are a number of interesting features in Table 1 and Figure 1. First, consistent with Boudarbat, Lemieux and Riddell (2003), the university-high school wage gap increased substantially between 1995 and 2000 for all groups of men except those age 56 to 60. As documented by Card and Lemieux (2001a), between 1980 and 1995 returns increase for younger workers, decreased for older workers, and remained relatively constant for “middle age men” (those age 36 to 50). Card and Lemieux’s explanation for this “tilting” in the age profile of the return to university was based on differences in the relative supply of university education for different age groups. In particular, returns for younger cohorts increased between 1980 and 1995 because of the stagnation in the educational attainment of the largest cohorts of the baby boom (those born between the early 1950s and the mid-1960s). This phenomenon can readily be seen in Table 2 that shows the fraction of men and women with a university undergraduate degree (BA, etc.) or more. For instance, the fraction of men age 31-35 with a university degree remained unchanged between 1980 (0.190) and 1995 (0.188). By contrast, the fraction of men age 51-55 with a university degree more than doubled from 0.093 in 1980 to 0.197 in 1995. Relatively speaking, there was thus a much larger increase in the relative supply of education for older than younger men. As predicted by the above model where age groups are imperfect substitutes for each other, this lead to a relative decline in the university-high school wage gap for older workers, and to a relative increase in the in the university-high school wage gap for younger workers. By contrast, the university-high school wage gap increased more uniformly across age groups between 1995 and 2000. As we will show later, this is consistent with a slowdown in the rate of growth of aggregate, as opposed to age-group specific, relative supply of university education.

A second important feature of Table 1 and Figure 1 is that the university-high school wage premium is substantially larger for women than men. For instance, the premium ranges from 0.336 to 0.467 for women but from 0.224 to 0.356 for men in 2000. Furthermore, the premium has generally been declining for women over time, except for the youngest (age 26-30) age group. Table 2 suggests a possible explanation for this difference between men and women. As is well known, the level of education of women has increased faster than the level of education of men. As a result, the faster growth in relative supply of education for women is expected to reduce the university wage premium for women relative to men. More specifically, Table 2 shows that in 1980, the fraction of women with a university degree was lower than the corresponding fraction of men for each and every age group. By 2000, however, women up to age 45 are now more educated than men. The difference is particularly striking for the 26-30 age group. Over 30 percent of women age 26-30 now have a university degree, compared to only 23 percent for men.

Figure 2 illustrates the differential evolution in the relative supply of men and women in a way more directly linked to the model estimates reported below. Remember that we compute the relative supply by computing "university" and "high-school" equivalent labour for each age group. To show how these relative supplies change over time, we estimate the regression model shown in equation (9) where age-group relative supplies ($\log(C_{jt}/H_{jt})$) a regressed on a set of birth cohort and age group dummies. The age dummies capture the fact that education changes over time for the same cohort for a variety of reasons. First, people may actually be upgrading their education (especially for people in their twenties). Second, immigration and emigration may change the education level of a cohort over time (we look at all workers, not only natives). Third, since we look at the relative supply of workers, changes in the relative employment rates of high school and university workers may also affect the mix of workers over the life-cycle. Finally, differential mortality by education may also affect the relative supplies at older ages. It is easy to see in Table 2 that, overall, relative education tend to increase for a given cohort over time. For instance, 0.167 of men age 26-30 had a university degree in 1980. Moving along the diagonal, the fraction of this cohort with a university degree increase to 0.182 in 1985, 0.195 in 1990, 0.203 in 1995 and 0.215 in 2000. This shows that it is important to adjust for age when comparing the level of education of different cohorts.

Figure 2a reports the age-adjusted estimates of the relative supply by birth cohort. We use age 41-45 as the base case in the regressions (dummies are included for all other age groups), which means that Figure 2a shows the predicted log relative supply of each cohort when they are in their early forties. (Figure 2b translates the log relative supplies into a more easily interpretable fraction of university labour $C_{jt}/(H_{jt}+C_{jt})$). A number of striking features emerge from the figure. As discussed earlier, the level of education of women used to the lower than men's. Figure 2a shows that the male-female gap in education increased between the 1916-20 and the 1921-25 and 1926-30 birth cohort, a change that is consistent with the "Canadian GI Bill" boosting up the level of education of younger WWII veterans (Lemieux and Card, 2001). But women eventually caught up and surpassed the education of men starting with the 1956-60 birth cohort.

Another striking feature is the prolonged stagnation in the level of educational achievement of the largest cohorts of the baby boom. Indeed, the level of education (or relative supply of university education) of the three largest birth cohorts (1951-55, 1956-60, 1961-65) is no larger than for the 1946-50 cohort.[5] This prolonged stagnation for men has also been documented for the United States by Card and Lemieux (2001a). This is the driving force behind the "tilting" in the age profile of the university premium discussed earlier. Note also that the rate of growth of the relative supply for women slowed down substantially during the same period.

Finally, Figure 2a indicates that the relative supply appears to be stagnating again for the 1976-80 cohort, which is the youngest one used in the analysis (age 21-25 in 2001). We discuss in much more detail in Section 3 the factors explaining these interesting inter-cohort trends in relative supply. We also provide more formal evidence below that differences in relative supply growth for men and women can account for differential male-female trends in the university wage premium.

2d. Results: Estimates of the Model

Table 3 reports estimates of the supply and demand model with imperfect substitution between age groups outlined in Section 2a. Columns 1 to 3 reproduce the results of Card and Lemieux (2001a) for the 1980-95 period. All models include a set of unrestricted age dummies for the seven age groups shown in Tables 1 and 2, but the estimated age effects are not reported in the tables. Column 1 shows estimates when the age-group relative supply $\log(C_{jt}/H_{jt})$ is included as a regressor along with a set of year dummies. The coefficient is precisely estimated at -0.165, suggesting a relatively large elasticity of substitution across age groups ($\sigma_A = 1/0.165 \approx 6$). Column 2 reports the estimates in which the year dummies are replaced by the standard Katz and Murphy aggregate supply index. As discussed earlier, the Katz and Murphy index is based on the assumption that age groups are perfect substitutes (elasticity of substitution σ_A is infinite) for each other, which is rejected in the data ($\sigma_A \approx 6$ which is large but not infinite). The results are nonetheless reported for the sake of comparability with most of the literature. A linear trend is also included to capture steady changes in the relative demand for university-educated workers. Column 3 then shows what happens when the Katz and Murphy index is replaced by the more appropriate index of aggregate supply that accounts for imperfect

[5] As we show later show in Figure 4, cohorts born in 1951-55, 1956-60 and 1961-65 are substantially larger than the cohort born in 1946-50, despite the fact that the latter is typically more closely identified with the "baby boom generation". We use the wider definition of the baby boom that goes until 1964 for the purpose of this paper.

substitutability between age groups. As discussed in Section 2b, this index is computed using a two-step procedure. Further estimation details are not discussed here since this is all explained in detail in Card and Lemieux (2001a).

Unfortunately, both the trend and the effects of aggregate supply are imprecisely estimated in column 2 and 3 (these are estimates of the model shown in equation (8b)). As a result, we cannot reject the null hypothesis that the effect of both variables is zero. Figure 3 shows that these results reflect the strong collinearity between aggregate supply and a linear trend. The figure shows that, for men, the index of aggregate supply that accounts for imperfect substitutability between age groups essentially grows linearly over time between 1980 and 1995. As a result, it is not possible to separately identify the effect of aggregate supply from the effect of a linear trend over this period.

Figure 3 also suggests, however, that 2000 represent a marked departure relative to earlier trends. While the aggregate supply of university labour grew by 0.144, on average, for each five-year interval between 1980 and 1995, it only increased by half as much (0.073) between 1995 and 2000. This results in a clear trend break that is clearly seen in Figure 3. This marked slowdown in the growth in aggregate supply for men is due to a combination of factors. First, the level of education of the newest cohort to enter the labour market (1976-80 birth cohort) is no larger than for the preceding cohort (1971-75). Second, the prolonged stagnation in the relative supply of the largest baby boom cohorts means that middle age workers in 2000 are not much more educated than older workers (born in the 1940s). As a result, older workers who exit the labour market are no longer replaced by much more educated workers, as used to be the case in the 1980s and early 1990s.

As noted earlier, the university premium increased significantly for men between 1995 and 2000. This is also shown in Figure 3 that shows the evolution of the average premium (over all age groups) between 1980 and 2000. Just like the change in supply between 1995 and 2000 represents a break relative to earlier trends, the marked increase in the return to university also represents a break relative to earlier trends. The relative evolution of the two series suggests that the decline in the growth in relative supply between 1995 and 2000 may be linked to the growth in the return to university during the same period.

Column 6 of Table 3 confirms this conjecture. When the 2000 data is added to the model, we are now able to separately identify the effect of the linear trend from the effect of aggregate supply. The results indicates that the trend accounts for a 1.5 percent annual growth in the return to university, while the effect of aggregate supply is estimated to -0.479, which implies an elasticity of substitution between university and high school labour of about 2 ($\sigma_E = 1/0.479 \approx 2$). Both estimated effects are significantly different from zero. Note also that the estimated effect of age-group specific supply remains relatively unchanged when the 2000 data is included in the analysis. Note finally that using the Katz-Murphy aggregate supply index yields qualitatively similar, but not statistically significant estimates (column 5). Since the aggregate supply index based on imperfect substitution across age groups is more appropriate (given that $\sigma_A \approx 6$) we focus on these model estimates for the rest of the paper.

Adding the 2000 data thus has a remarkable impact on the estimates. Table 4 shows that the estimates that include the 2000 data are now surprisingly similar to those for the United States of United Kingdom reported in column 1 and 2 of the table (these estimates are from Card and Lemieux (2001a)). This gives us quite a bit of confidence about the validity of these estimates. The fact that the estimates are robust over three different countries for different time periods (the U.S. samples go back the late 1950s) suggest that it may be sensible to use the models estimates to try to forecast was is likely to happen in the next twenty years in Canada. We explore this issue in detail in Section 4.

Finally, the last column of Table 4 shows what happens when the main model is fit to the university-high school wage gaps for both men and women. The only extra variable included in the model is a dummy variable for women that captures the fact that the return to university is generally larger for women than men. The estimated effect of the trend and aggregate supply (computed for women using the same procedure as for men) are very similar to the estimates for men only. Note, however, that the effect of both the trend and aggregate supply are much more precisely estimated than in the models for men only. The reason why the model works so well can again be seen in Figure 3. The figure shows that aggregate supply increases faster for women than men, while the opposite is true for the return to university. So the male-female trend differences in relative supply and return to university are also consistent with a simple supply and demand story. This suggests that returns to university have increased less for men than women because female supply increased more. The fact that the standard errors are smaller when women are also included in the regression models suggests that male-female trend differences are a powerful source of additional identification for the model. The similarly in the estimated effect of aggregate supply in the last two columns of Table 4 also suggest that the same supply and demand model with imperfect substitution across age groups can explain both the growth in return to university for men between 1995 and 2000, and the steady decline in the return to university for women throughout the 1980s and 1990s.

3. Existing Evidence on the Determinants of Post-Secondary Enrollment Rates

A higher education economic framework is appropriately set at the jurisdictional level, where policy makers determine the level of higher education funding, as well as tuition and capacity levels at public colleges and universities. The observed enrollment rates can then be seen as outcomes of a supply and demand model, where prospective students demand university/college seats and where public institutions supply those seats with tuition fees serving as the intermediating price. Enrollment demand is negatively related to tuition fees, which increase the cost of attending university or college. Enrollment supply is positively related to tuition fees, which have the potential to increase the revenues of higher educations institutions. However, as pointed by Clotfelter (1999), a singular feature of the higher education market is the presence of non-price rationing: excess demand for college seats is a necessary condition for selectivity in admissions. In turn, selectivity in admissions is the mechanism used by institutions to set a lower bound on the quality of applicants. Institutions can thus in theory use a combination of these two instruments—price and grades—to equilibrate supply and demand.

In practice, different countries have favoured more or less rigid institutional framework. In France, admission in the elite “Grandes Écoles" is restricted to very high aptitude students on the basis of an admission test that often requires attendance in preparatory schools, but tuition is very low (380€). There is virtually universal and free access (on average 200€ at La Sorbonne) to universities thought to be of lower quality. The United States enjoys a mixed system of private and public institutions. Admission to the American elite private institutions is restricted by very high tuition (20,015$US in 2003-04) and/or very high grades. Public institutions use a combination of price and grades with public research universities requiring moderate tuition (4,793$US in 2003-04) and restricting access on the basis of aptitude, while public community and technical colleges have very low tuition (2,142$US) and unrestricted admission.

As often thought, the Canadian higher education system can be placed at some intermediate point between the French and American systems: it attempts to emphasize wider access while being somewhat preoccupied with quality. Skolnik and Jones (1992) argue that Canadian universities are not hierarchically differentiated. Yet, while they are no elite private institutions in Canada, the three best public research universities (University of Toronto, UBC and McGill) rank 18th, 28th and 50th in North-America, respectively. Like in the United States, Canadian public institutions have less latitude in setting tuition fees than private institutions. Until the mid-1990s tuition was set at the provincial level with institutions having very few options to ask for differential tuition. In the mid-1990s, however institutions in Ontario began asking close to market price for professional programs.

In theory, institutions can compete for the best students by using combinations of price and grades—or price discrimination—almost on a per student basis with “merit" based scholarships. In Canada, institutional outlays to student support went from 7.5 percent in 1980 to 10.4 in 1999. Yet much of the competition among institutions may take other forms, including the influential Canadian MacLeans’s and U.S. News and World Report rankings of universities and colleges (Mueller and Rockerbie (2002), Monks and Ehrenberg (1999)).

Governments on the other hand are concerned with equality of opportunity objectives. In the 1970s in particular, many jurisdictions kept hikes in tuition fees well below the inflation rate. At times, they have even frozen nominal tuition fees. Governments also offer means-tested scholarships and loans making the net cost of attending universities less than posted tuition for many students. While Clotfelter (1999) finds some evidence of increasing inequality in the link between socio-economic status and college attendance, this troublesome trend is sharpest among private universities. In Canada, Corak et al. (2003) find no evidence of an increase in the link between parental income and participation in post-secondary education. But Coelli (2004) finds substantial negative effects of changes in parental income associated with unemployment shocks. Recent research (Kane (2003)) has also focused on financial aid as way to alleviate the potential inequality increasing effect of rising tuition.

In economics, the post-secondary enrollment decisions of high school graduates are seen as solutions to a simplified version of the human capital investment model. After completing high school, individuals are faced with the decision of whether or not to get a university degree by maximizing the discounted present value of lifetime earnings, net of education costs. Assuming that the marginal cost of attending university rises faster than the marginal benefit, the discounted lifetime earnings function is concave and the solution to this maximization problem equates the marginal costs of a university education to the marginal benefits. Individual heterogeneity in the decision to attend university or not will arise from differences in the marginal benefits of obtaining a university degree or differences in the marginal costs obtaining a university degree. Aggregating across individuals in any given jurisdiction will imply that jurisdictional differences in educational attainment will arise from differences in the returns to a university/college education and in the marginal costs of that education. Thus enrollment rates should be higher in jurisdiction with higher returns to a university degree and lower net costs of attendance, and conversely.

Yet precise information about the marginal benefits and the marginal costs of a university education may not be precisely known or correctly estimated by prospective students. In evaluating the marginal benefits, do prospective students use the national university/college premium or rather the provinces/state specific values? Do they use a contemporaneous, past, or discounted expected present value of that premium? In evaluating the marginal costs, prospective students may not be fully aware of the parameters of the financial assistance available to them and may make irrational decisions (Avery and Hoxby (2004)). Because of these informational difficulties, it is reasonable to believe that the very concrete level of tuition fees may have an unduly important effect on those decisions (Kane, 1999). In effect, Fortin (2005a) finds that in the United States the negative impact of tuition on enrollment rates is more significant than the positive impact of within-state college premia.

On the enrollment supply side, the ability of public institutions of higher education to supply university/college seats greatly depends on provincial funding, which constitute their most important single revenue source. There are many quasi-fixed costs associated with the expansion of college seats. At the extensive margin, increasing the number of college seats by increasing the number of institutions entails expansions in physical buildings, which are not easily scaled down. Card and Lemieux (2001b) argue that the partial adjustment of the higher education system to the temporary bulge in enrollment caused by the baby boom may have been a rational response. At the intensive margin, increasing the number of seats at existing institutions may imply the hiring of tenured or tenured-track faculty whose numbers are also not easily brought down. Bound and Turner (2002) argue that institutions face a quality-quantity tradeoff in expanding the number of college seats. When financial resources do not fully adjust to changes in the college-age population, limiting the expansion of college seats preserves institutional quality. Either argument has become known as the “cohort crowding" hypothesis, which implies a negative impact of cohort size on enrollment rates. However, the 1980s onwards were characterized by the baby bust cohort becoming of university-age, thus one should expect enrollment rates going up as a “cohort hollowing" effect.

Given the above considerations, it is reasonable to think that tuition levels seldom play the equilibrating role that prices ought to play in supply and demand system. Thus the higher education system is often in a state of dis-equilibrium, where the short side of the market determines the enrollment rate. If tuition is too low, the short side of the market will be the supply side and the provincial funding will determine the enrollment rates. If tuition is too high, the short side of the market will be the demand side and the tuition levels will determine the enrollment rates. Another complication arises from the fact that at times, tuition levels are exogenously determined by policy makers, when tuition levels are frozen in nominal terms for example (as in Quebec in the early 1980s). At other times, tuition levels and provincial funding are negatively correlated. It is thus also possible for tuitions to be high while low provincial funding determines enrollment rates. A reduced form equation of enrollment rates observed at the jurisdictional level and thus focuses on higher education policies will be of the form

$$E_{kt} = \beta_0 + \beta_1 Tui_{kt} + \beta_2 r_{kt} + \beta_3 App_{kt} + \beta_4 Col_{kt} + \varepsilon_{kt} \tag{13}$$

where represents E_{kt} the logarithm of the ratio of FTE Fall enrollments in universities and 4-year colleges divided the number of persons aged 18 to 24 in jurisdiction k at time t , Tui_{kt} represents the logarithm of average tuition, r_{kt} represents the university-high school wage gaps, App_{kt} represents the logarithm of per-university-age person provincial/state appropriations, Col_{kt} the logarithm of the number of persons aged 18 to 24. The jurisdiction-time specific errors are further modeled as $\varepsilon_{kt} = \beta_k J_k + \beta t\, T + \zeta_{kt}$, where J_k are jurisdiction-specific dummies.

Other authors (Quigley and Rubin (1993), Berger and Kostal (2002) among others) have attempted to estimate separate more structural models of enrollment demand and enrollment supply. The difficulties there are of finding appropriate instruments to identify either curve. Quigley and Rubin (1993) for example acknowledge that the negative sign on tuition in their legislative supply equation may be the result of an identification problem.

Table 5 presents the results from the estimation of model described by equation (13). The logarithm of the jurisdiction specific ratio of FTE university enrollment divided by university-age population is the dependent variable and the regressions are estimated by weighted least squares, where the weights are the provincial total population estimates. Because the population estimates are thought to be relatively free of measurement error, equation (13) is not prone to the division bias found often found in labour supply regressions. Provincial dummies are included in all regressions to control for jurisdiction specific effects. The provincial-level returns to a university degree are computed from the Censuses of 1981, 1986, 1991, 1996 and 2001, while educational data is from Fortin (2005b).

Column (1) of Table 5 shows the dramatic negative impact of log population age 18-24 on log enrollment rates. The estimated effect of -0.93 (0.19) indicates almost perfect crowding: a 1 percent increase (decrease) in the university-age population entails an almost 1 percent decrease (increase) in the enrollment rate. While 11 out of the 93 universities associated with the AUCC were founded after 1973, these were generally smaller institutions. Thus virtually all increases in college seats had to come at the intensive margin, that is, at the expense of quality as the increase in faculty-student ratio reported previously indicates.

In column (2), the logarithm of real average tuition is added to the explanatory variables. This yields an elasticity of -0.18 (0.3-0.2) of enrollment rates with respect to tuition. The impact of tuition on college enrollment rates is most often reported in terms of the impact of a $1000 change in direct costs on student demand. Leslie and Brinkman (1987) perform a meta-analysis of twenty-five U.S. student demand studies, who seek to evaluate the impact of student responses to tuition using 1960s and 1970s data. The meta-analysis attempts to harmonize the results of studies using national, state, individual, district and institutional samples that are based on experiments, hypothetical situations, cross-sectional and time-series designs, etc. The results of most studies are found to lie in the very close range of -0.03 to -0.05 percentage point decline in the participation rates among 18-24 year olds to a $1000 tuition increase. Kane (2003) brings this meta-analysis up-to-date by including the results of more recent studies, which use state-time differences in public tuition levels or evaluate the impact of changes in financial aid. As with the previous studies, the latter ones assume that the supply of college seats is perfectly elastic and find similar estimates of -0.04 (0.01). Given an average tuition of $4,000 in 2001, a $1000 increase corresponds to a 25% increase. With an elasticity of -0.18, this increase would lead to -0.045 (-0.15*0.25) decline in enrollment rates consistent with the more recent U.S. findings. It is thus interesting that despite substantial differences in the financing of higher education institutions in Canada and in the United States, the negative impact of tuition on enrollment rates in Canada is similar to that of the United States.

The estimates of the tuition effects are somewhat robust to the introduction of supply effects (government funding) in column (4), but are sensitive to the introduction of a quadratic time trend in column (6). Both Kane (1994) and Card and Lemieux (2001b) had difficulty finding significant negative tuition effects in the presence of state fixed effects using Current Population Survey data. As pointed by Kane (2003), one problem there, as with Canadian labour force survey data, is that many students are assigned to the state or province of residence of their parents rather than to their jurisdiction of college attendance. Neill (2004) argues that, with the use of a proper instrument, this problem can be overcome and presents some estimates of the negative effect of tuition in the range of what has been found in the literature.

In column (3), the logarithm of real provincial funding per person age 18-24 replaces tuition and yields an estimated elasticity of enrollment supply with respect to that variable of 0.187 (0.110), that is not significant in this small sample of 49 observations. In effect, provincial funding becomes significant when the quadratic time trend capturing the slowdown in enrollment rate of the 1990 is introduced in column (6).

As pointed out in Fortin (2005a,b), the three decades of the 1970s, 1980s and 1990s were characterized by different regimes in terms of trends in higher education policies. For Canada, the 1970s were characterized by steep declines in tuition and slow increases in provincial funding; the 1980s were characterized by relatively stable tuition levels and moderately rising provincial funding; the 1990s saw tuition escalate very steeply while provincial funding barely increased. The analysis shows that both tuition and provincial appropriations had significant impacts on enrollment rates in the 1970s and in the 1980s. In the 1990s, university-age population stabilized and there were severe provincial funding cut-backs, then only provincial funding is significant consistent with the enrollment supply side of the market becoming binding. Column (4) includes both log average tuition and log provincial funding per person age 18-24 as regressors, with a linear trend and column (6) with a quadratic trend. Consistent with Fortin (2005b), tuition levels are more significant with the linear specification, which captures the dramatic rise in enrollment rate of the 1980s and that provincial funding is more significant with the quadratic specification, which captures the deceleration in enrollment rates of the 1990s.

Columns (5) and (7) add the provincial university-high school wage gaps among the regressors. As in Fortin (2005a) for the United States, it is found not to be significant and, here even of the wrong sign. At first glance, this result may appear surprising given that the theory of enrollment demand predicts a positive role for the returns to education. Yet one has to remember that the within-province analysis requires that differences across provinces in university-high school wage gaps drive differences in enrollment demand across provinces. Thus the empirical analysis confirms that the confounding factors alluded to above may in practice dominate the effect of the return to education.

Overall, this analysis shows that the impact of higher education policies on enrollment rates has to be understood in the context of underlying demographics. Similarly, the impact of rising tuition has to be understood in the context of the overall funding of higher education institutions and their ability to increase the number of college seats while maintaining the quality of instruction. The impact of financial aid on enrollment rates need to be assessed bearing in mind the possibility that it could be offset by other government cut-backs.

At the dawn of the 21st century, there are worries about the future of higher education in Canada and the United States (Laidler (2004), Ehrenberg (2004)). Population projections of the Canadian university-age population show increases up to around 2014 (Statistics Canada (2003)). The modest but sustained growth, coupled with a higher propensity to attend university as a result of parents' higher educational attainment, signals a continued excess demand for college seats. Thus, enrollment demand should not be expected to become the constraining side of the market until 2020. Tuition increases are thus unlikely to be the factor adversely affecting the supply of skills, although they could undermine equality of opportunities objectives. Note that these objectives are also undermined when a restricted supply of university/college seats implies that institutions increasingly ration seats using grades, themselves linked to socio-economic status.

Arguments that support continued tuition increases point out to the persistently favourable labour market outcomes of university/college graduates. In the United States, increases in the college/high school wage premium had slowed down in the 1990s. Fortin (2005a) links this deceleration to the increase in enrollment rates associated with the relatively favourable higher education policies of the 1980s. These increases in enrollment rates translated into increases in the relative supply of college graduates in the 1990s, which exerted downward pressure on the premium. A similar inference likely holds for Canada where the near stagnant university/high school premium of the 1990s (Burbidge, Magee and Robb (2002)) was replaced by a climbing premium in the 2000s (Boudarbat, Lemieux and Riddell (2003)). As pointed out by Freeman and Needels (1993), the steeply increasing enrollments of the 1980s, which can be traced back to the relatively flat increases in tuition over that period, suppressed the growth of the university premium in the 1990s. By contrast, the skyrocketing tuition fees and severe government cut-backs implied stagnant enrollment rates over the 1990s. Thus the relatively stable university premium of the 1990s gave way to a rising premium in the 2000s.

Much future research is needed to assess the impact of these recent funding initiatives on enrollment rates in an enrollment supply and demand framework. The fungibility of diverse sources of funding and the extent to which the impact of financial aid is mitigated when that aid crowds out other forms of funding, are not well understood.

4. Forecasts and Policy Experiments

This section has several goals. First, we want to forecast the effect of aging on the return to university, in general, and on the return to university for young workers, in particular. This exercise is complicated by the fact that education decisions of young workers may themselves be affected by changes in return to university induced by the aging of the population. To deal with this problem, we first look at two extreme scenarios. Under Scenario 1, we assume that human capital investments (i.e. university education) of future cohorts of workers will remain the same as for the youngest cohort we currently observe in the labour market (those born between 1976 and 1980). Under Scenario 2, we assume that the growth rate in university education of future cohorts will be the same as what has been historically observed for men in all the cohorts we see in the 1980 to 2000 Census. Under these two scenarios we can use the model estimates of Section 2d to forecast what will be the return to university for each age group in the future. We provide forecasts for up to 2020. In light of our analysis of Section 3, we then discuss how plausible these two scenarios are. We show in particular what kind of education policies are required to sustain the highest growth paths in educational achievements.

4a. Forecasting Future Returns to University Education

Recall from Section 2 that both the aggregate supply and the age-group specific supplies of education depend on the amount of high school, H_{jt}, and university, C_{jt}, labour provided by each age group j. While these quantities are readily computed within the observed samples, assumptions have to be made to forecast future values of H_{jt} and C_{jt} (for t=2020, for example). One useful way of thinking about this problem is to write down H_{jt} and C_{jt} as functions of the relative supply RS_{jt} ($RS_{jt}=C_{jt}/H_{jt}$), and the overall working population POP_{jt} ($POP_{jt}=C_{jt}+H_{jt}$) of age group j at time t. Solving these two equation yields:

(14a) $H_{jt} = POP_{jt} / (1+RS_{jt})$,

and

(14b) $C_{jt} = POP_{jt} [RS_{jt} /(1+RS_{jt})]$.

This means that forecasts for H_{jt} and C_{jt} can be computed as a function of forecasts for POP_{jt} and RS_{jt}. We compute these forecasts using a regression approach similar to the approach used in Section 2 to compute the cohort effects in relative supplies illustrated in Figure 2. As in equation (9), consider models for the log relative supply and the log population that depend on only on cohort effects and age effects:

(15a) $\log (RS_{jt}) = \lambda_{r,t-j} + \varphi_{r,j}$, and

(15b) $\log (POP_{jt}) = \lambda_{p,t-j} + \varphi_{p,j}$.

where t-j represents the birth cohort. We can then compute changes in RS_{jt} or POP_{jt} (and thus H_{jt} and C_{jt}) across time by simply looking at change in cohort effects. For example, the change in (log) population for age group j between time t' and t is given by the difference in cohort population effects for cohorts t'-j and t-j:

$$\log (POP_{jt'}) - \log (POP_{jt}) = (\lambda_{p,t'-j} - \lambda_{p,t-j}) + (\varphi_{p,j} - \varphi_{p,j}) = (\lambda_{p,t'-j} - \lambda_{p,t-j}).$$

Since we have population counts from the 2001 Census for all cohorts up to the 1996-2000 cohort, we estimate the population model in equation (15b) for the 1916-20 to 1995-2000 cohorts. The estimated cohort effects relative to the 1946-50 cohort are illustrated in Figure 4. The pattern in these (age-adjusted) cohort population effects follows the expected path. Cohort population rises sharply from the trough of the Great Depression (early/mid-1930s) to the peak of the baby boom (late 1950s /early 1960s), followed by the steep decline associated with the "baby bust". There is then a mild recovery (echo of the baby boom) for cohorts born between the early 1970s and the mid-1990s, followed by another decline (echo of the baby bust?) for the very youngest cohort observed in the 2001 data (1996-2000). Note that we stop our forecasts in 2020 since by this time the youngest birth cohort observed in the 2001 census (1996-2000 cohort) will have entered the labour market. Projections beyond 2020 would thus have to be based on (arbitrary) assumptions about fertility rates in the future.

The cohort effects in relative supply (estimates from equation (15a)) were already reported in Figure 2. As discussed at the beginning of this Section, we forecast future relative supplies under two extreme scenarios illustrated in Figure 5. Under Scenario 1, relative supply (i.e. educational achievement) of future cohorts remains as for the newest cohort observed in the labour market (1976-1980 birth cohort). Under Scenario 2, the growth rate in relative supply across cohorts resumes the historical trend observed for the 1916-1920 to 1976-1980 cohorts for men. In light of the slow inter-cohort supply growth for men since the 1946-50 cohort, reverting back to historical trends is probably an overly optimistic scenario. Note, however, that this may be a more realistic scenario for women who have experienced a much steadier growth in relative supply over time. [6]

With these cohort forecasts at hand, we compute the forecasts of C_{jt} and H_{jt} using equation (14a) and (14b). Forecasts of aggregate supplies can then be obtained by simply aggregating up the supplies for each age group (as in the case described in Section 2 where actual values of (C_{jt} and H_{jt}) were available). The resulting aggregate supply index is shown in Figure 6a (men) and 6b (women). The aggregate supplies for 1980 to 2000 are simply the aggregate supplies already shown in Figure 3. The figures then show the aggregate supplies predicted under the two different scenarios. The figures also compare these forecasts of the aggregate supply to the trend growth in supply required to keep return to university constant. Remember from Table 3 that the trend growth in demand is about 1.5 percent a year. Given the aggregate supply coefficient of -0.479, this means that aggregate supply has to grow by about 3 percent a year to keep the return to university constant.

Figure 6a shows that, for men, aggregate supply has grown barely less than the required rate of 3 percent a year to keep returns constant between 1980 and 1980. As a result, the return to university only barely increased over this period. Things change radically after 1995,

6 We use the historical trend for men in Scenario 2 for women. If we were to use the historical trend for women instead, this would lead to an increasing divergence in educational achievement for women and men that would eventually become very large.

however. As we already saw, the aggregate supply grew almost twice as slowly between 1995 and 2000, resulting in a substantially higher return to university (demand outstripping supply). Figure 6a shows that this trend will continue unabated over the next 20 years under either the optimistic (Scenario 1) or more pessimistic (Scenario 2) scenario. As a result, supply growth will not be sufficient to outstrip the trend growth in demand, resulting in ever increasing returns to university (more below).

What account for this remarkable prediction that aggregate supply will now grow much more slowly for men than it has grown over the 1980s and early 1990s? The answer is that we are now seeing the full-fledge consequences of the dramatic stagnation in education achievement of the largest cohorts of the baby boom. Basically, the largest segment of the workforce (those born from the early 1950s to the mid-1960s) is no more educated than men born in the 1940s who have now started retiring from the workforce. Increasingly, the sole source of progression in aggregate educational achievement of men is the smaller cohorts born after 1964, which are more educated than men born before 1965. Unfortunately, these cohorts are too small relative to the larger baby boom cohorts to keep driving up the growth in aggregate supply. This explains why aggregate supply will keep growing slowly even under the optimistic scenario that new cohorts will gain substantially in terms of educational achievement. Even under this scenario, we will have to wait until the bulk of the baby boom generation starts retiring before finally seeing a recovery in aggregate supply. Since the peak of the baby boom was reached in 1959-60, it will likely take until the 2030s before we see a major recovery in the rate of growth of aggregate supply.

The situation is much less dramatic for women. Figure 6b shows that, prior to 1995, aggregate supply actually grew faster than the trend growth required to keep the return to university constant. This explains why the return fell between 1980 and 1995, as the growth in aggregate supply outstripped the trend growth in demand. By contrast, we predict that this phenomenon will come to an end in the years to come. Under both scenarios, we expect aggregate supply to grow slower that the trend growth required for keeping returns constant. Note, however, that the difference will be minimal under the more optimistic scenario.

The story for why aggregate supply will grow slower for women after 1995 than it did prior to 1995 is related to the story for men. As seen in Figure 2a, even for women there was a marked slowdown in the growth in supply for the largest baby boom generations. A simple way to describe inter-cohort trends for men and women is that the trend for women is generally higher for women, but supply swings around the trends for various cohorts (baby boom, etc.) are similar for men and women. This explains why aggregate supply growth remains higher for women than men, though growth slows down for both men and women after 1995.

We are finally in a position to forecast the future return to university by age groups using the model estimated in Section 2 and the forecast of both age-group specific and aggregate supply. Of course, the predictions critically depend on the parameters of the model remaining constant over time. For example, if the estimated trend growth in demand (1.5 percent a year) was to fall between 2000 and 2020, this would negatively affect the forecast of the return to university.

With these caveats in mind, Figures 7 and 8 illustrate the predicted returns for men and women under the two aforementioned scenarios. We show predicted returns for 2010 and 2020, along with the observed returns in 1980 and 2002 that are reported as a benchmark. Starting with the "pessimistic scenario" (Scenario 1), Figure 7a shows that returns to university are predicted to substantially grow for men. In particular, returns from men age 26-30 would increase from 0.18 in 2000 to 0.30 in 2010 and 0.42 in 2020. Returns for other groups would grow by 20 percentage points or so. While the predicted increases are very large, this would put male returns (in 2020) at a level comparable to those for women in 1980, and around the levels currently observed for men in the United States.

Not surprisingly, returns would grow much less for women (Figure 7b) under this scenario, and essentially go back to levels observed in 1980. As mentioned earlier, the reason for this large discrepancy between men and women is that the predicted growth in aggregate supply is almost large enough to keep returns more or less constant for women, but not for men (Figure 6).

Also consistent with Figure 6, returns under the more optimistic scenario would still grow for men (Figure 8a) but essentially remain unchanged for women (Figure 8a). For example, returns for men age 26-30 would increase by 0.14 between 2000 and 2020 under Scenario 2 (from 0.18 to 0.32), compared to a predicted increase of 0.24 (from 0.18 to 0.42) under Scenario 1. Under either scenario it is clear, however, that returns for men will increase by much more over then next 20 years than over the last 20 years. By contrast, returns will remain much more stable for women, and essentially unchanged under Scenario 2 (Figure 8b).

4b. How Plausible are these Two Scenarios? Alternative Forecasts of Future Enrollment Rates

The two related questions we ask here are how realistic the two proposed scenarios are in light of the enrollment models estimated in Section 3, and whether the predicted growth in returns to university for young men over the next 20 years can yield a substantial supply response? The answer to the second section is relatively straightforward. Since returns have no significant effects on enrollment rates in Table 5, it is hard to see how increasing returns can generate a substantial supply response for men. This is also consistent with most of the literature that views the effect of returns on enrollment rates as small, at best (see Kane, 1999). We thus focus our analysis on factors like demographics and education policies that we have shown to have a significant effect on enrollment decisions in Section 3.

In table 6, we project what the enrollment supply─or the capacity of the higher education system─ should be in 2010 and 2020 for our Scenario 2 to unfold. We begin in row 1 with the university enrollment rates required to obtain a growth in relative supply consistent with Scenario 2, then using population projections of the population age 18-24 (Statistics Canada (2003), we obtain in row 3 the increased capacity required, that is of 7,500 university seats/year seats over the decade 2000-2010 and of 10,000 university seats/year over the decade 2010-2020 to meet those goals.

Next, in the bottom panel of Table 6, we ask whether bold but "reasonable" higher education policies can achieve these goals; these policies consist of yearly real increases of 2% of both tuition levels and provincial funding. They correspond to the policies applied in the province of British Columbia over the 1990s, noting that British Columbia is the province that had the most catching-up to do in terms of university enrollment rates (Fortin, 2005b). The corresponding levels of tuition and provincial funding per person age 18-24 are displayed in the first two rows of the bottom panel. The next three rows predict the enrollment rates from our model of Section 3 using the estimates reported in Table 5. We assess various specifications of the time trend, which can be seen as capturing increases in the propensity to attend post-secondary education. The linear trend of column (4) of Table 5 leads to an over-prediction of the enrollment rate in 1999 and is thus seen unrealistic. By contrast, the quadratic trend of column (6) of Table 5 results in very accurate predictions of the actual rates up to 2000. The simulation B continues the plateau reached by the quadratic in 2000 until 2020 and results in enrollment rates that are short of our goal set in row 1 of the top panel. The simulation C meets those goals by reintroducing the previous linear trend of the 1980s for the period 2010-2020.

In summary, the steep goals set by our Scenario 2 are attainable, but require sustained investments in higher education, as well as sustained efforts in the K-12 education system to increase the propensity to attend post-secondary education among the smaller cohorts that will follow the echo of the baby-boom generation, an echo which is expected to peak in 2014. The real challenges to the renewal of a high skilled work force are anticipated in the years 2020 and beyond.

5. Conclusion

An important finding of this paper is that the return to university education has increased for men from 1995 to 2000 because of a sharp slowdown in the rate of growth of the relative supply of university education that started in the mid-1990s and that will persist until at least 2020. As a result, we expect that the return to university will keep increasing for men for the next ten to twenty years provided that relative demand keep growing at the rate observed between 1980 and 2000. These findings are based on estimates of the Card and Lemieux (2001a) model that allows for imperfect substitution between various age and education groups in the labour market.

The reason we can safely predict that the aggregate supply of university education for men will keep growing at a relatively slow rate over the next twenty years is that it is linked to fundamental demographic forces linked to the aging of the baby boom generation. In particular, there was a dramatic stagnation in the educational achievement of the largest cohorts of the baby boom born between 1950 and 1964. As a result, men born in the 1940s who have started leaving the labour market are essentially as educated as those who will reach retirement in the twenty years to come. New cohorts entering the labour market are more educated but too small in size to counterbalance the weight of the main baby boom generations. By contrast, thanks to the remarkable growth in the education achievement of women over the last several decades, the supply of university-educated women will keep growing essentially fast enough to keep return to university more or less constant (among women) until 2020.

We then ask the question of whether the large predicted increase in the university wage premium forecasted for men will generate an important supply response. Based on our survey of the literature and new results of our own, we conclude that this supply response is unlikely to be important. Our findings rather suggest that demographics and education policies have a potentially bigger role to play in increasing the fraction of young men and women going to college and university. The reason is simple. Even if more young people wanted to go to university to take advantage of increasing returns to university education, this will not happen in a country like Canada unless more university "seats" become available relative to the size of the university-age population. This is the very reason why the educational achievement of the largest baby boom generations failed to grow, and even declined, when the college and university system failed to fully cope with this unprecedented influx of young people in the 1970s and early 1980s. As a result, the stock of human capital in Canada is not as large as it could be, and the relative scarcity of highly-educated labour will likely push up its price in the years to come. It is unlikely, however, that the price system will enable the system to self-correct itself by inciting a large fraction of young people to go to university. Favourable provincial and federal education policies are instead required to enable an increasingly large fraction of young people getting a higher education and reaping the growing benefits of higher education in the future.

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Data Appendix

The wage gaps in Table 1 are based on samples of men in the 1981, 1986, 1991, 1996, and 2001 Censuses (public use files). The Census samples for "year t" (t=1980, 1985, 1990, 1995, 2000) include men and women who were age 26-60 in t. Weekly wages of full-time workers are formed by dividing annual wage and salary earnings by weeks worked during the previous year for individuals who worked full-time in the previous year. We use the CPI to deflate all wages to 1989 dollars. Individuals whose earnings are less than CAN$50.00 per week in 1989 dollars are excluded.

The wage gaps are estimated in separate regression models for each cohort in each "year", using samples of men with exactly a "high school degree" or exactly a university bachelor's degree. Each model includes a dummy for a "college graduates" and a linear age term. The inverse of the estimated variance of the coefficient on the dummy for college graduates is used as weight in the models reported in the paper.

As mentioned in the text, relative supply measures are constructed by giving different weights on workers with different levels of education. These weights are based on relative wages by education groups estimated using a standard log wage equation with experience controls also included in. Following the literature, we first assume that workers with exactly a high school degree supply 1 high school equivalent; workers with exactly an undergraduate university degree supply 1 university equivalent; workers with less than high school education supply 0.89 of a high school equivalent; workers with an advanced degree supply 1.13 university equivalent; workers with a trade certificate supply 0.81 high school equivalents and 0.19 university equivalents; workers with a college degree (or university diploma below a BA) supply 0.58 high school equivalents and 0.41 university equivalents.

Table 1: University-High School Wage Differentials by Age and Year

	Age Range						
	26-30	31-35	36-40	41-45	46-50	51-55	56-60
A. Men							
1980	0.095	0.182	0.256	0.297	0.291	0.393	0.366
	(0.012)	(0.014)	(0.017)	(0.024)	(0.028)	(0.031)	(0.035)
1985	0.115	0.214	0.279	0.263	0.327	0.356	0.433
	(0.014)	(0.014)	(0.015)	(0.018)	(0.026)	(0.030)	(0.035)
1990	0.146	0.253	0.263	0.279	0.297	0.337	0.349
	(0.011)	(0.011)	(0.012)	(0.013)	(0.018)	(0.023)	(0.031)
1995	0.151	0.304	0.299	0.271	0.297	0.285	0.320
	(0.012)	(0.012)	(0.013)	(0.014)	(0.015)	(0.020)	(0.034)
2000	0.224	0.315	0.356	0.335	0.314	0.314	0.302
	(0.013)	(0.013)	(0.013)	(0.014)	(0.015)	(0.017)	(0.028)
B. Women							
1980	0.304	0.452	0.495	0.502	0.462	0.612	0.491
	(0.014)	(0.019)	(0.027)	(0.036)	(0.039)	(0.046)	(0.052)
1985	0.303	0.384	0.471	0.483	0.420	0.471	0.597
	(0.015)	(0.018)	(0.020)	(0.026)	(0.037)	(0.039)	(0.054)
1990	0.329	0.388	0.430	0.460	0.467	0.494	0.395
	(0.011)	(0.013)	(0.013)	(0.014)	(0.020)	(0.027)	(0.036)
1995	0.320	0.412	0.410	0.428	0.466	0.473	0.443
	(0.012)	(0.013)	(0.014)	(0.014)	(0.015)	(0.021)	(0.034)
2000	0.336	0.410	0.439	0.391	0.411	0.445	0.467
	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)	(0.016)	(0.027)

Notes: Standard errors in parentheses. Elements of the table are estimates of the difference in mean log weekly earnings between full-time Canadian men (women) with a bachelor’s degree (but no post-graduate degree) versus those with exactly a high school degree.

Table 2: University Completion Rates by Age and Year

	Age Group:						
	26-30	31-35	36-40	41-45	46-50	51-55	56-60
A. Men							
1980	0.167	0.190	0.180	0.132	0.102	0.093	0.092
1985	0.150	0.182	0.200	0.183	0.145	0.109	0.099
1990	0.164	0.169	0.195	0.210	0.188	0.144	0.120
1995	0.202	0.188	0.180	0.203	0.220	0.197	0.157
2000	0.233	0.237	0.203	0.191	0.215	0.227	0.196
B. Women							
1980	0.161	0.149	0.102	0.071	0.058	0.052	0.049
1985	0.162	0.165	0.162	0.123	0.089	0.066	0.058
1990	0.184	0.169	0.174	0.163	0.130	0.092	0.077
1995	0.255	0.208	0.180	0.189	0.184	0.146	0.110
2000	0.316	0.273	0.211	0.193	0.200	0.189	0.148

Table 3: Estimated Models for the College-High School Wage Gap, By Cohort and Year (Men)

	Card and Lemieux, 1980-95			1980-2000		
	(1)	(2)	(3)	(4)	(5)	(6)
Age-group specific relative supply	-0.165 (0.042)	-0.166 (0.041)	-0.165 (0.041)	-0.159 (0.042)	-0.138 (0.043)	-0.152 (0.041)
Trend	--	-0.001 (0.007)	-0.002 (0.015)	--	0.010 (0.007)	0.015 (0.006)
Year Effects:						
1985	0.029 (0.014)	--	--	0.030 (0.017)	--	--
1990	0.054 (0.014)	--	--	0.054 (0.016)	--	--
1995	0.089 (0.017)	--	--	0.090 (0.019)	--	--
2000	--	--	--	0.143 (0.022)	--	--
Katz-Murphy Aggr. Supply Index	--	0.069 (0.247)	--	--	-0.255 (0.269)	--
Aggr. Supply Index for Men with Imperfect Substitution Across Age Groups	--	--	0.134 (0.547)	--	--	-0.479 (0.222)
R-squared	0.94	0.94	0.94	0.92	0.90	0.91

Notes: Standard errors in parentheses. Models are fit by weighted least squares to the age-group by year college-high school wage gaps shown in Table 1. Weights are inverse sampling variances of the estimated wage gaps. All models include age effects.

Table 4: Alternative Models for the University-High School Wage Gap, By Cohort and Year.

	Card-Lemieux		Canada, 1980-2000	
	U.S. men 1959-96	U.K. men 1974-96	Men Only	Men and Women
Age-group specific Relative supply	-0.209 (0.025)	-0.233 (0.078)	-0.152 (0.041)	-0.059 (0.033)
Trend	0.020 (0.002)	0.018 (0.006)	0.015 (0.006)	0.014 (0.002)
Aggr. Supply Index with Imperfect Substitution Across Age Groups	-0.483 (0.053)	-0.340 (0.114)	-0.479 (0.222)	-0.396 (0.074)
Female dummy	--	--	--	0.152 (0.007)
R-squared	0.95	0.73	0.91	0.93

Notes: Standard errors in parentheses. Models are fit by weighted least squares to the age-group by year college-high school wage gaps shown in Table 1. Weights are inverse sampling variances of the estimated wage gaps. All models include age effects.

Table 5: Determinants of University Enrollment Rates 1980-2000

Dependent Variable: Provincial Log Enrollment Rates	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log Population	-0.926	-0.825	-0.838	-0.796	-0.798	-0.602	-0.605
Age 18-24	(0.188)	(0.155)	(0.180)	(0.153)	(0.149)	(0.155)	(0.152)
Log Average		-0.179		-0.166	-0.165	-0.032	-0.030
Provincial Tuition		(0.046)		(0.051)	(0.053)	(0.024)	(0.023)
Log Provincial Funding			0.187	0.076	0.078	0.131	0.134
per Person Age 18-24			(0.110)	(0.106)	(0.111)	(0.075)	(0.078)
Log University Premium					-0.056		-0.075
					(0.454)		(0.358)
Time Trend	0.020	0.021	0.017	0.027	0.027	0.049	0.050
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.009)	(0.009)
Time Squared /10						-0.013	-0.013
						(0.003)	(0.003)
R-squared	0.94	0.95	0.94	0.96	0.96	0.96	0.96
No. of Observations	49	49	49	49	49	49	49

Notes: Robust standard errors in parentheses. Models are fitted by weighted least squares using population as weights. All models include provincial dummies. The data on enrollments, tuition and provincial funding are from Fortin (2005b). The log university premium is computed from the five Censuses of 1981, 1986, 1991, 1996 and 2001.

Table 6: Simulated Impact of Demographics and Higher Education Policies on Enrollment Rates in 2010-2020

	Actual				Simulated	
Years:	1973	1980	1990	1999	2010	2020
University Enrollment Rates	13.2	13.6	21.7	23.4	27.7	33.2
%change/year		0.2	6.0	0.7	2.0	2.0
Population Age 18-24 (in 1000s)	2,474	3,410	2,928	2,876	2,720	2,571
%change/year		1.2	-1.4	-0.2	-0.6	-0.5
FTE Univ. Enrollees (in 1000s)	387	464	635	674	753	854
%change/year		1.4	3.7	0.5	1.3	1.3
Average Tuition (in 1999 $CAN)	2300	1500	1600	3100		
%change/year		-2.4	0.7	8.4		
Provincial Funding per Person Age 18-24 (in 1999 $CAN)	1810	1920	2590	2720		
%change/year		0.4	3.5	0.5		
Simulation of 2%/year increase in real tuition and provincial funding						
Average Tuition (in 1999 $CAN)					3755	4500
Provincial Funding per Person Age 18-24					3650	4380
University Enrollment Rates						
A. Linear Trend		14.1	21.3	24.4	33.9	43.6
B. Quadratic Trend with time effect kept at 2000 level in 2010 and 2020		13.6	21.8	23.7	25.6	26.1
C. Quadratic Trend with time effect kept at 2000 level in 2010 and with linear 0.02 trend in 2020		13.6	21.8	23.7	25.6	31.8

Notes: The educational data is from Fortin (2005b). The simulations are based on the estimates presented in Table 5.

Figure 1a: University-High School Wage Gap by Age Group, Men

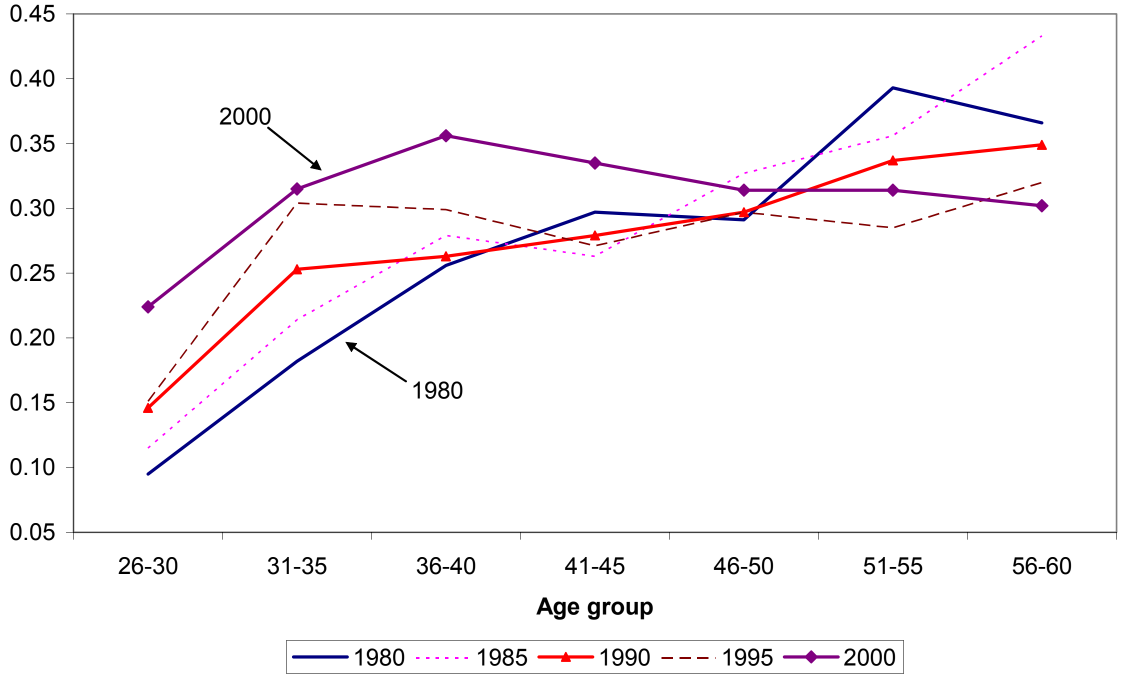

Figure 1b: University-High School Wage Gap by Age Group, Women

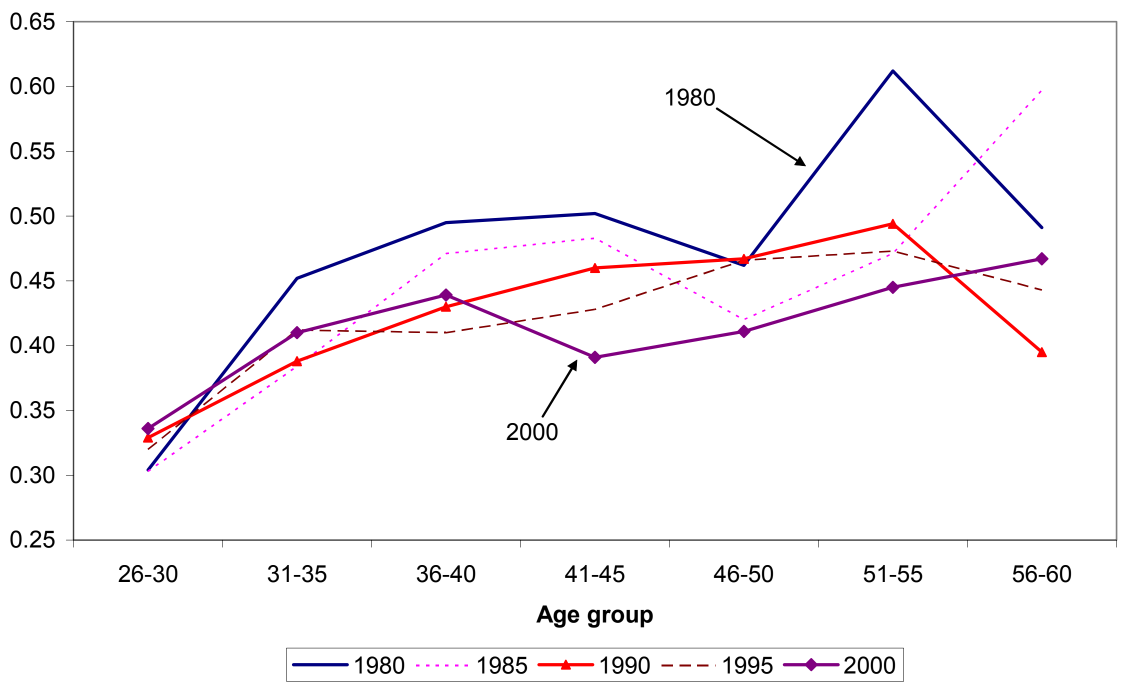

Figure 2a: Relative Supply of University Education (Log Supply) by Birth Cohort

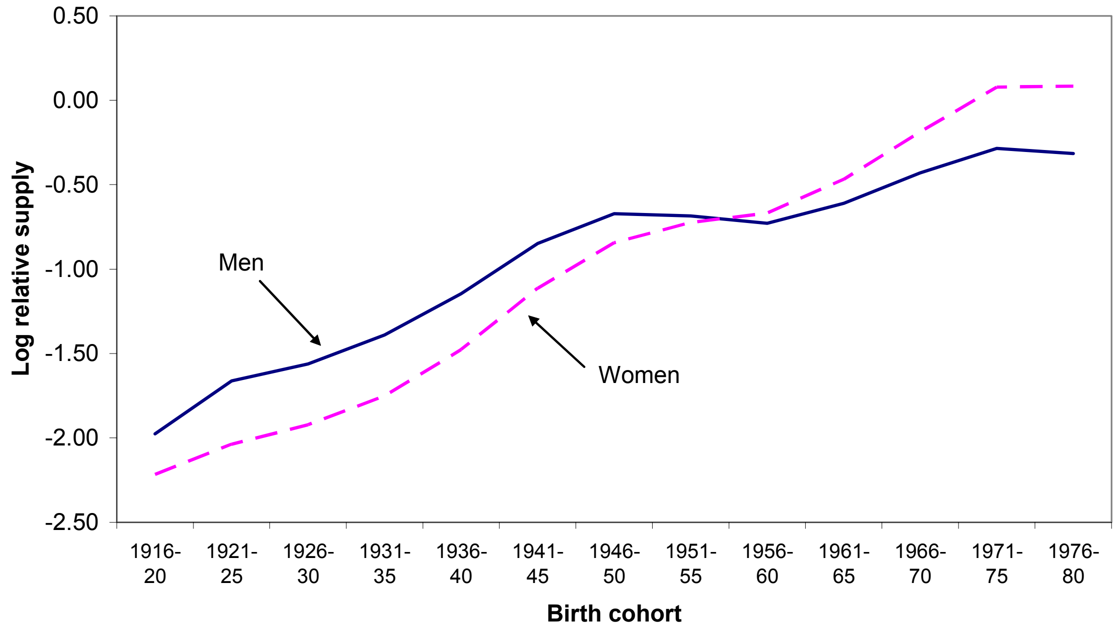

Figure 2b: Relative Supply of University Education (Fraction of Total Supply) by Birth Cohort

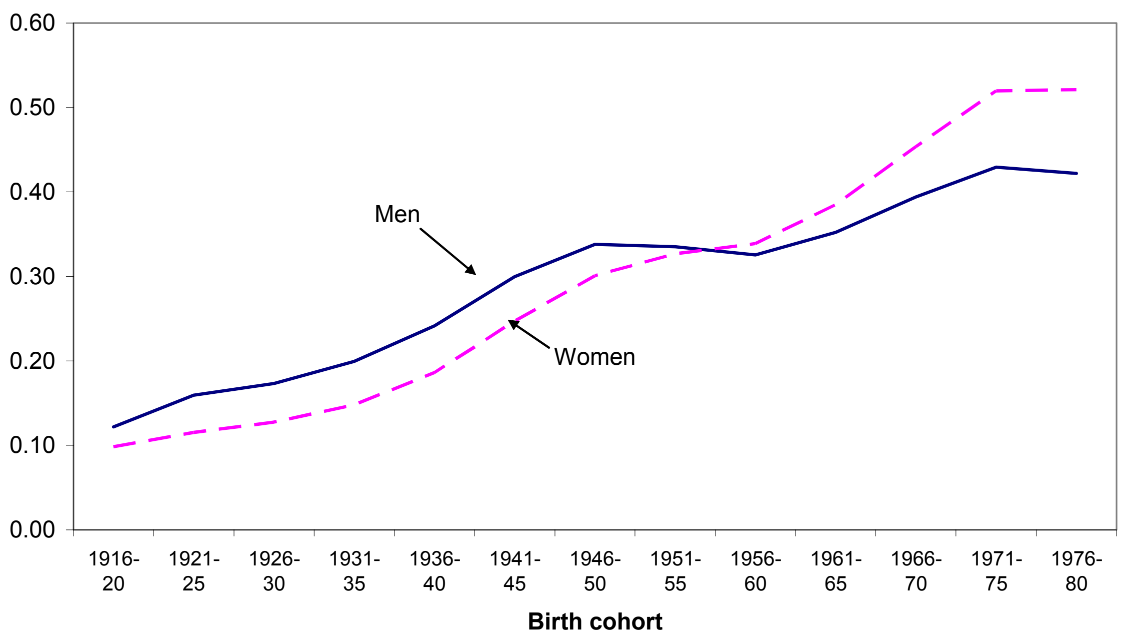

Figure 3: Aggregate Supply and Return to University

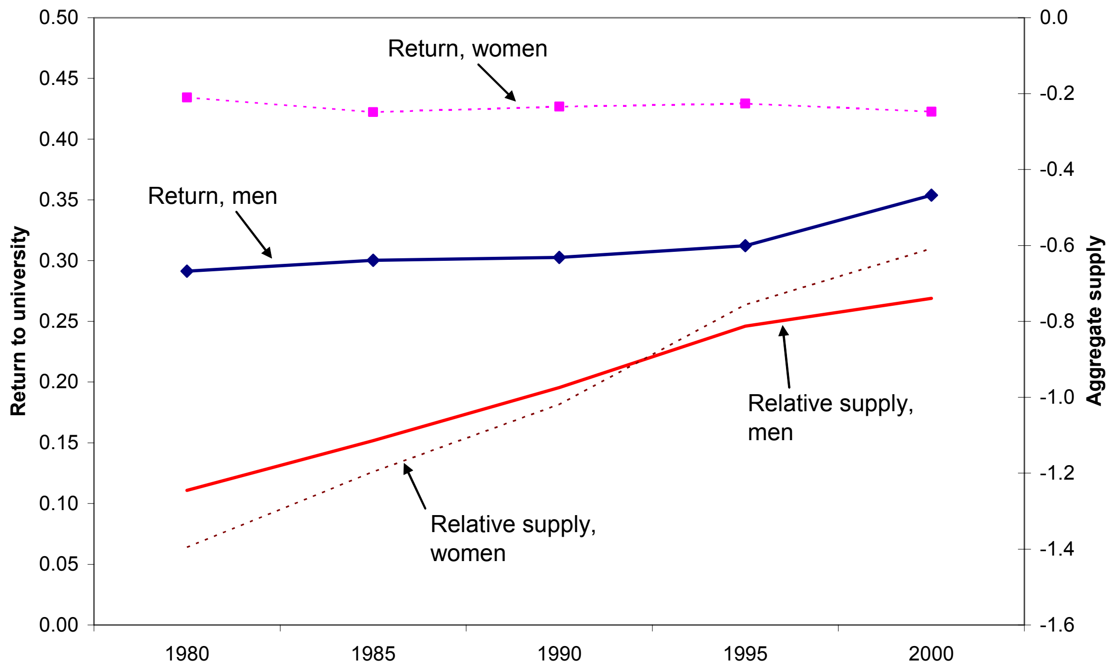

Figure 4: Age-Adjusted Log Population by Birth Cohort (Relative to 1946-50 Cohort)

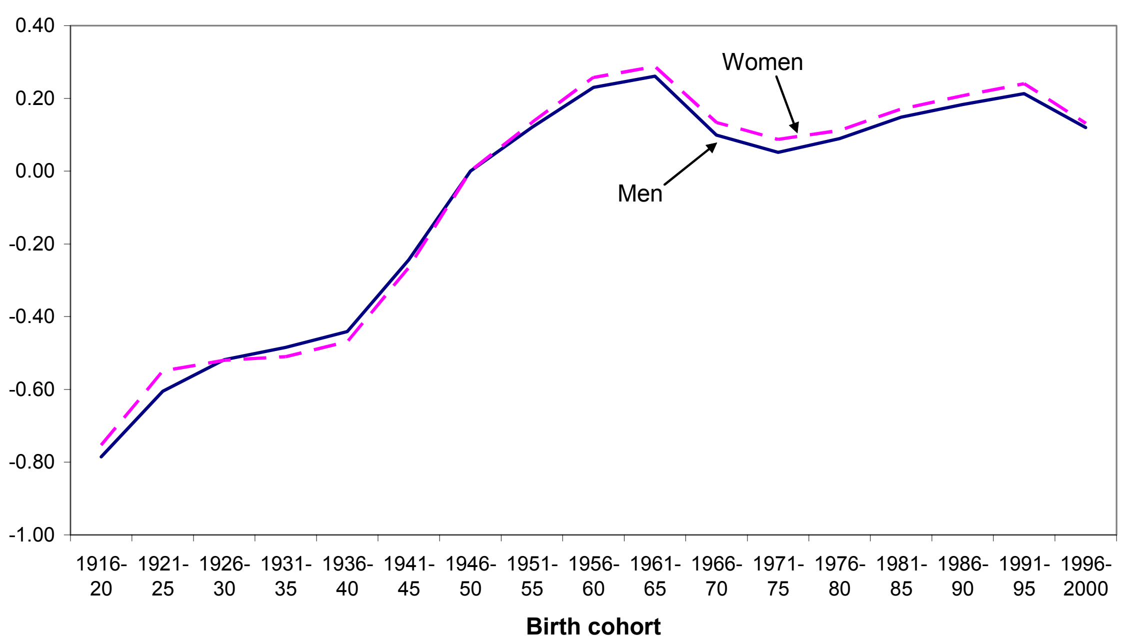

Figure 5a: (Log) Relative Supply of Men by Cohort: Two Scenarios

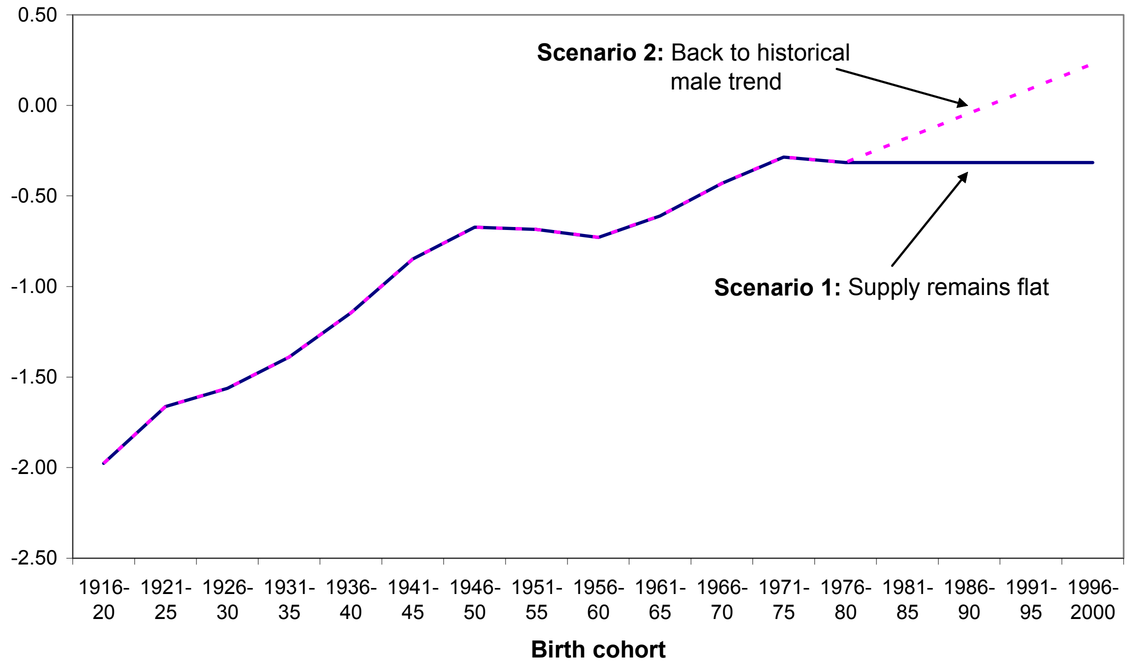

Figure 5b: (Log) Relative Supply of Women by Cohort: Two Scenarios

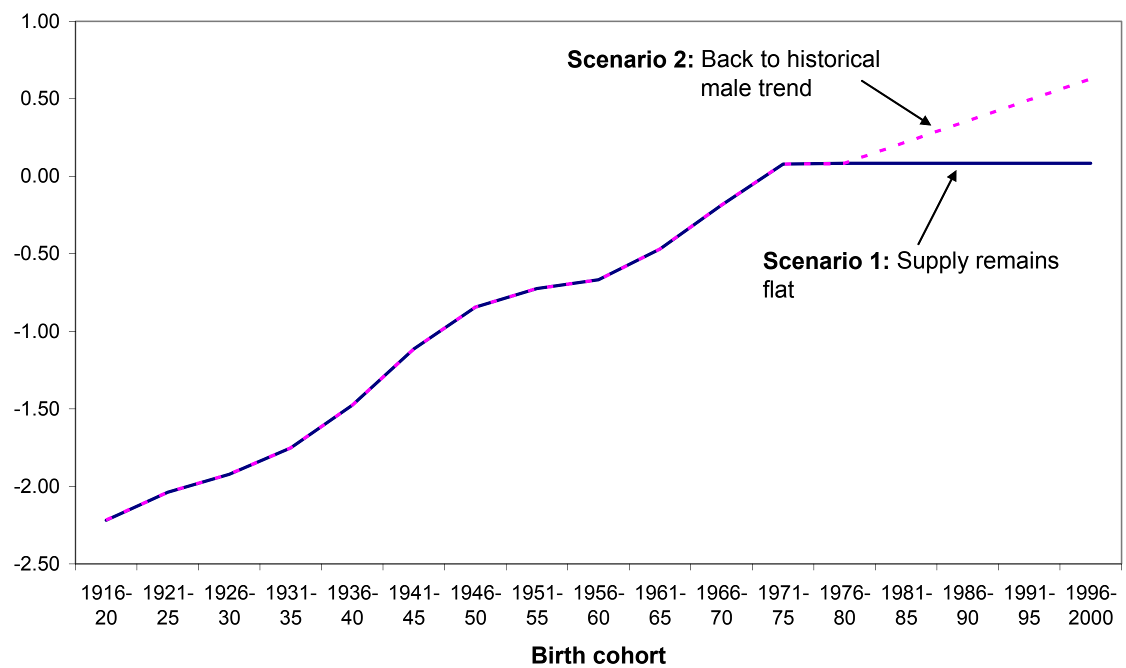

Figure 6a: Aggregate Supply of University Education of Men under Two Scenarios

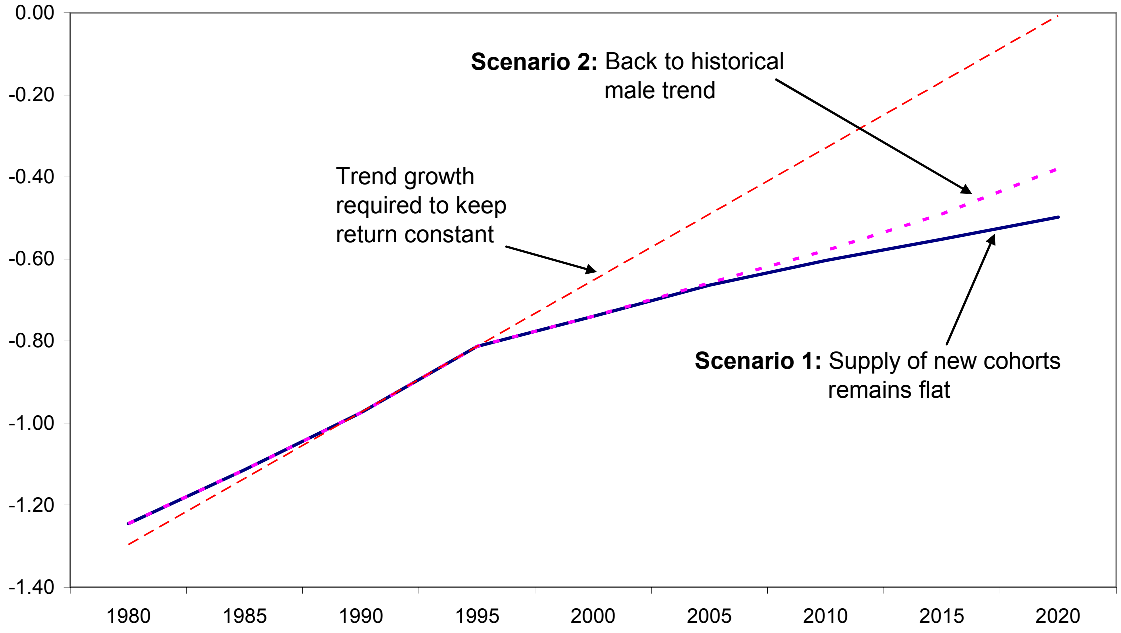

Figure 6b: Aggregate Supply of University Education of Women under Two Scenarios

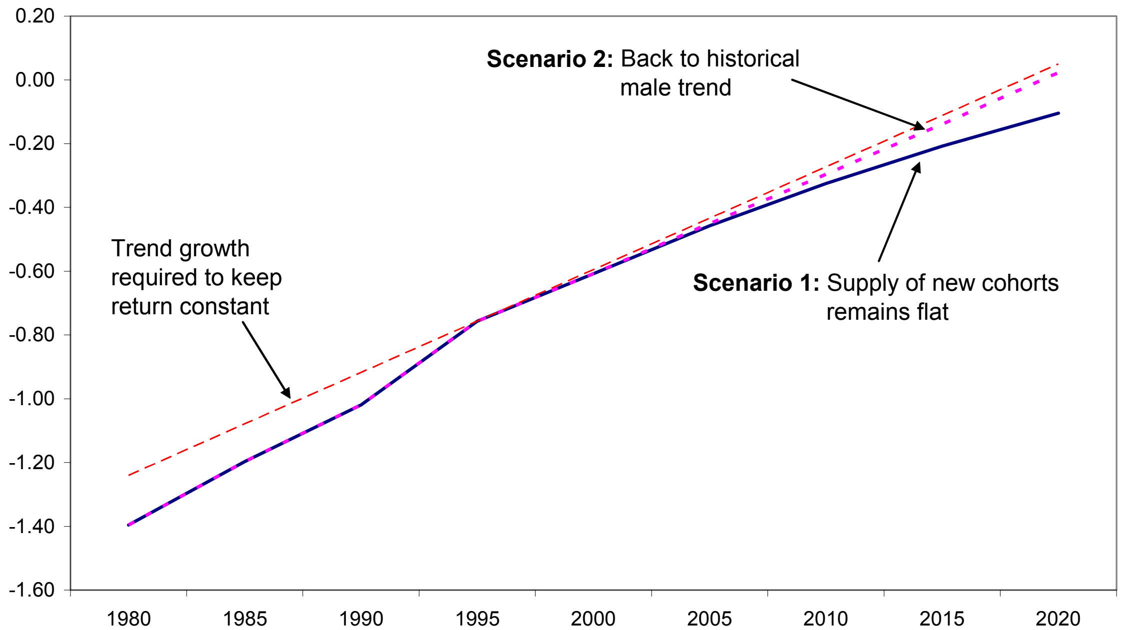

Figure 7a: Projected University-High School Wage Gap of Men under Scenario 1 (supply of new cohorts remains flat)

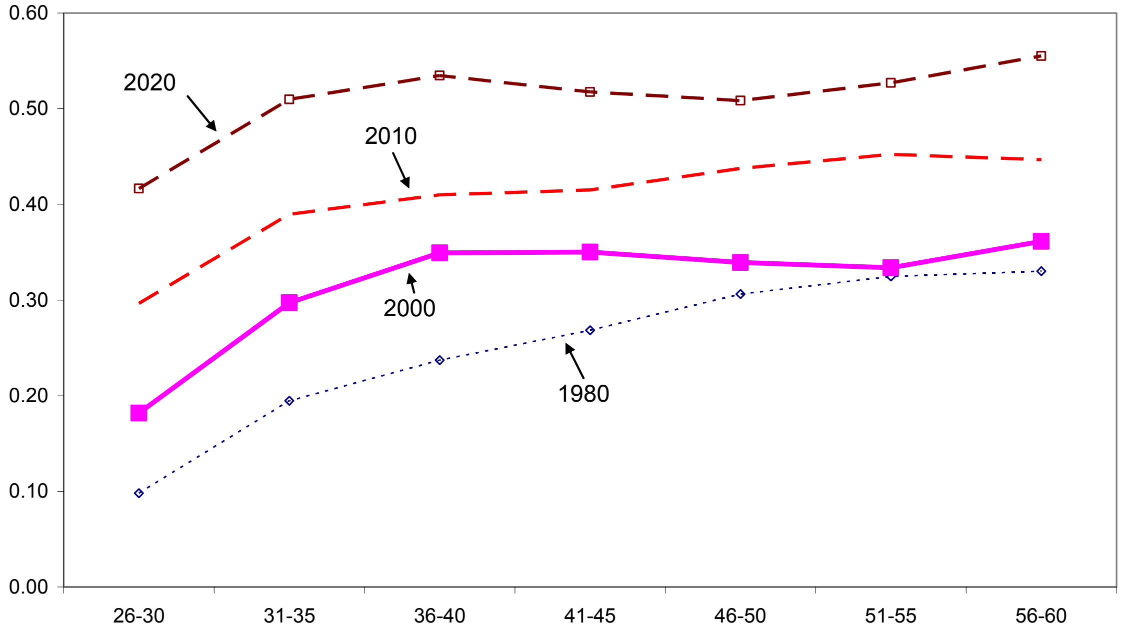

Figure 7a: Projected University-High School Wage Gap of Women under Scenario 1 (supply of new cohorts remains flat)

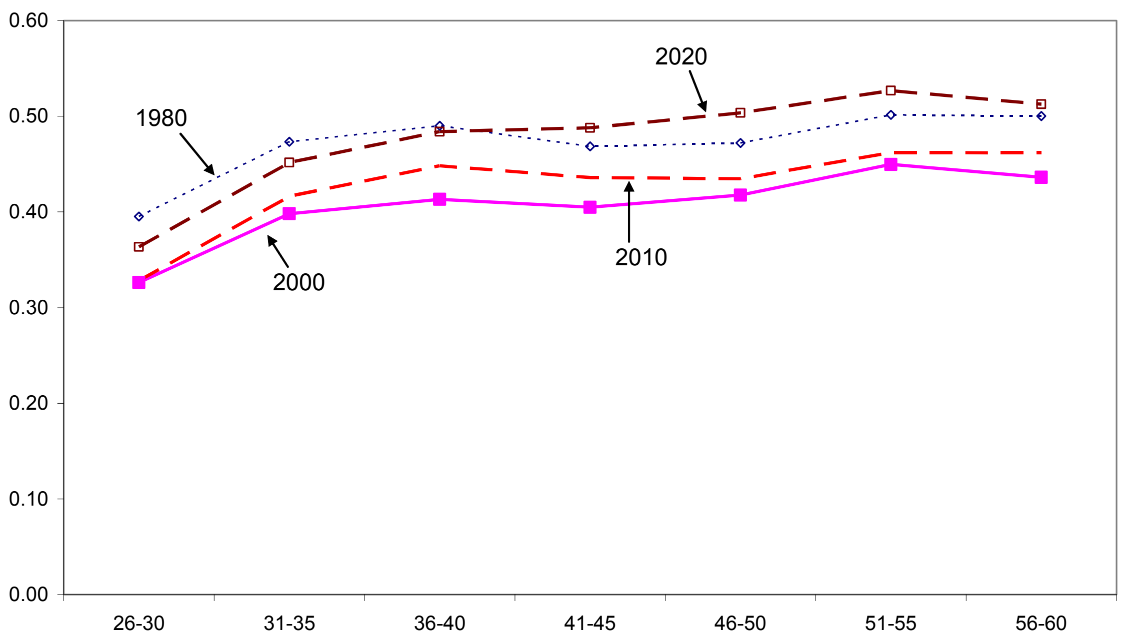

Figure 8a: Projected University-High School Wage Gap of Men under Scenario 2 (supply of new cohorts back to historical male trend)

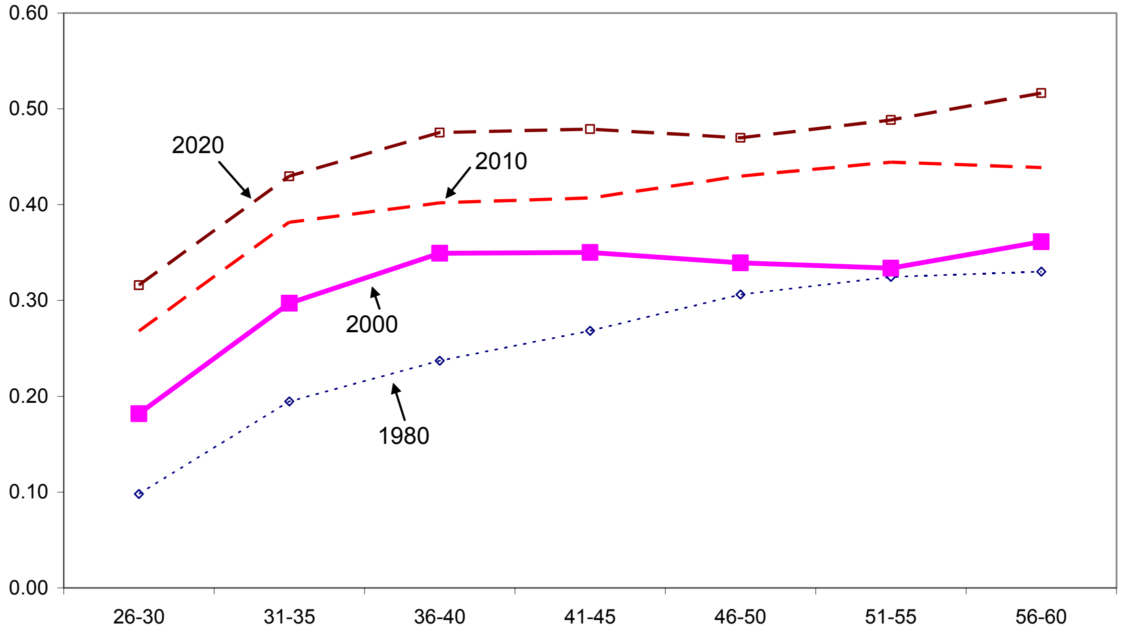

Figure 8b: Projected University-High School Wage Gap of Men under Scenario 2 (supply of new cohorts back to historical male trend)