The Equity Supply Chain: Is it the Cause of So Few Women in Management and Leadership Positions?

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Abstract

Women have comprised over half of US university students since the 1980s. Women make up 45% of the US workforce. However women are poorly represented in senior and leadership positions both in industry and on university faculties. Only 16% of corporate officers and only 2% of CEOs at major companies are women. If increasing numbers of women have been in the pipeline for over 25 years should more have emerged at the other end as leaders? A simple model indicates that the pipeline delay hypothesis is not sufficient to explain the relatively small numbers of women in senior and leadership roles.

Keywords: gender equity, supply chain, women, system dynamics, workforce

Introduction

The role of women as a part of the US labor force is significant and still growing. In addition, over 50% of university students in the United States are women and this has been the case for over 25 years. This is now true even at institutions dominated by engineering and science curricula such as the Massachusetts Institute of Technology, where more than half the undergraduate science majors and more than one third of the engineering students are women (Dean, 2006). Two well known universities in the Boston area, MIT and Harvard, have women presidents.

Nevertheless, the proportion of women in higher positions, both in academia and in business circles is less than what one might expect given the high proportion of female students and the proportion of women in the workforce. Although half of the students in fields such as medicine are women, only about 15% of full professors in social behavioral and life sciences at top-tier institutions are women (Dean, 2006). Although women now make up almost 45% of the workforce, they account for only about 16% of corporate officers at Fortune 500 companies, and only 2% of CEOs (Creswell, 2006). A recent international survey of businesses found that, in the USA, only 23% of senior management positions were filled by women (Anon, 2007).

In this paper I briefly examine the apparently low proportion of women in leadership and senior positions in order to determine if this apparent discrepancy could be due to the time it takes for women to move up through the management hierarchy. In other words: Is this merely a supply-chain problem? As Cresswell (2006) comments: "For decades, the pat explanation was that women simply had not been in the work force long enough; with patience, the pipeline would fill."

Background

There is a significant amount of literature on the question of womens role in the workforce, and a lot of additional information in the form of workforce statistics and government studies of educational trends. The use of some of these data as sources for a generic system dynamics model is problematical because the reports often are related to a particular situation (e.g. a specific university), a specific period of years, or are otherwise restricted to a subset of the required details. Obtaining overall summary information is more difficult.

One interesting summary of changes in educational trends for women is provided by Goldin et al (2006). She reports that the relative proportion of women in college, compared to men, actually dropped during the 1930s and 40s. That is, early in the 20th century the relative proportions of men and women at colleges were approximately 50-50. However, at that time the proportion of the total population attending college was also quite low -- below 10%. Between 1940 and 2000 the proportion of college students who were women increased from about 35% to somewhat above 55% (Figure 1). In 1940 the fraction of the general population who graduated from college was approximately 10% for men and 5% for women. By the year 2000 this had risen, more or less exponentially, to about 30% for men and 38% for women (Figure 2).

Substantial increases in women's participation in the work force also occurred during this period. Typically this information is reported as the fraction of each sub-population participating in the workforce, but for our purposes this can be converted to the fraction of the work force made up of each gender. In 1950 the workforce was composed of approximately 27% women and 73% men. By 1998 this had changed to 45% women and 55% men (Fullerton, 1999) (Figure 3). However during this period the fraction of work force participants who worked full time, as opposed to part-time, remained at about 75% for women and about 90% for men.

Even accounting for the larger portion of part-time workers in the workforce the question remains: if 45% of the workers are women then why are only 2% of CEOs, 15% of senior faculty, and 16% of corporate officers women? We would expect a larger proportion of women in higher positions. Wouldn't we?

The model

The model is composed of 10 stocks, each subscripted for male and female. The model follows the flow of people through the educational system (four stocks) into the basic workforce (three stocks) and on into more senior level positions (three stocks). Starting with students in their last year of high school, people flow through up to three possible stages of university training, or directly into basic jobs.[1] College students also move into basic jobs, but those which lead to more rapid advancement. Graduate students and upper level graduate students move directly into more advanced positions (Figure 4).

The nature of the flows from one stock to another is an important consideration in a supply-chain model of this sort. A standard stock within constant fraction outflow would allow people to move rapidly to higher positions, which we know is not the case. Nevertheless some of the stocks should be represented this way. For example, a promising new graduate moving into a basic job could be promoted immediately to higher-level position.

On the other hand, outflows from some stocks must be treated as higher-level delays or conveyors. One of these, the stock *university students*, is treated as a high-level delay causing students to "graduate" in more or less 4 years. Importantly the stock *people during early career* is treated as a conveyor. That is, workers in this category can not move to the next category unless they have been in this category for a fixed number of years: they are limited by the delay called *becoming established*, which is restricted by *time needed to become established*. Once workers move into the next higher category, *people with established career path*, they can move further up only if there are openings in the next category: *people in relatively senior and responsible positions*. The same is true when moving from that category to the final category: *people in leadership positions*. The proportion of the workforce expected to be in these two senior categories has been set at 10% for the people in responsible positions and 2% of the total workforce for people in leadership positions. The number of positions actually open in these last two categories is determined by retirement and, in the first case also by people being promoted from responsible positions to leadership positions. Consequently, it is possible for people to move up in the basic job categories fairly quickly but moving beyond *people during early career* becomes more difficult (Figure 5).

In stocks representing basic job categories the situation is more straightforward, and each is formulated as a standard stock. However, this is complicated by the fact that each has three outflows: moving to the next category, retirement, and the process of leaving the workforce to become a homemaker. Becoming a homemaker, in the model, can occur from high school, from basic careers, and from post college basic careers. For the sake of

[1] Model runs presented here assume a constant inflow to the final year of high school of an equal number of male and female students. An alternative, using a constant population growth of 2 or 3 percent, does not significantly change the resulting proportions of women in the workforce.

simplicity people who are in college or graduate school, and people at higher career levels do not permanently leave the workforce to become homemakers.[2]

Outcomes, Modifications, and Discussion

Runs of the model reported here include a period of increasing participation by women in the workforce covering the years 1920 to 2010. Rather than using a ramp change, changes in the three different *fraction becoming homemakers* values is determined by a goal seek approach adjusted to match the actual fraction found in the workforce. The final fraction is the goal. The time needed to reach this goal is the difference between the ramp start year and a ramp and year divided by four, a value sufficient to permit the goal to be reached within the selected period. For most runs the period of change was from 1920 to 2010. Constants in the model related to becoming a homemaker were then adjusted so that the total fraction of women in the workforce is about 20% in 1940 and about 35% in 2005, matching information from Fullerton (1999).

Initial runs of the model appear to illustrate what we might expect anyway: compared to initial model outcomes, real world women are underrepresented at higher occupational levels. I say 'we expect this anyway' because we know that the fraction of women in the workforce was somewhat below 30% in the 1950s but the current fraction of women at higher levels in the workforce is only about 15% to 23% depending on what data we use. The 50 plus years elapsed should be sufficient to allow people to move up in the hierarchy.

Obviously other factors are at work. The most obvious factor which might account for this difference is that the model should also account for the fact that 25% of the female workforce works less than full-time. For all remaining model runs I have adjusted model constants so that the model output, fraction of women in the total workforce, follows the lower curve in Figure 3. This change allows us to be more conservative in checking to see if the supply-chain hypothesis could possibly be correct.

This change, on its own, is insufficient to account for the lower levels of women we currently find in management and leadership positions. Model output presented in Figure 7 shows the overall fraction of women in the workforce paralleling what we have seen in the real world. However, the real world fraction of women in leadership and senior-level positions is well below that seen in model output. If the real world paralleled what we see in the model we would expect, by 2007, about 35% of leadership positions to be filled by women.

Another realistic possibility is that the large proportion of women who become homemakers not only prevents those women from moving through the hierarchy but also tags women in general as "homemakers" and consequently restricts their upward mobility in the workforce. That is, people are reluctant to hire them because they are

[2] In the model *becoming a homemaker* refers to a situation where workers permanently leave the workforce. Because of the nature of the stocks and the exponential outflow this perhaps can include the idea that some people are "partially removed" from the stock.

perceived as people who may quit to become homemakers. This can be represented in the model as in additional factor limiting the movement of female workers from the two categories of basic careers into early careers. Thus the normal flow of workers into the early career category is multiplied by an *effect of homemaker fraction on the likelihood of moving up*. This has been formulated as a look-up inversely related to the fraction of homemaker departures from the workforce from each basic career. If the homemaker fraction is high (for example 0.7) then the likelihood of remaining workers (of that gender) moving out of the basic career categories will be diminished by a multiplier (for example 0.3).

Applying this option, however, makes relatively little difference in the outcome (Figure 8). In this case, although the proportion of women in basic careers increases substantially during the earlier part of the period of change, the ultimate result is similar. This is because the restriction applied increases the number of people in *basic careers*. Since *moving up* is calculated as a fraction of those present in the stock ultimately they will move up anyway as the stock size grows. By 2007 we would still expect approximately 31% of the senior positions to be filled by women – not including those who are *leaders*. That outcome is higher than in the real world value. The fraction of women in senior management positions reported by USA companies is about 23% (Anon, 2007).

Perhaps a more likely scenario is that the tag "homemaker" limits women's promotion at all levels. Under this scenario even if women move into an established career path their likelihood of promotion to senior positions is still limited in the same way as is their junior colleagues' promotion to a beginning career. Adding this limitation in the promotion of women moving from established career to senior positions and from senior positions to leaders produces the outcome exhibited in Figure 9. Restricting promotions in this way would significantly lower the fraction of senior and leadership positions held by women, although it does not lower them to the low levels seen in the USA workforce.

Obviously we can continue to limit these promotions to a point where we can match the real data. From the model, we can not determine what factors limit promotion, but we can reject the supply chain hypothesis. Literature on the subject discusses many potential limiting factors including active bias, passive bias, women actually leaving the workforce, and differences in what men and women desire from their work environment, and their work task strengths (Anon, 2005; Campbell *et al.*, 2004; Gneezy *et al.*, 2003; Hurley, 2005).

One area where women's participation has changed significantly over the period under consideration is in education. Women students have outnumbered men at the undergraduate level since 1980. Given this fact, the intervening 27 years, and the continued lack of women in senior positions we may wonder what might have happened if the boom in women's university education had commenced earlier. That is, 27 years ago women became more numerous than men in undergraduate programs. Some of these individuals have entered, or will be entering, senior positions and will be moving into

leadership. If we had had, for example, 37 years, would we have seen a bigger change in the leadership proportion in spite of the hypothesized bias in promotions at higher levels?

In the model the *fraction entering university* from high school is formulated as a lookup function based on data from (Goldin *et al.*, 2006). As a test we can change this lookup function to something much more aggressive: a more rapid increase in women's enrollment in college (Figure 11).

The results of this test are presented in Figure 12. More aggressive programs to attract women students into university programs would have led to some improvements in the proportion of women in senior and leadership positions. Nevertheless, such changes would not have altered the hiring bias. The results of such a program would still have lagged far behind an equitable hiring and promotion process. This leads to the conclusion that to enhance women's participation in senior and leadership positions more emphasis must be placed on promotion practices within the later stages in the employment chain. There would appear to be, and have been for some time, sufficient numbers of women in the supply chain at lower levels -- certainly enough to provide candidates for women's attainment of senior positions.

As pointed out by others there is the possibility that men tend to hire men, and women tend to hire women, on the average. This possibility was discussed by Campbell *et al.* (2004), and reported by Creswell (2006) and others. If implemented in the model, this would lead to a situation whereby all senior and leader positions would become 100% to one sex or the other, depending which was in the majority at the start of the test. A similar idea is that current leaders hire in patterns that conform to what they are used to seeing around them. This approach would tend to stabilize the status quo, implying that pushing for change is necessary, assuming that change is desired.

Fortunately, some also believe that even a relatively small number of women in senior positions would be sufficient to remove hiring bias (Creswell, 2006). If this is true then as more women enter positions of responsibility -- especially related to hiring -- then the proportions of male and female workers should fairly rapidly align with those in the supply chain.

Regardless of these possibilities, it is fairly obvious that the pipeline delay hypothesis is not sufficient to explain the relatively small numbers of women currently in senior and leadership roles.

Literature Cited

Anon. 2005. Women “Take Care,” Men “Take Charge:” Stereotyping of U.S. Business Leaders Exposed. CATALYST: New York

Anon. 2007. International Business Owners Survey: http://www.gti.org/pressroom/articles/pr_03082007.asp. Grant Thronton International

Campbell D, Hovmand PS. 2004. Is Your Organization Collegiality-Challenged? : A Case Study Demonstrating the Effect of Unconscious Gender Bias, *22nd International Conference of the System Dynamics Society*. The System Dynamics Society: Oxford, England

Creswell J. 2006. How Suite It Isn't: A Dearth of Female Bosses, *New York Times*: New York

Dean C. 2006. Women in Science: The Battle Moves to the Trenches, *New York Times*: New York

Fullerton HN, Jr. 1999. Labor force participation: 75 years of change, 1950–98 and 1998–2025. *Monthly Labor Review* **1999**(December): 3-12

Gneezy U, Niederle M, Rustichini A. 2003. Performance in Competitive Environments: Gender Differences. *Quarterly Journal of Economics*(Aug 2003): 1049-1074

Goldin C, Katz LF, Kuziemko I. 2006. The Homecoming of American College Women: the Reversal of the College Gender Gap, *Nber Working Paper Series - Working Paper 12139*: 46. National Bureau of Economic Research: Cambridge, MA

Hurley K. 2005. Mind the (Gender) Gap A Follow-up Experimental Analysis of Gender Differences in Performance in Competitive Environments, *Department of Economics*: 85. Stanford University

Figures

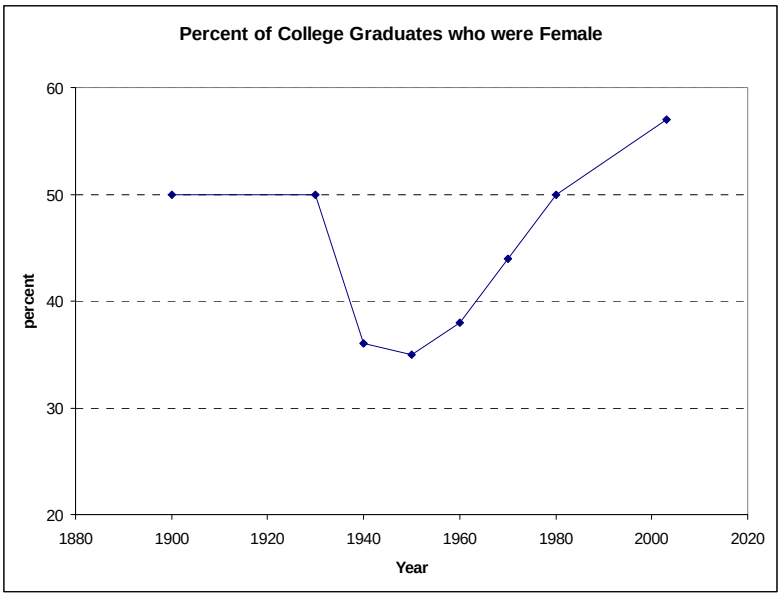

Figure 1. Percent of USA college graduates who were female during the past century (adapted from Goldin *et al.*, 2006). Note that the proportion of the population graduating from college changed during the same period from less than 10% to almost 40%.

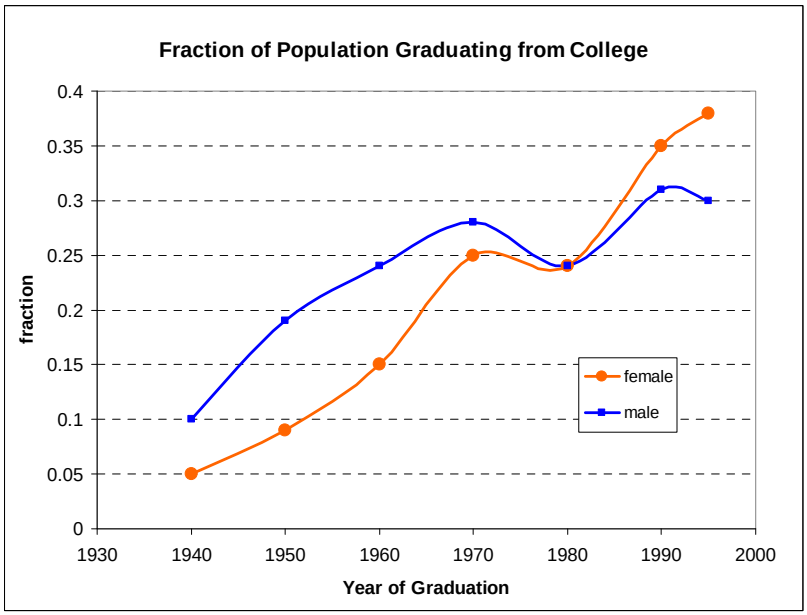

Figure 2. The fraction of the population graduating from college -- male and female

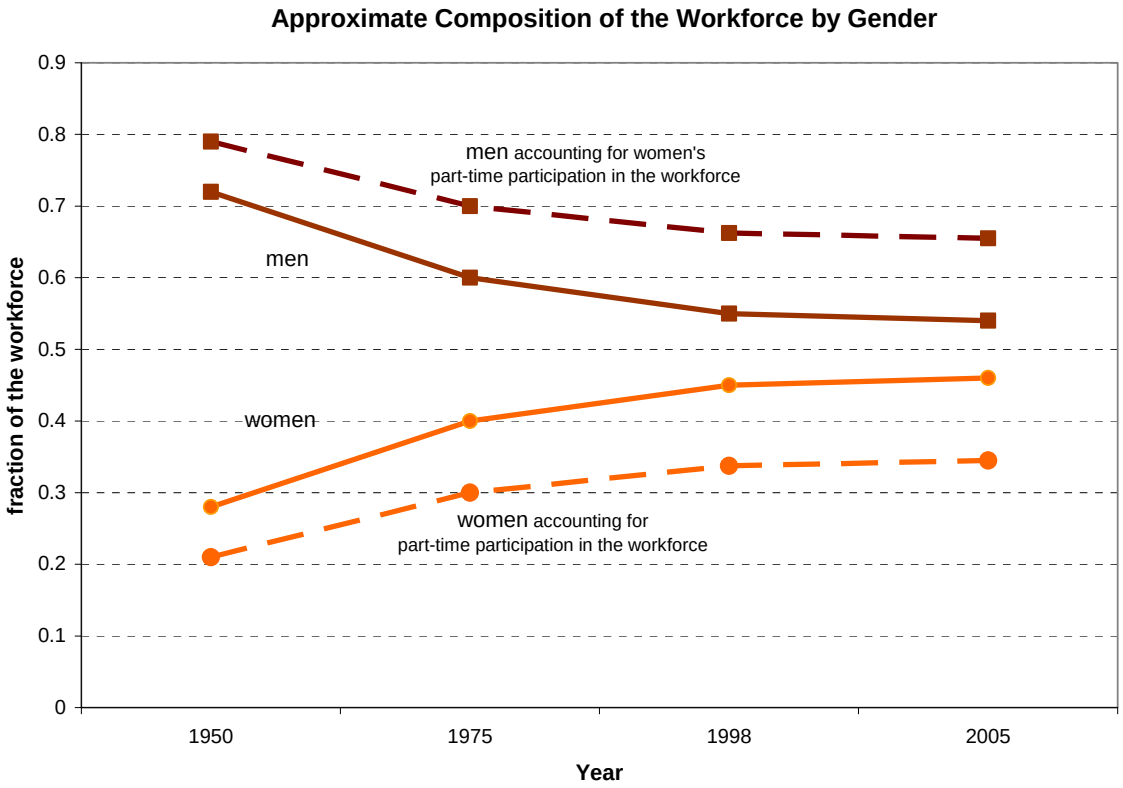

Figure 3. Approximate composition of the workforce during the period 1950 through 2005. Data obtained from several sources as cited. The lower line is calculated as 75% of the orange line reflecting the fact that about 25% of women in the workforce are part-time workers.

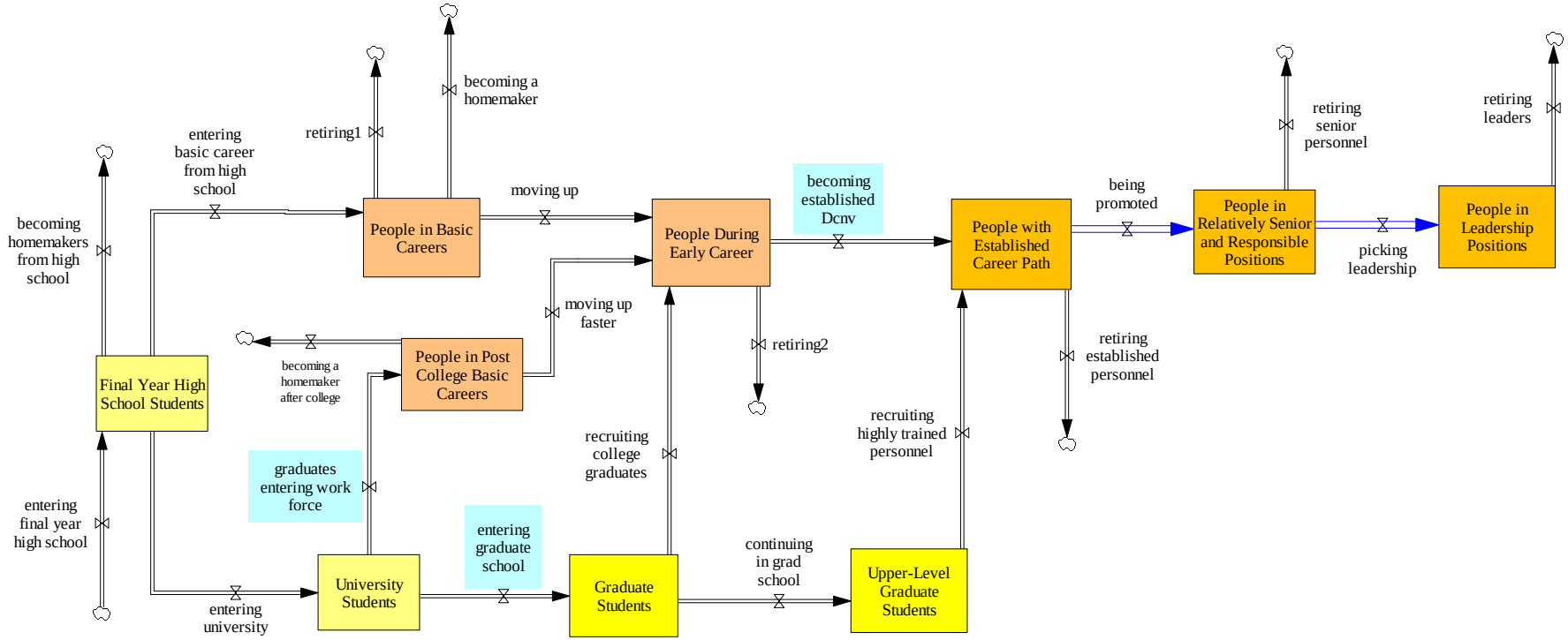

Figure 4. Basic structure of the model stocks. Yellow stocks represent educational stages, pale orange represent basic careers, darker orange represent established careers. Pale blue represents delayed flows. See text for explanation on other restrictions on flows from one stock to another. Note that all stocks are subscripted by gender. (Note: Dcnv refers to delay-conveyor).

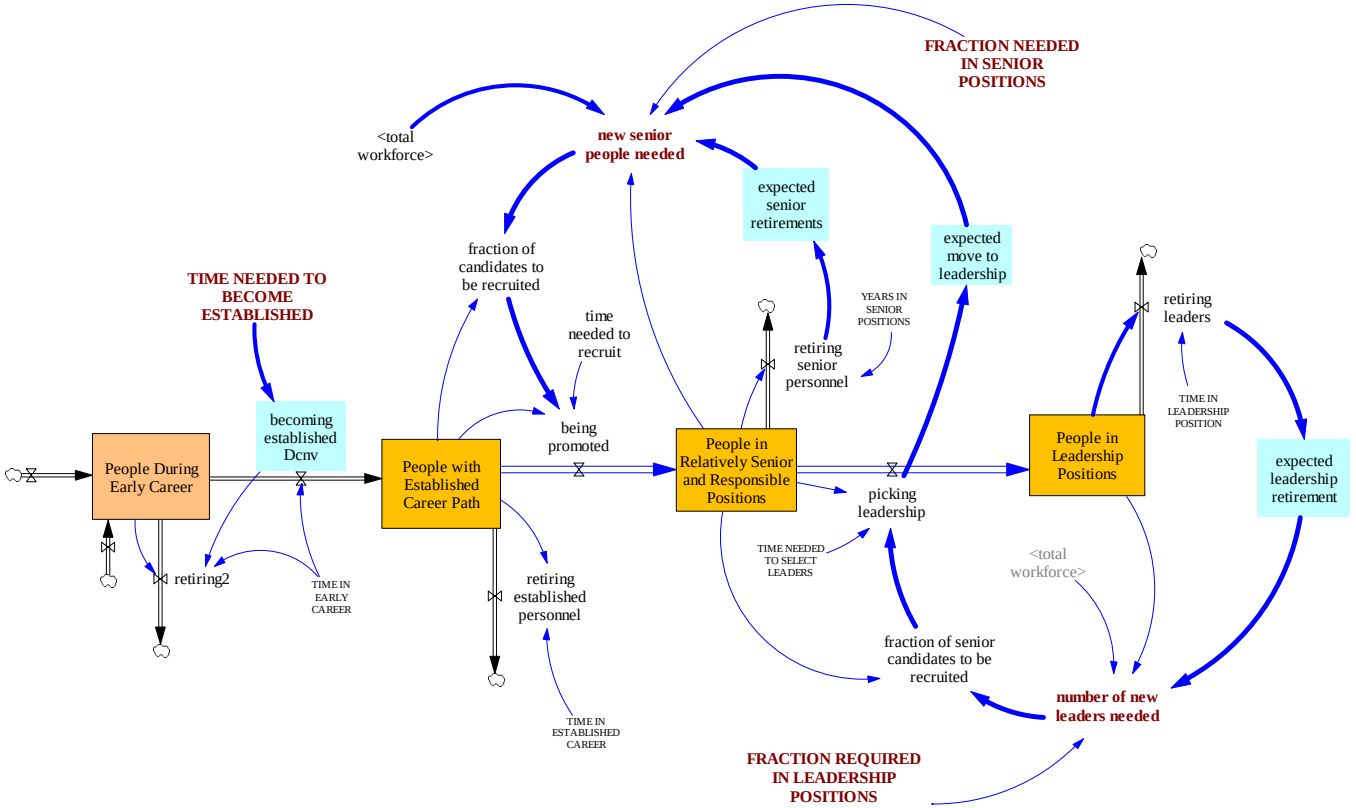

Figure 5. Detail of the last four stocks in the supply chain. Flows between these stocks are all restricted. The first is a delay conveyor with a time constant *time needed to become established*. The second flow, *being promoted*, can only be as large as the number of candidates needed to be recruited into the next labor pool category. The same holds true for the flow *picking leadership* which is restricted by the number of new leaders needed. Both of these labor pool categories are limited to a constant fraction of the *total workforce*. (Note: Dcnv refers to delay-conveyor).

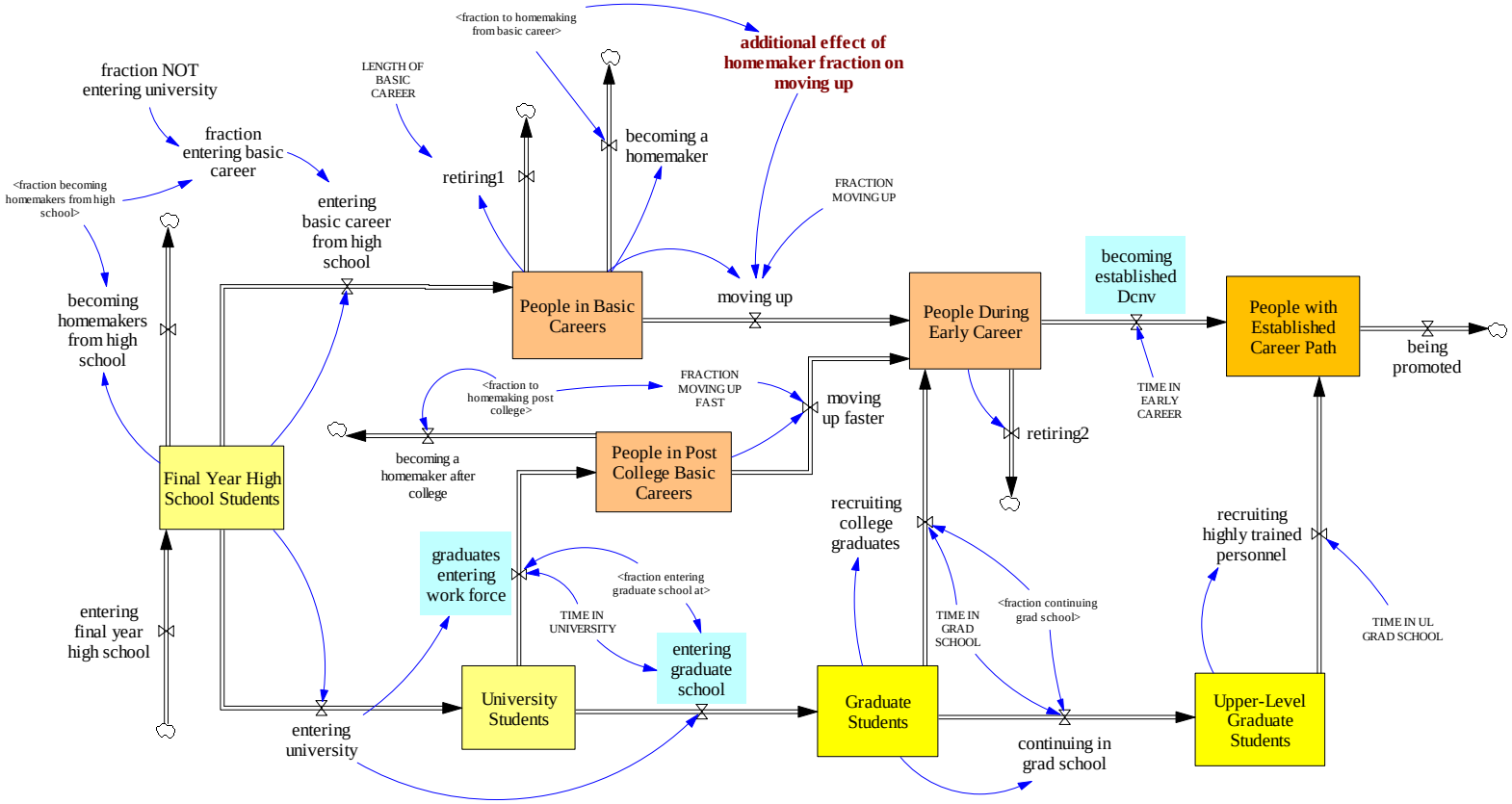

Figure 6. Stocks in the model referring to educational and early career categories.

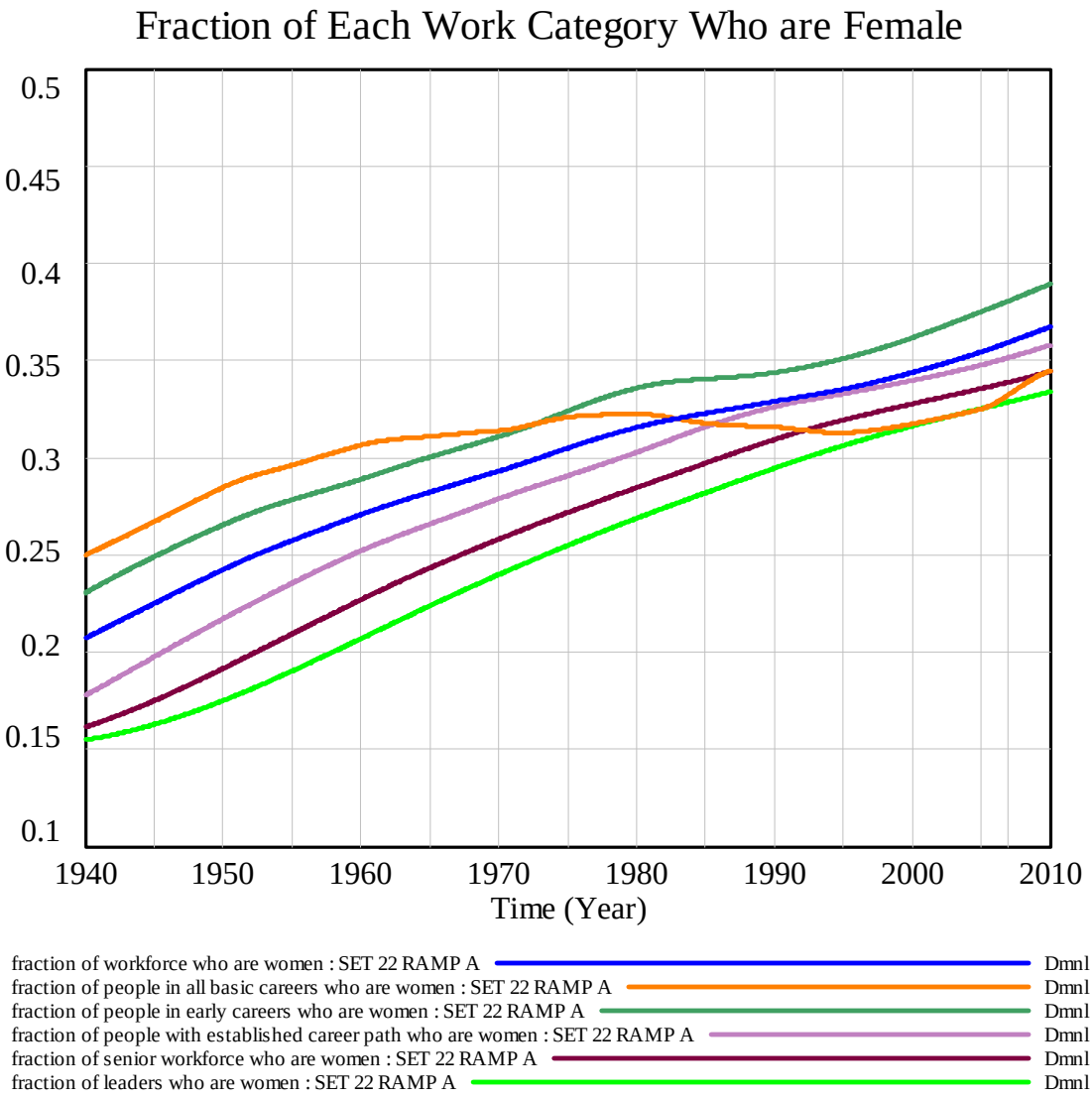

Figure 7. Fraction of women in different workforce categories. This run assumes that the movement up from basic careers to early careers is dependent only on the number of people in the workforce, and not on other factors. Note: blue line represents fraction of women in the total workforce and model parameters were adjusted so that this roughly matches the lower line in Figure 3.

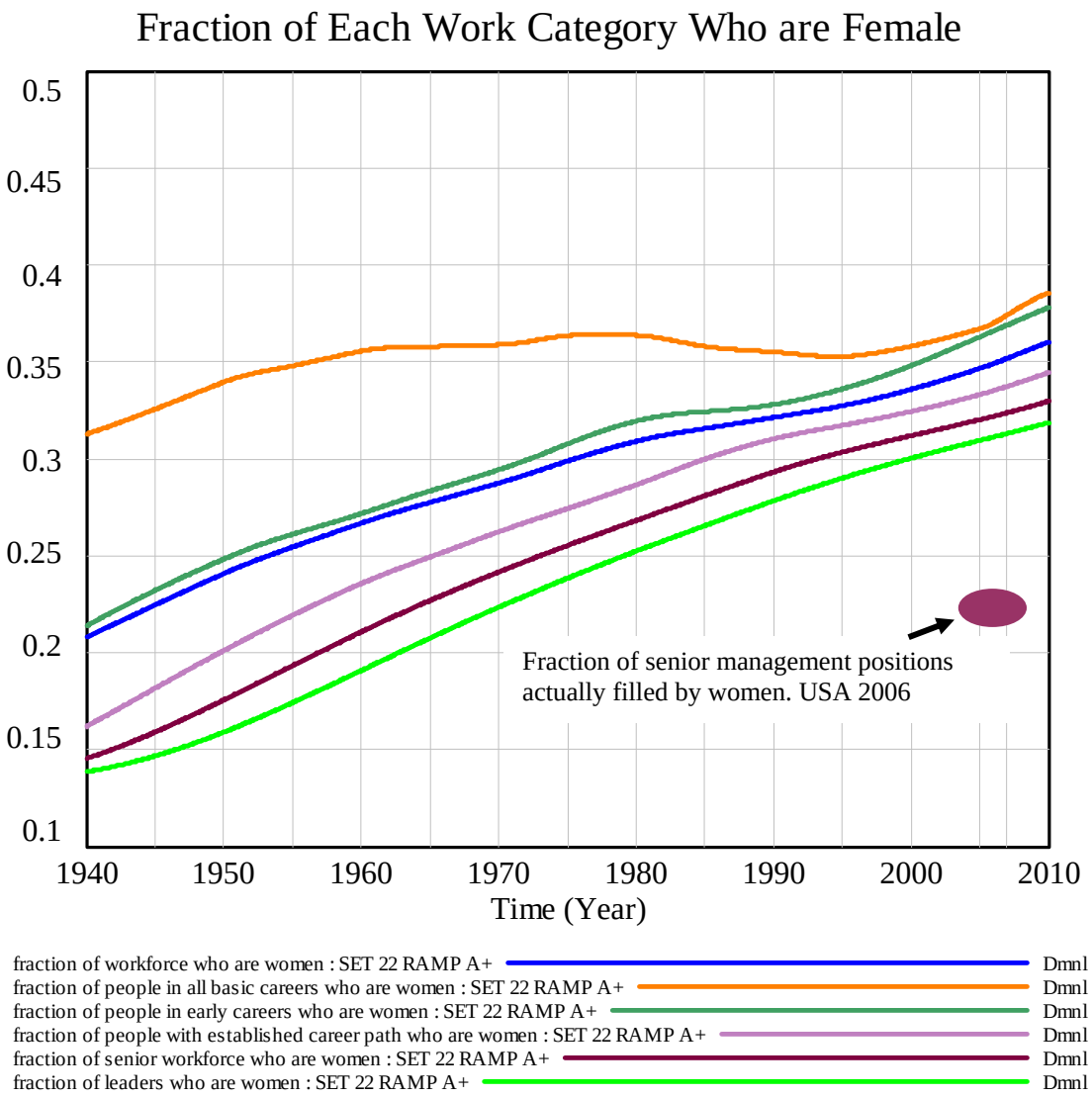

Figure 8. Fraction of women in different workforce categories (as in Figure 6). But in this case the likelihood of moving out of basic careers is further directly limited by the fraction of workers within basic careers who become homemakers. That is, even those people who did not become homemakers will be less likely to be promoted from basic careers. The point in the lower right represents data from an international survey (Anon, 2007).

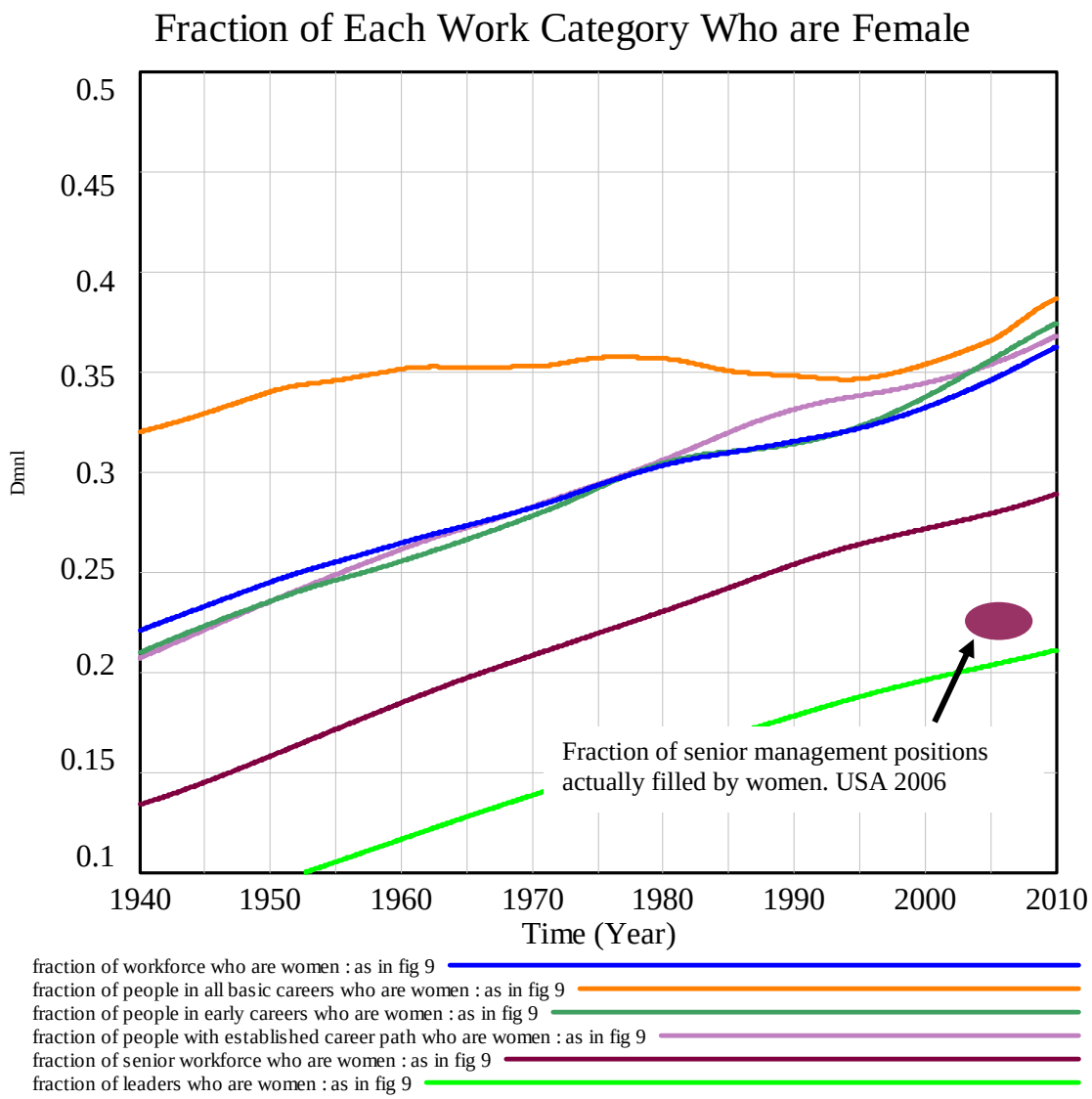

Figure 9. As in Figure 8, but in this case the fact that women are categorized as homemakers also limits hiring and promotion into senior positions and leadership positions. This brings the model outcome closer to the real world figure. This type of negative influence on promotion could explain the current situation.

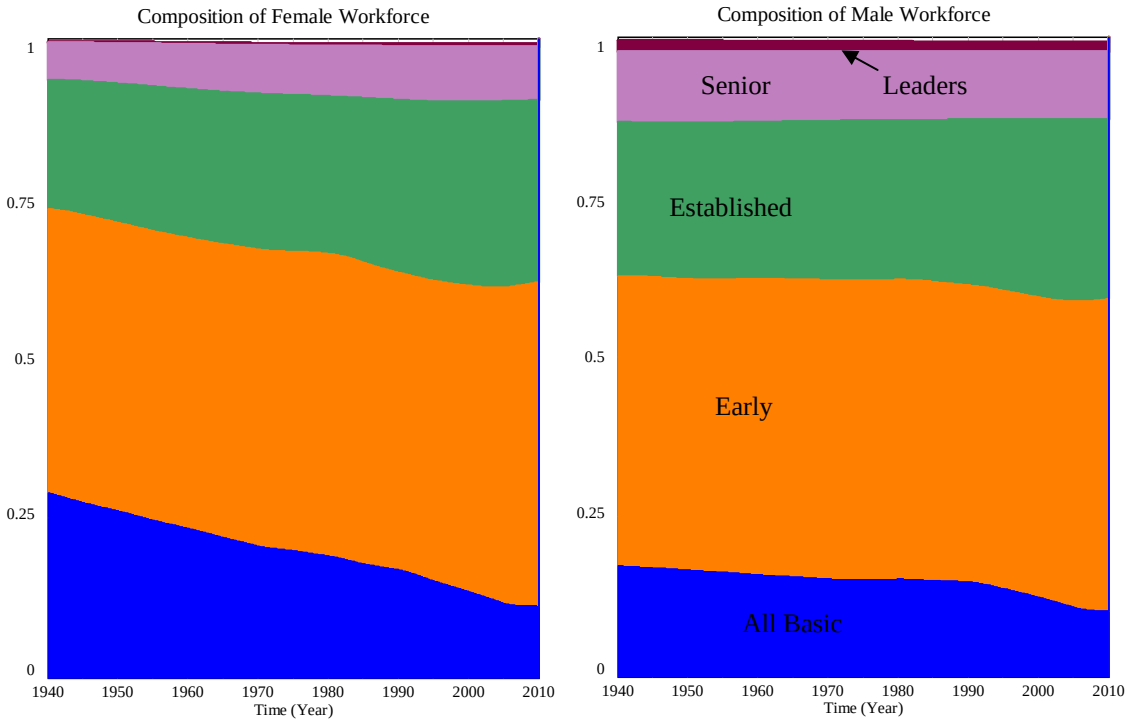

Figure 10. Expected composition of the female and male workforce by work category during the period 1940 to 2010. Although women moved out of the basic career category they became locked in the early and established categories with some limited movement into the senior and leadership categories. This result is from the same model run as figure 8.

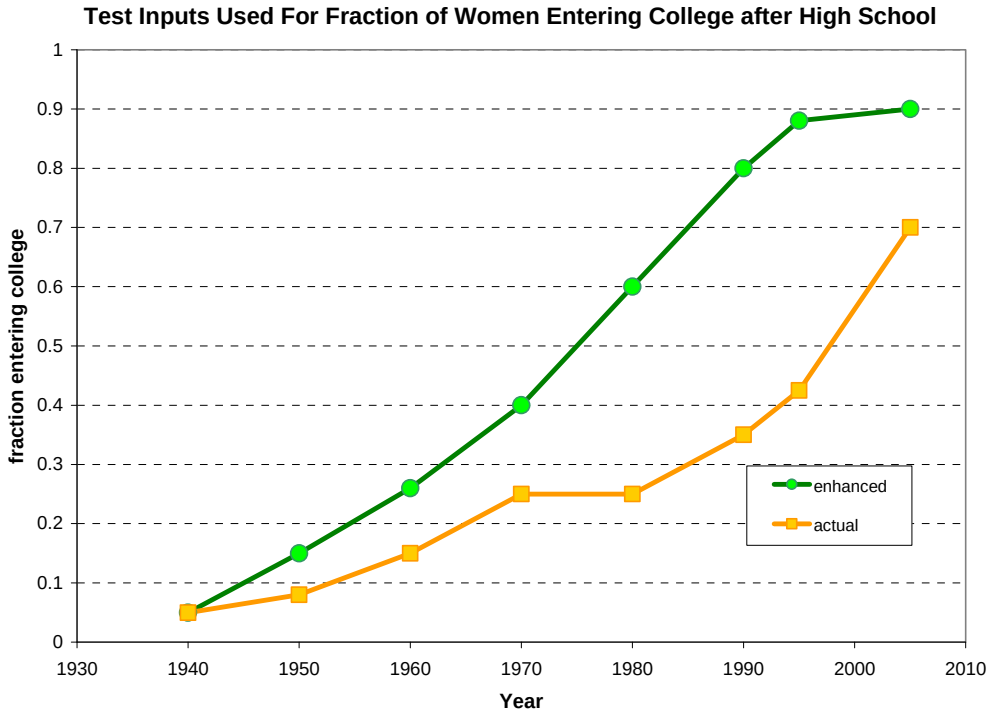

Figure 11. Values used for testing the effect of enhanced recruitment of women into university programs. The lower line represents data adapted from (Goldin *et al.*, 2006). The upper line is a test input assuming that we were able to recruit more women into university programs in the past.

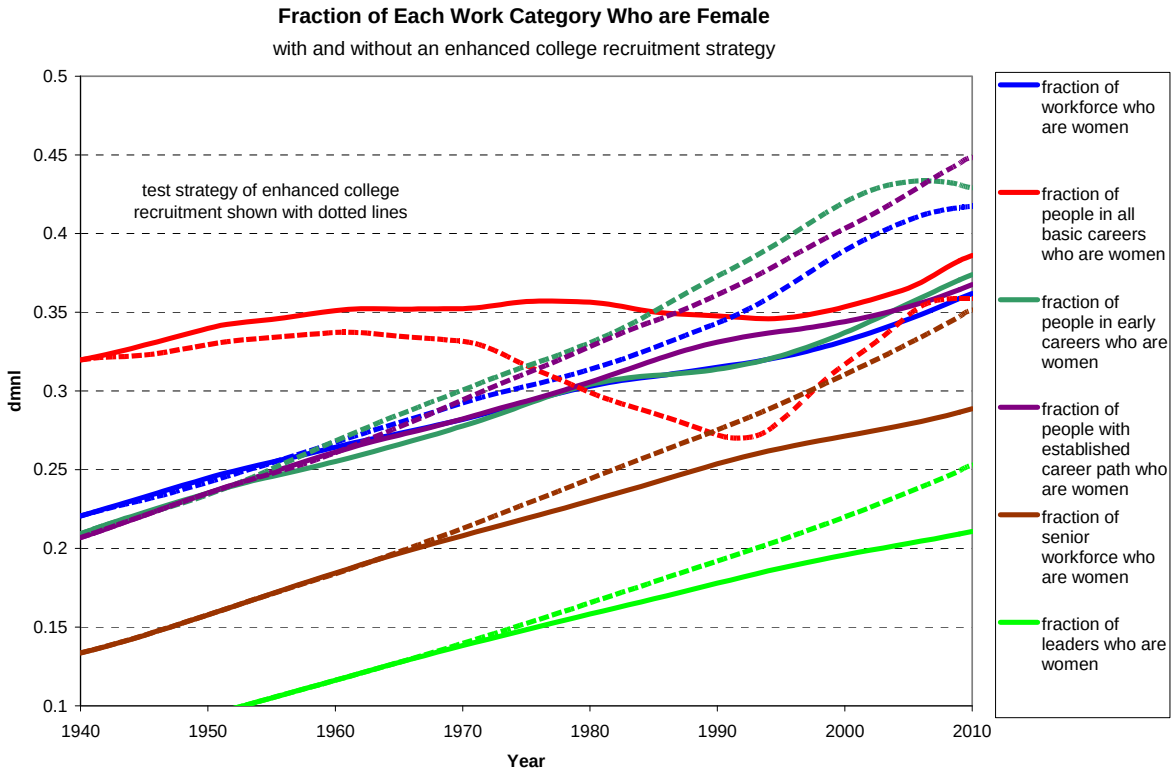

Figure 12. The effect that a theoretical enhanced college recruitment program (dotted lines) would have had on women in various workforce categories. Given the model as structured, enhanced college recruitment would have created modest increases in numbers of women in higher-level positions. Note that these gains assume that no change in male recruitment to college occurred. Compare to **Figure 7** where promotion is proportional to the proportion of each gender in the workforce.