Effects of taxes and safety net pensions on life-cycle labor supply, savings and human capital: The case of Australia

Fedor Iskhakov,
Australian National University and CEPAR

Michael Keane,
University of Oxford and CEPAR

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ARC CENTRE OF EXCELLENCE IN POPULATION AGEING RESEARCH

Research objectives

Main research question:

- Labor supply responses to Age Pension and taxes
- Over the whole life cycle (long run effects)
- With anticipated and unanticipated policy changes

Structural approach:

- Stochastic lifecycle model in discrete time
- Estimated with the method of simulated moments using Australia-wide longitudinal household survey (HILDA)
- Simulate counterfactual scenarios of alternative policy settings
- Simulate anticipated and unanticipated changes in policy

Stochastic life cycle model

Main features of the model:

1. Discrete time = age from 19 to 100
2. Annual decisions on
   - How much to consume of accumulated wealth (continuous choice)
   - How much to work from [0, 24, 40, 45, 50, 60] hours per week (discrete choice)
3. Stochastic elements in the model
   - Survival process (longevity risk): survival probability amplifies discounting of future utility
   - Multiplicative idiosyncratic log-normal wage shock: unforeseen circumstances of employment
4. Random utility framework and risk aversion
   - Rational forward-looking decision makers
   - Solution to the model are time-consistent decision rules
   - Constant relative risk aversion (CRRA) specification for the instantaneous utility

Stochastic life cycle model

5. Human capital accumulation
   - Learning-by-doing → Accumulating work experience is human capital
   - Human capital increases future wage → Wage at early ages is only part of compensation
6. Wealth accumulation and decumulation
   - Endogenous, dependent of wage income and consumption decisions
   - Credit constraint and bequest motive
7. Observed and unobserved heterogeneity in the population
   - Education → Initial endowment and human capital technology
   - Unobserved types → Preference for leisure
8. Australian institutional settings
   - Age Pension → Accurate representation of means testing
   - Superannuation → Lump sum at age 65 based on accumulated human capital
   - Tax rules → Simplified representation with 2 tax brackets

Preliminary results

- The model replicates available historical data very well
- Direction of the effects for all simulated policy changes are as anticipated
- Heterogeneity in labor supply effects
  - Increase along the life cycle for all education groups
  - Smaller elasticity in the beginning of life cycle for higher educated
  - Larger elasticity in the end of life cycle for higher educated
  - Negative elasticity in mid-life for college graduates
- Sizable effects of changes of social security policy
  - Effects appear early in the life cycle
  - Stronger effect on the extensive margin
  - In the absence of safety net pension, labor supply before 60 would be about 20% higher,
    and after 65 up to 60% higher

Time and choices

- Discrete time, finite horizon
  t_0 = right after school,
  $T = 100$ time of certain death
  Time periods are calendar years, data is annual

- Choices
  1. consumption/savings (continuous) subject to credit constraint

$$c_t \leq M_t$$

M_t – consumable wealth in the beginning of the period t

  2. hours of labor supply (discrete) subject to market frictions

$$h_t \in H \text{ (discrete, 6 levels)}$$

Discrete levels of hours

K-medians cluster analysis

h_t	Nobs	annual	week	min	max
0	18,168	0	0	0	500
1	4,484	1200	24	500	1600
2	15,930	2000	40	1600	2125
3	5,466	2250	45	2133	2368
4	8,735	2500	50	2375	2750
5	6,259	3000	60	2750	4200

Correspondence to HILDA

Empl FT	Empl PT	Unemp	OLF
251	1,260	1,269	13,329
880	3,604	0	0
15,814	116	0	0
5,466	0	0	0
8,735	0	0	0
6,259	0	0	0

State variables

- Human capital, learning-by-doing
  $\mathcal{E}_t$ is fraction of total working time in total time budget
  - Bounded to $[0, 1]$
  - Everybody starts with $\mathcal{E}_0 = 0$
  - Simple recursive formula for $\mathcal{E}_{t+1}$

- Heterogeneity
  Education $\rightarrow$ Endowment + human capital production technology
  Unobserved $\rightarrow$ Preference for leisure

- State variables
  1. Consumable wealth M_t (continuous, endogenous grid)
  2. Work experience $\mathcal{E}_t$ (continuous, discretized)
  3. Education (discrete, constant over time)
  4. Unobserved heterogeneity types (discrete, constant over time)

$$X_t = \left(M_t, \mathcal{E}_t, \text{education}, \text{type}\right)$$

Wage

- Employment $\rightarrow$ Human capital (work experience) $\rightarrow$ Higher wage
- Human capital accumulation

$$K_t = f\left(\mathcal{E}_t, \mathcal{E}_t^2, \text{age}, \text{age}^2, \text{education}, \text{type}\right)$$

- Wage

$$wage_t = K_{t-1} \cdot R_t \cdot \epsilon_t^{wage}$$

$R_t = 1$ is uniform rental rate of human capital

- Two sources of uncertainty in the model:
  1. Survival process (longevity risk)
  2. Wage shocks $\epsilon_t^{wage} \sim lnN(0, \sigma_t^{wage})$

Intertemporal budget

$$
\begin{aligned}
M_{t+1} = (M_t - c_t)(1+r) + \text{AfterTax}\left(h_t \cdot wage_{t+1}\right) \\
+ tr_{t+1} \cdot \mathbb{1}\{t+1 \leq 22\} \\
+ pens_{t+1} \cdot \mathbb{1}\{t+1 \geq 65\} \\
+ super_{t+1} \cdot \mathbb{1}\{t+1 = 65\}
\end{aligned}
$$

- tr_{t+1} transfers from parents at young ages
- $pens_{t+1}$ means tested old age pension
  Simplified equation estimated outside of the model
- $super_{t+1}$ accumulated DC pension (super) can be spent from age 65

Preferences

- CRRA utility of consumption

$$u(c_t) = \frac{c_t^{1-\zeta} - 1}{1-\zeta}$$

- Additively separable disutility of work

$$v_t(h_t) = \mathbb{1}\{h_t > 0\} \cdot \kappa_{type}(\tau_{uh}) \cdot \kappa_{age}(t) \cdot \gamma(h_t)$$

$\gamma(h_t) = (\gamma^{(1)}, \ldots, \gamma^{(5)})$ associated with the discrete levels of hours

- Bequest utility

$$w(B_t) = b_{scale} \cdot \frac{(B_t + a_0)^{1-\xi} - a_0^{1-\xi}}{1-\xi}$$

Bellman equation

$$V_t(M_t, \mathcal{E}_t, \tau_{edu}, \tau_{uh}) =$$

$$\max_{\substack{0 \le c_t \le M_t + a_0, \\ h_t \in H_t}} \Big\{ u(c_t) - v_t(h_t, \tau_{uh})$$

$$+\delta_t \cdot \beta(\tau_{edu}) E\Big[V_{t+1}(M_{t+1}, \mathcal{E}_{t+1}, \tau_{edu}, \tau_{uh}) \,|X_t, c_t, h_t \Big]$$

$$+(1-\delta_t) w(M_t - c_t) \Big\},$$

- τ_{edu} education (observed heterogeneity)
- τ_{uh} unobserved heterogeneity
- a_0 credit constraint (maximum amount of borrowing)
- $\beta(\tau_{edu})$ discount factor dependent on education
- δ_t survival probability

HILDA data

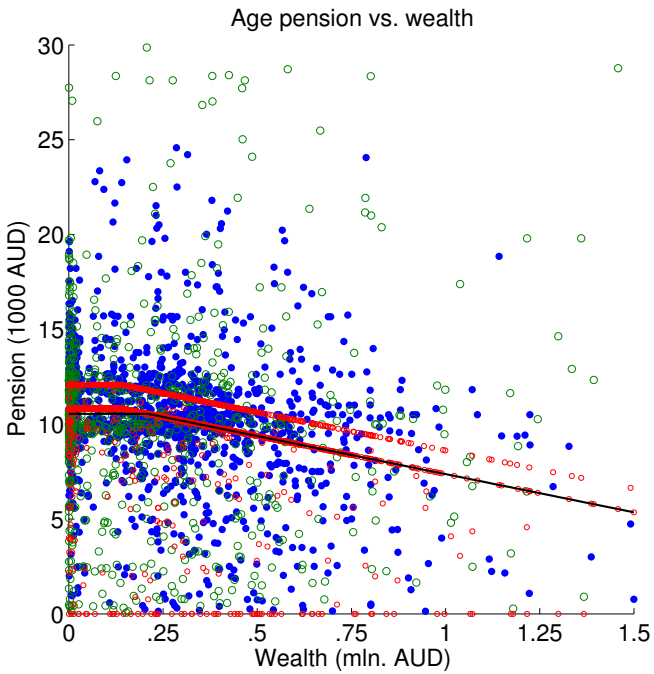
Household, Income and Labor Dynamics in Australia survey

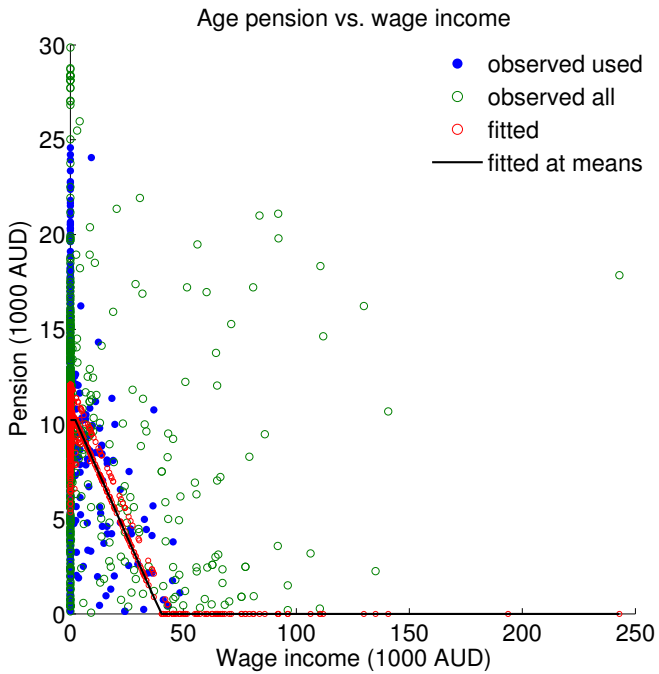
- The primary source of data is Wave 12 of the Household, Income and Labor Dynamics in Australia Survey (HILDA).
- Broad social and economic longitudinal survey
- Annual waves 2001-2012
- Family dynamics, income and labor supply (each year)
- Modules on wealth, health and health insurance, retirement, fertility, literacy and numeracy (particular years, reoccurring)
- Australian national representative sample
- First wave administered to 19,914 people in total
- In 2011 (wave 11) 2,153 new households were added to replenish the sample.

Education levels

Original HILDA classification	N obs	%	Coarsened 3 level classification	N obs	%
Postgrad (Master or PhD)	452	5.12	College	2,023	22.89
Grad diploma	436	4.93			
Bachelor or honours	1,135	12.85			
Diploma	793	8.97	High school	4,497	50.89
Certificate III or IV	2,697	30.52			
Certificate I or II	0	0.0			
Year 12	1,007	11.40			
Year 11 and below	2,316	26.21	Dropouts	2,316	26.21
Undetermined	0	0.0			

Age Pension equation

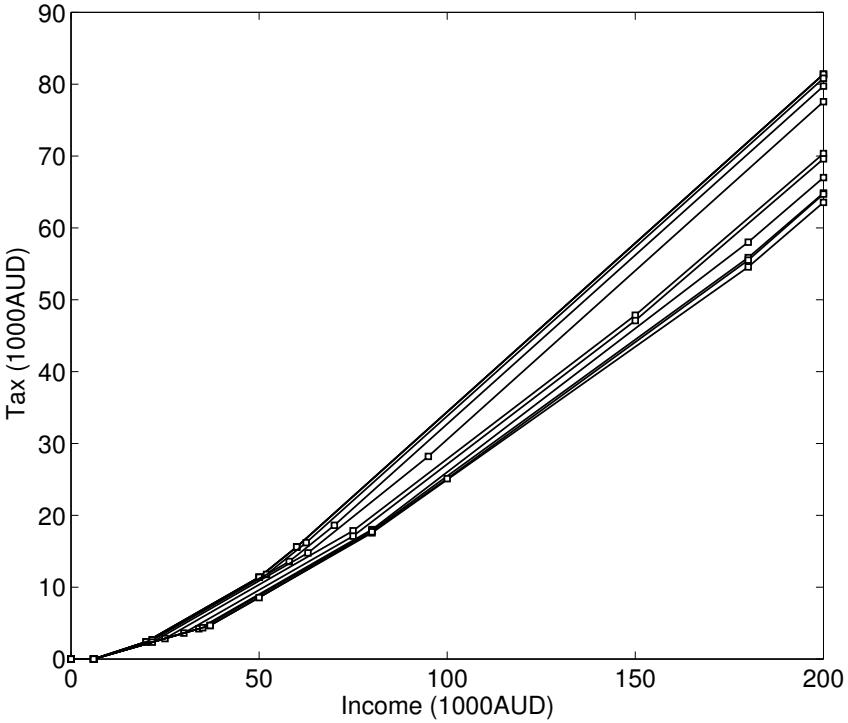


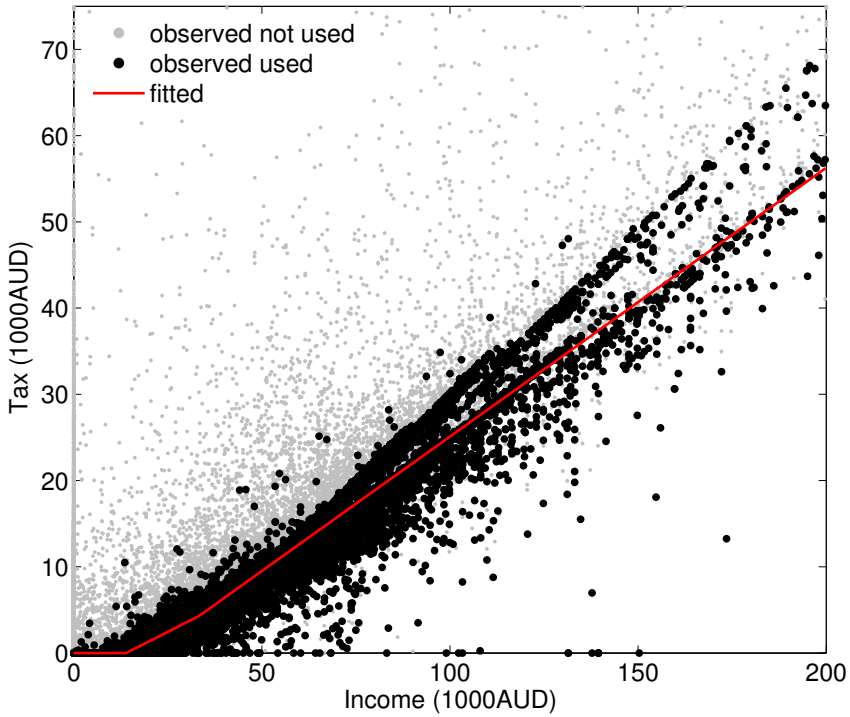


$$\text{benefit}_{\max} = \underset{(171.32)}{10,826.40} + \underset{(203.37)}{1249.67}(\text{when year} \geq 2010)$$

$$\text{pension} = \max\Big\{\text{benefit}_{\max} - \max\Big[\max\{\underset{(0.023)}{0.26906}\,\text{income}, \underset{(0.0005)}{0.00402}(\text{wealth} - \underset{(59,346.92)}{140,326.90})\}, 0\Big], 0\Big\}$$

Income tax function





$$\text{tax} = \begin{cases} 0 & \text{if income} < \text{thld}_1 = \underset{(0.32217)}{13.92775}, \\ \underset{(0.00556)}{0.22149} \cdot (\text{income} - \text{thld}_1) & \text{if } \text{thld}_1 \leq \text{income} < \text{thld}_2, \\ \underset{(0.00061)}{0.31183} \cdot (\text{income} - \text{thld}_2) + \underset{(0.00556)}{0.22149} \cdot \text{thld}_1 & \text{if income} \geq \text{thld}_2 = \underset{(0.63874)}{33.28298}, \end{cases}$$

Model solution, estimation and simulation

Solution: Dynamic programming

- For given value of all preference parameters and policy parameters
- Compute optimal decision rules from terminal period backwards through time
- Fast DC-EGM method for solving discrete-continuous choice model

Estimation: Method of simulated moments

- Minimize the distance between simulated and observed data
- Search for best parameters values using numerical optimization

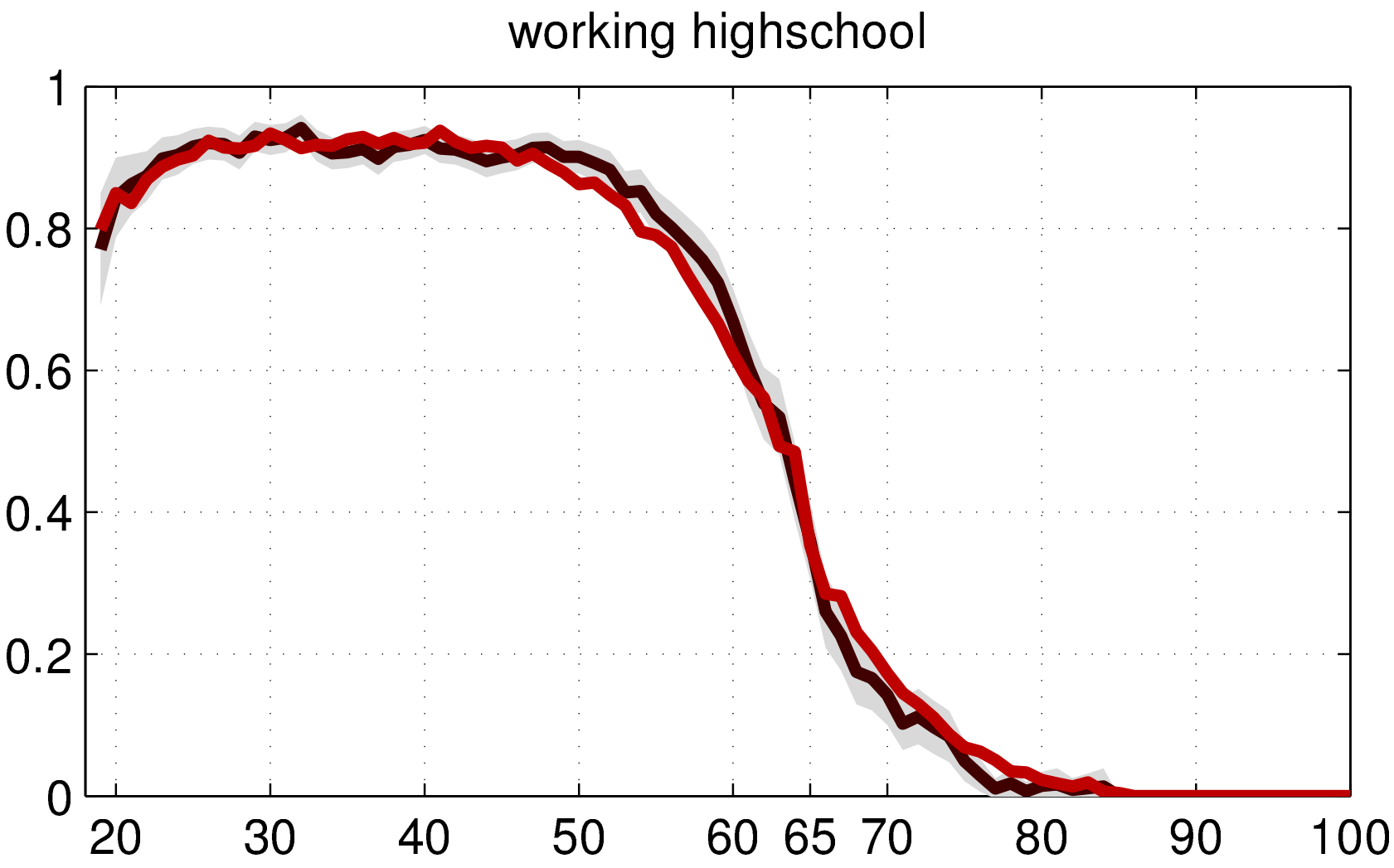
Simulation

- Fix a large array of pseudo random numbers
- Endow a large number of simulated individuals with initial wealth and human capital
- Simulate choices and transitions of states from initial period forward

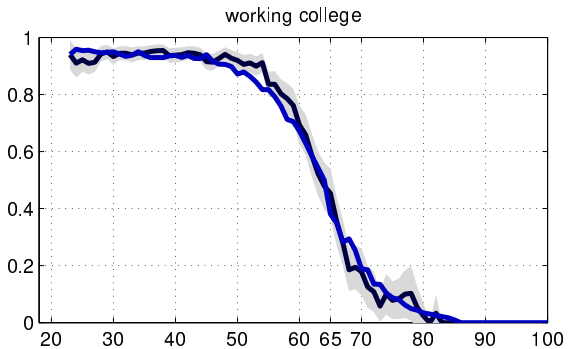
Choice of moments to match in estimation

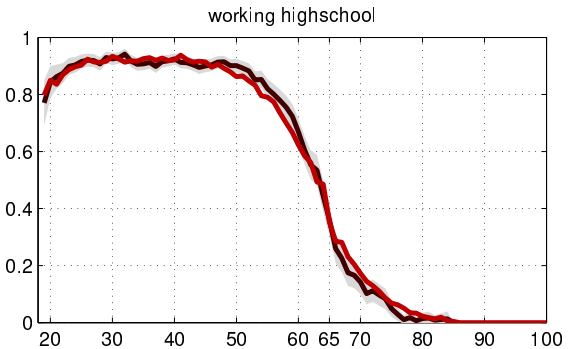
	High school		Dropouts		College	
Moments	Ages	N	Ages	N	Ages	N
Fraction of working	19 - 85	67	19 - 85	67	23 - 85	63
Hours conditional on working	19 - 75	57	19 - 78	60	23 - 71	49
Wage (conditional on working)	19 - 73	55	19 - 69	51	23 - 69	47
Variance of wage	19 - 73	55	19 - 69	51	23 - 69	47
Fraction of working 20h per week	19 - 85	67	19 - 85	67	23 - 85	63
Fraction of working 40h per week	19 - 85	67	19 - 85	67	23 - 85	63
Fraction of working 45h per week	19 - 85	67	19 - 85	67	23 - 85	63
Fraction of working 50h per week	19 - 85	67	19 - 85	67	23 - 85	63
Wealth	19 - 85	55	19 - 85	55	23 - 85	49
Transition from work work	19 - 74	56	19 - 77	59	23 - 70	48
Transition from no work to no work	19 - 85	67	19 - 85	67	25 - 85	61
Total		681		679		617

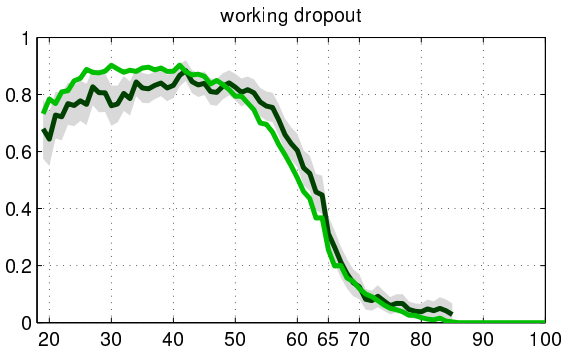
Goodness of fit: fraction working high school graduates



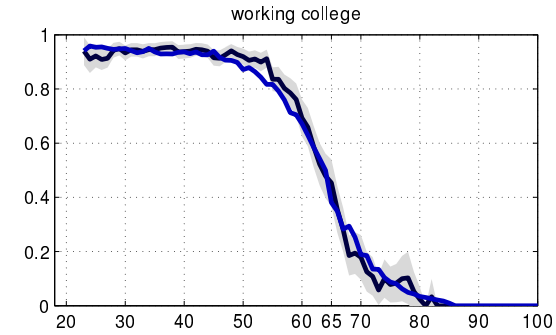
Goodness of fit: fraction working for all education groups

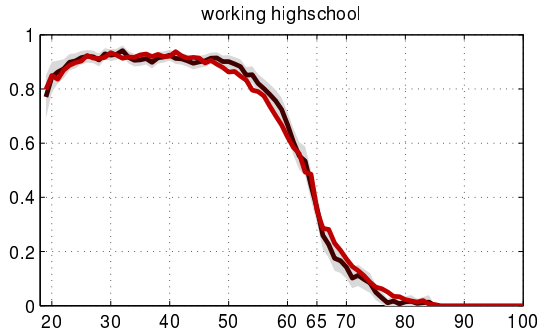


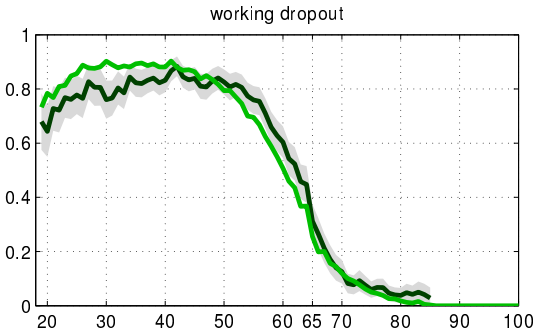


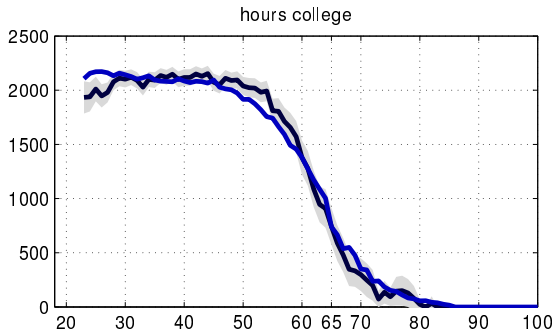


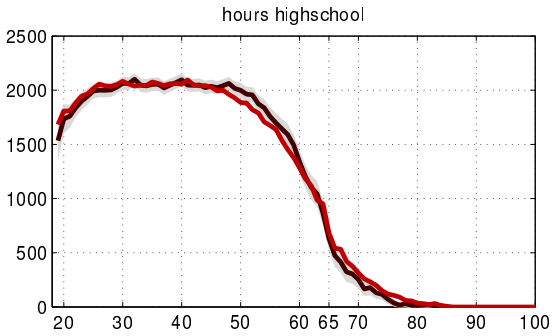
Goodness of fit: fraction working and hours

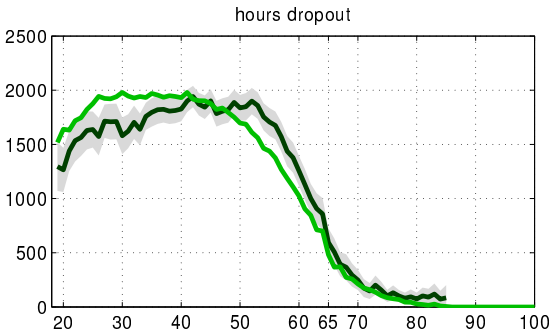


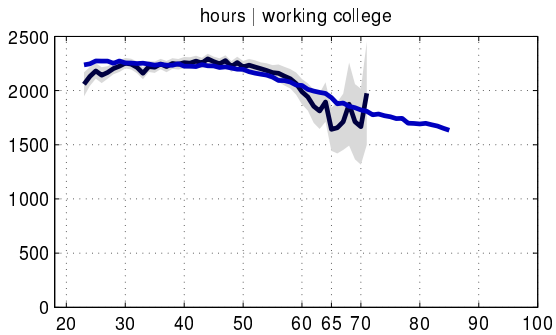


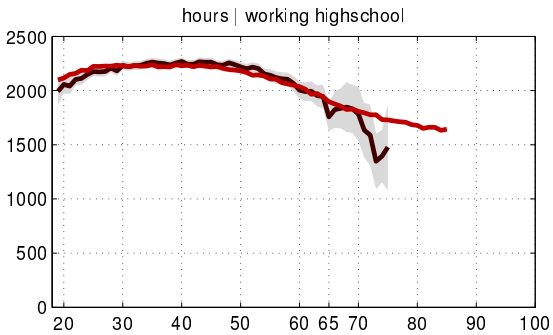


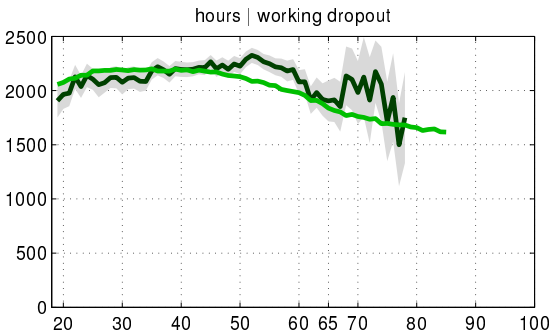




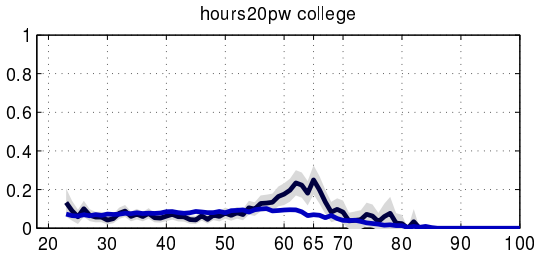


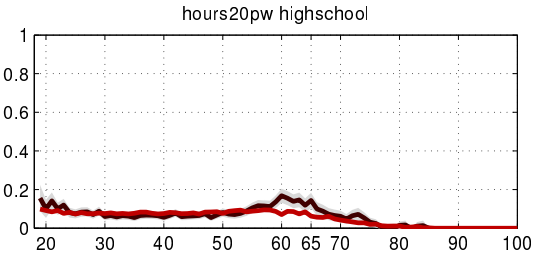


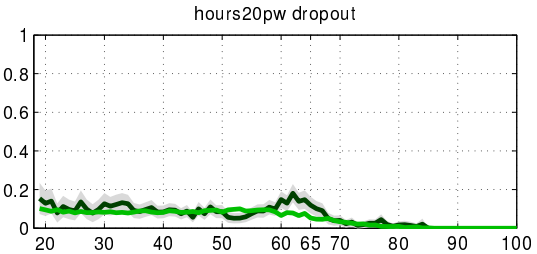


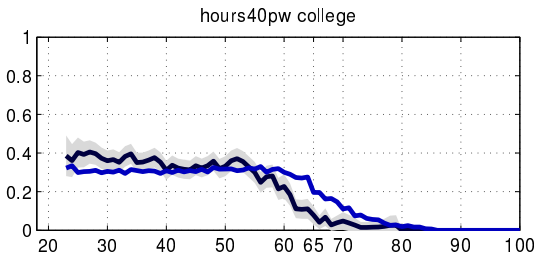


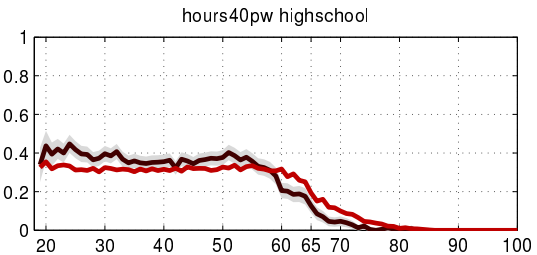
Goodness of fit: discrete levels of hours

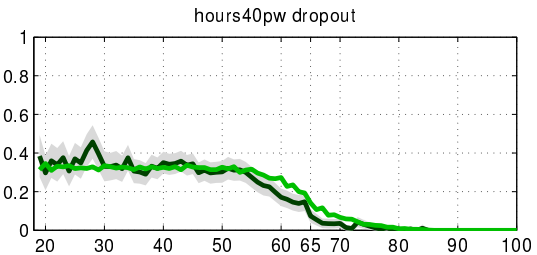


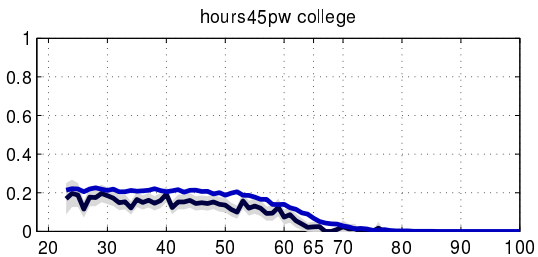


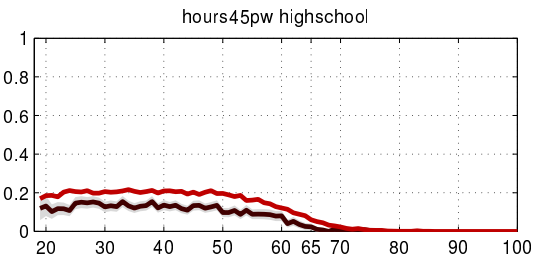


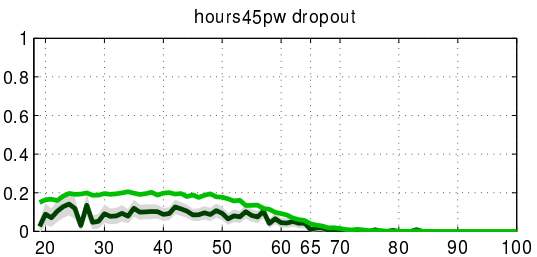


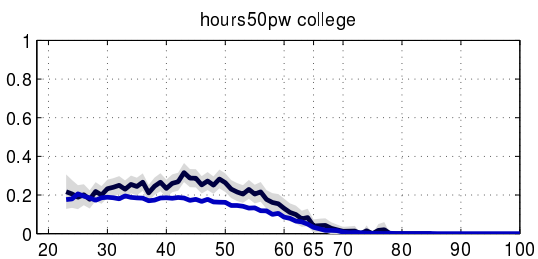


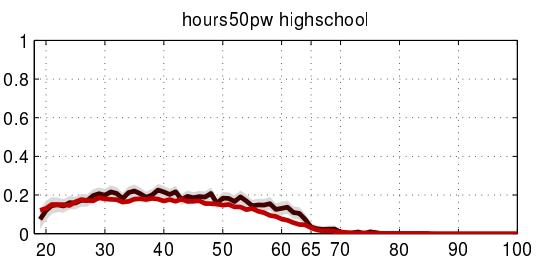


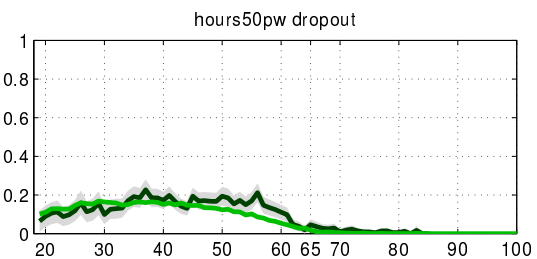




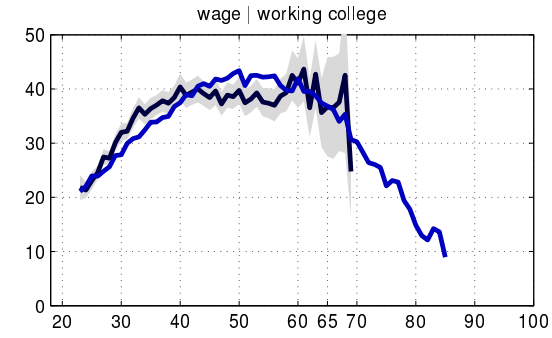


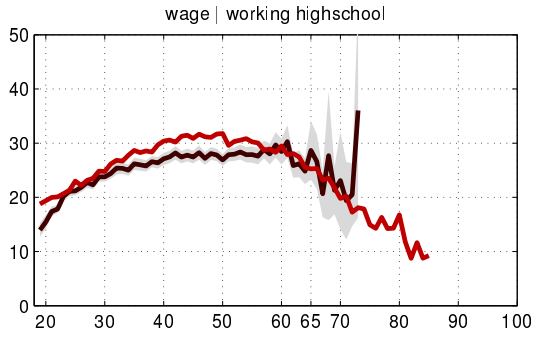


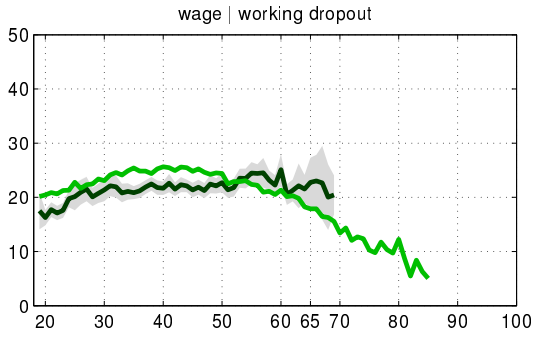


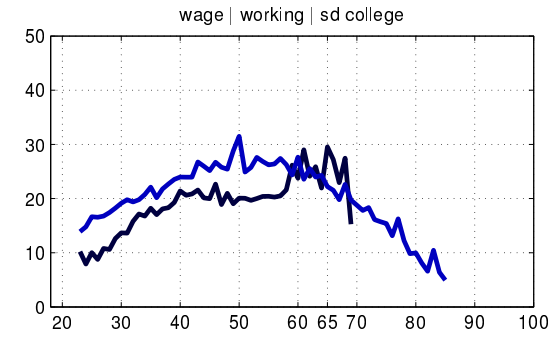


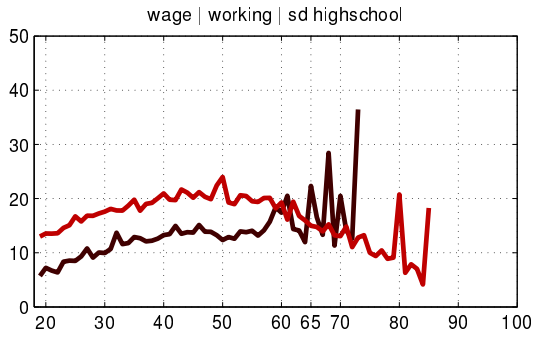
Goodness of fit: wage and wealth

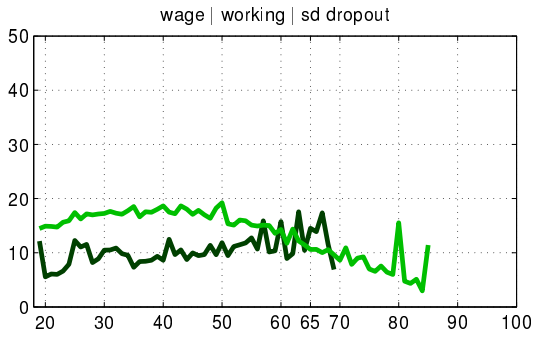


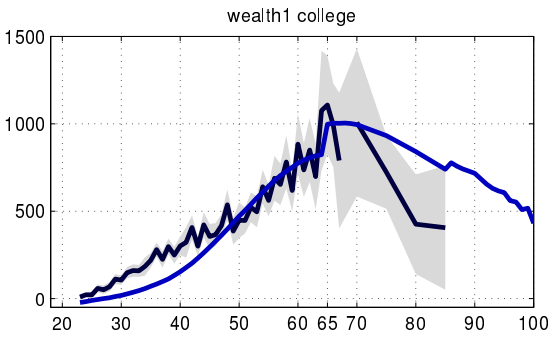


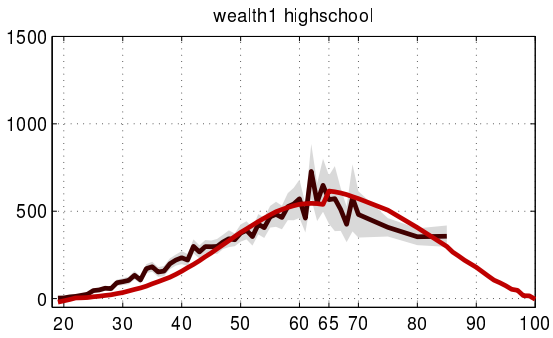


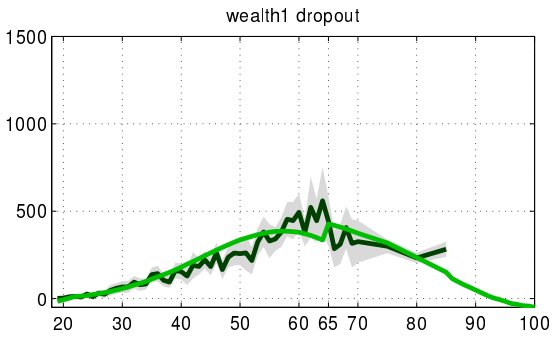












Policy simulation algorithm

- Solve the model separately under both baseline and alternative policy regimes
- Simulate the behavior implied by the estimated parameters

Baseline: whole life cycle under status quo policy (regime 1)

- Policy parameters are constant and known to the decision maker

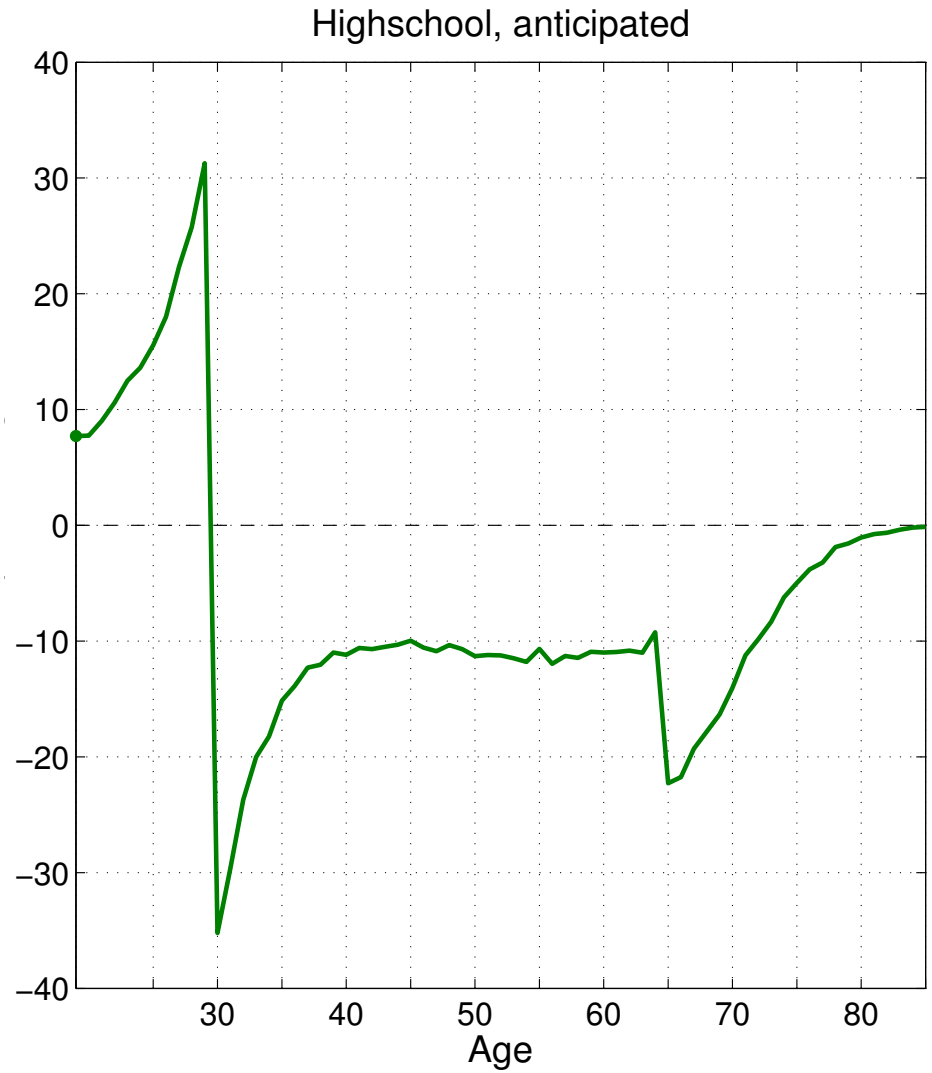
Anticipated: Fully anticipated shift to alternative policy (regime 2)

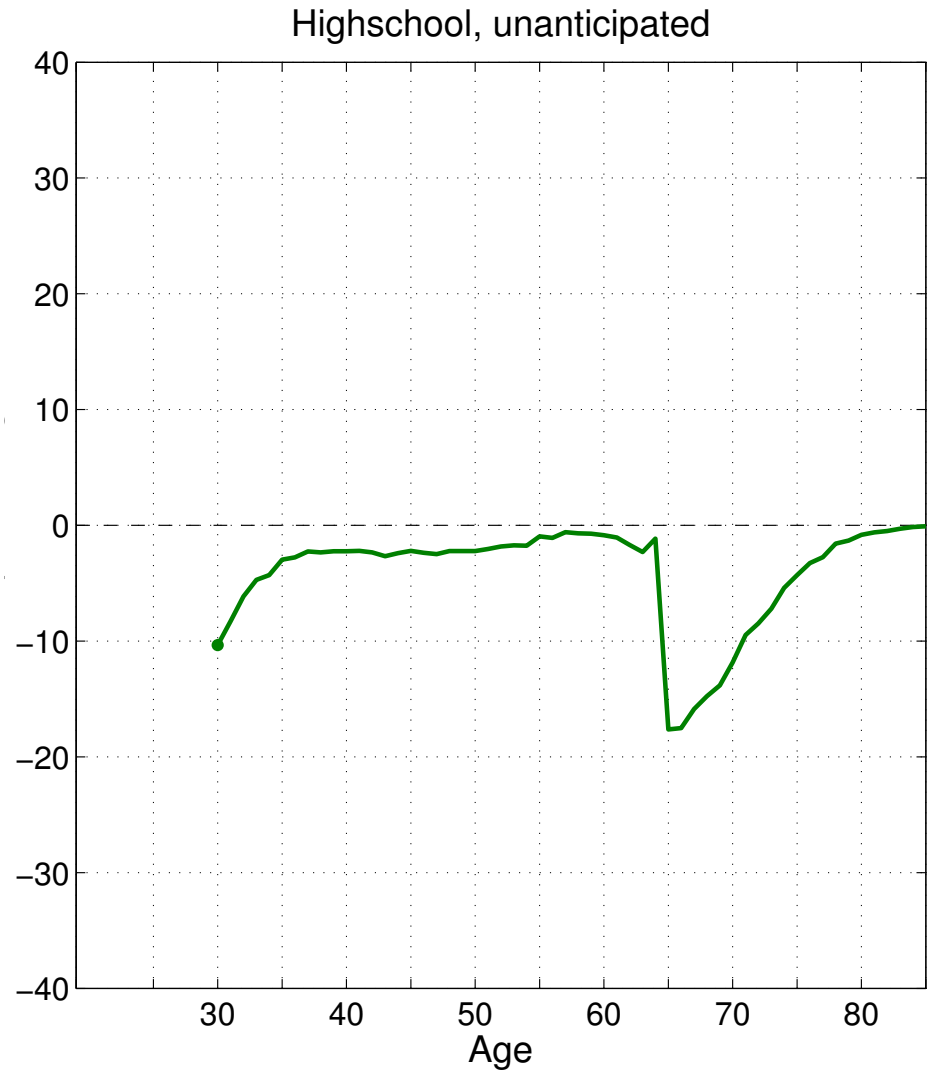
- Parameters of both policies are known over the whole life cycle
- The time when alternative policy is introduced is also known

Unanticipated: Surprise shift from regime 1 to regime 2

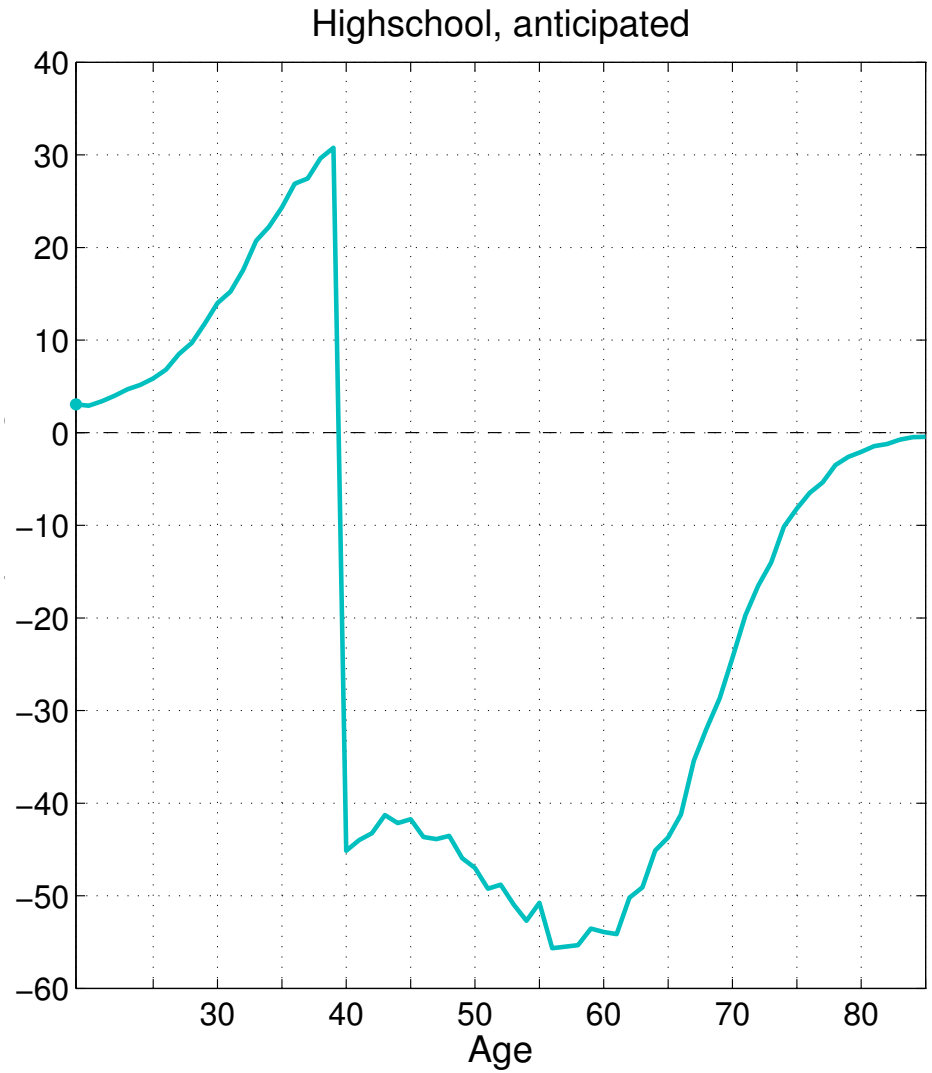
- At early ages parameters of baseline policy are believed to hold over the whole life cycle
- Alternative policy is introduced at a given age without warning
- Technically: exogenous shift from one model solution to the alternative

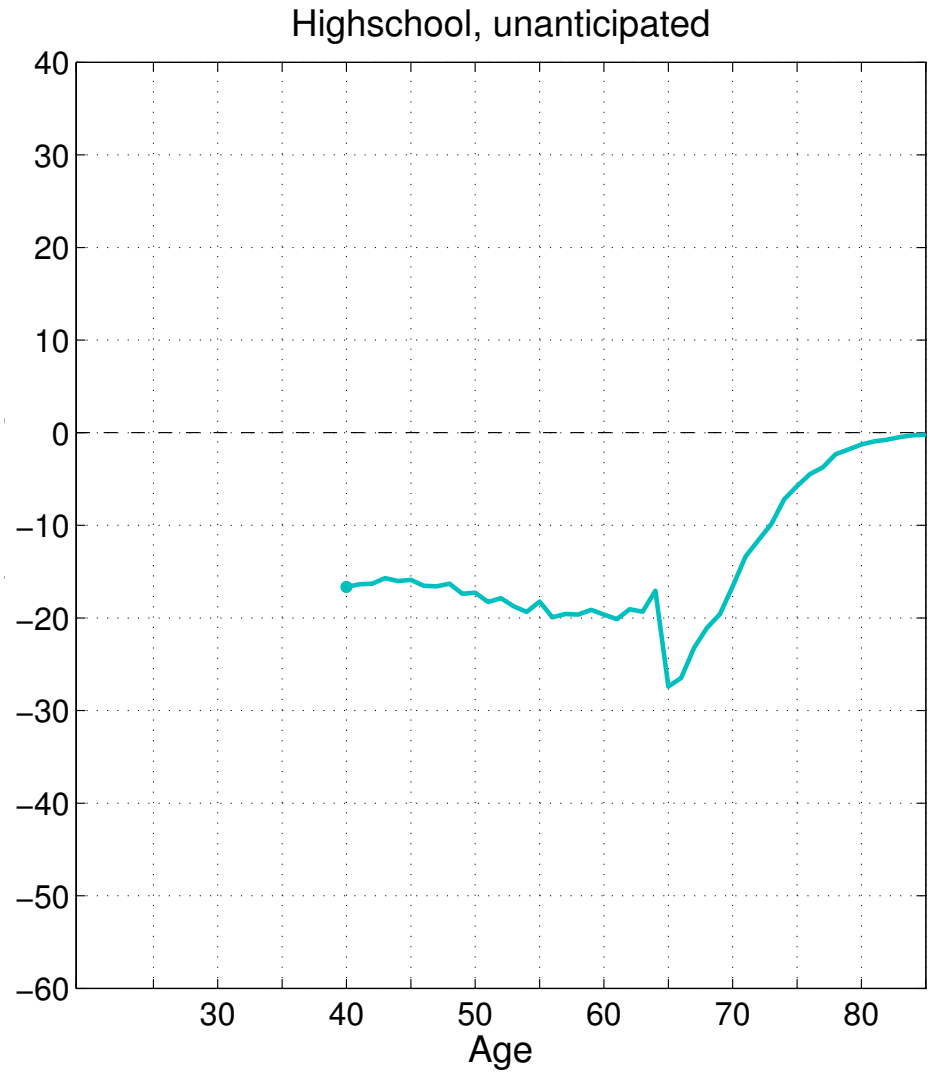
Permanent 10% wage decrease $\rightsquigarrow$ hours



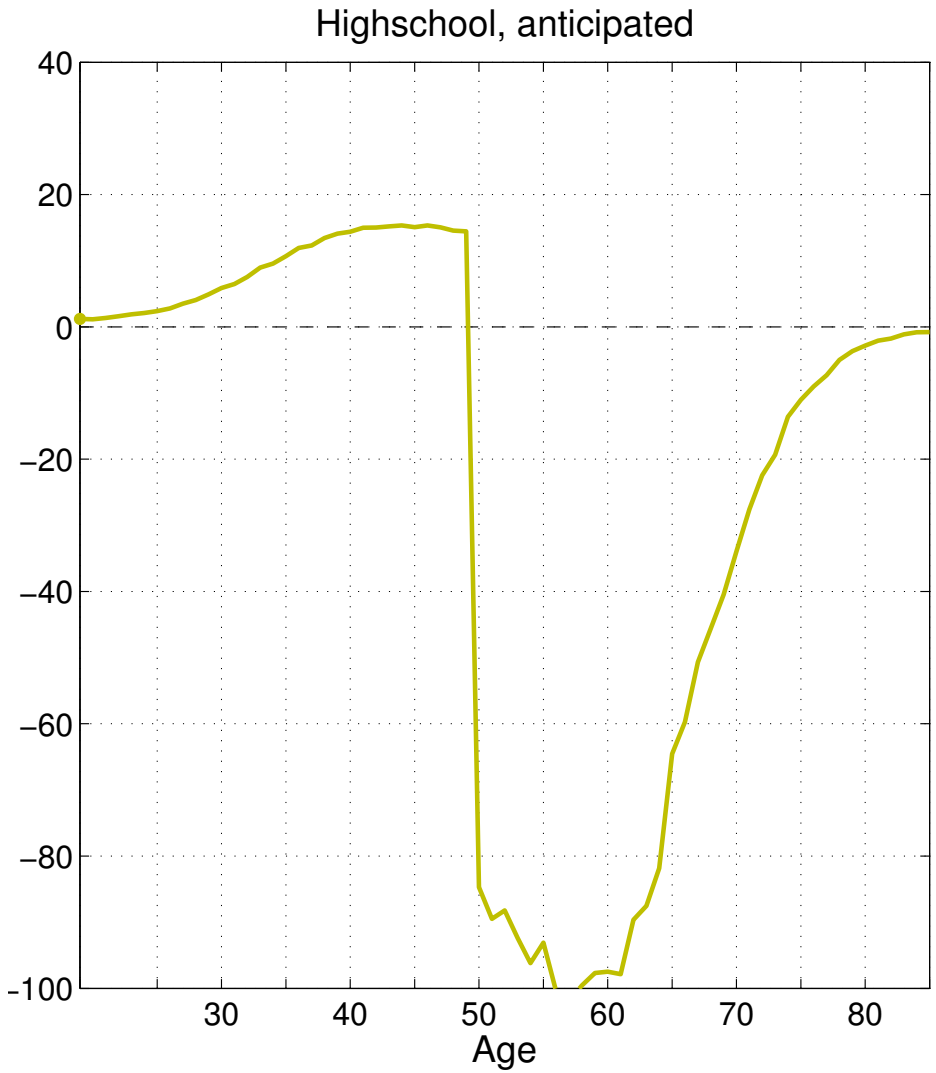


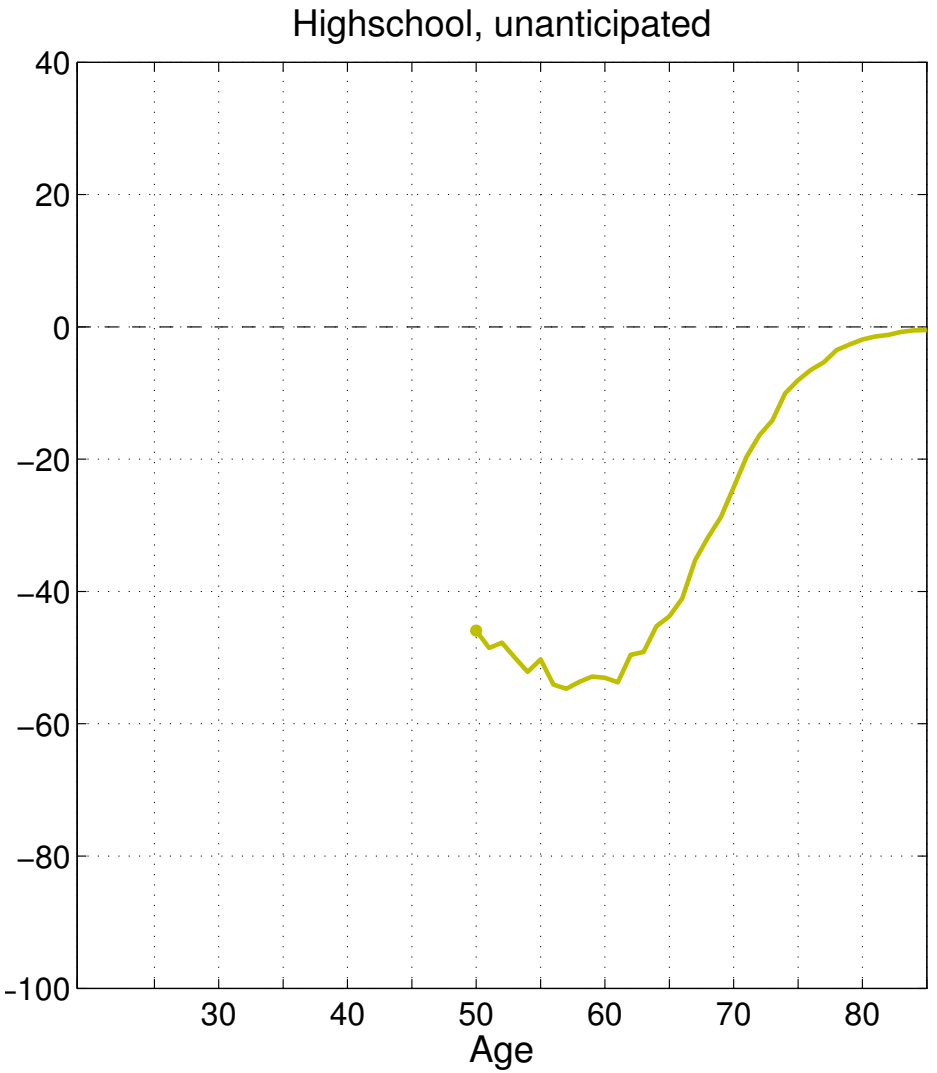
Permanent 10% wage decrease $\rightsquigarrow$ hours



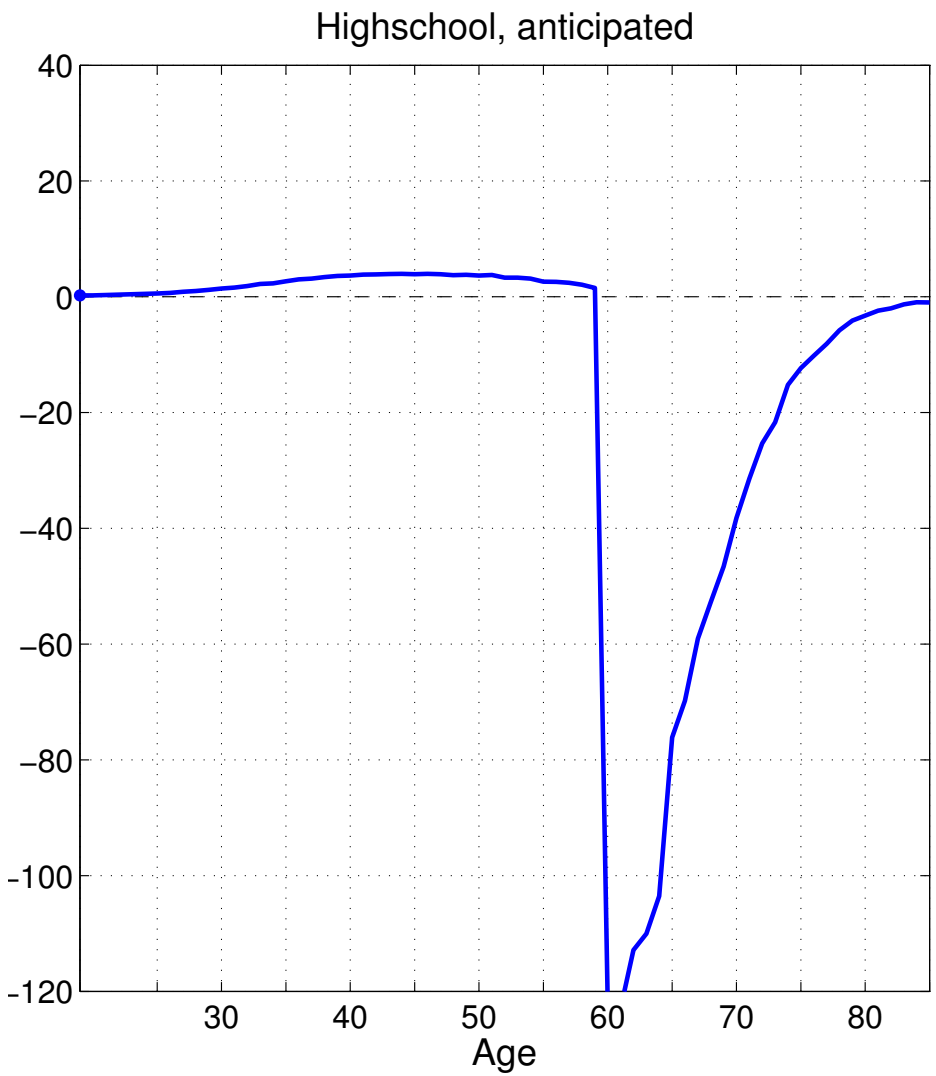


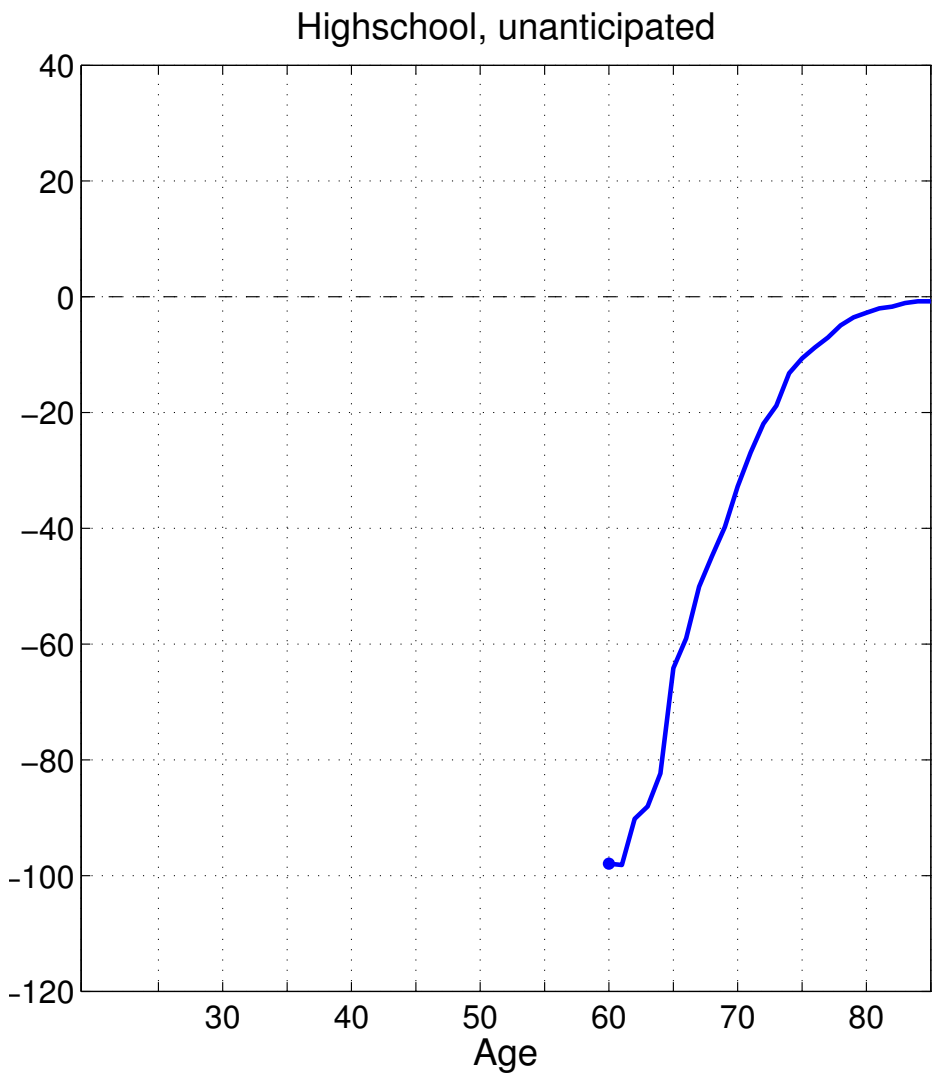
Permanent 10% wage decrease $\rightsquigarrow$ hours



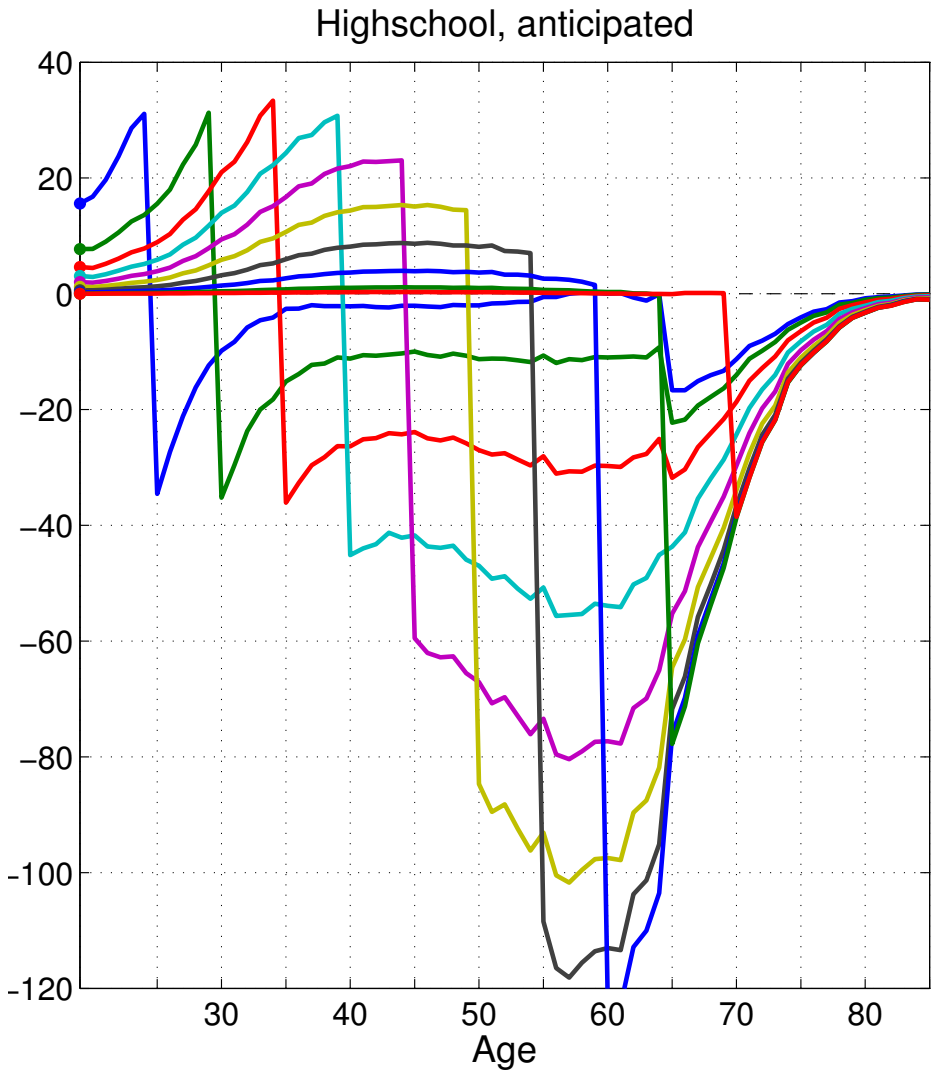


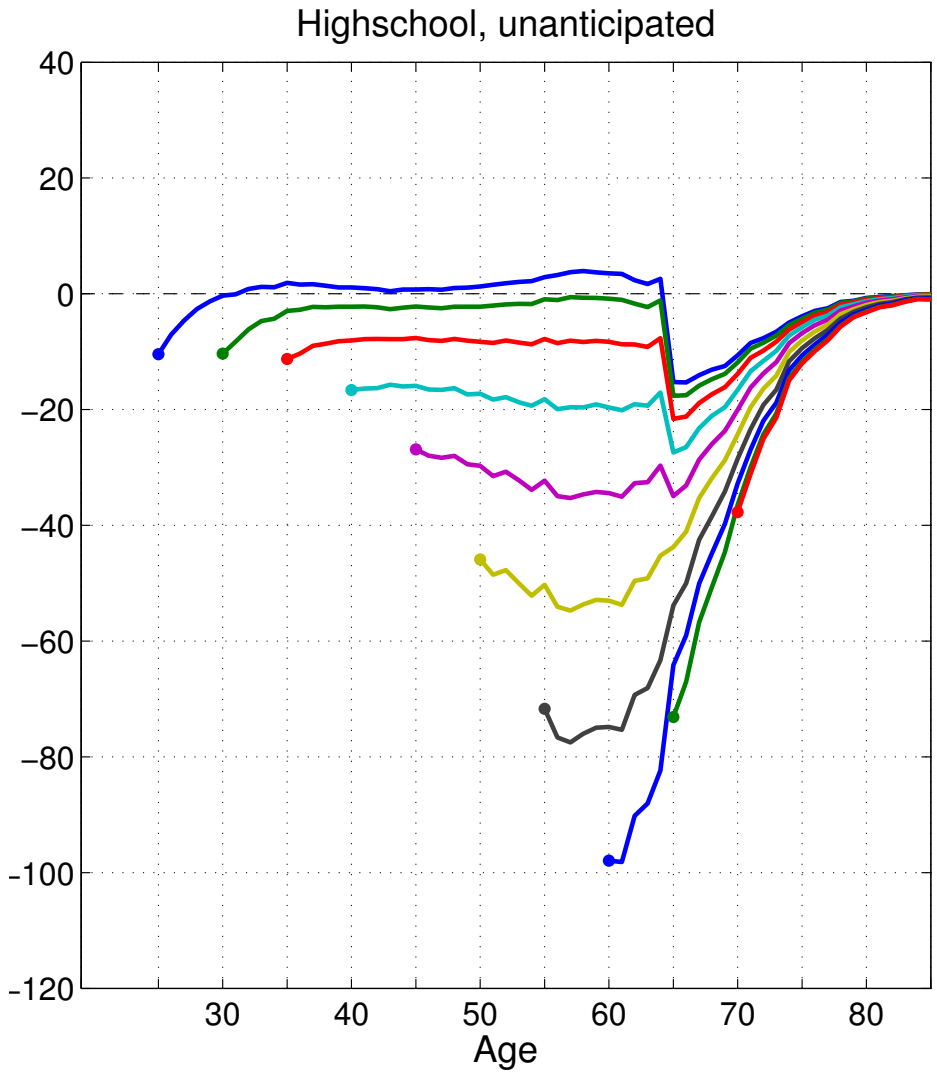
Permanent 10% wage decrease $\rightsquigarrow$ hours



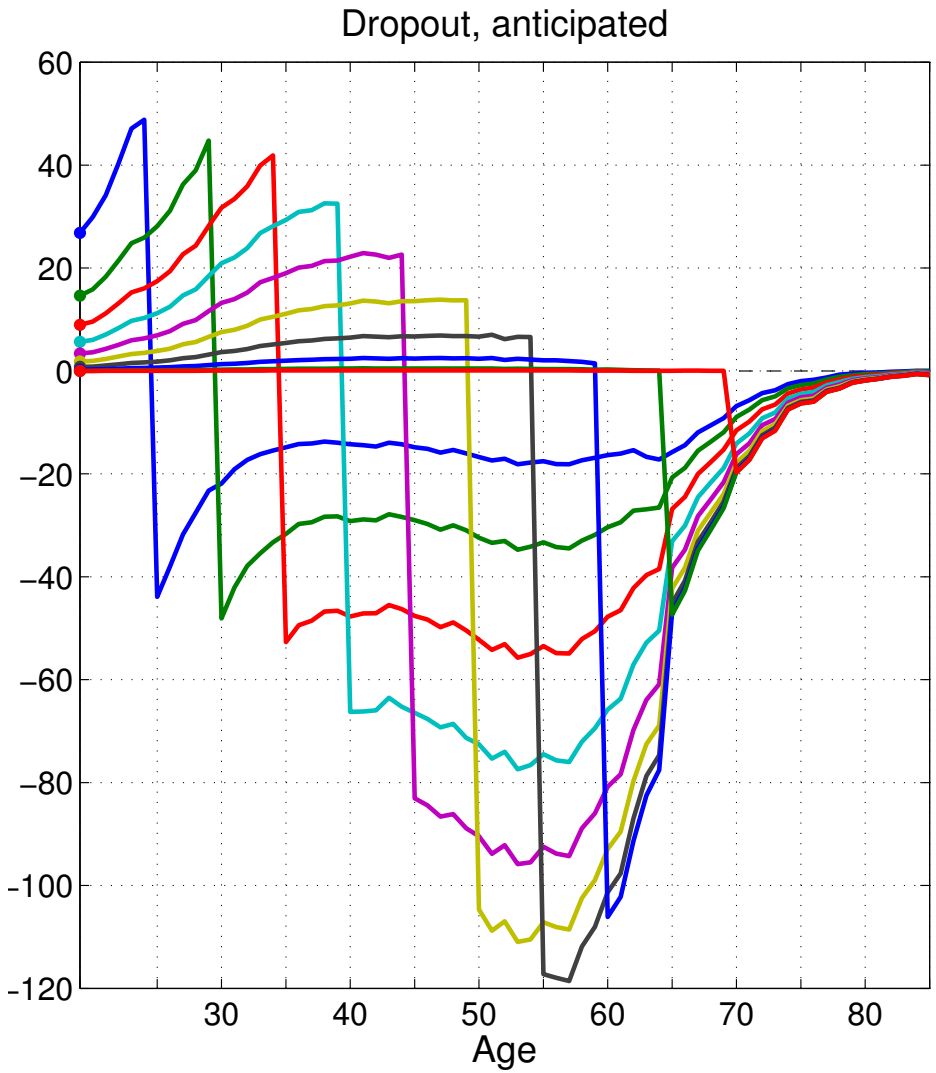


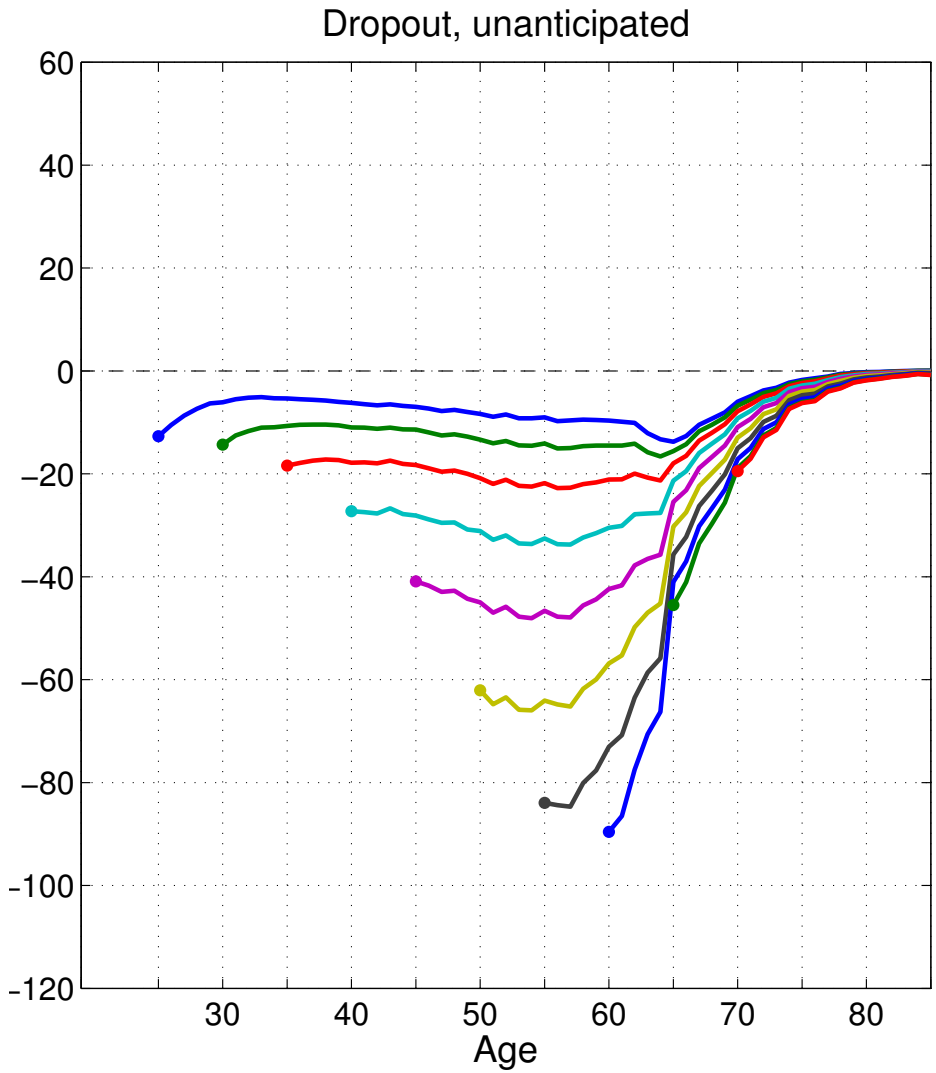
Permanent 10% wage decrease $\rightsquigarrow$ hours (high school)



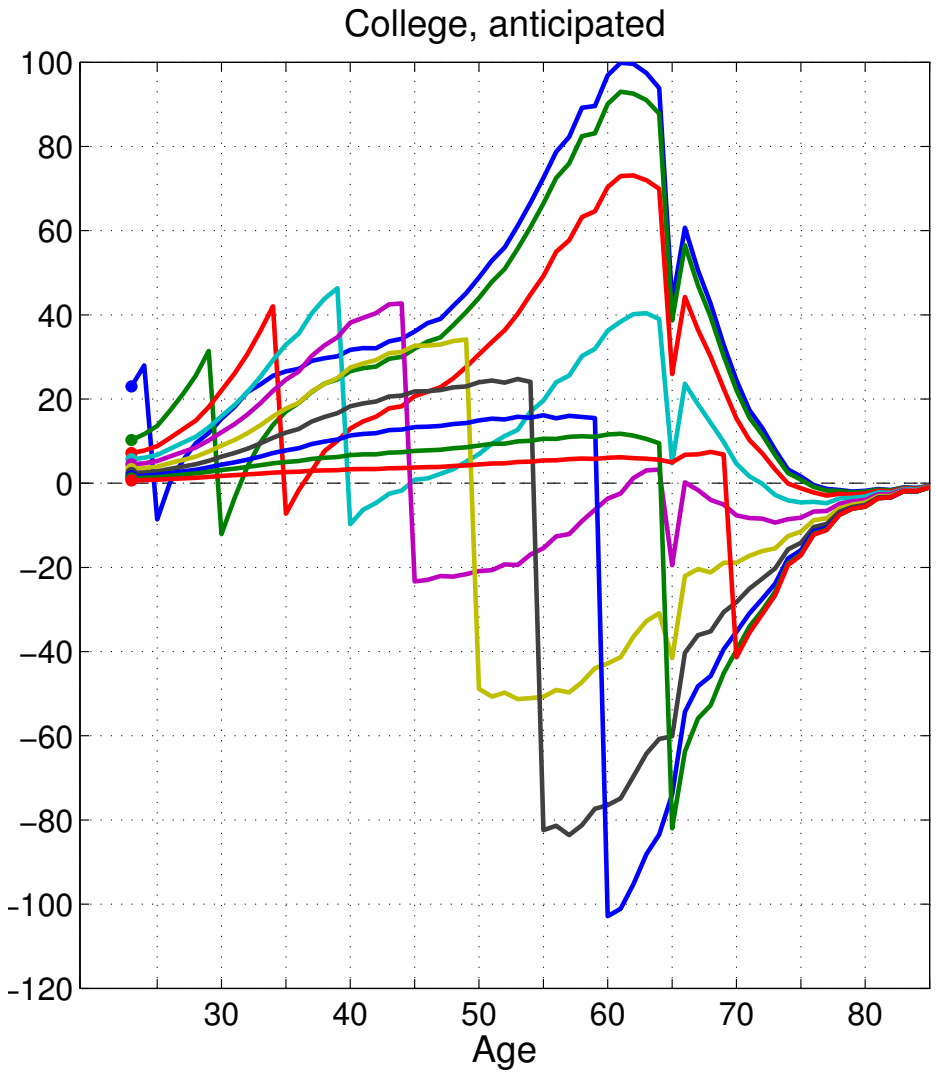


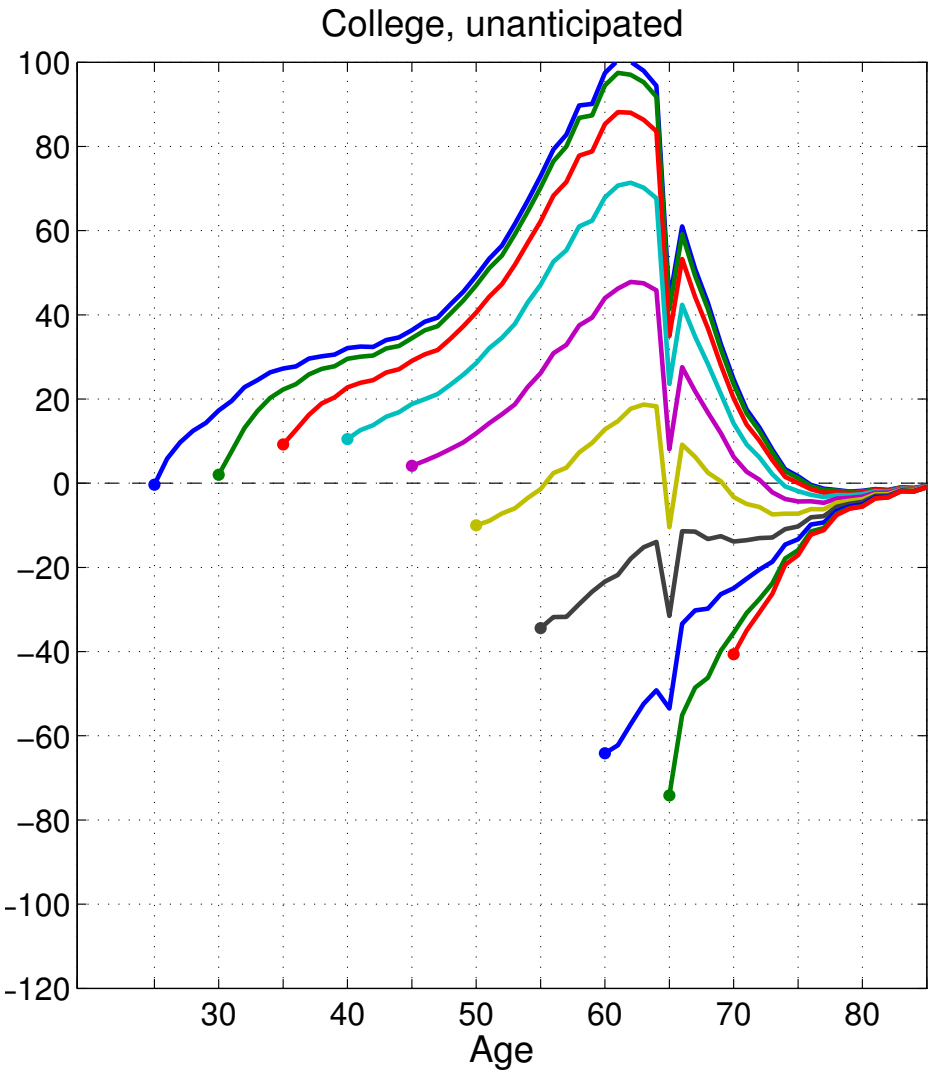
Permanent 10% wage decrease $\rightsquigarrow$ hours (dropouts)





Permanent 10% wage decrease $\rightsquigarrow$ hours (college)





Summary of the effects on labor supply

- Labor supply elasticities change over life cycle and are heterogeneous in population
- Larger decline in hours if policy is anticipated, labor supply shifts forward
- Effect is very different at different points of the life cycle
- Sizable increase in hours following a wage decrease in young age, especially for college graduates (even negative labor supply elasticity)

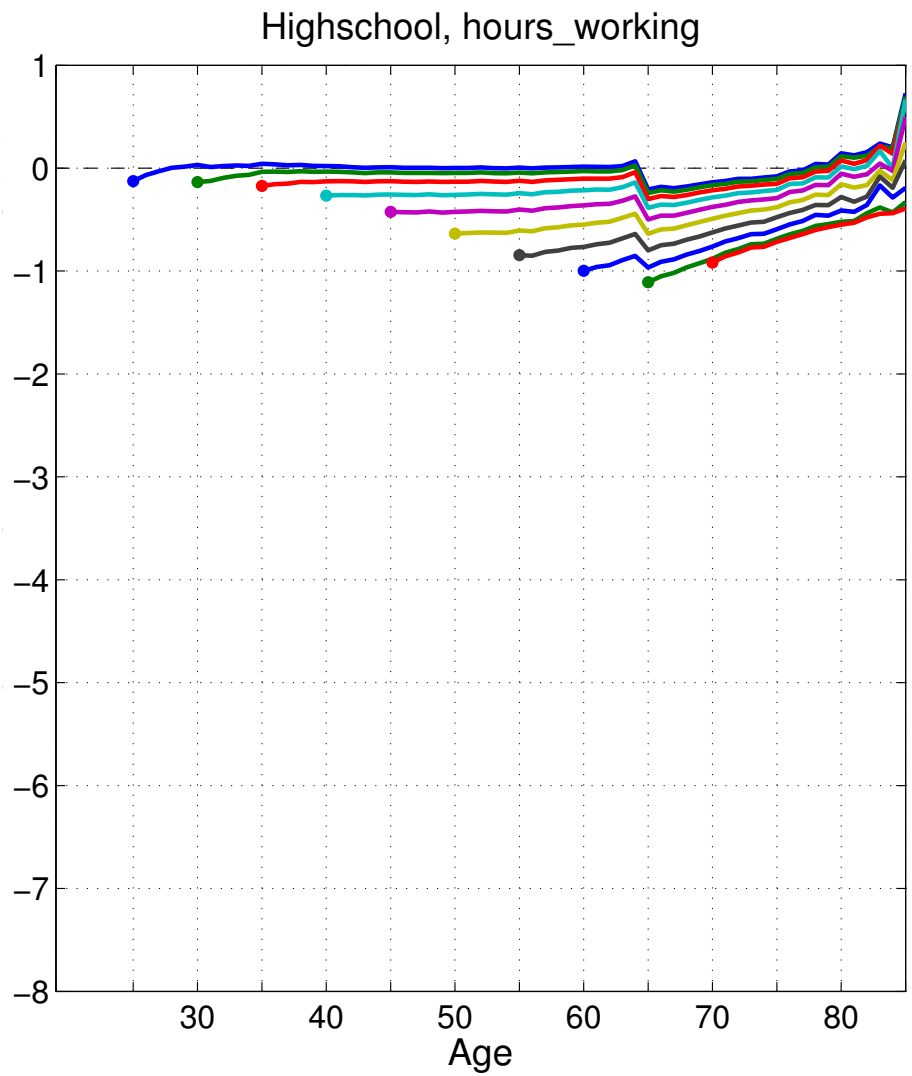
Implied labor supply elasticities:

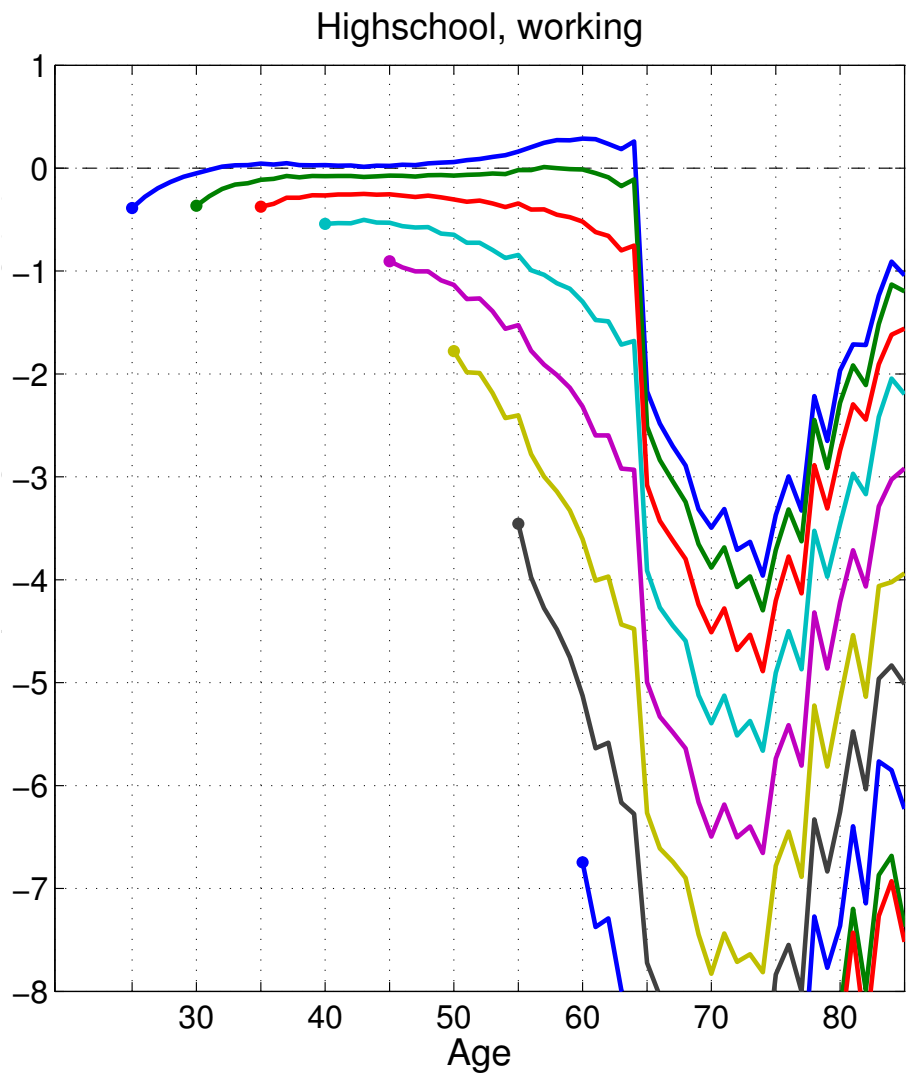
- High school: < 0.1 at young age to > 1 at retirement age
- Dropouts: slightly higher, similar range
- College: 0 and negative at young age, > 1 at retirement age

Intensive vs. extensive margin of labor supply

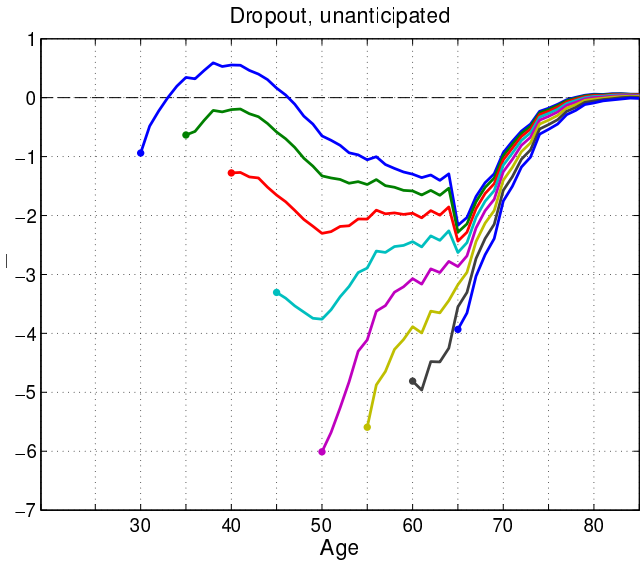
- How is change in *total* hours decomposed into
  - Reduction in hours of those who work (intensive margin), and
  - Decision not to work at all (extensive margin)?
- Permanent unanticipated 10% wage decrease $\rightsquigarrow$ probability of working
- Permanent unanticipated 10% wage decrease $\rightsquigarrow$ hours conditional on working
- Relative changes (%) to be able to compare effects
- Evidence of significantly higher elasticity on the extensive margin for all education groups

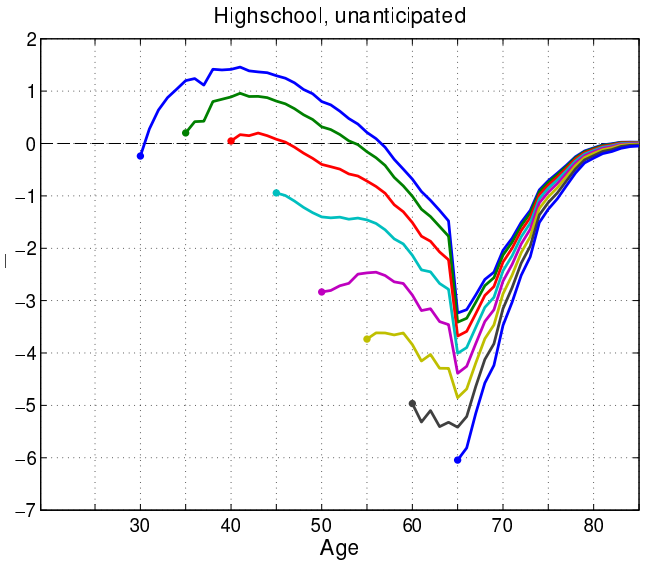
Intensive vs. extensive margin (high school, %)

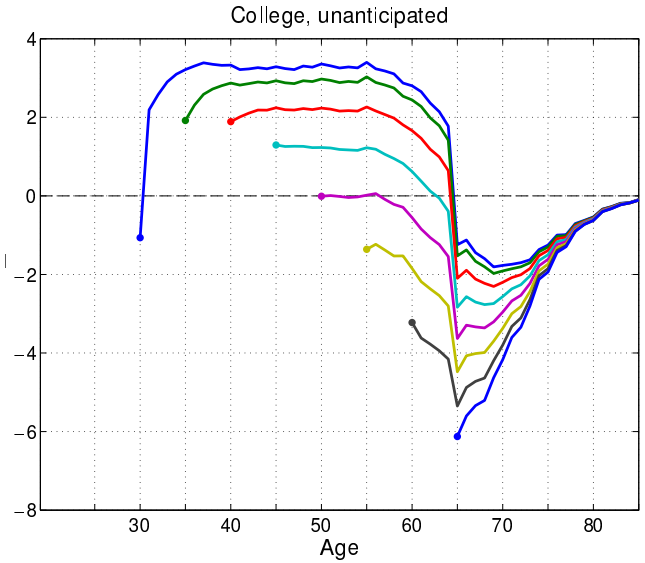


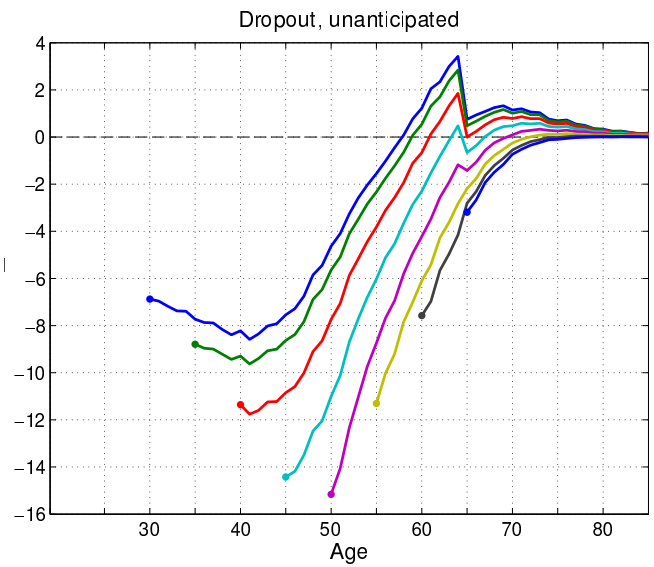


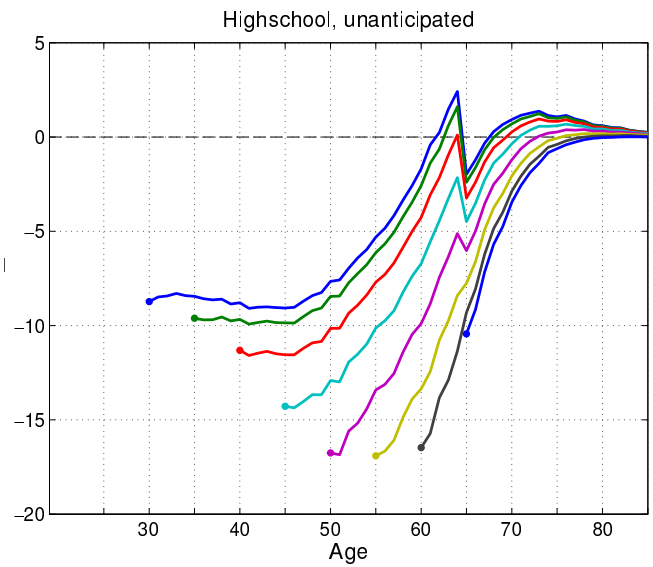
Income tax rates $+10\% \rightsquigarrow$ hours

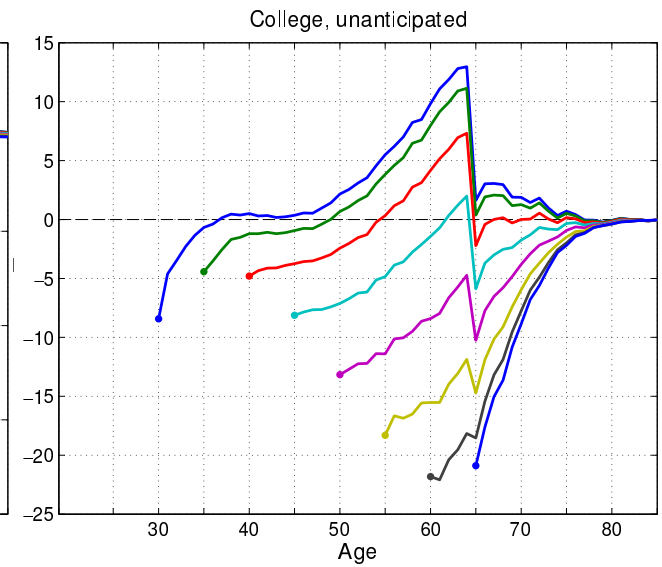










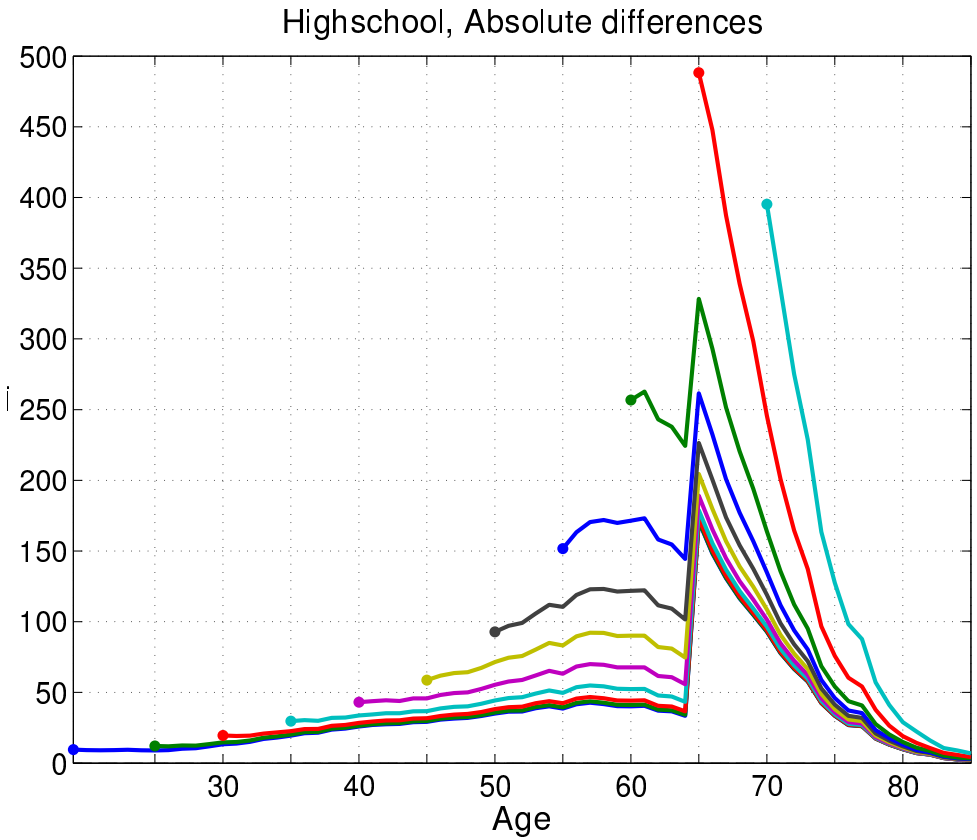


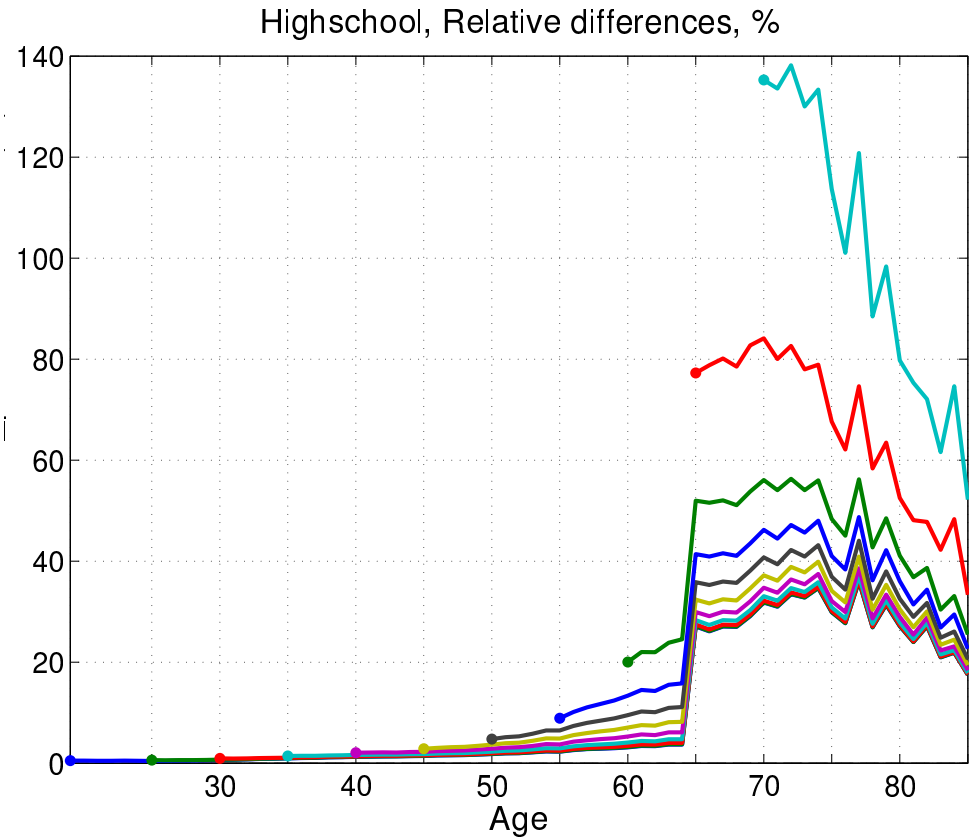
Effects of Age Pension on labor supply

- Increase in full pension benefit (+25%)
- Decrease in income taper rate (-10%)
- Decrease in taper rate in asset test (-10%)

- Complete removal of Age Pension program
  - Regime 2 is the world without Age Pension
  - The effects on labor supply are seen from the comparing this "alternative" policy to the baseline

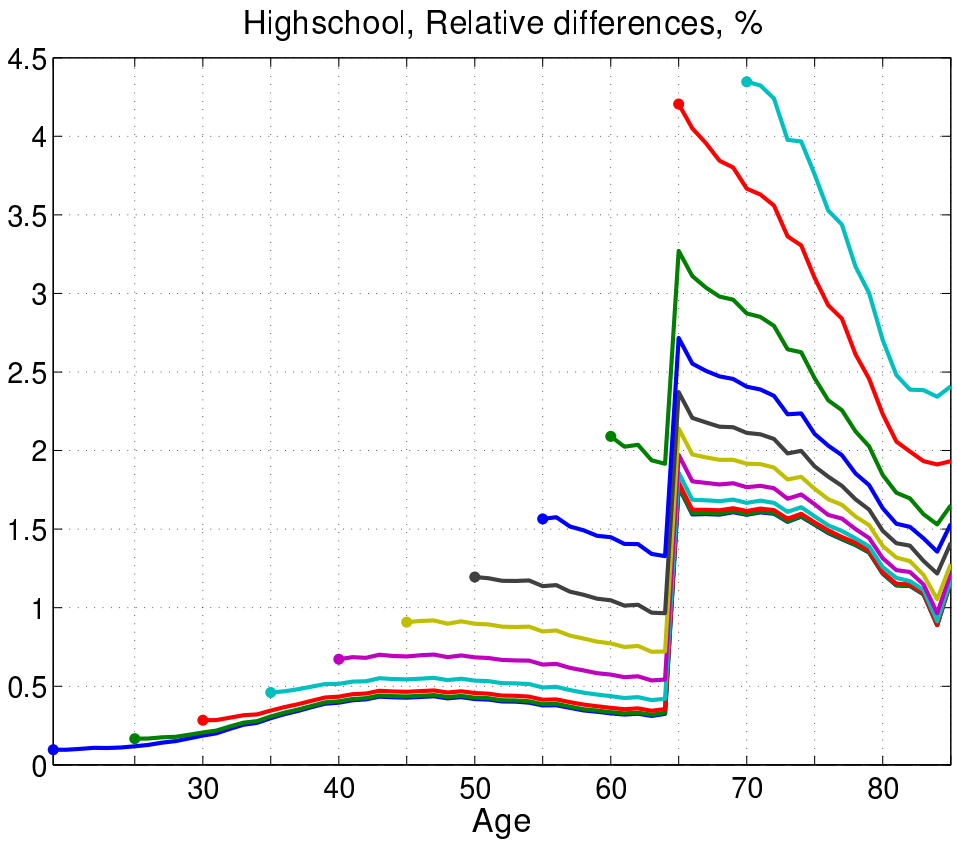
Elimination of age pension $\rightsquigarrow$ hours (annual and %)



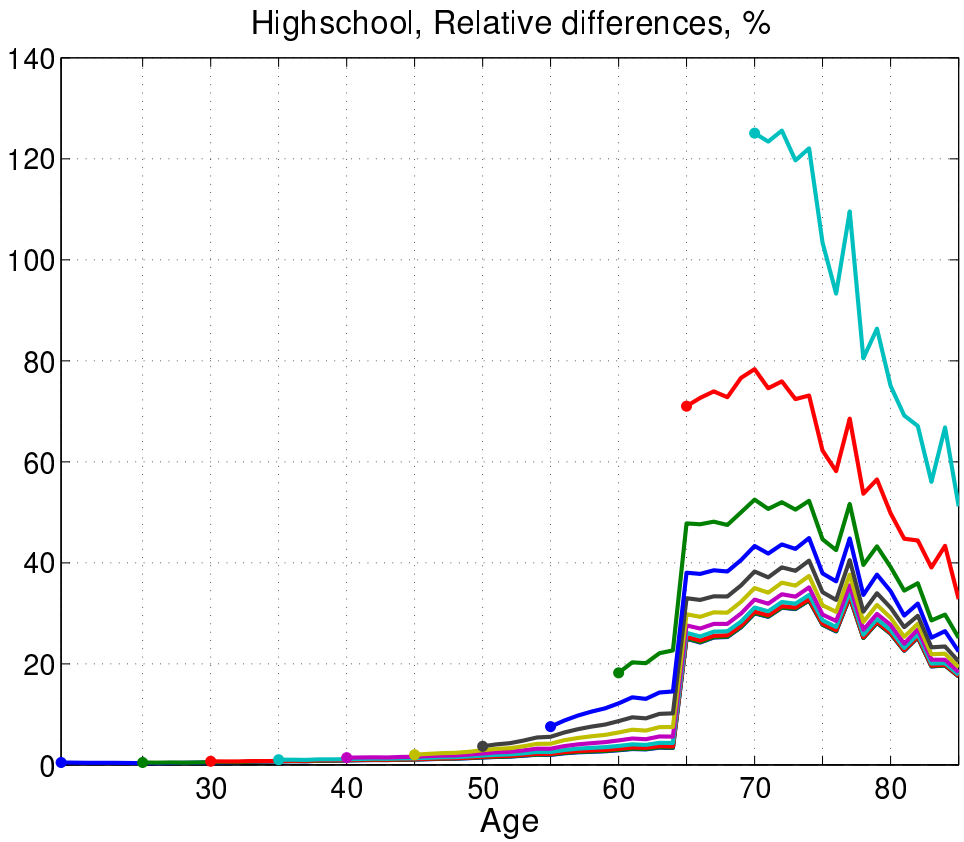


Elimination of age pension, intensive vs. extensive margins

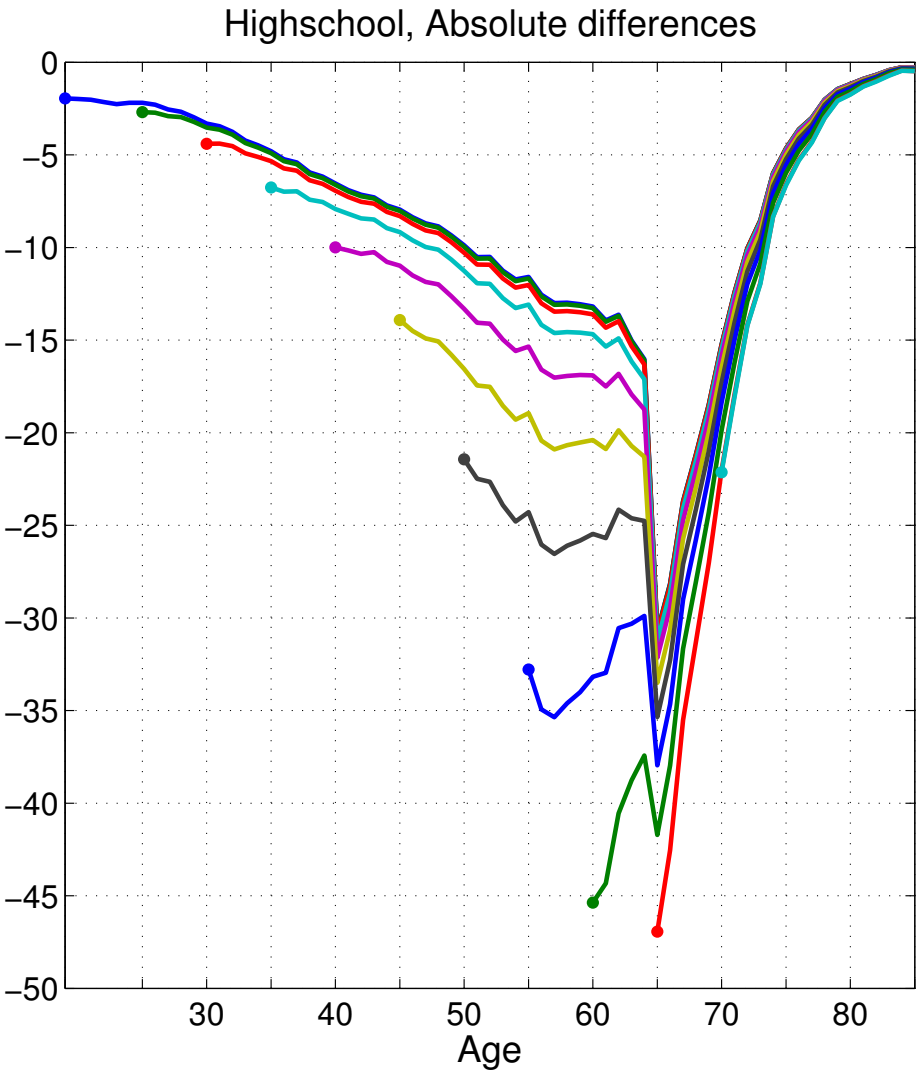
Hours conditional on working (%)

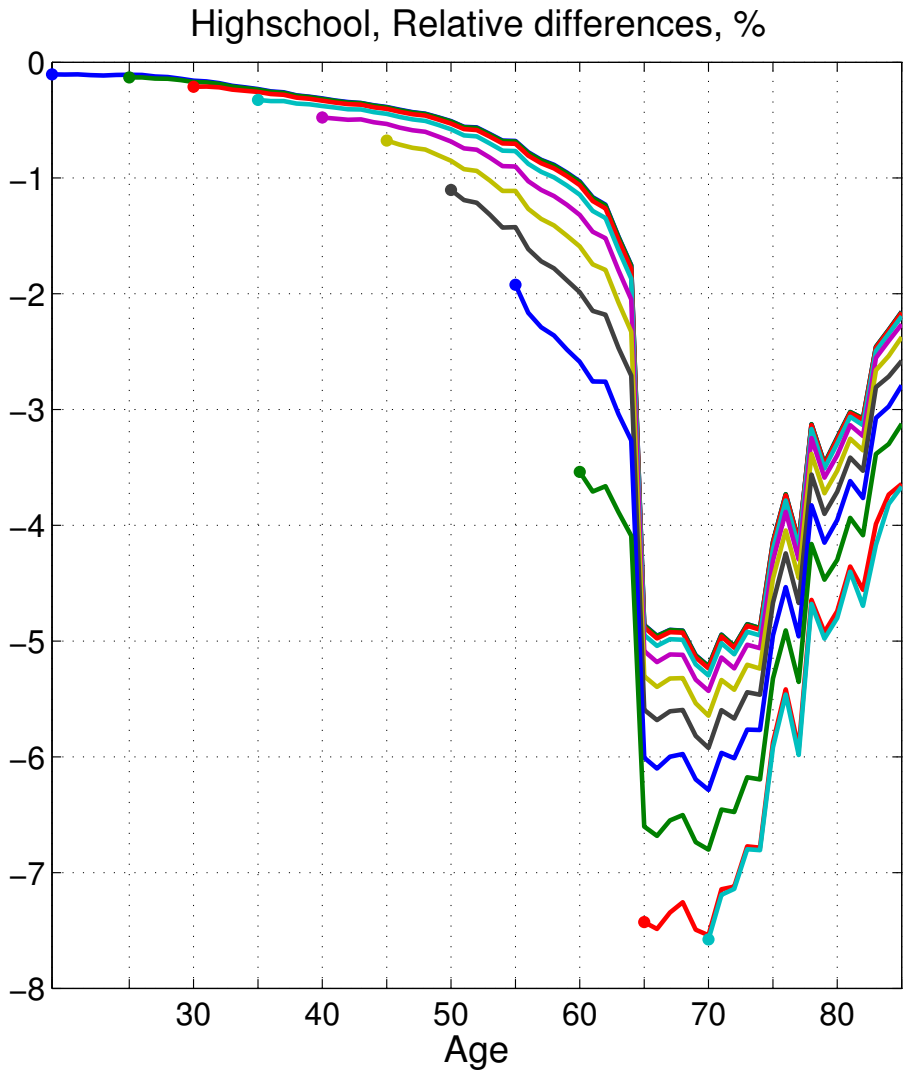


Fraction of working (%)

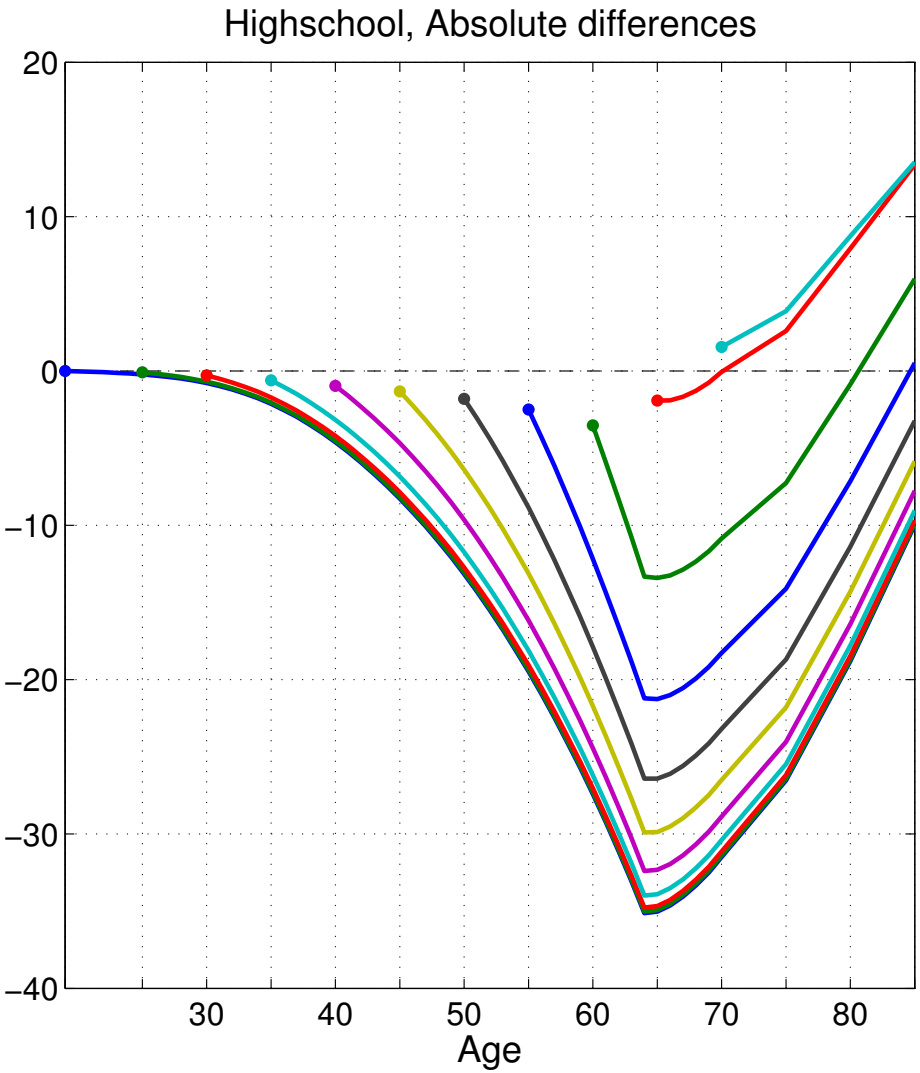


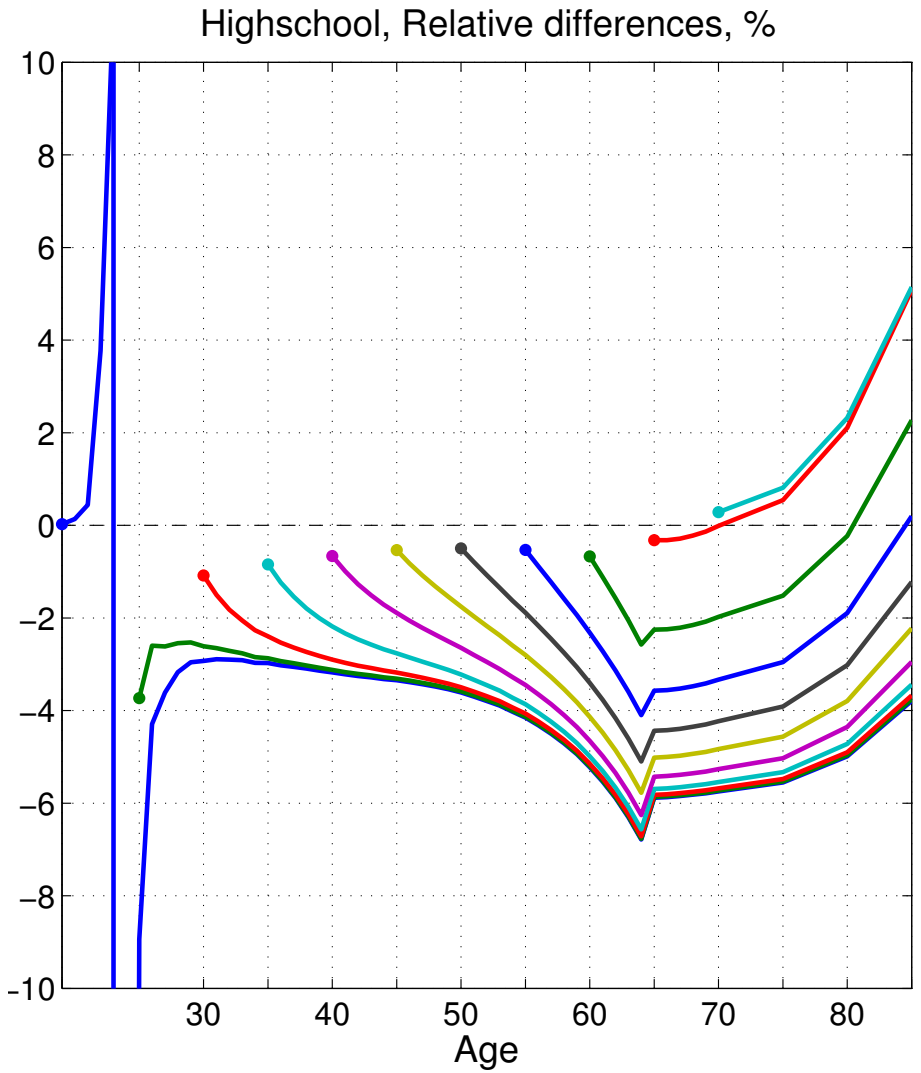
Maximum age pension +25% $\rightsquigarrow$ hours (annual and %)



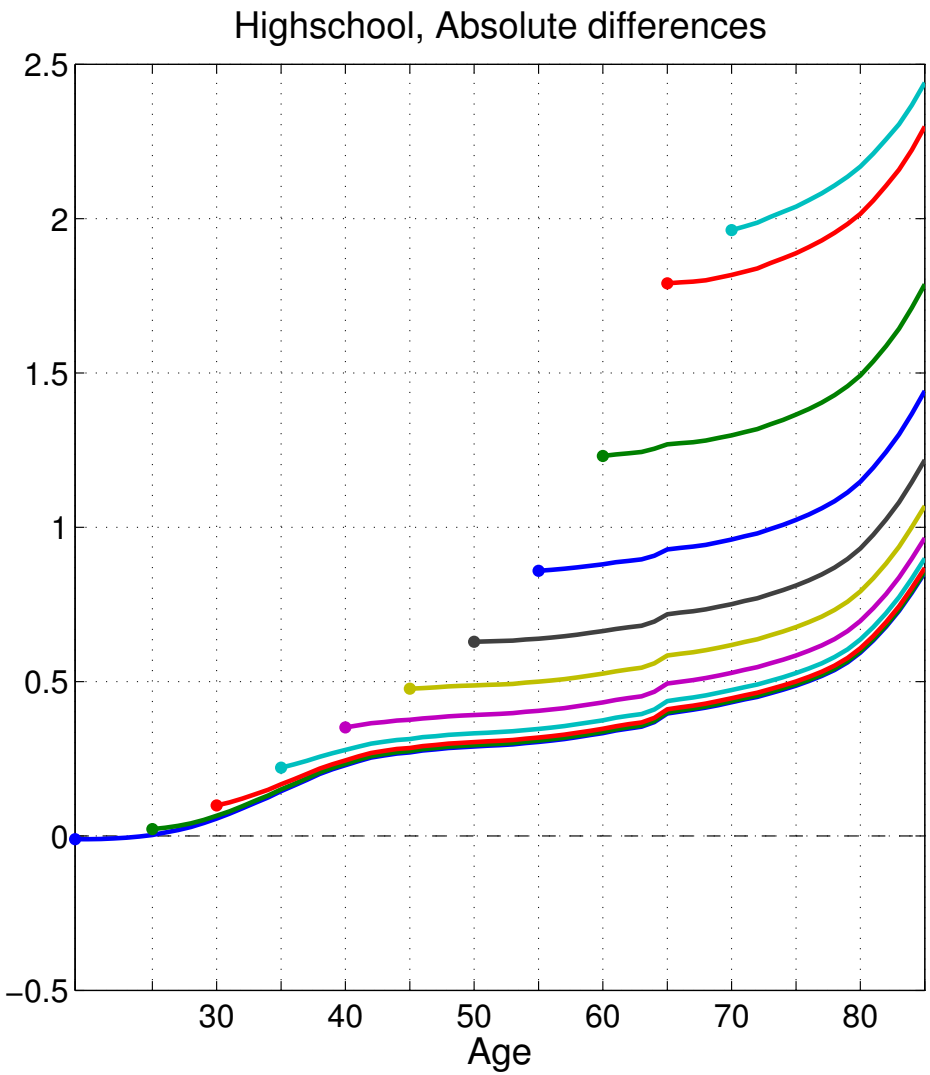


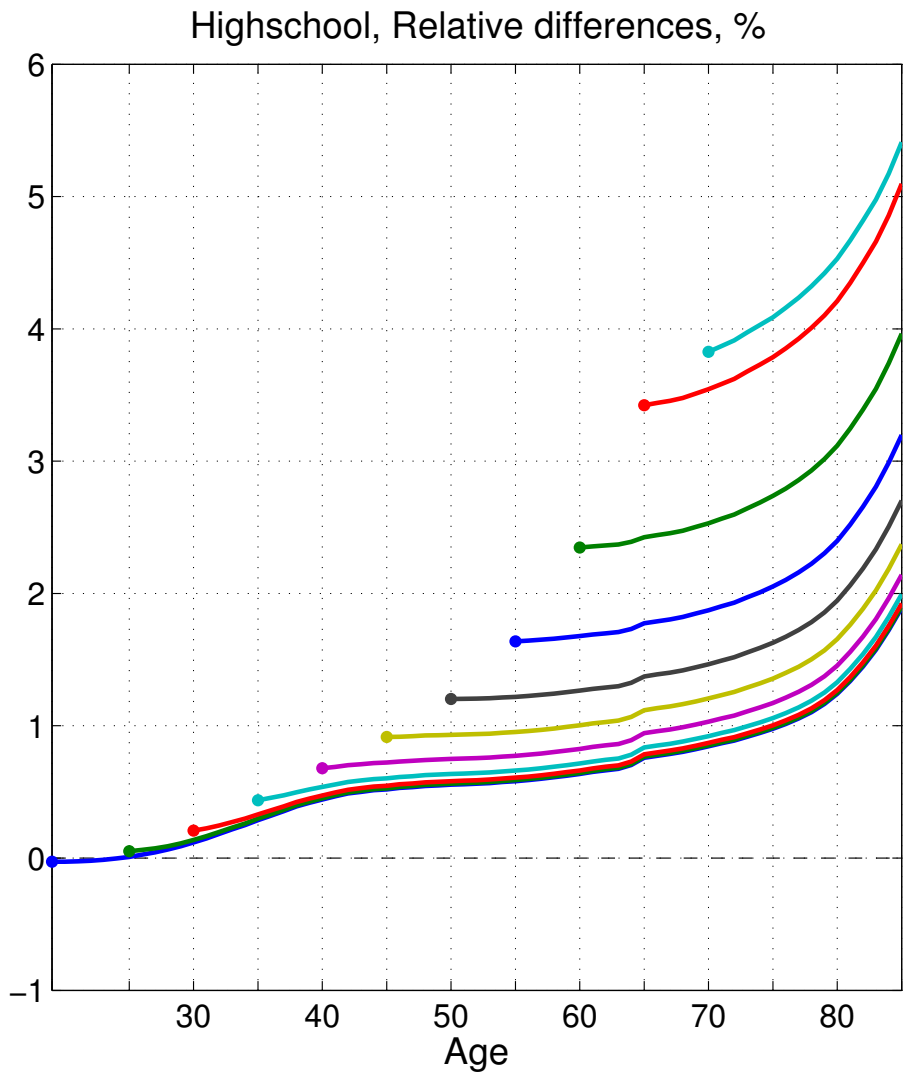
Maximum age pension +25% $\rightsquigarrow$ wealth ($1000 and %)





Maximum age pension +25% ⇝ consumption





Effects of Age Pension

- Increase in full pension benefit (+25%)
  ⇒ Up to 7% decrease in hours before age 65
  ⇒ About 7% decrease in wealth before 65
  ⇒ Uniform increase in consumption with up to 5% in old ages

- Decrease in income taper rate (-10%)
  ⇒ About 2.5% increase in hours after 65
  ⇒ Up to 0.3% decrease in wealth before 65, similar magnitude increase thereafter
  ⇒ Small uniform increase in wealth over the life cycle

- Decrease in taper rate in asset test (-10%)
  ⇒ Small (up to 0.2%) increase in hours before 65, up to 1% decrease thereafter
  ⇒ Uniform increase in wealth over the life cycle, up to 3% in old ages
  ⇒ Up to 0.4% decrease in consumption before 65 and up to 0.6% increase in old ages

Preliminary results

- The model is sufficiently flexible to replicate the observed data well
- Policy experiments produce reasonable behavioral responses
- Large variations of labor supply responses over the life cycle and among education levels
  - Labor supply elasticity increases with age
  - Smaller for the higher education groups in the beginning of life cycle
- Strong influence of age pension system on the labor supply
- Effects seen throughout the life cycle
- Different magnitudes for anticipated and unanticipated changes
- Stronger effects on the extensive margin for all education levels