Education, cognitive ability and Cause-Specific Mortality: A structural approach

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Motivation

- Differences in health and mortality across educational groups are striking and pervasive (Meara et al. 2008)
- Impact of education differ by disease (Mackenback et al.)
  Some diseases involve complex treatments
  other simple or hardly effective treatment
  Impact of education on cause-specific mortality may differ

Causal impact of education on mortality

- Recent results deriving from natural experiments in education suggest that causal effect of education on health is small or even absent (e.g. Lleras-Muney, 2005; Van Kippersluis et al. 2011; Meghir et al. 2013; Clark and Royer, 2013)
- Suggest an important role for confounding factors, such as cognitive ability (Elias, 2004; Auld and Sidhu, 2005; Murasko, 2007; Carneiro et al. 2007; Kaestner and Collison, 2011)
- Educational attainment and cognitive ability strongly correlated. Difficult to disentangle.
- Using structural models:
  About half of health disparities across education levels due to selection of the healthier into higher education (Conti and Heckman 2010; Bijwaard et al. 2015a, 2015b).
- Studies on educational differences in cause-specific mortality ignore endogeneity

Our contribution

Disentangle the effects of education and cognitive ability on years-lost due a specific cause of death using an extension of structural model of Bijwaard et al. (2015a, 2015b)

Contribution is twofold:

1. Causal effect of education on years-lost due to specific cause
2. Decompose the observed years-lost (18-63) difference by education level in treatment effect, educational gain, and selection effect both on observed and unobserved characteristics (cognitive ability)

Swedish Military Conscription Data

Examinations for military service men born 1951-1960: 446,545 individuals.

- Detailed info on individual demographic and socioeconomic characteristics, including SES (father and mother at birth) parental education, parental age at birth, birth order and region of birth
- Intelligence test: IQ in 9 categories
- Education classified in 4 levels:
  less than 10 years, Secondary education (max 12), Full Secondary education and, university (and PhD)
- Mortality by cause of death, till end 2013.

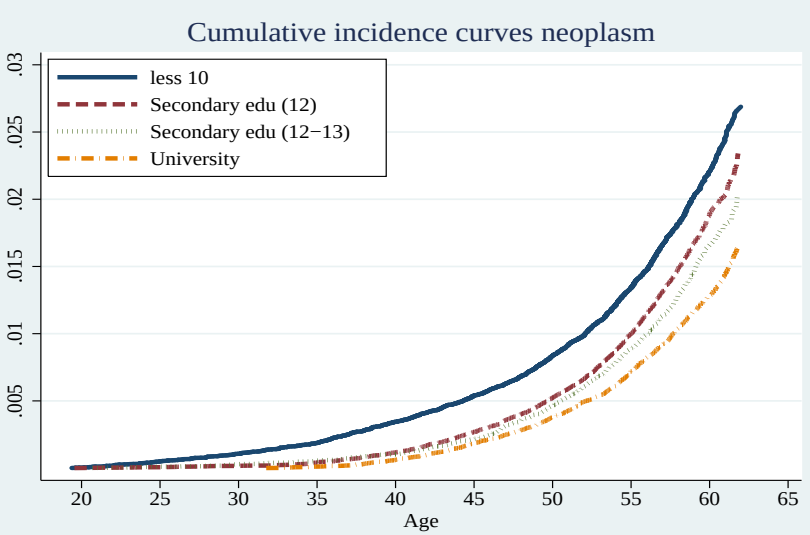
Descriptive statistics: selected variables

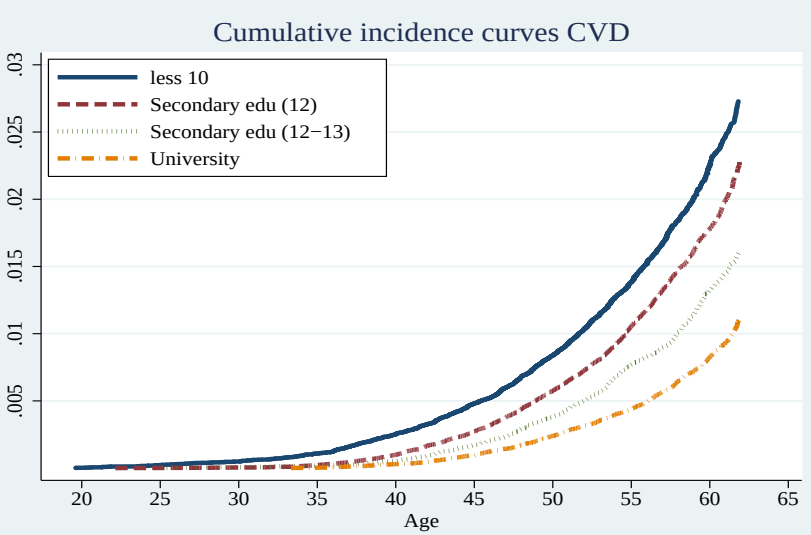
	less 10	Sec edu (12)	Full Sec edu	university
		mother ses		
unskilled workers	10%	9%	7%	6%
Skilled workers	49%	48%	37%	27%
farmers	19%	15%	14%	11%
non-manual (low)	14%	19%	30%	39%
non-manual (intermediate)	2%	2%	5%	8%
non-manual (high)	1%	1%	4%	6%
		father's education		
less 9 years	66%	59%	46%	34%
9–10 years	3%	3%	4%	4%
Secondary edu (max 12)	11%	15%	18%	17%
Secondary edu (13)	5%	8%	11%	15%
university	3%	4%	10%	21%
IQ (1–9)	4.0	4.6	5.7	6.5

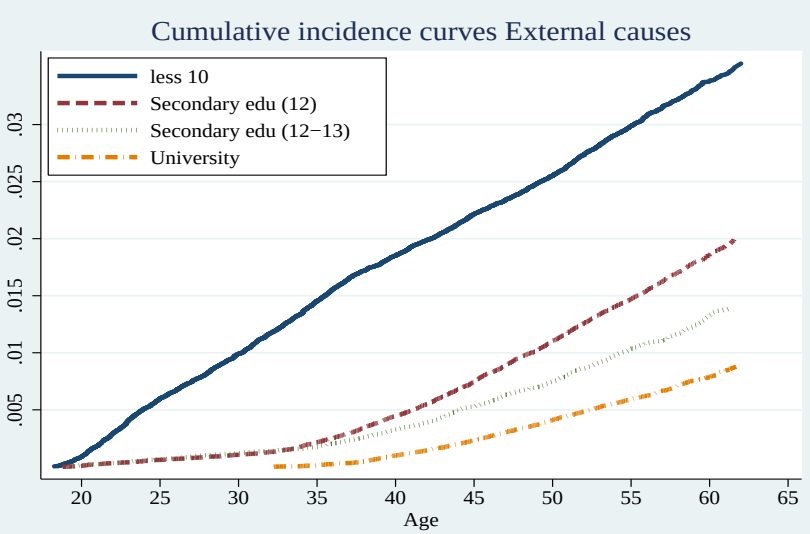
Descriptive statistics: distribution cause of death

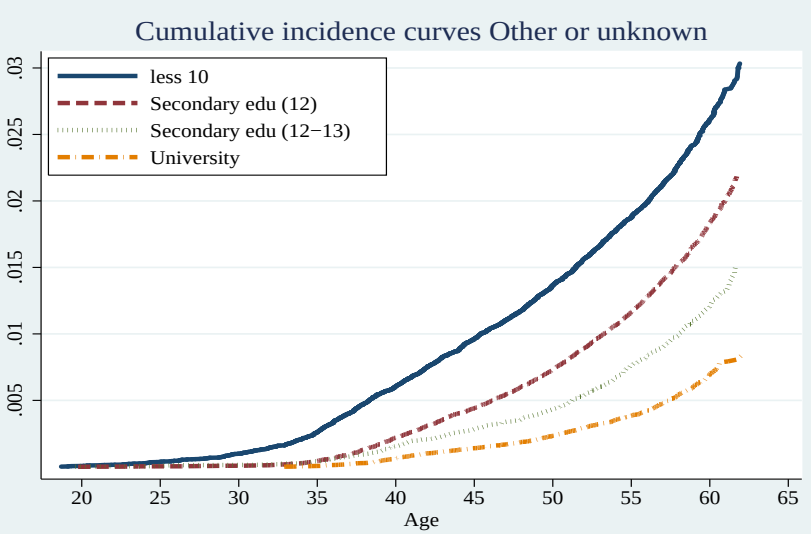
	less 10	Sec edu (12)	Full sec edu	university
# of deaths	8,770	9,451	2,506	3,829
deaths per 1000	90.8	59.1	45.3	28.4
		causes of death		
neoplasm	18.2	14.0	13.1	10.0
Cardiovascular diseases	18.4	13.9	10.4	6.3
External causes	31.5	16.5	11.7	6.8
Other causes	22.6	14.7	10.1	5.3

Cumulative incidence curves by cause of death and education level









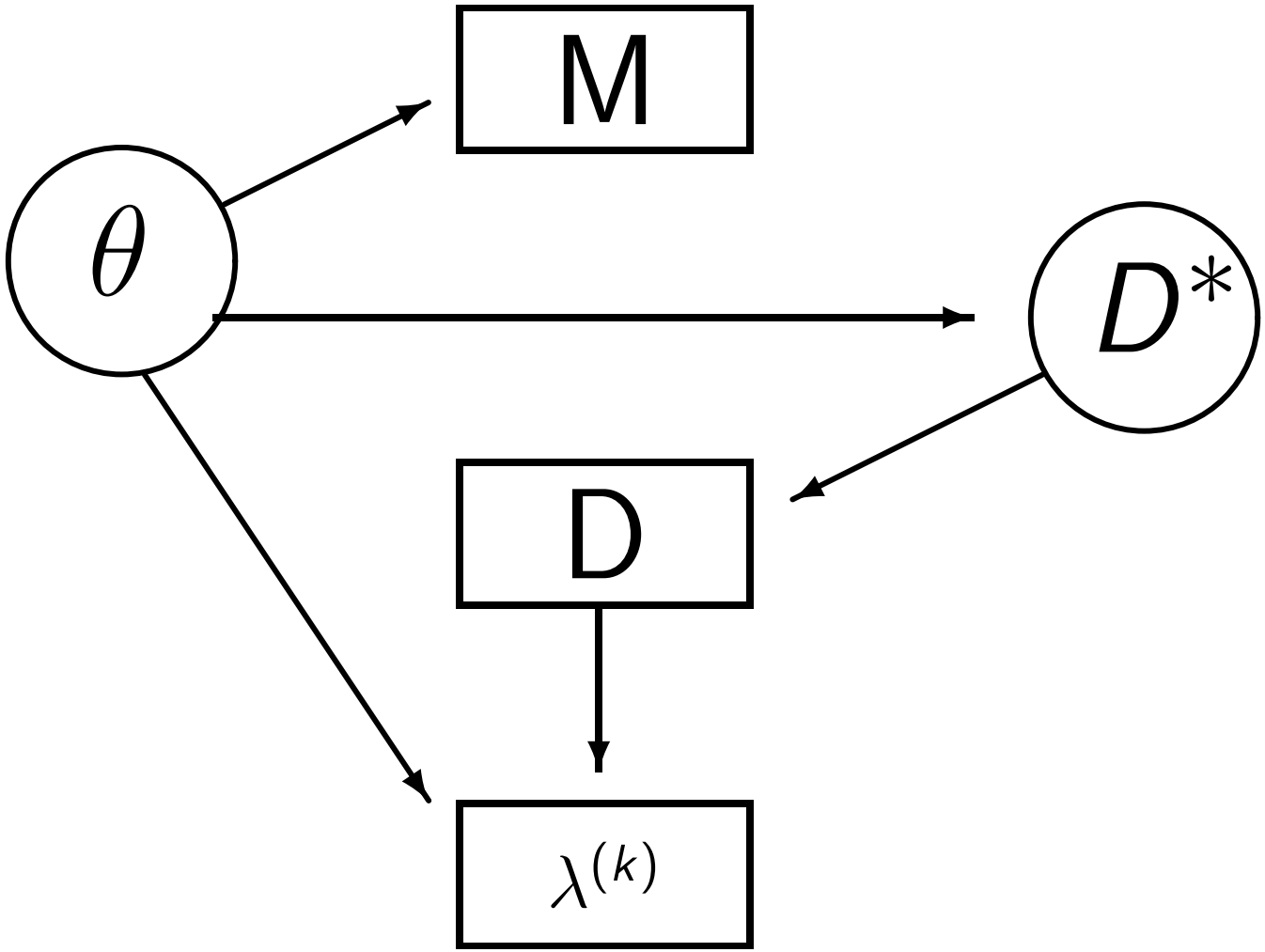
Structural model of education and cause-specific mortality

Extension of structural model of Bijwaard et al. (2015a,2015b)

Model the interdependence between education and cause-specific mortality, because both are affected by cognitive ability.

1. Education attainment D
   Ordered probit model depending on observed characteristics and latent cognitive ability, θ
2. Potential cause-specific hazard λ
   Depending on education attained and latent cognitive ability: only observe hazards for observed education.
   Gompertz with shape and scale depending on education and cause of death
3. Measurement, M
   Measuring (a proxy) of cognitive ability, IQ, depending on observed characteristics and latent cognitive ability

Graphical representation



Inference in competing risks model

- Cause-specific Cox hazard models, $\lambda_k(t)$
  Difficult interpretation if one covariate appears in several competing hazards and assumes independence of causes of death.
- Cumulative incidence: probability dying from cause k before t

$$F_k(t) = \int_0^t \lambda_k(s) S(s)\, ds$$

  Fine-Gray model sub-distribution hazard also difficult to interpret
- Years (months) lost due a specific cause, (from age 18 till age 63)

$$L_k(18, 63) = \int_{18}^{63} F_k(s)\, ds$$

Gains from changing school level

1. Educational gain $G_c(\tau_0, \tau_1)$;
   Average educational difference in months due cause c
   Educational gain (difference) implied by structural model

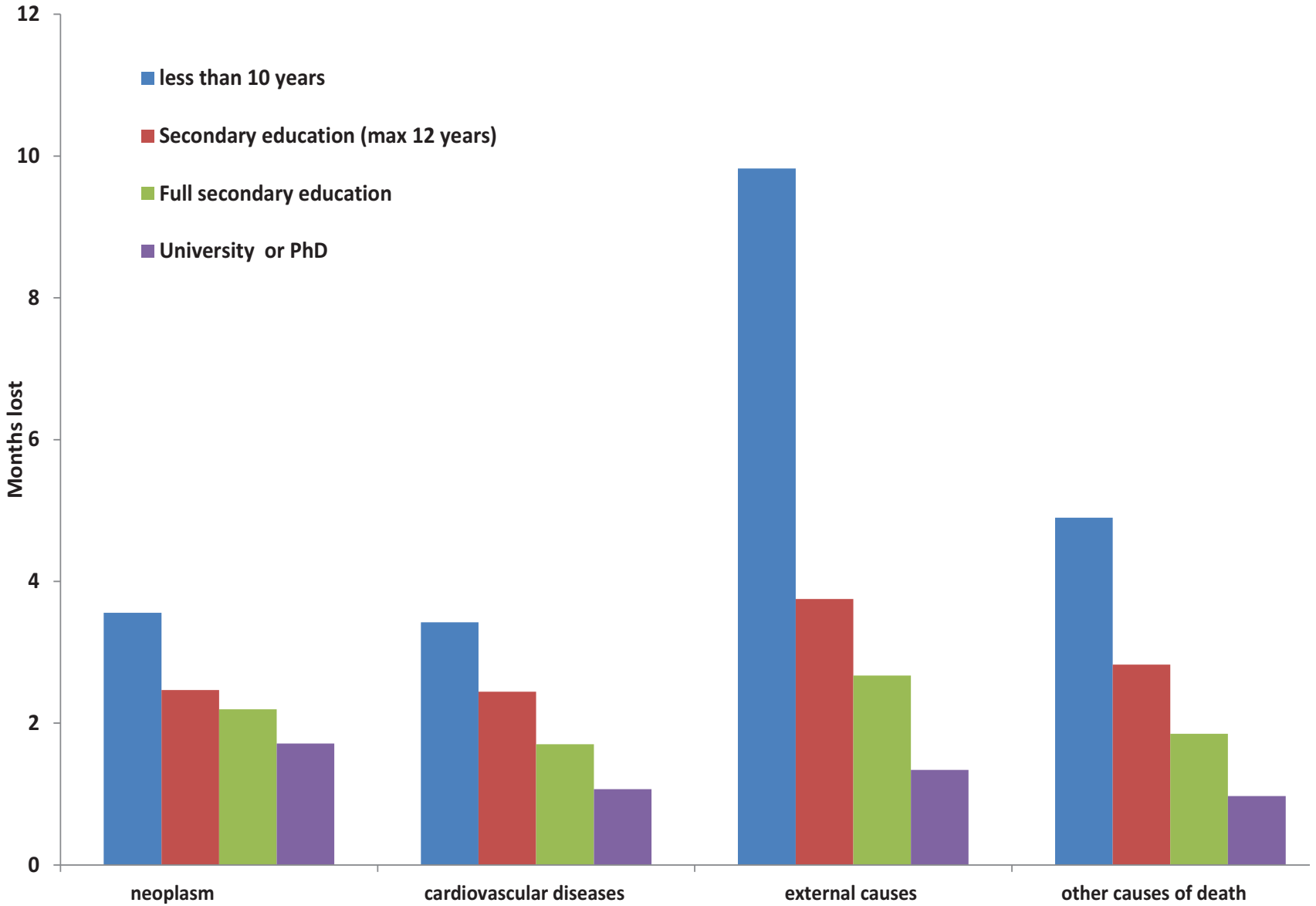
2. Selection effect;
   Effect of selecting education: difference with non-parametric estimate $G_{NP,c}(\tau_0, \tau_1)$
   - selection on observables $G_{NP,c}(\tau_0, \tau_1) - G_{sep,c}(\tau_0, \tau_1)$
     with $G_{sep,c}(\tau_0, \tau_1)$ is the educational gain based on a stratified model (ignoring cognitive ability)
   - selection on cognitive ability $G_{sep,c}(\tau_0, \tau_1) - G_c(\tau_0, \tau_1)$
     difference structural model and stratified model

Model estimates of months lost due to specific cause 18-63

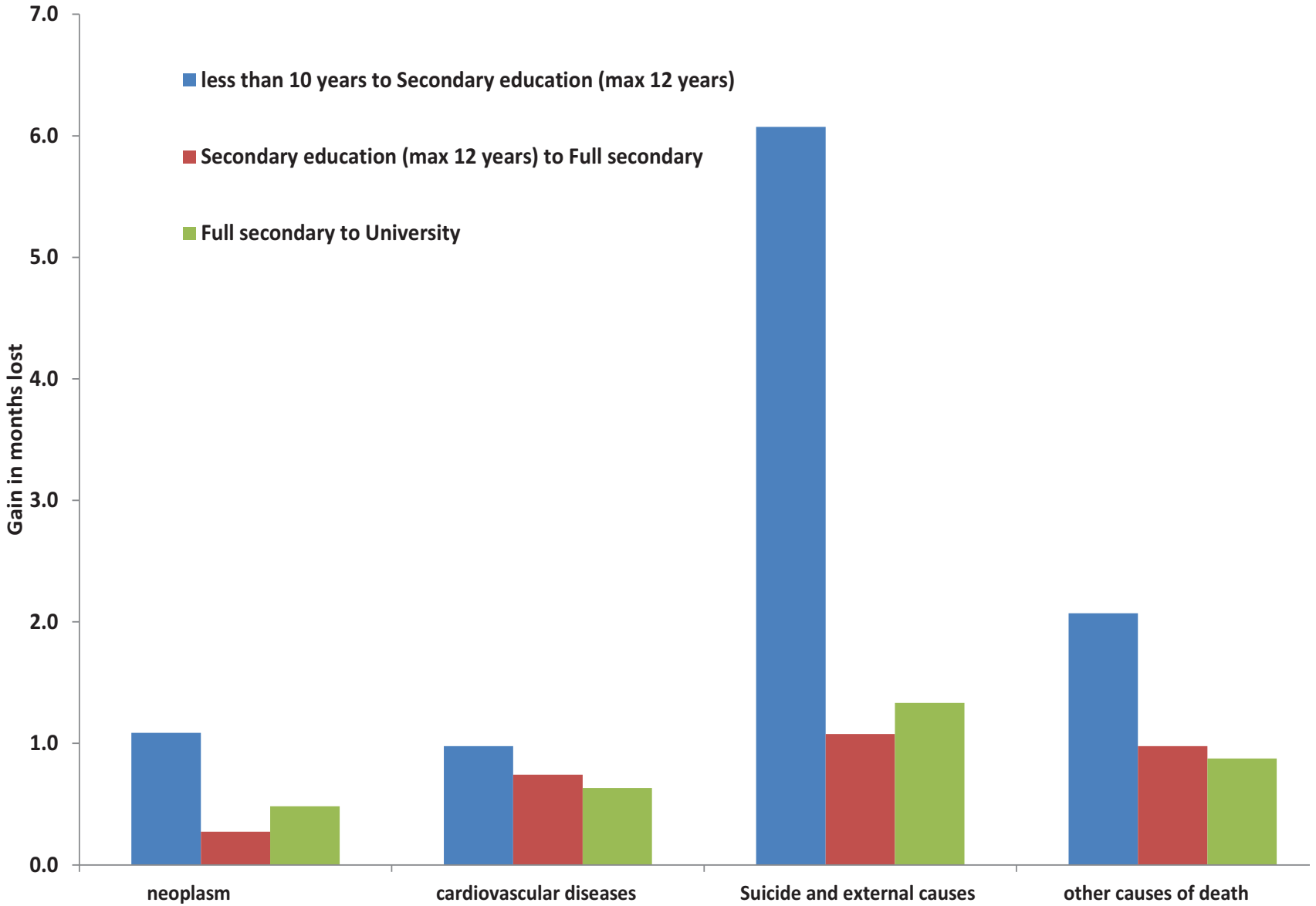
Educational gains

1. Non-parametric estimates
2. Stratified models
   Separate Gompertz hazard models by education level and cause of death, including observed individual characteristics
3. Structural model
   Model accounting for (latent) cognitive ability influencing both education and cause-specific hazards.

Non-parametric: Months lost due to specific cause



Non-parametric: Educational gain



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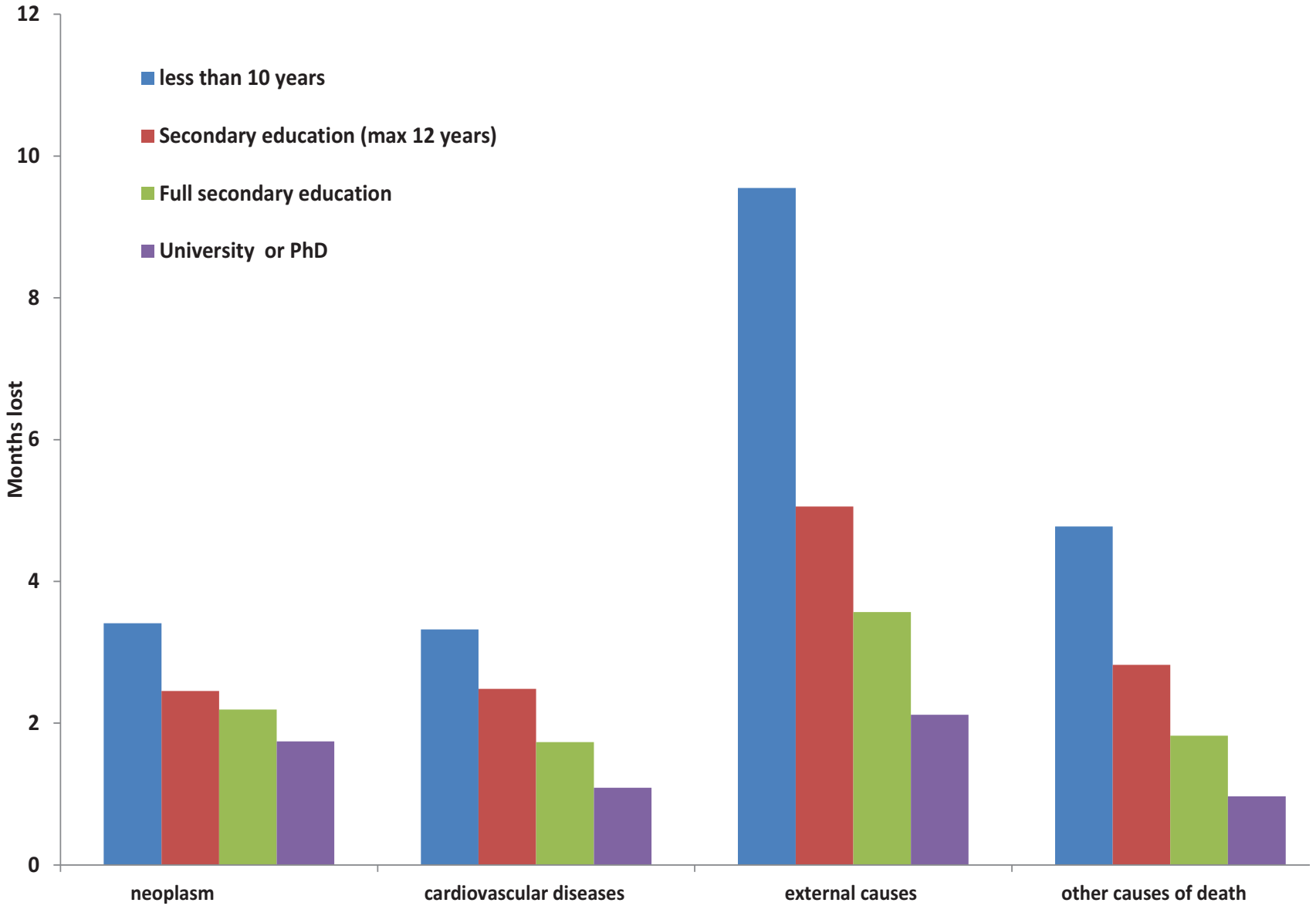
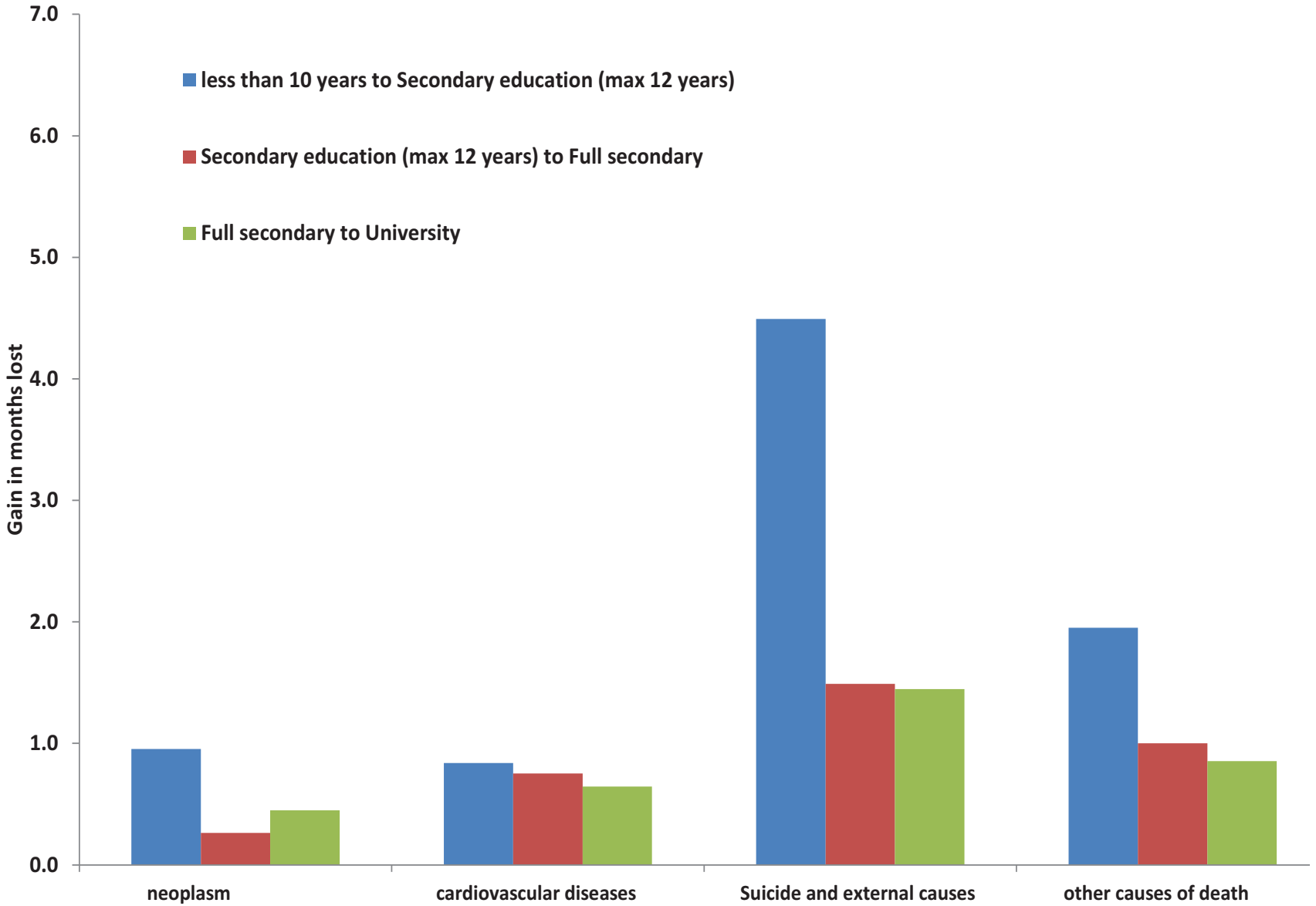
Stratified model: Month lost due to specific cause



Stratified model: Educational gain



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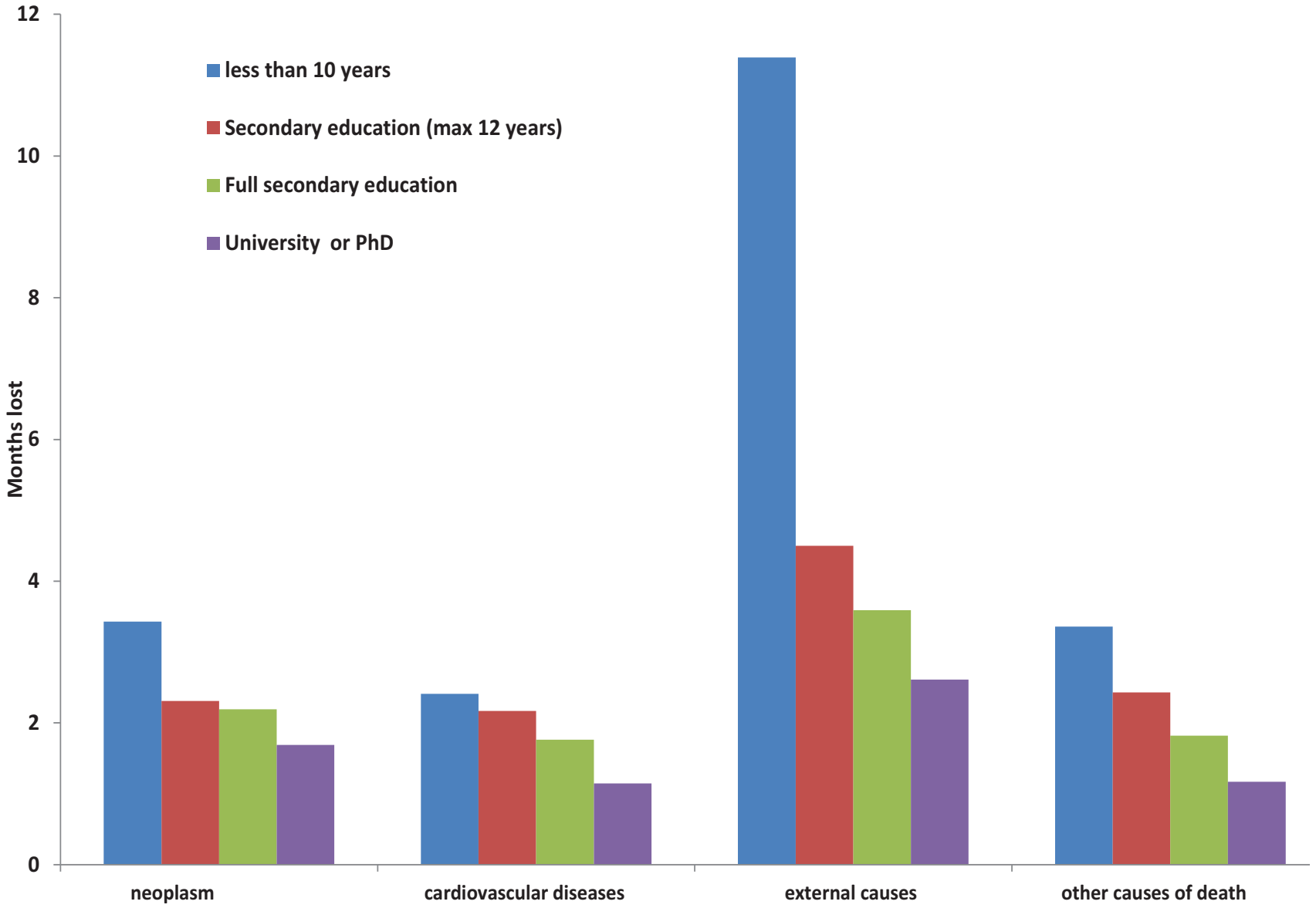
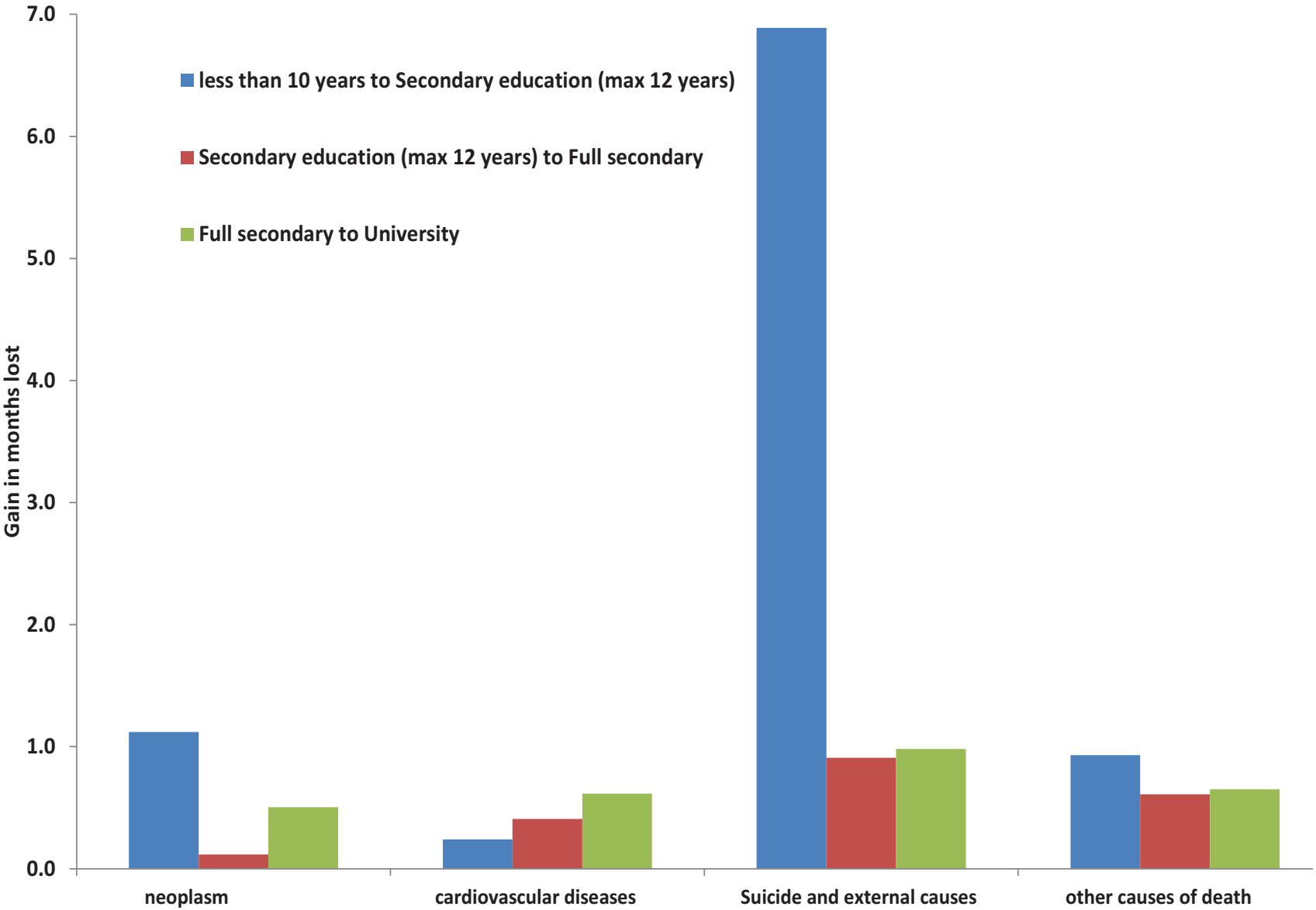
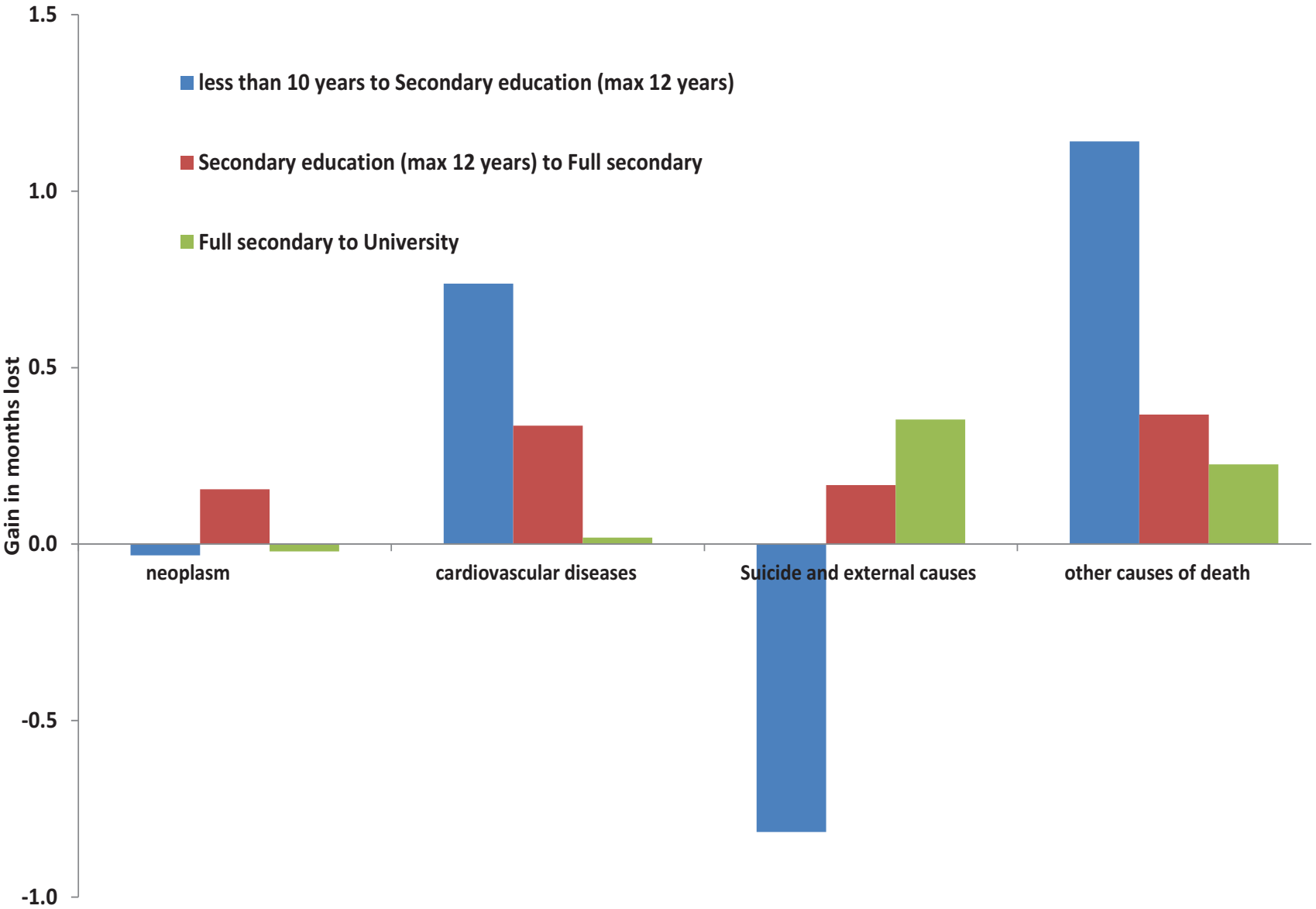
Structural model: Months lost due to specific cause



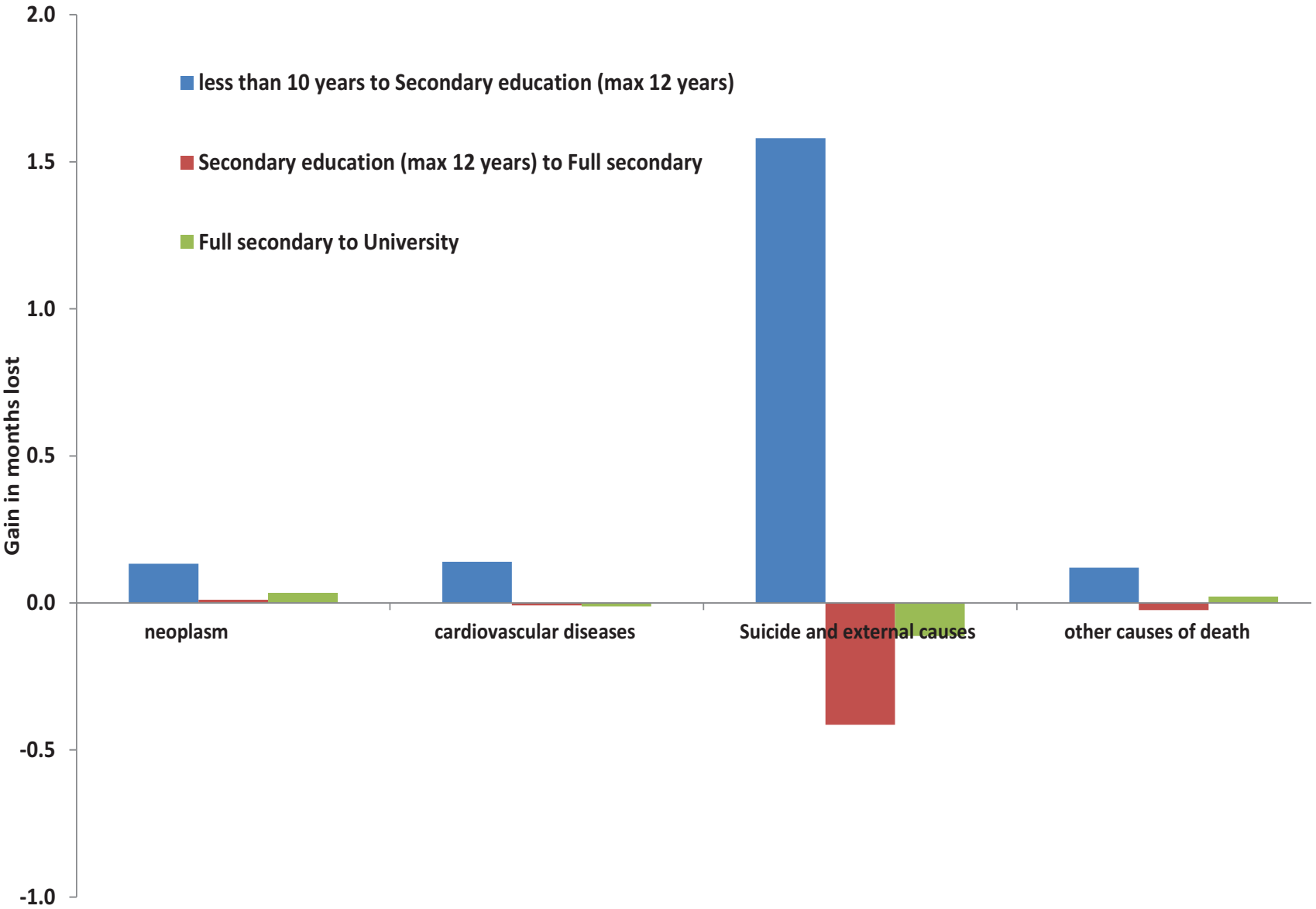
Structural model: Educational gain



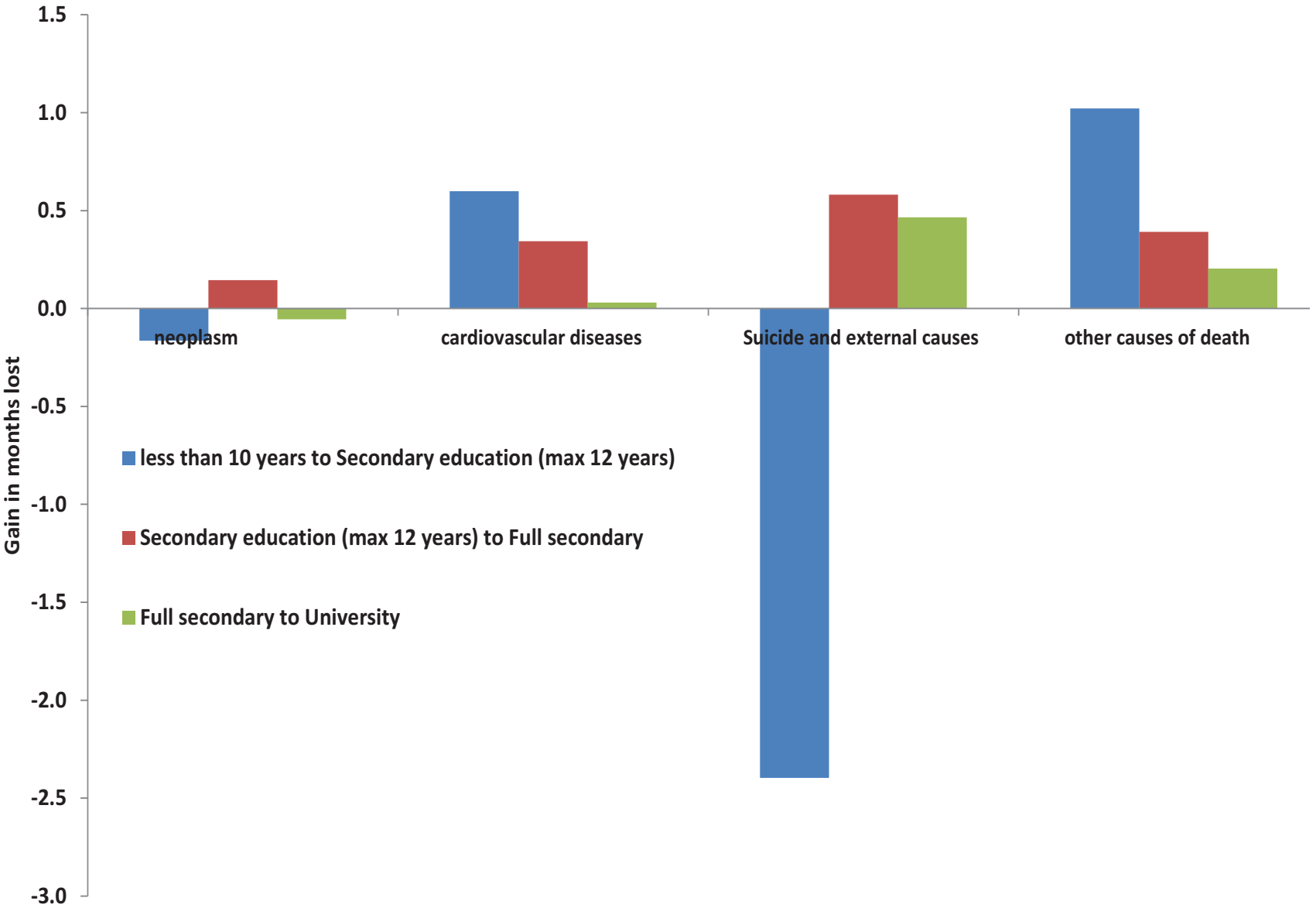
Total selection effect



Selection on observed characteristics



Selection on cognitive ability



Summary: Educational gains on cause specific mortality

- educational gain in months lost due to specific cause (accounting for cognitive ability)
- Selection effects: observed and (latent) cognitive ability

Main empirical results:

- Highest educational gain for Lowest education group ($<$ 10 years): 9 mo
- Largest gain due reduction in external causes: 1–7 mo
  small gains for CVD: $<$ 1 month
- Largest selection effect lowest 2 groups: 2 mo
- Largest selection effect for external causes
- Positive selection on cognitive ability.

Discussion

- Education, cognitive ability, socio-economic background and health at 18 highly intercorrelated
  Our structural model accounts for this
- Ignoring this leads to overestimate educational gains
- Still educational improvement beneficial to life expectancy, especially in improving death to external causes.

Limitations

- Other personal traits might affect education
  non-cognitive skills
  Educational gain is likely to be upper-bound
- Only men