Improving Equality of Opportunity at School Entry
Primary Education Enrollment in the Netherlands

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Primary education enrollment policies

- At what age are children enrolled in primary education?
- Default enrollment policy in most countries: calendar year of enrollment based on birth-day cutoff policy
- For example: children with birthdays before (after) October 1 enroll in the calendar year they turn 6 years old (7 years old)
- Not in the Netherlands. Education Inspectorate: enroll children by developmental skills, not their date of birth

Equality of opportunity and primary education enrollment solely by date of birth

- Age at enrollment in primary education has causal effect on later outcomes (e.g. Bedard Dhuey, 2006)

  $\Longrightarrow$ Enrollment solely by date of birth: later education outcomes depend on random birth date

- Enrollment by date of birth fully preserves differences in skill endowments among children with the same birth date

$\Longrightarrow$ No offsetting of (random) differences in skill endowments
$+$ introduction of additional source of randomness

Equality of opportunity and primary education enrollment by developmental skills: potential improvements?

- Developmental skills at a given point in time reflect broader set of child characteristics than birth date

  $\Longrightarrow$ Enrollment by developmental skills should mitigate link between random birth dates and expected outcomes

- Children with low skill endowments could be enrolled at older ages, giving them more time to mature and possibly improving their outcomes

$\Longrightarrow$ Raises education outcomes at the bottom + mitigates randomness in date of birth

Enrollment by developmental skills: possible drawbacks

- Assessments of developmental skills are imperfect

  $\Longrightarrow$ Could introduce bias and new sources of noise

  $\Longrightarrow$ Enrollment by development skills **assessments** could be worse than enrollment by date of birth
  - Replace birth-date randomness with assessment randomness
  - Lower education outcomes at the bottom

Related literature

- Our paper is about which child starts primary education when, keeping average age at primary education enrollment constant
- Focused on alternatives to birth-date enrollment
- Doesn't seem to be any literature
- Builds on quite large literature on the consequences of individual differences in school starting age in countries with birth-date enrollment default (e.g. Bedard Dhuey, 2006)
  - Strong evidence on primary and secondary school outcomes
  - Some evidence of effect on long-term earnings
- Not much related to literature on early-childhood education

Outline

1. Background on Dutch elementary education and some data
2. Theoretical framework
3. Estimation of ordered probit model for enrollment year
4. Calibration of model for skills end of primary education
5. IV estimation of model for skills end of primary education
6. Counterfactual analysis of alternative enrollment policies

Outline

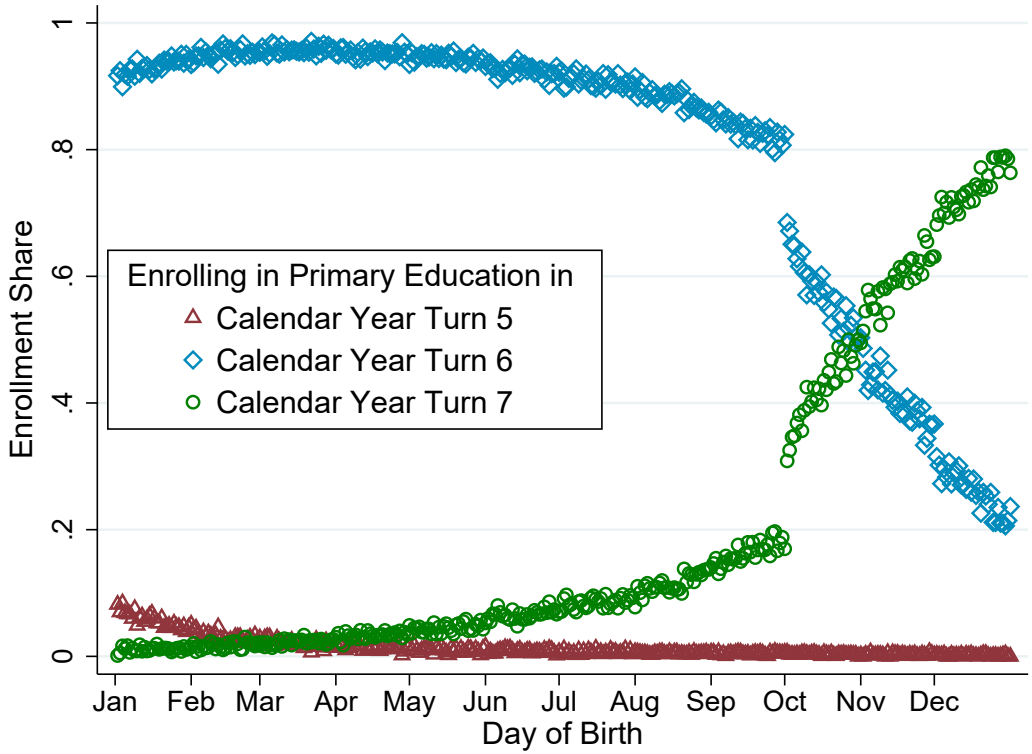
Kindergarten and primary education in the Netherlands

- Both types of education in same (elementary) school
- Children can start elementary school the day after they turn 4
- Start with a kindergarten education (usually in a mixed-age group)
- Enrollment in primary education. Start of the school year (around 1 September) of the calendar year when children
  - either turn 7 years old
  - or turn 6 years old
  - or turn 5 years old (1 percent)
- Enrollment should be based on developmental skills, not birth dates
- Primary education consists of six grades
- Secondary school with different tracks; tracking partly based on standardized test performance at end of primary education

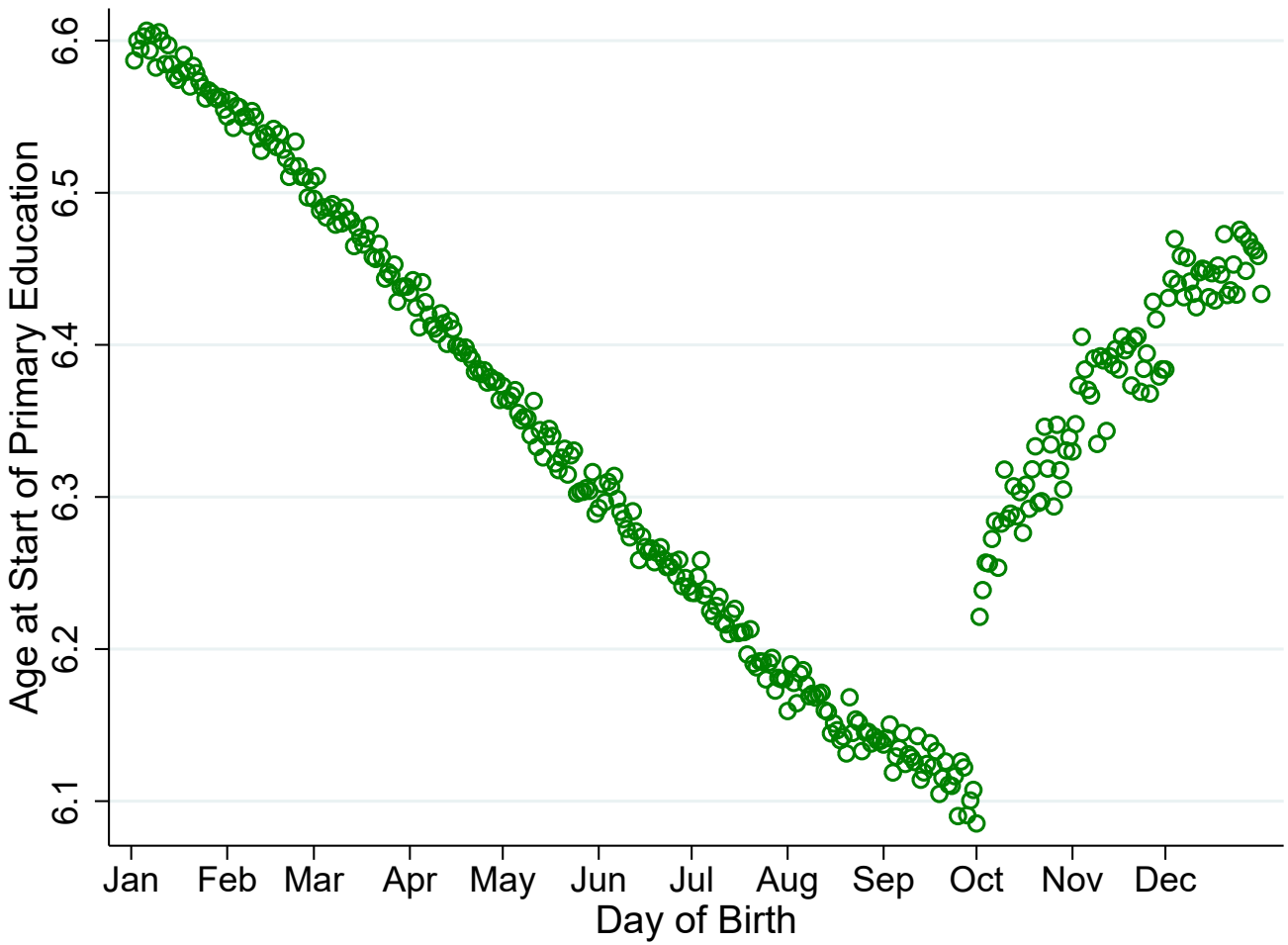
Main data

- All children born in Netherlands in 2003, 2004, 2005
- Family background:
  - Maternal education
  - Parental income
- Children:
  - Exact birth date
  - When enrolled in primary education
  - Standardized test score end of primary education (end of grade 6; children around 12 years old)
  - Secondary school track
- End up with approx 340,000 children

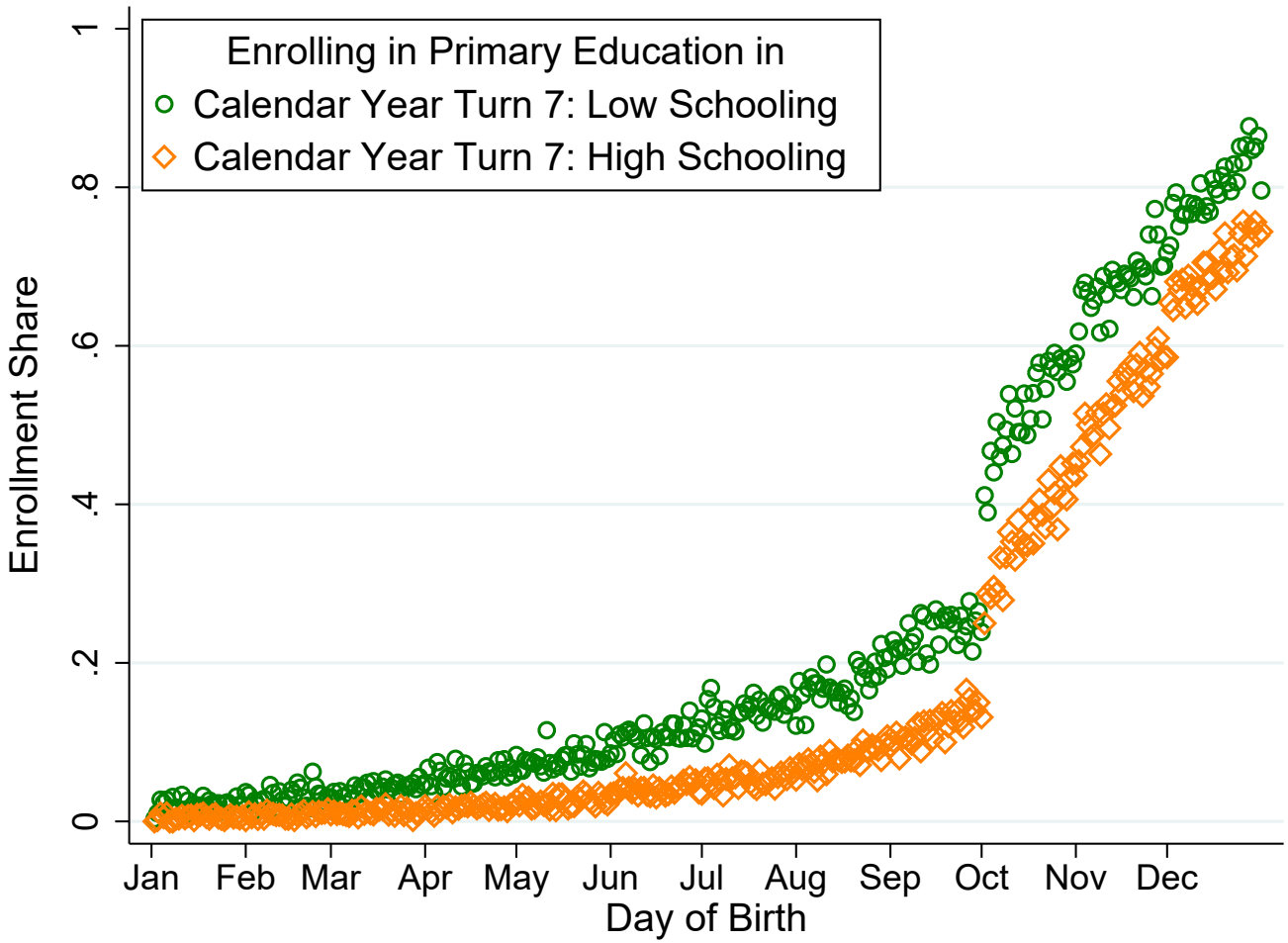
Children enrolled in primary education in the calendar year they turn 5, 6, and 7 years old



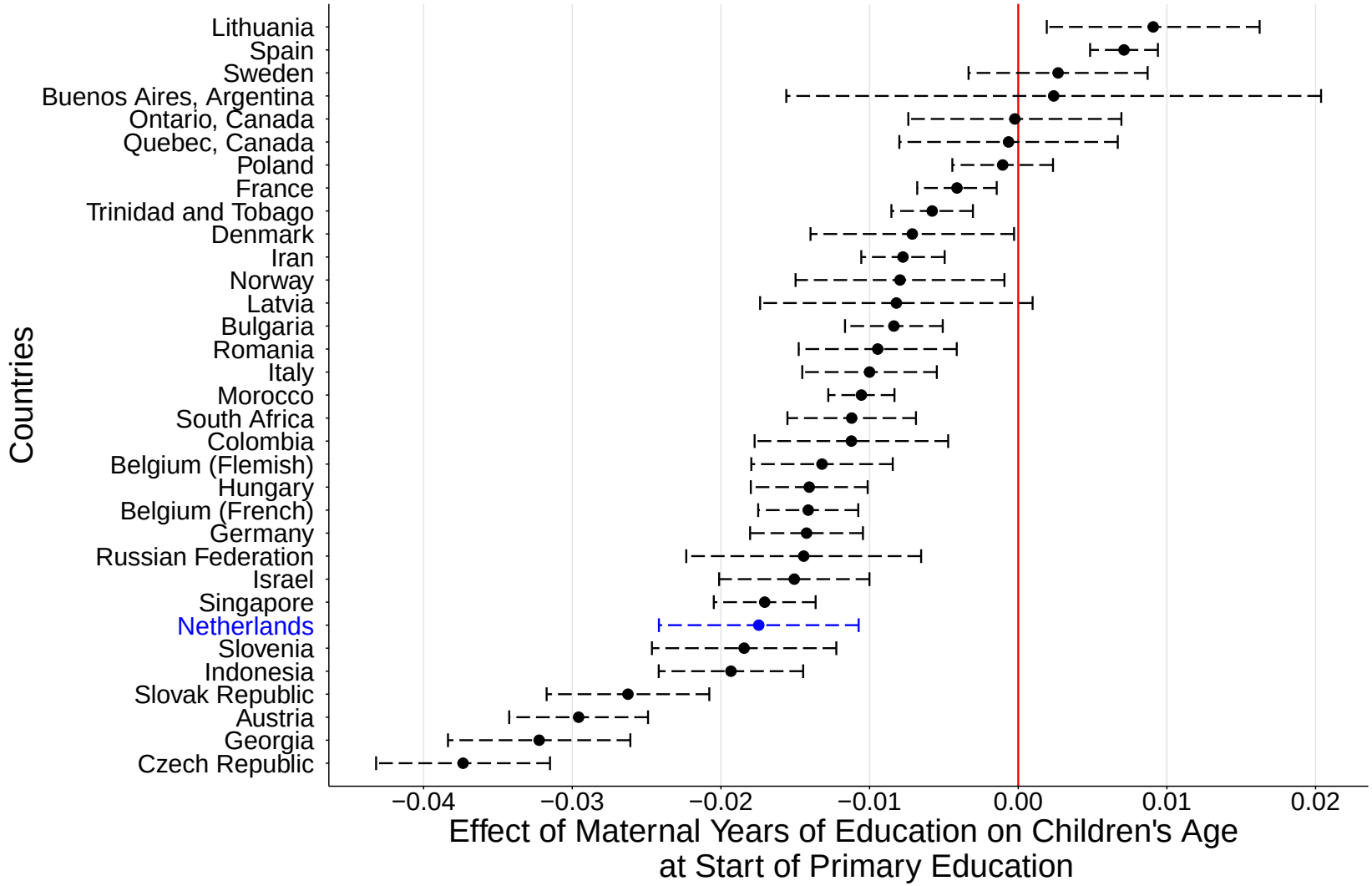
(Exact) Age at the start of primary education



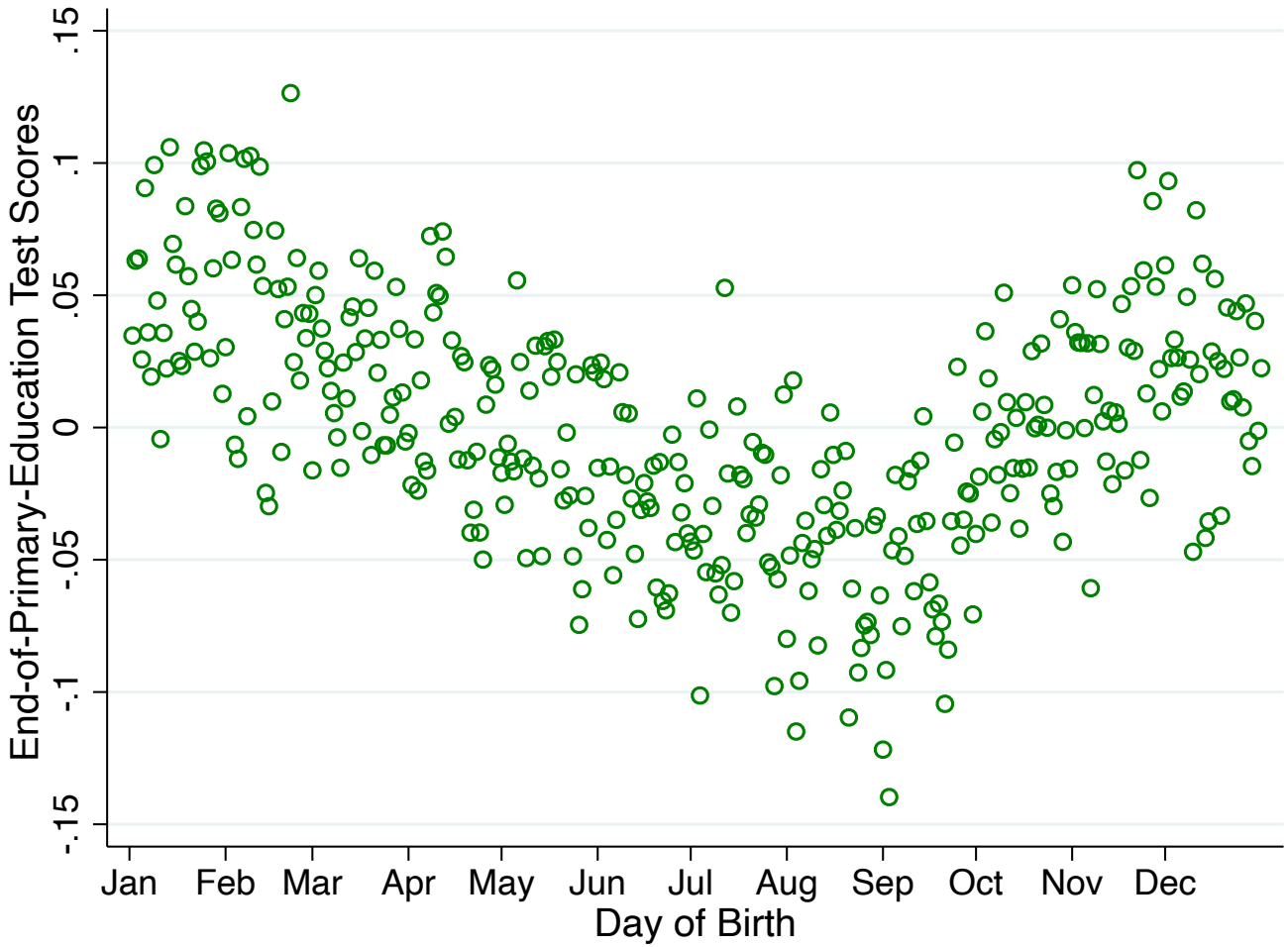
Enrollment calendar year turn 7 and maternal schooling



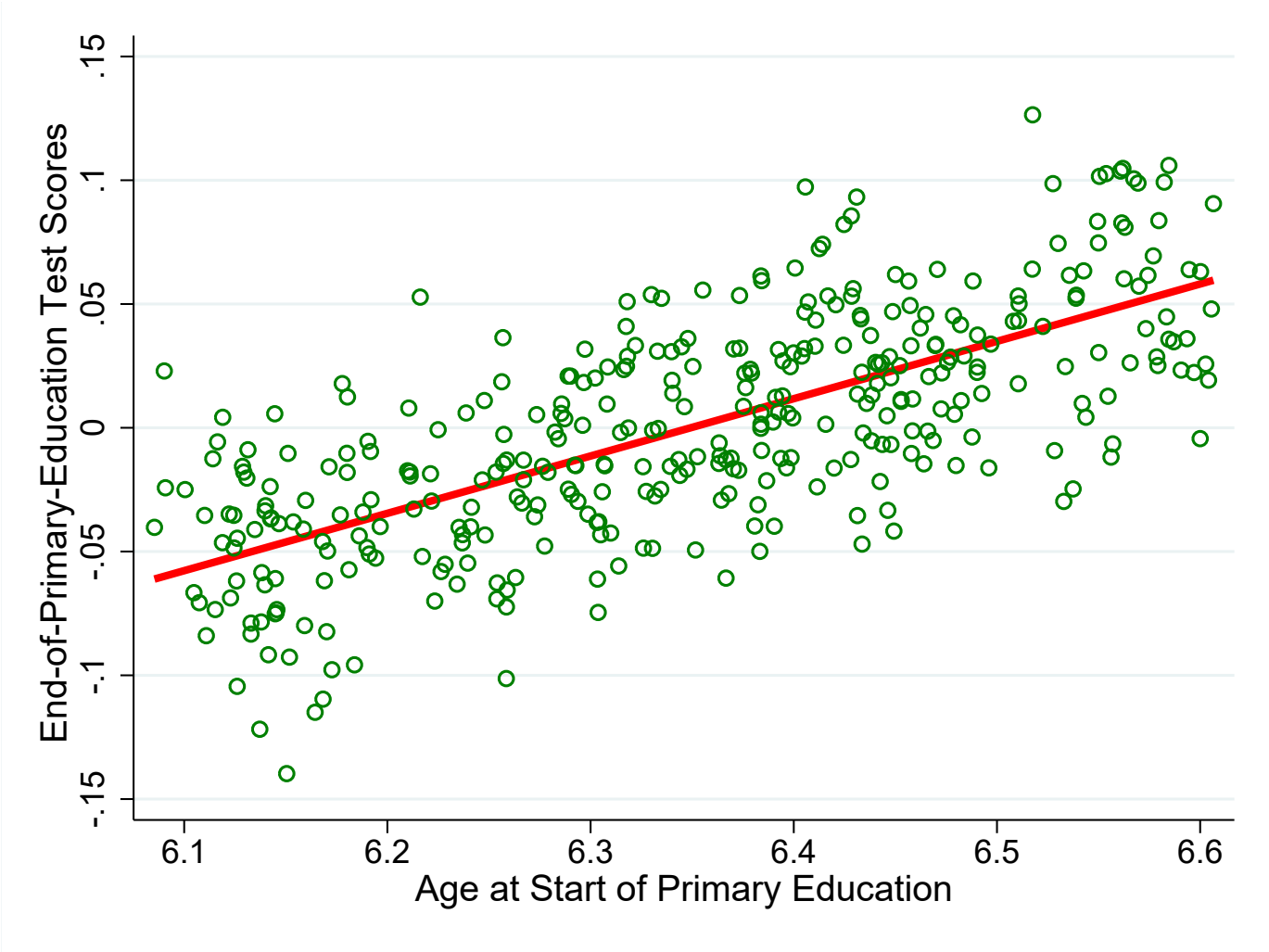
Maternal schooling and exact age at the start: international comparison using PIRLS



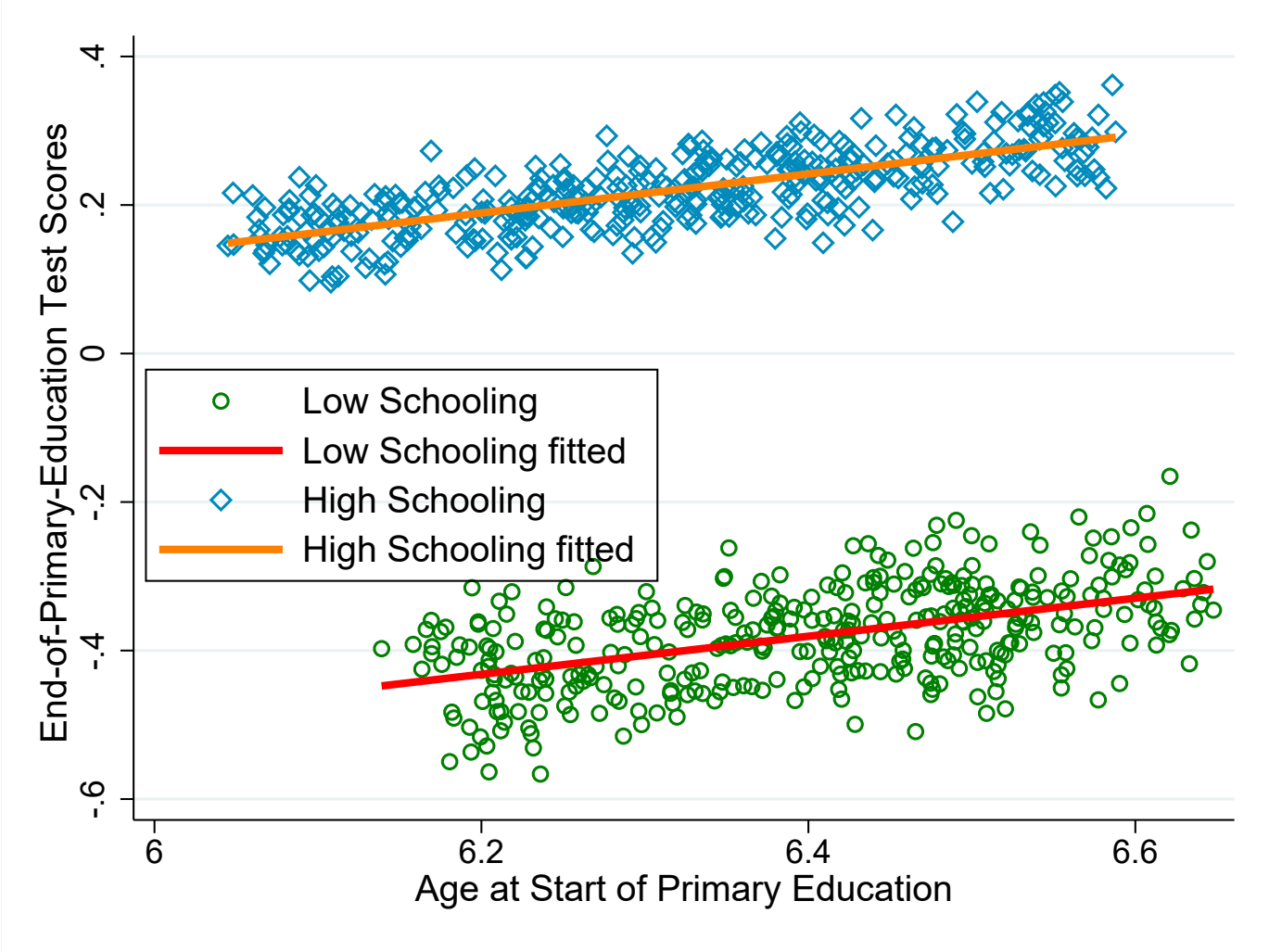
Test performance at the end of primary education



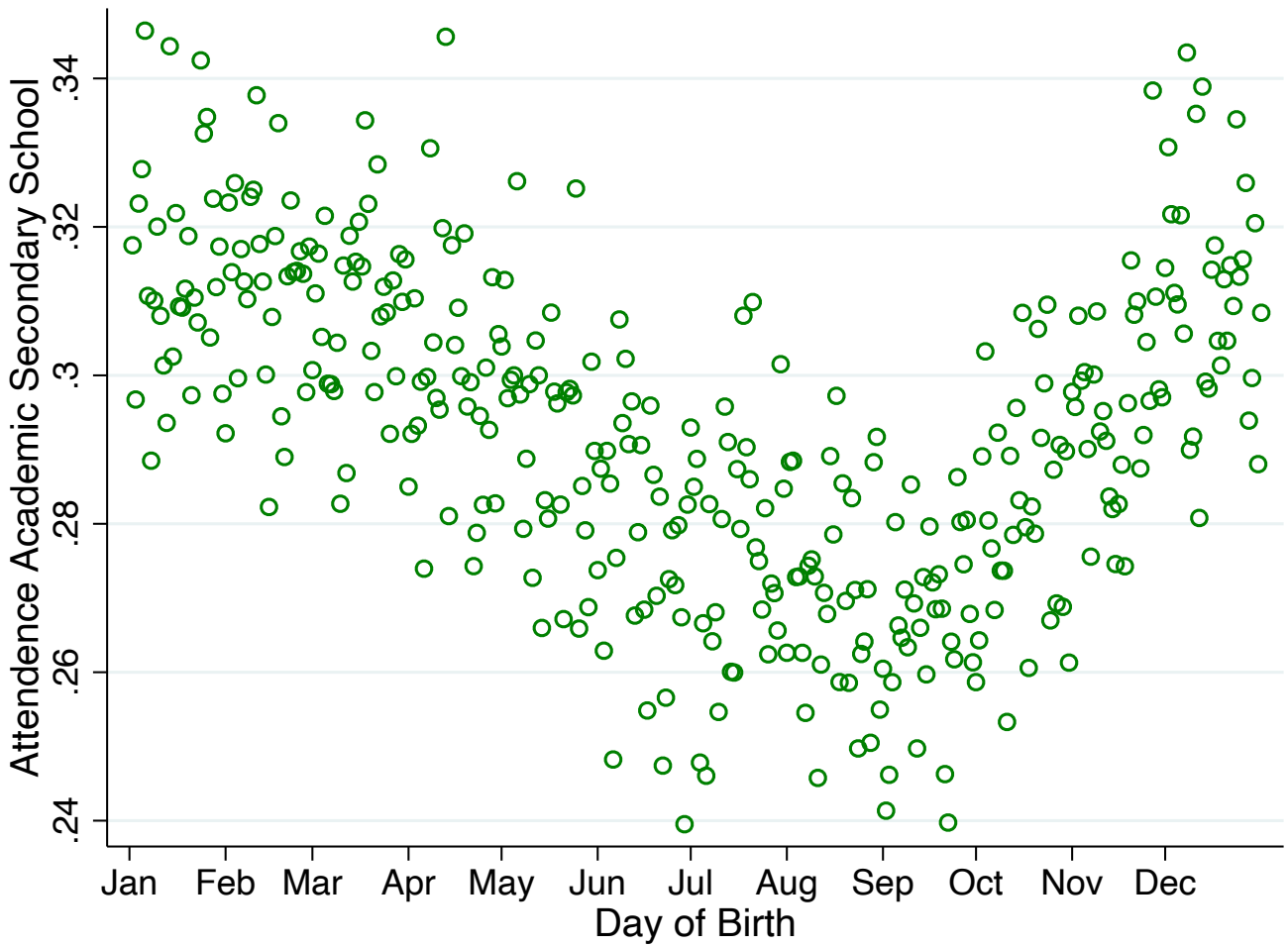
Scatter plot: test performance at the end of primary education against age at the start of primary education



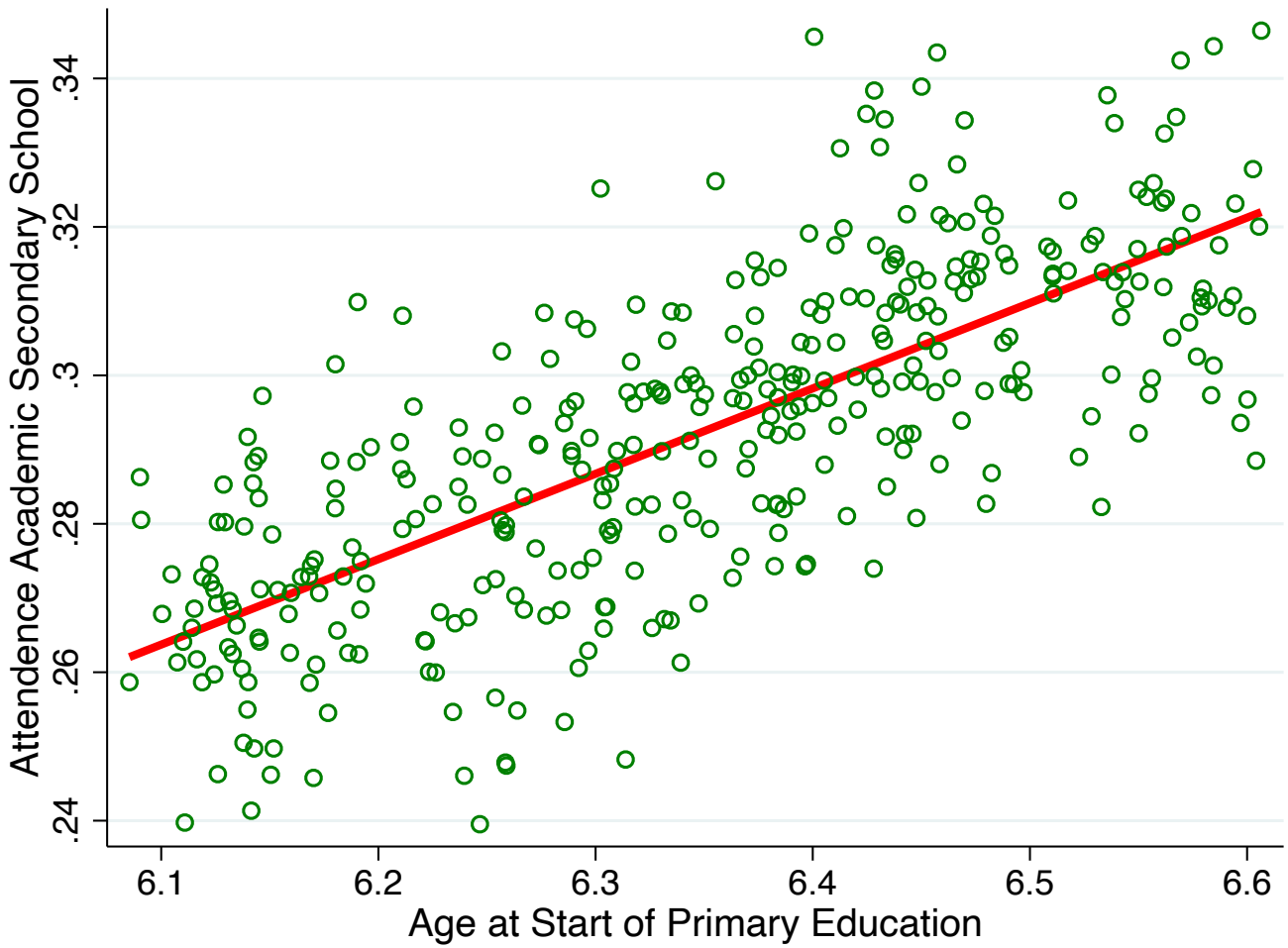
High vs low maternal schooling: test performance end of primary education against age start of primary education



Attendance most academic secondary school track and birthday



Attendance most academic secondary school track against age start of primary education



Outline

Model where children enroll in primary education in calendar year they turn 6 or 7

- Assess children's skills at the start of the school year in the calendar year they turn 6
- Enroll in primary education in calendar year turn 7 if and only if

$$KindergartenSkills_i < MinSkills[Birthday_i] - ParentInfluence_i$$

- Exact age at start or primary education

$$AgeStartPrimEdu_i = 6 + D_i^7 + f - x_i$$

  - $D^7 = \mathbf{1}$(enroll calendar year turn 7)
  - x birthday normalized to 0–1
  - f day school year starts normalized to 0–1

Model for skills at the end of primary education

$$SkillsEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + dZ_i + \eta_i$$

- Z_i child characteristics that can be observed by kindergarten teachers
- Will keep average of $AgeStartPrimEdu_i$ constant in counterfactual analysis
- Model therefore captures both maturity effects and relative age effects

$$SkillsEndPrimEdu_i = a + b\,(6 + D_i^7 + f - x_i) + dZ_i + \eta_i$$

Primary education enrollment policies: implied variances

- $D_i^7 = D^7(x_i, Z_i)$
- $Variance(AgeStartPrimaryEducation_i | Z_i, x_i)$
- $Variance(SkillsEndPrimaryEducation_i | Z_i, x_i)$

Primary education enrollment policies

- Minimize variance in **age at start** of primary education

  $\rightarrow$ Enroll by date of birth only (primary education enrollment in calendar year turn 7 iff birthday after some cutoff day)

- Minimize variance in **skills at end** of primary education

  $\rightarrow$ Enroll calendar in year turn 7 iff skill assessment below a threshold that is independent of birth date

  Which type of skill assessment?

  $\rightarrow$ Expected skills given Z_i and x_i at end of primary education

  if child was enrolled in primary education in calendar year turn 6

Kindergarten skills assessments (latent variable) at start of school year in calendar year children turn 6

$KindergartenSkills_i$ assessment not observed by us

$$\begin{aligned} KindergartenSkills_i &= \mathbb{E}(KindergartenSkills_i \mid Age_i, W_i) + u_i \\ &= \alpha + \beta Age_i + \gamma W_i + u_i \\ &= \alpha + \beta Age_i + \gamma W_i + \sigma v_i \end{aligned}$$

$\rightarrow v$ assumed standard normal conditional on Age and W

Which children are enrolled in primary education in calendar year turn 7?

$$KindergartenSkills_i < MinSkills[Birthday_i] - ParentInfluence_i$$

$$\alpha + \beta(6 + f - x_i) + \gamma W_i + \sigma v_i < MinSkills[x_i] - \pi W_i$$

Skills at the end of primary education

$$SkillsEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + dZ_i + \eta_i$$

$\rightarrow$ Z_i characteristics that may enter kindergarten skills assessments
$\rightarrow$ Z_i not observable to us, but W_i (e.g. parental education/income) is

$$Z_i = \mathbb{E}(Z_i|W_i) + \mu_i = eW_i + \mu_i$$

$\rightarrow$ assume μ normally distributed
$\rightarrow$ μ and unobservable part of skills assessment v can be correlated
$\rightarrow$ write μ as $\rho v + \epsilon$ with ϵ normal and independent of v

$$TestEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + cW_i + d\mu_i + \eta_i$$
$$TestEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + cW_i + \phi v_i + d\epsilon_i + \eta_i$$

Outline

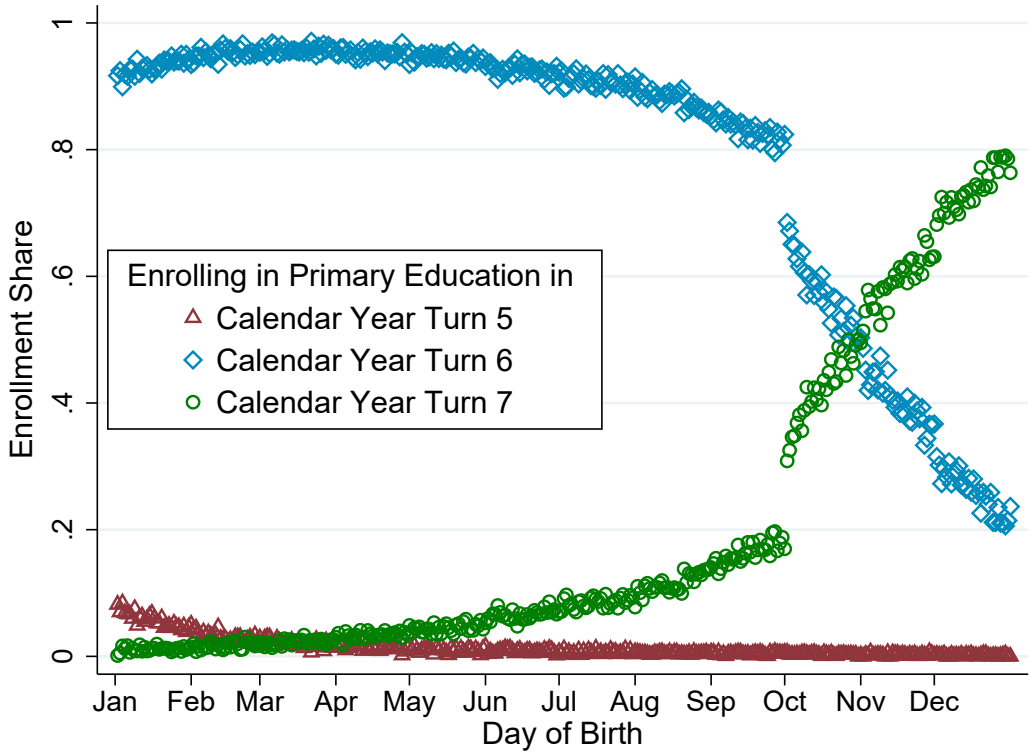
Estimation of ordered probit for enrollment in calendar year children turn 5, 6, or 7: specifying $MinSkills[x_i]$ (1 of 3)

$$KindergartenSkills_i < MinSkills[Birthday_i] - ParentInfluence_i$$

$$\alpha + \beta(6 + f - x_i) + \gamma W_i + \sigma v_i < MinSkills[x_i] - \pi W_i$$

$$\alpha + \beta(6 + f - x_i) + (\gamma W_i + \pi) + \sigma v_i < MinSkills[x_i]$$

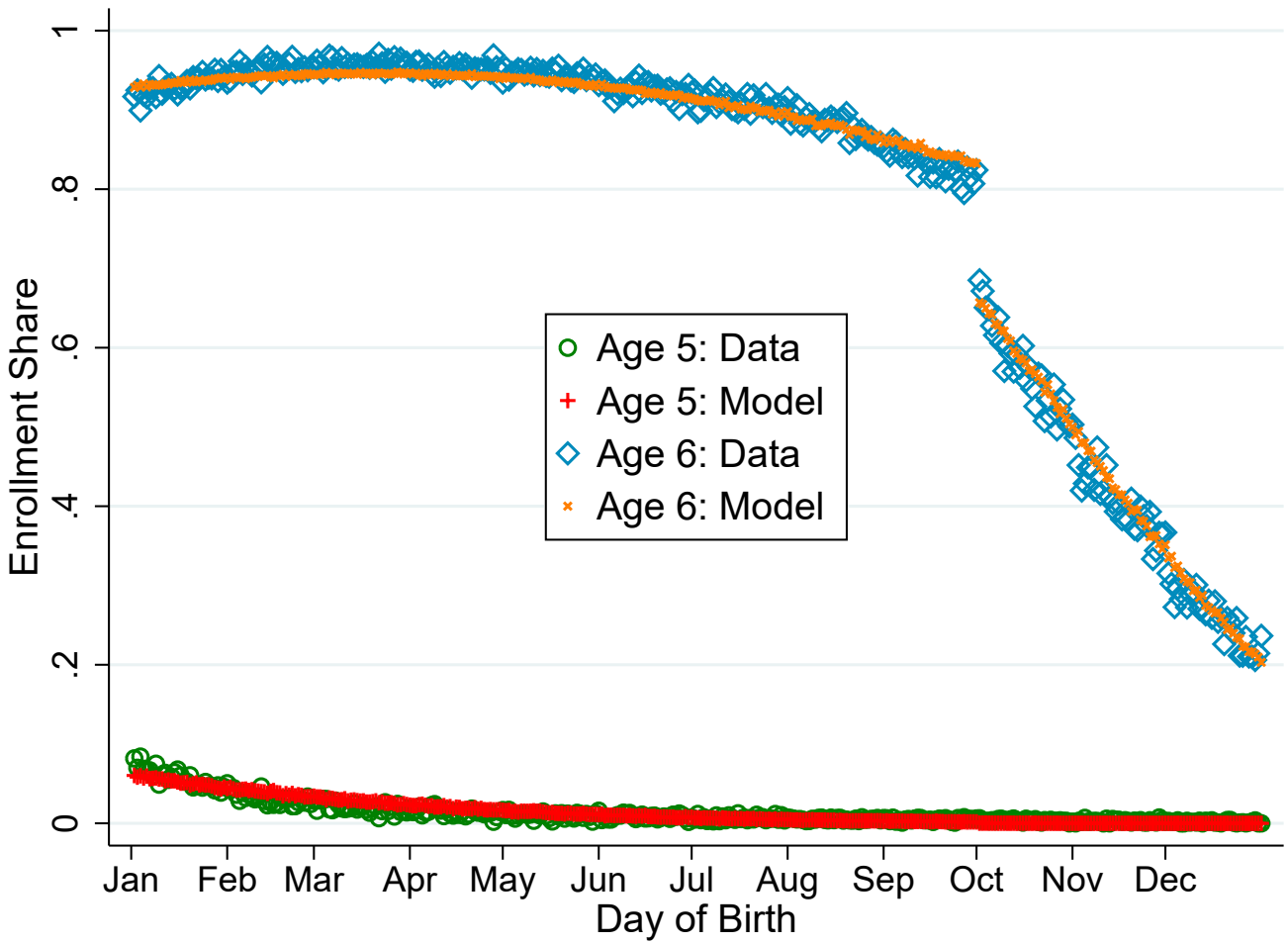
Estimation of ordered probit for enrollment in calendar year children turn 5, 6, or 7: specifying $MinSkills[x_i]$ (2 of 3)



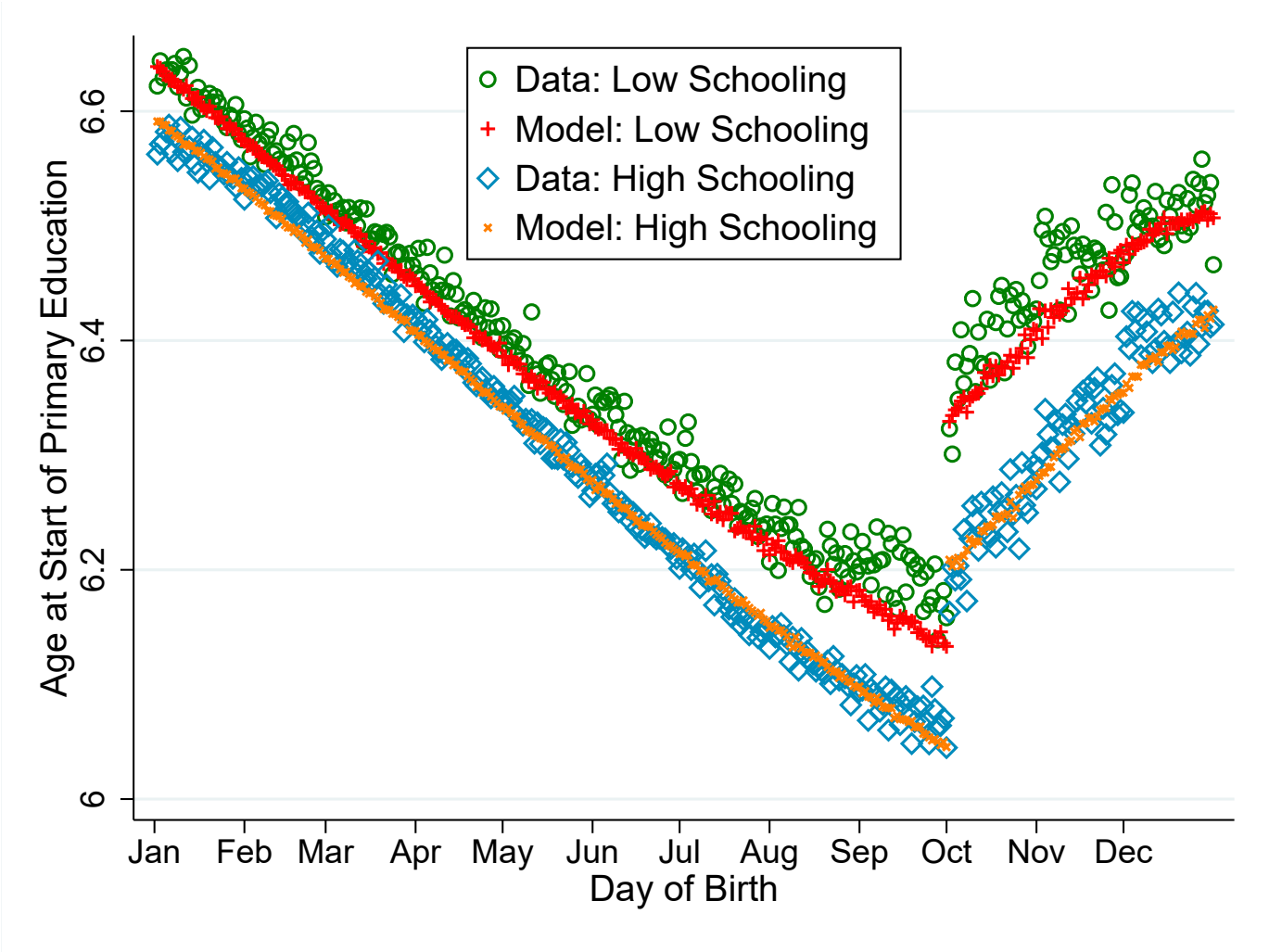
Estimation of ordered probit for enrollment in calendar year children turn 5, 6, or 7: specifying $MinSkills[x_i]$ (3 of 3)

- *MinSkills* for enrollment age 5, 6, 7 independent of birthday (x) for children born before 1 October
- Discrete jump up in *MinSkills* at $x = 1$ October
- Allow for linear profile of *MinSkills* in x after 1 October
- Another discrete jump up in *MinSkills* at $x = 1$ January

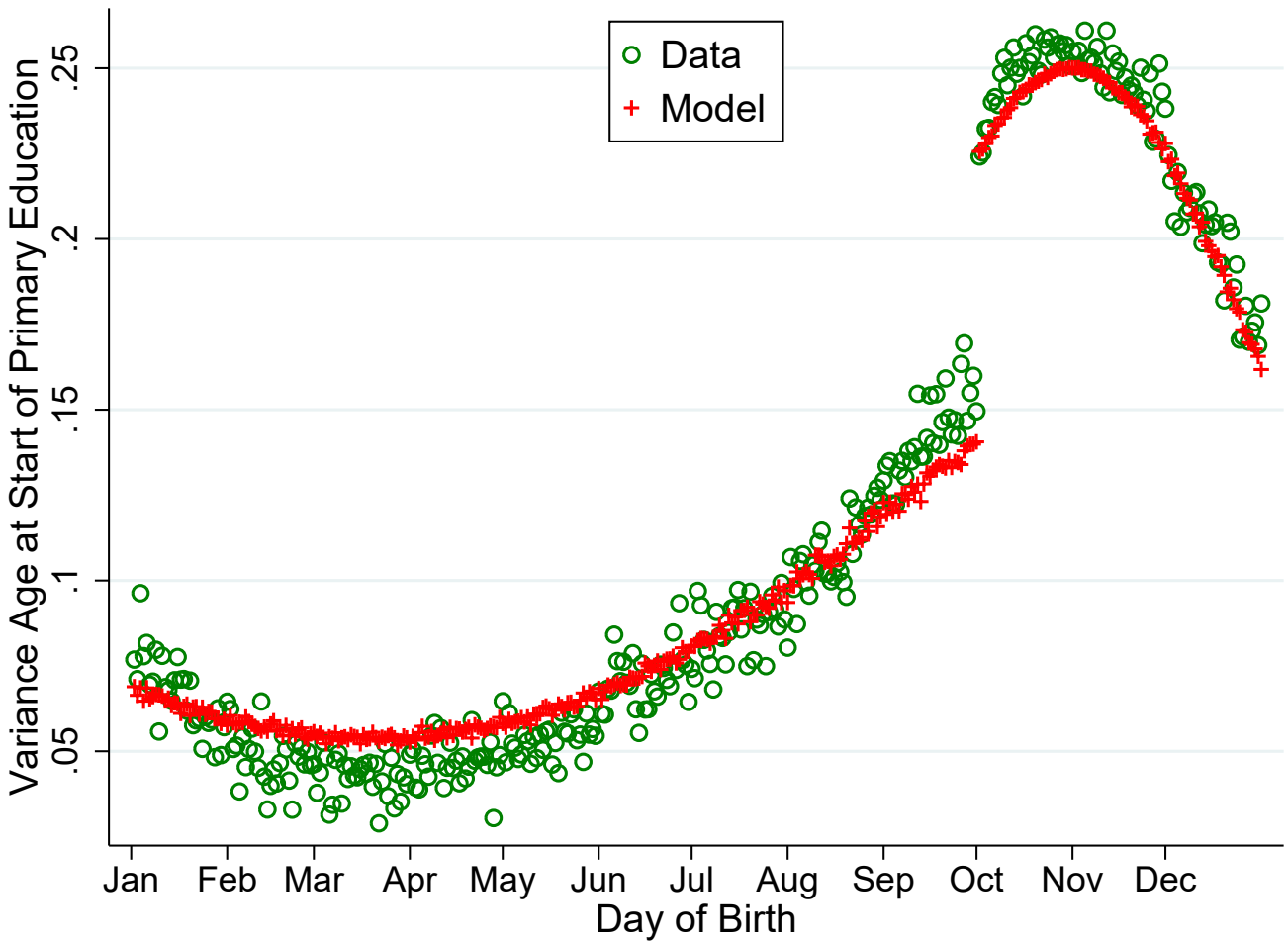
Ordered probit for enrollment in calendar year children turn 5, 6, or 7: fit enrollment year



Probit for enrollment in year: fit age at the start primary education; high vs low maternal schooling



Probit for enrollment in year: fit variance of age at the start primary education



Outline

Calibration: model equations

$$v \sim N(0,1)$$

$$AgeStartPrimEdu_i = 6 + \hat{D}^7(W_i, v_i) - \hat{D}^5(W_i, v_i) + f - x_i$$

$$TestEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + cW_i + \phi v_i + d\epsilon_i + \eta_i$$

$$\mathbb{E}(TestEndPrimEdu_i | W_i, x_i, v_i) = \hat{a} + \hat{b}\, AgeStartPrimEdu_i + \hat{c} W_i + \hat{\phi} v_i$$

Targeted moments

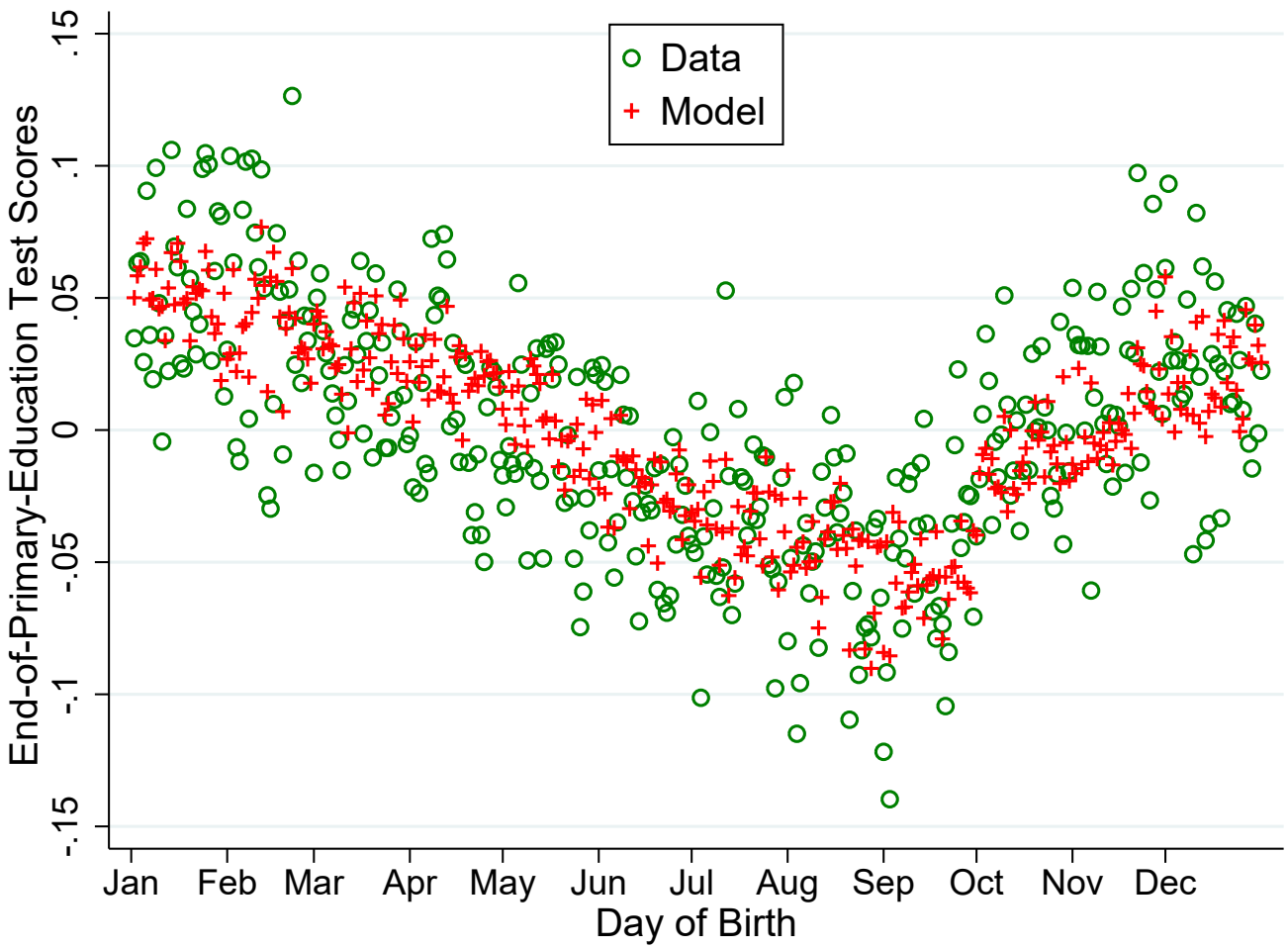
- (1 & 2) the test scores for children with family income below/above the median
- (3 & 4) the average test scores for children with family income above the median
- (5) the difference in the average test scores between children enrolling in primary education in the calendar year they turn 7 years old and children enrolling in the calendar year they turn 5 or 6

Calibration results

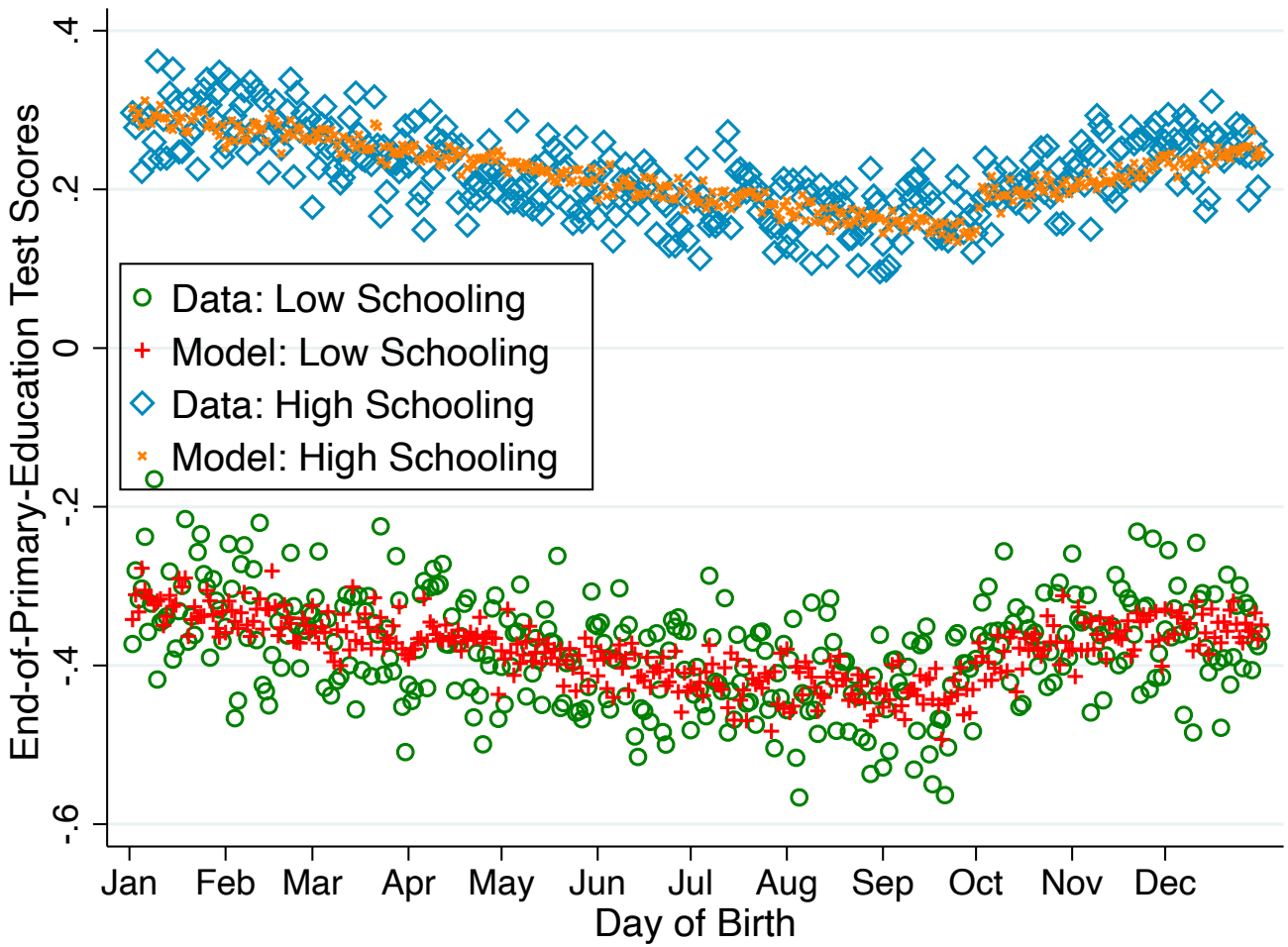
Table 1: Test score end of primary education

Age start primary education	0.281
Maternal schooling	0.0943
Family income	0.2878
v	0.3153

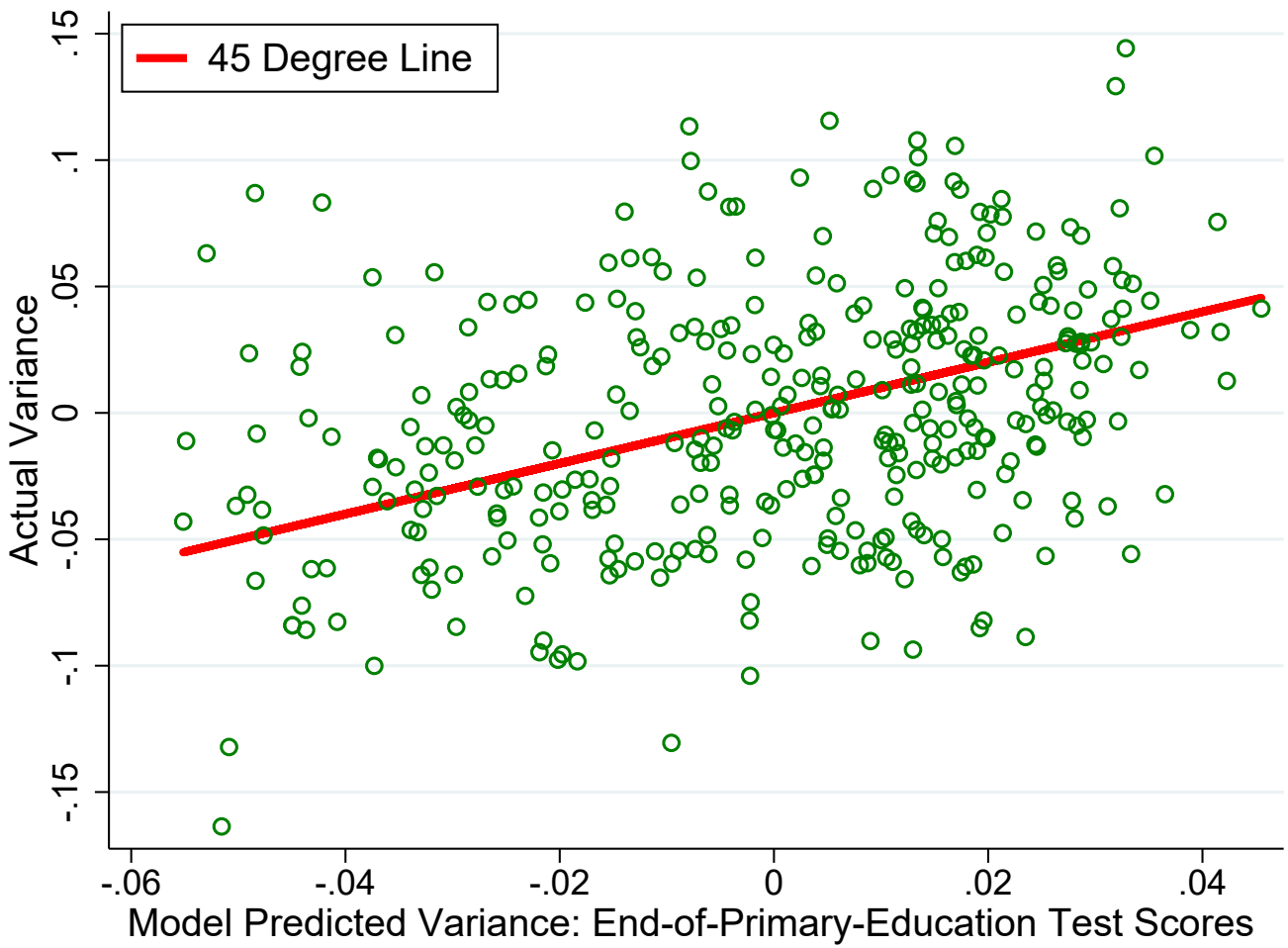
Skills end of primary education: fit



Skills end of primary education: fit; high vs low maternal schooling



Skills end of primary education: fit variance



Outline

Identifying assumption

$$\begin{aligned} KindergartenSkills_i &= \mathbb{E}(KindergartenSkills_i \mid Age_i, W_i) + u_i \\ &= \alpha + \beta Age_i + \gamma W_i + u_i \\ &= \alpha + \beta Age_i + \gamma W_i + \sigma v_i \end{aligned}$$

$$Age_i = 6 + f - x_i$$

$$\implies \mathbb{E}(v_i|x_i) = 0$$

$$\implies \mathbb{E}(v_i|\mathbb{E}[AgeStartPrimEdu|x_i]) = 0$$

IV estimation of effect of age at the start of primary education: using variation across birthdays only

$$TestEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + d\, W_i + \phi\, v_i + d\, \epsilon_i + \eta_i$$

Instrument for $AgeStartPrimEdu_i \rightarrow \mathbb{E}[AgeStartPrimEdu_i \mid x_i]$.

IV estimation compared with calibration results

Table 2: Test score end of primary education

	Calibration	**IV estimation**	**OLS**
Age start (primary education)	0.281	0.268***	-0.235***
		(0.0113)	(0.00467)
Maternal schooling	0.0943	0.0696***	0.0646***
		(0.00140)	(0.000585)
Family income	0.2878	0.289***	0.272***
		(0.00496)	(0.00286)
v	0.3153		
Observations	340,185	340,185	340,185
School fixed effects		Yes	Yes

More sophisticated IV approach

Define $Z_i = 5, 6, 7$ depending on calendar year of enrollment and

$$\tau_i = v_i - \mathbb{E}[v \mid x_i, W_i, Z_i] \,.$$

$$\implies \mathbb{E}(\tau_i | x_i, W_i, Z_i) = 0$$

$$\implies \mathbb{E}(\tau_i | \mathbb{E}[AgeStartPrimEdu | x_i, W_i, Z_i]) = 0$$

$$\begin{aligned} TestEndPrimEdu_i = a + b\, AgeStartPrimEdu_i + d\, W_i \\ + \phi\, \mathbb{E}[v \mid x_i, W_i, Z_i] + \phi\, \tau_i + d\, \epsilon_i + \eta_i. \end{aligned}$$

Instrument for $AgeStartPrimEdu_i \;\rightarrow\; \mathbb{E}[AgeStartPrimEdu_i \mid x_i, W_i, Z_i]$.

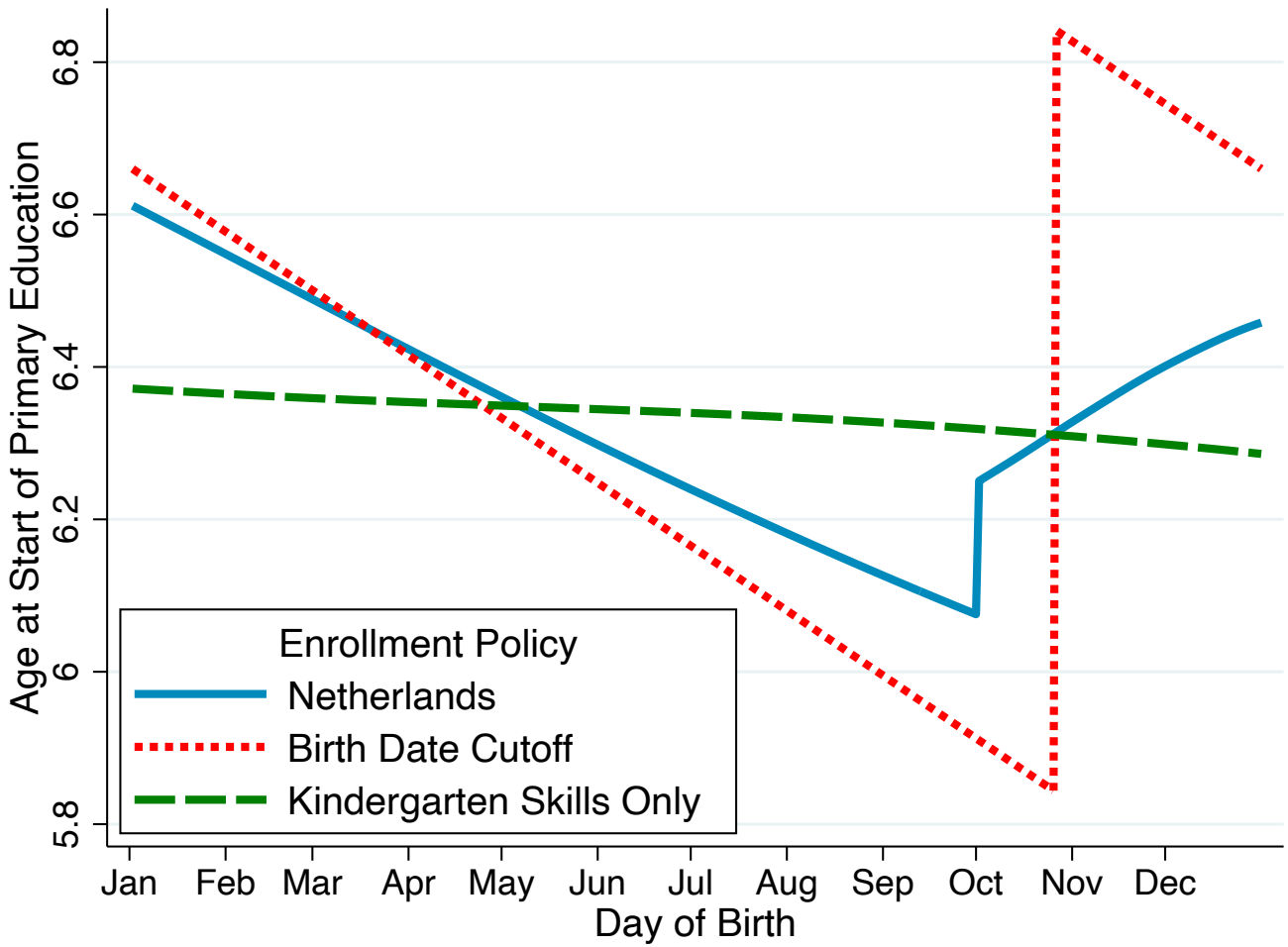
IV estimation compared with calibration results

Table 3: Test score end of primary education

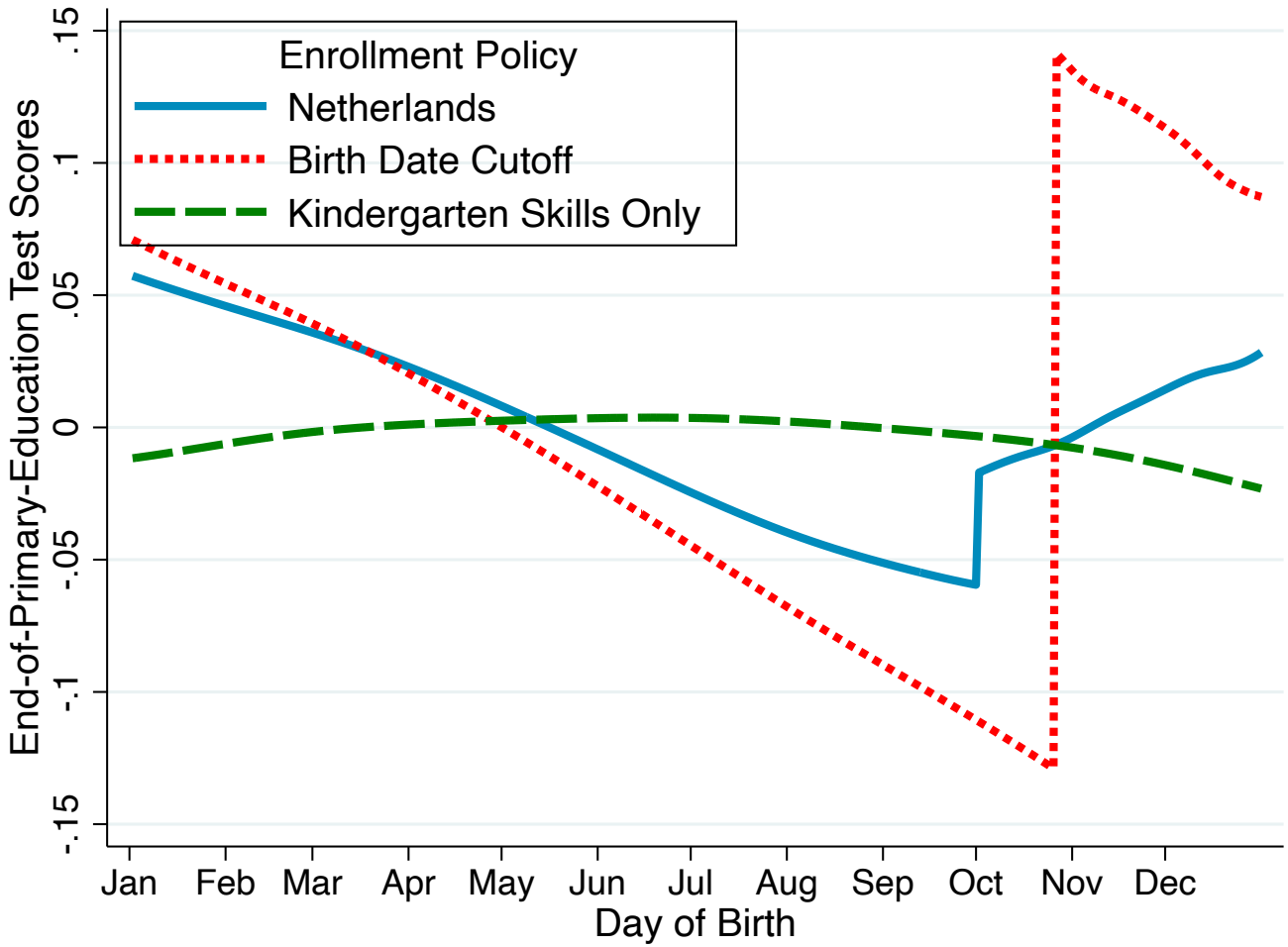
	Calibration	**IV estimation**	
Age start primary education	0.281	0.268*** (0.0113)	0.271*** (0.0111)
Maternal schooling	0.0943	0.0696*** (0.00140)	0.0702*** (0.000591)
Family income	0.2878	0.289*** (0.00496)	0.291*** (0.00287)
Other predetermined (v)	0.3153		0.329*** (0.00646)

Outline

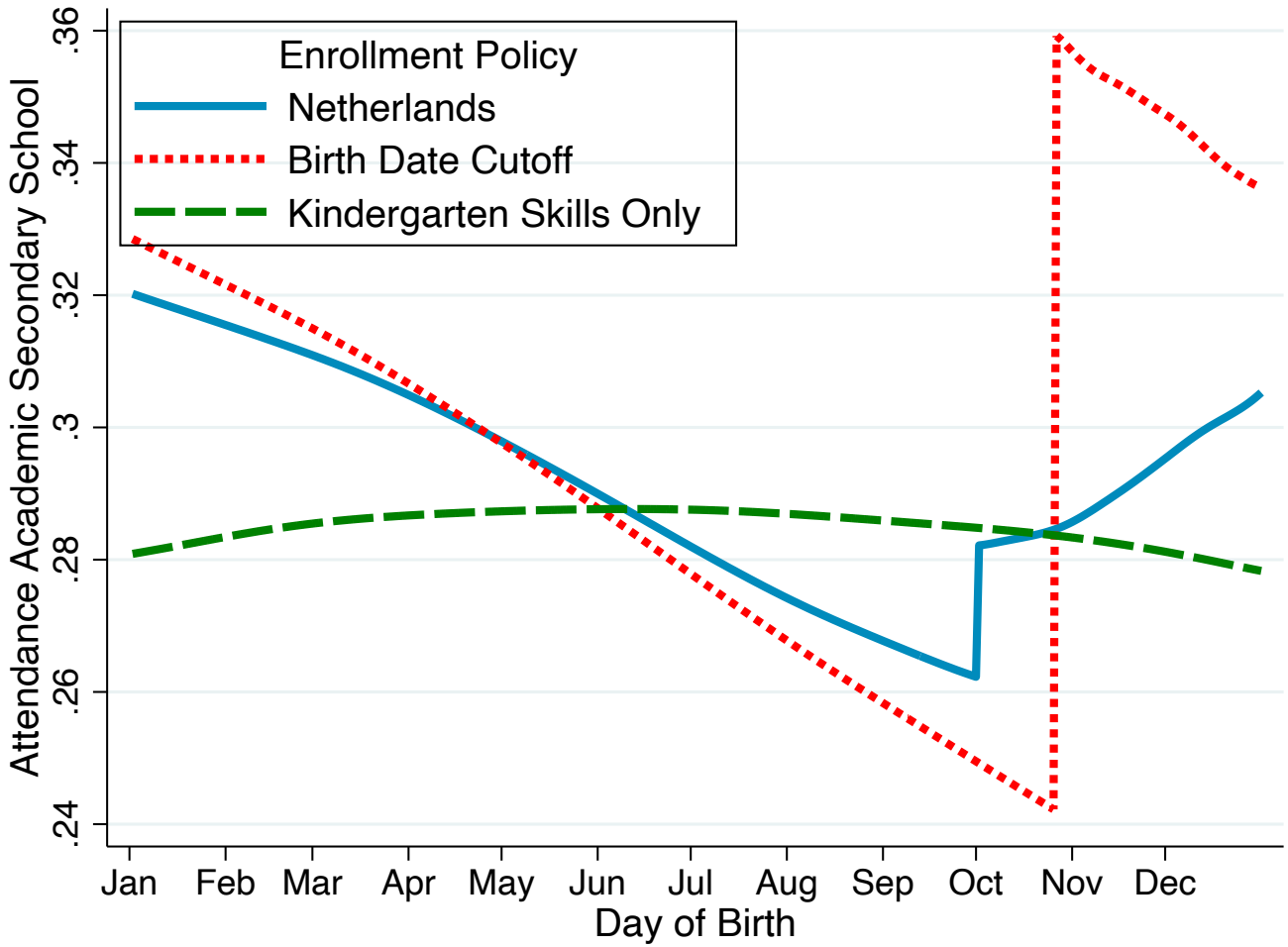
Alternative enrollment policies: age at the start of primary education



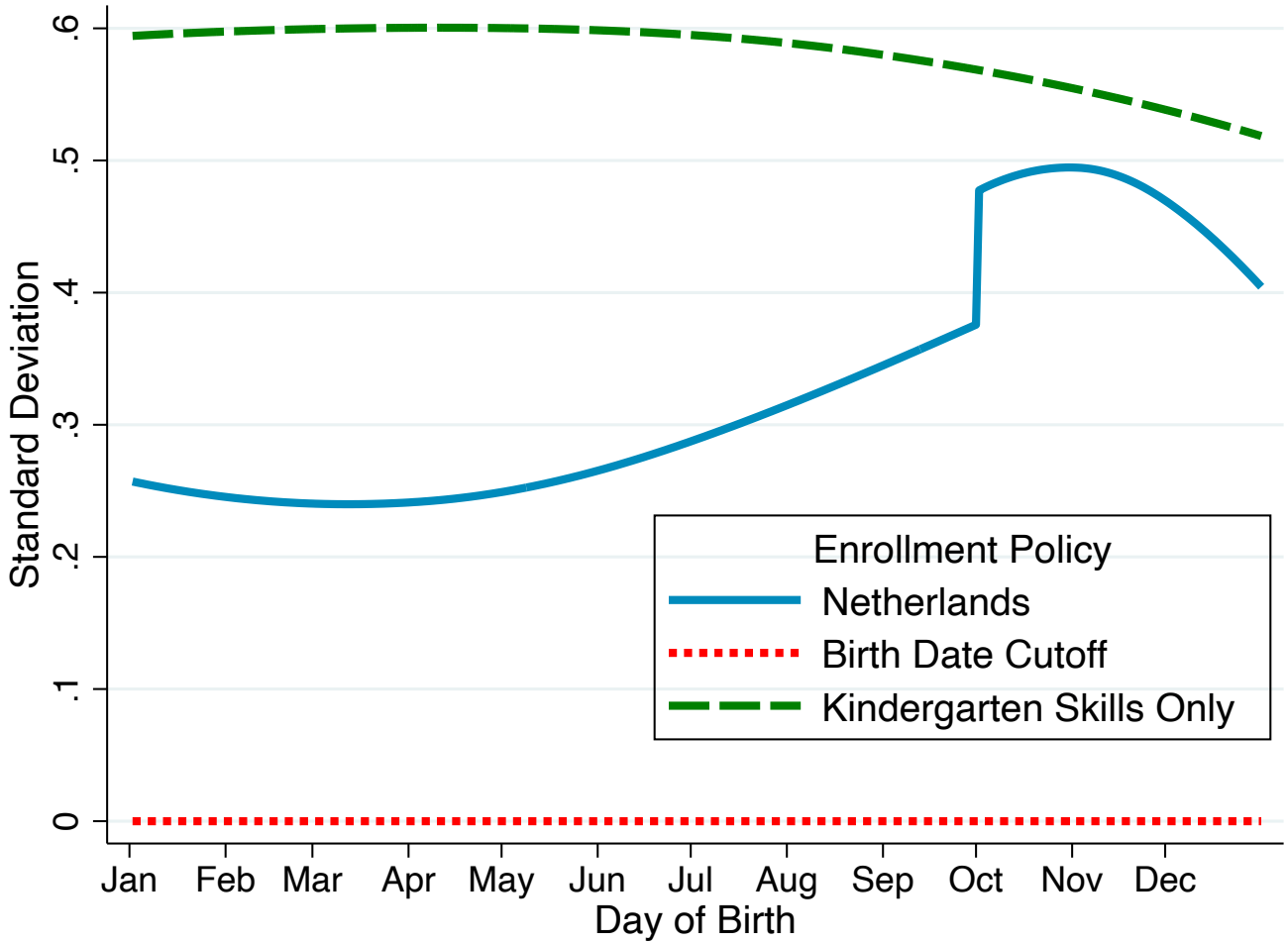
Alternative enrollment policies: test performance at the end of primary education



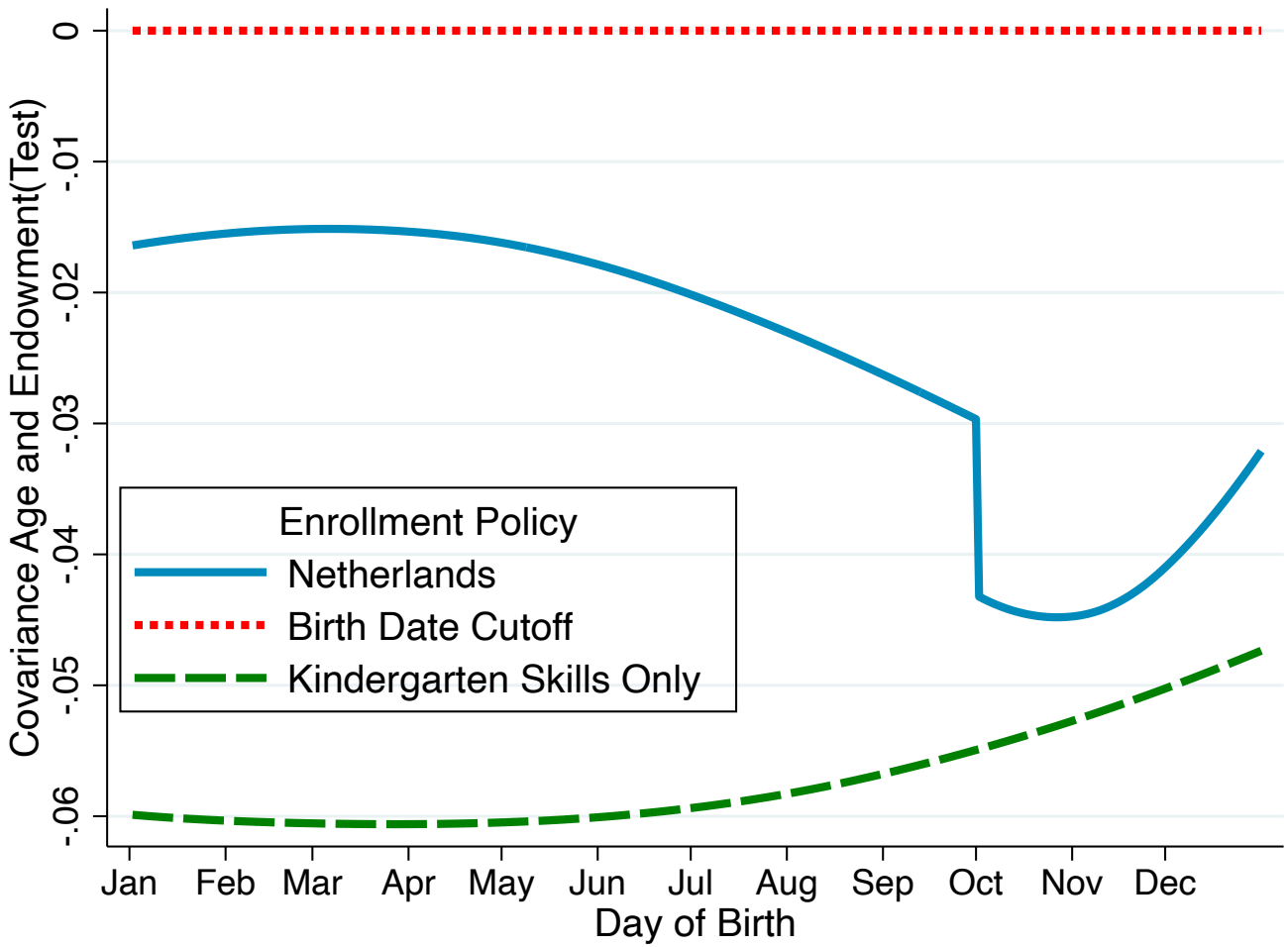
Alternative enrollment policies: share attending most academic secondary education



Alternative enrollment policies: standard deviation of age at the start of primary education



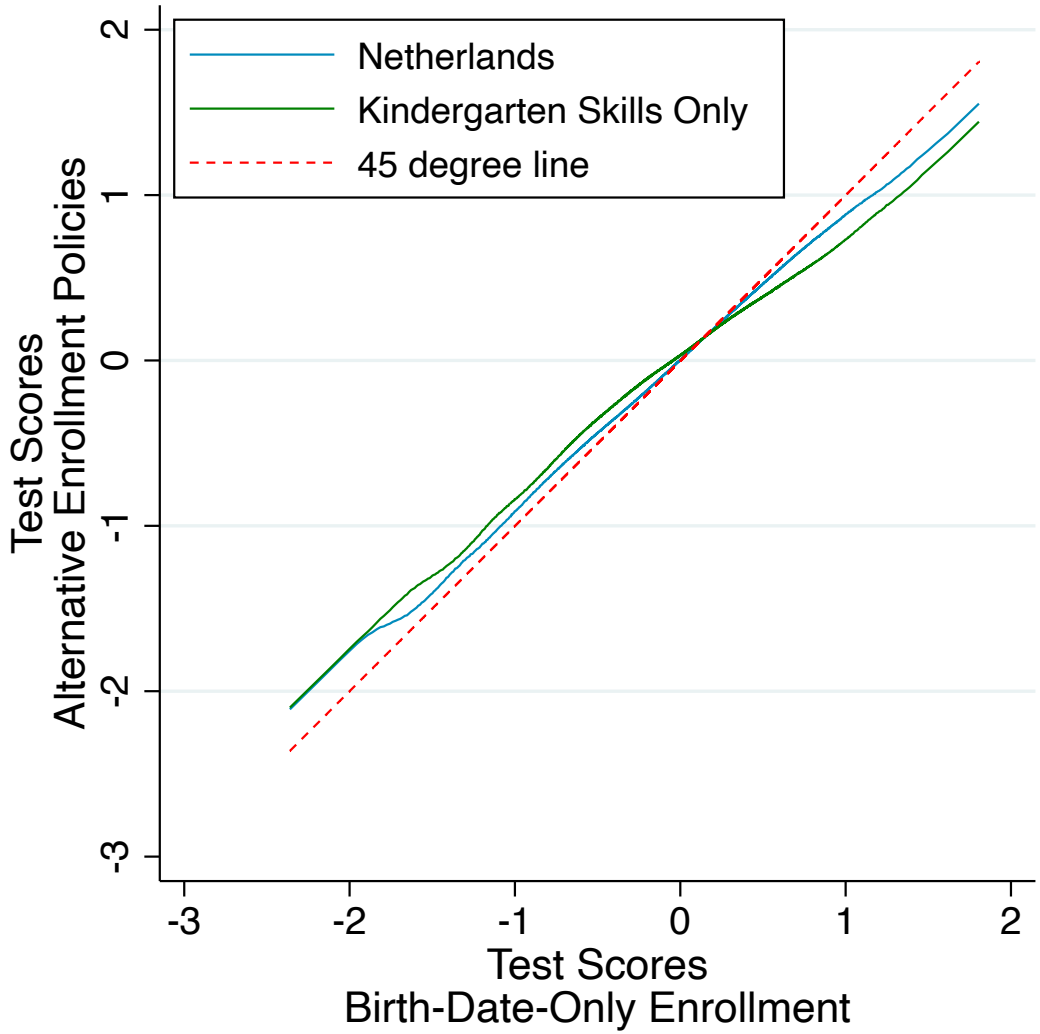
Alternative enrollment policies: standard deviation of test performance at the end of primary education



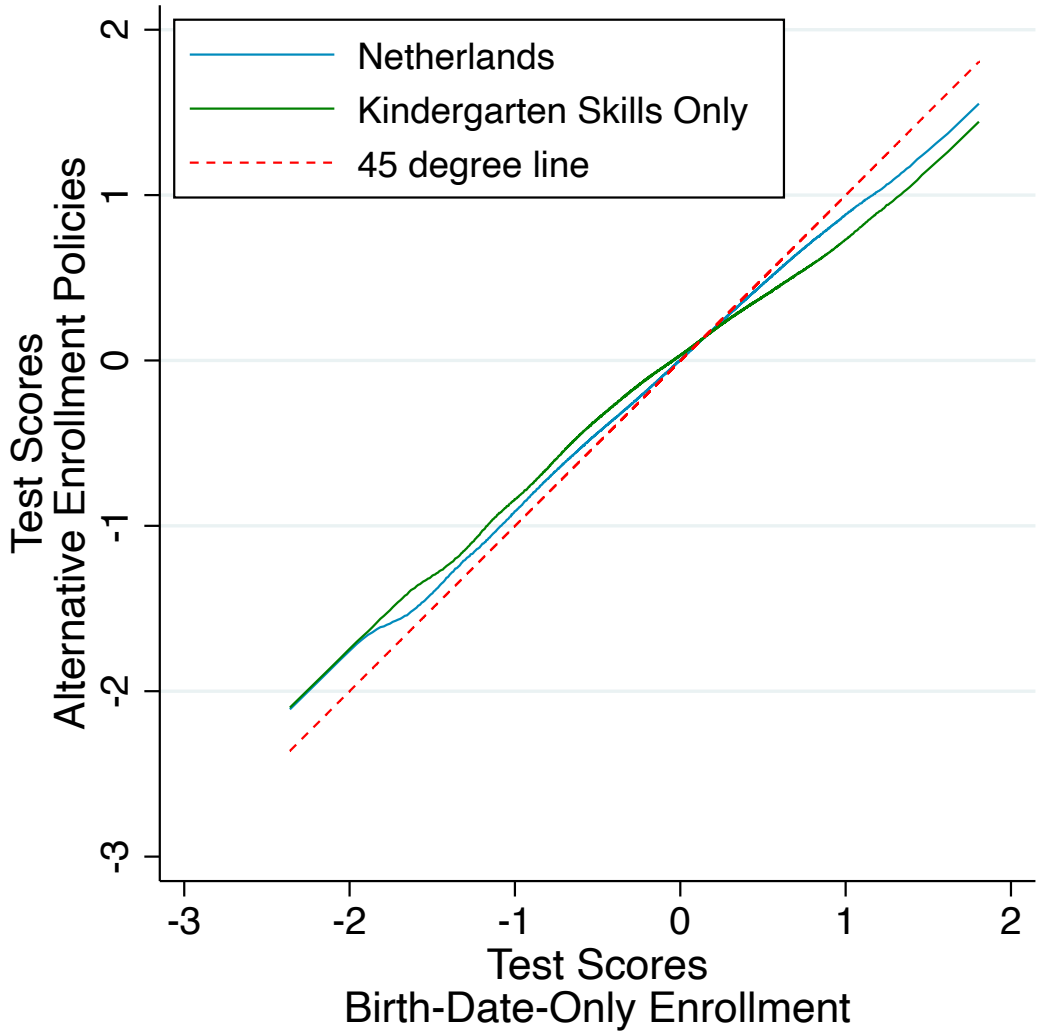
Standard deviation of outcomes by enrollment rule

	Enrollment policies		
	Birth date	**Netherlands**	**Skills assessments**
Age at start of primary education	0.29	0.37	0.59
Test performance end of primary education	0.54	0.5	0.45

Expectation test performance conditional on birth-date-enrollment test performance, given W and x



Expectation test performance conditional on birth-date-enrollment test performance, given W only



Conclusion

- Dutch system of enrollment in primary education is improvement over enrollment based on birth dates
- Effects are clear and consistent with findings elsewhere
- Should be taken into account that improvements come solely from reallocating "extra" year in kindergarten education across children
- Putting even more weight on kindergarten skills assessments would improve things further