How Effective is Population-Based Cancer Screening?

Regression Discontinuity Estimates from Across Canadian Provinces

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ARCC Conference
May 28, 2012

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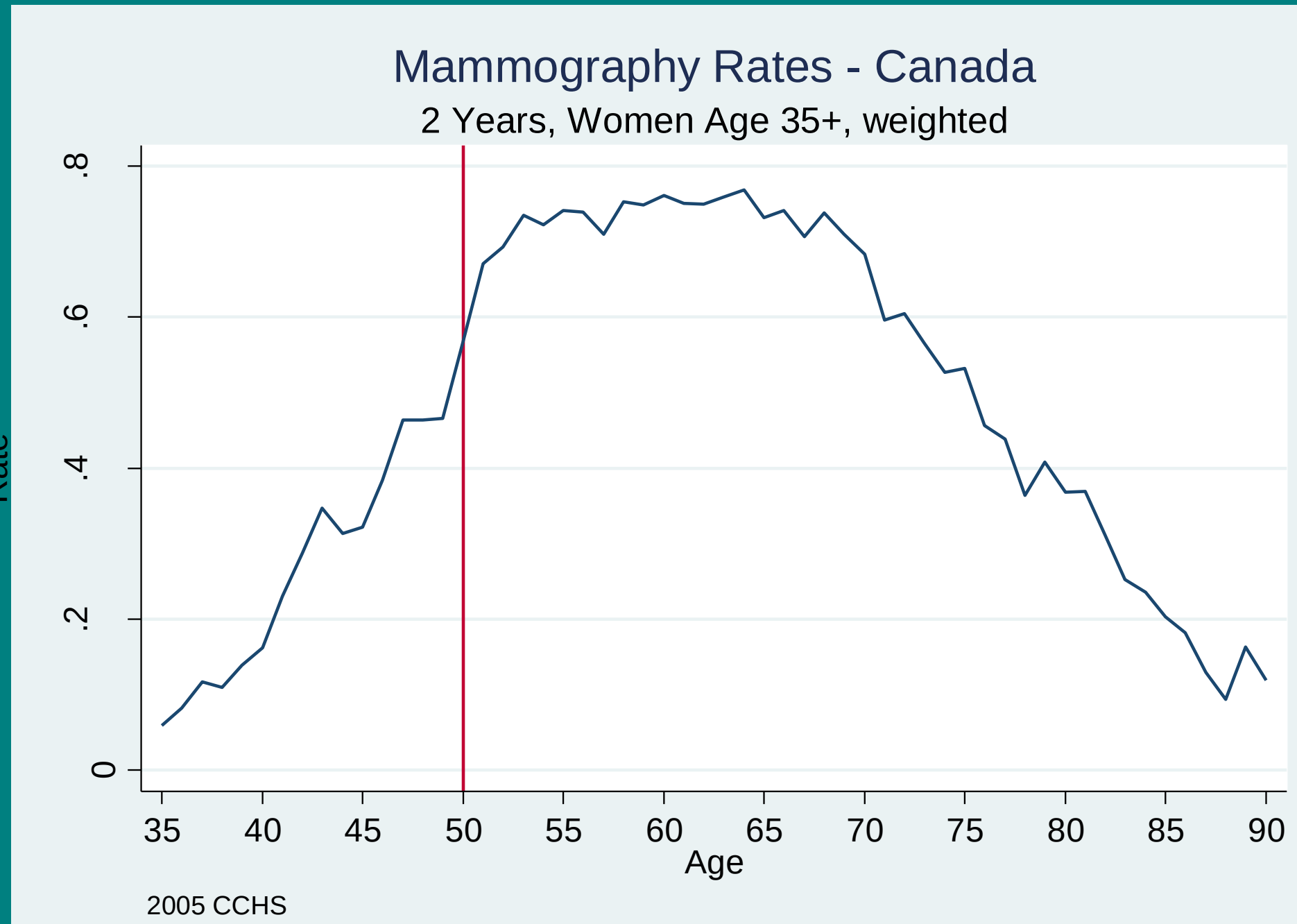
Overview

- Screening is an important strategy to reduce cancer-related morbidity and mortality
- Clinical guidelines specify tests, periodicity, and initiation age
  - Based largely on RCTs that evaluate the sensitivity and specificity of tests across a range of ages
- Efforts to increase screening rates co-exist with a continuing debate about the appropriate tests and initiation and end ages for targeted screening
  - CTFPHC breast cancer screening changes/ clarifications in 2011

Canadian Breast Cancer Screening Guidelines

for the asymptomatic general population

CTFPHC (2001)	Canadian Cancer Society (2005)
Women ages 50-69, Mammography every 1-2 years	Women ages 50-69, Mammography every 2 years


Mammography Rates - Canada
2 Years, Women Age 35+, weighted
Rate
0
.2
.4
.6
.8
35
40
45
50
55
60
65
70
75
80
85
90
Age
2005 CCHS

Research Questions

- Is clinical practice consistent with screening guidelines?
  - Adherence with respect to recommended initiation ages
- How effective is population-based screening in terms of cancer detection and stage at diagnosis?
- What are the costs and benefits of screening at the guideline-recommended screening initiation ages?

Why an Observational Study Design?

- RCTs are not powered to estimate effects at specific ages (rely on meta-analyses)
- Up-to-date (changing underlying incidence)
- Representative of population of interest
- Based on real-world data, as opposed to disease models and simulations
- Policy-relevant estimate of the impact of a marginal change in the probability of screening at a specific age
- BUT, the usual concerns about selection and bias of course apply
  - Need a “random” shock to the probability of screening

Methodology

- Regression Discontinuity Design
  - Identifies the sharp discontinuity in screening rates at or near the recommended initiation age
  - Compares cancer detection for ages on either side of this threshold
- Assumes:
  - Confounders change smoothly across the cutoff
  - In the absence of treatment (increase in screening), outcomes (cancer detection) change smoothly as well

Data

- Cancer screening rates come from nationally-representative population surveys
  - CCHS 2003, 2005, 2007, 2008
  - Atlantic provinces, QC, ON, MB/SK, AB, BC
  - Not all provinces conduct the cancer screening module in all years
    - Age- and province-specific averages are used for missing years where feasible
- Cancer detection rates come from registries and population denominators
  - Canadian Cancer Registry database, all provinces
  - Available via a pilot project in the Statistics Canada RDC

Merging Screening and Detection Data

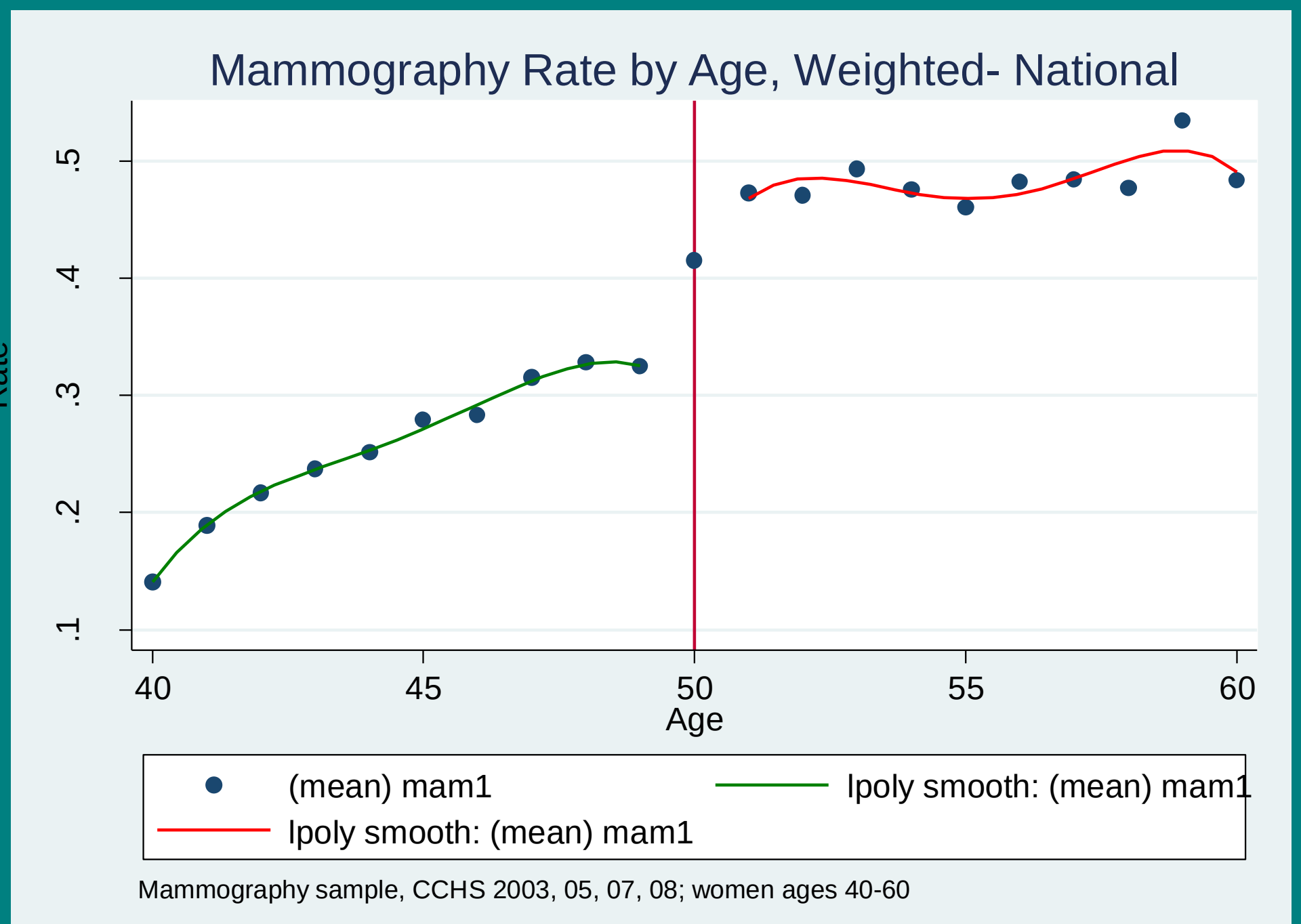
- Cancer Screening
  - Age- and province-specific screening rates by calendar year
- Cancer Detection
  - Age- and province-specific detection rates by calendar year
- Merge and pool years together

Regression Analysis

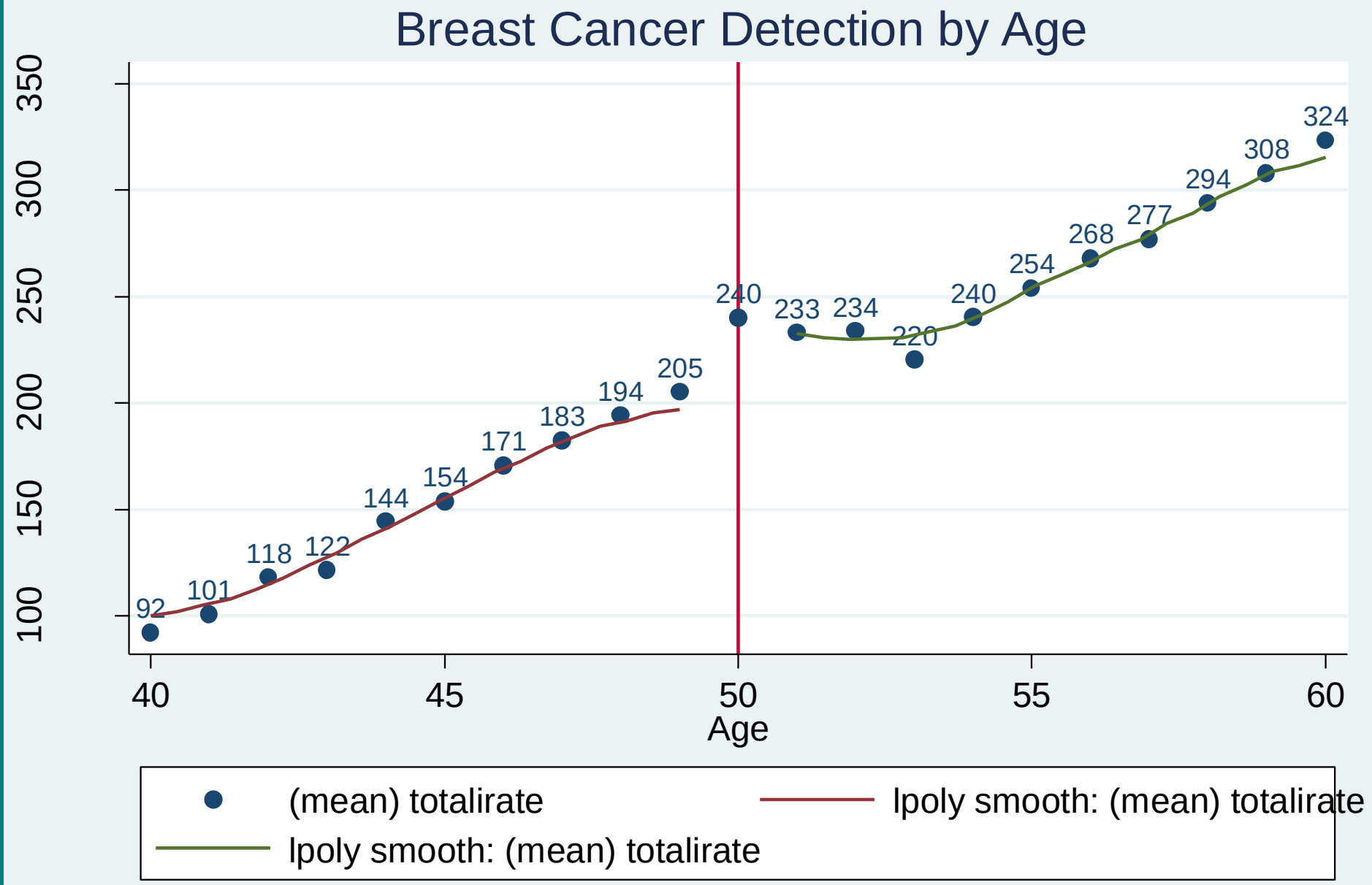
$$Y = \alpha + \beta 1 GRIA + \beta 2 GRIA*(a-A) + \beta 3(1-GRIA)*(a-A) + \ldots + \varepsilon$$

- Local linear regression with triangle kernel weighting and various bandwidths
  - No controls other than age trends
- OLS with controls for age, education, income, marital status

- Wald estimate
  - $(\Delta \text{Detection} \mid a=A) / (\Delta \text{Screen} \mid a=A)$
  - 2-stage IV estimate with screening instrumented by screening rate by age
  - Estimates change in detection driven by the change in screening at the cutoff



Mammography sample, CCHS 2003, 05, 07, 08; women ages 40-60



Mammography sample, CCR 2003-2008; women ages 40-60

Impact of Screening on Breast Cancer Detection

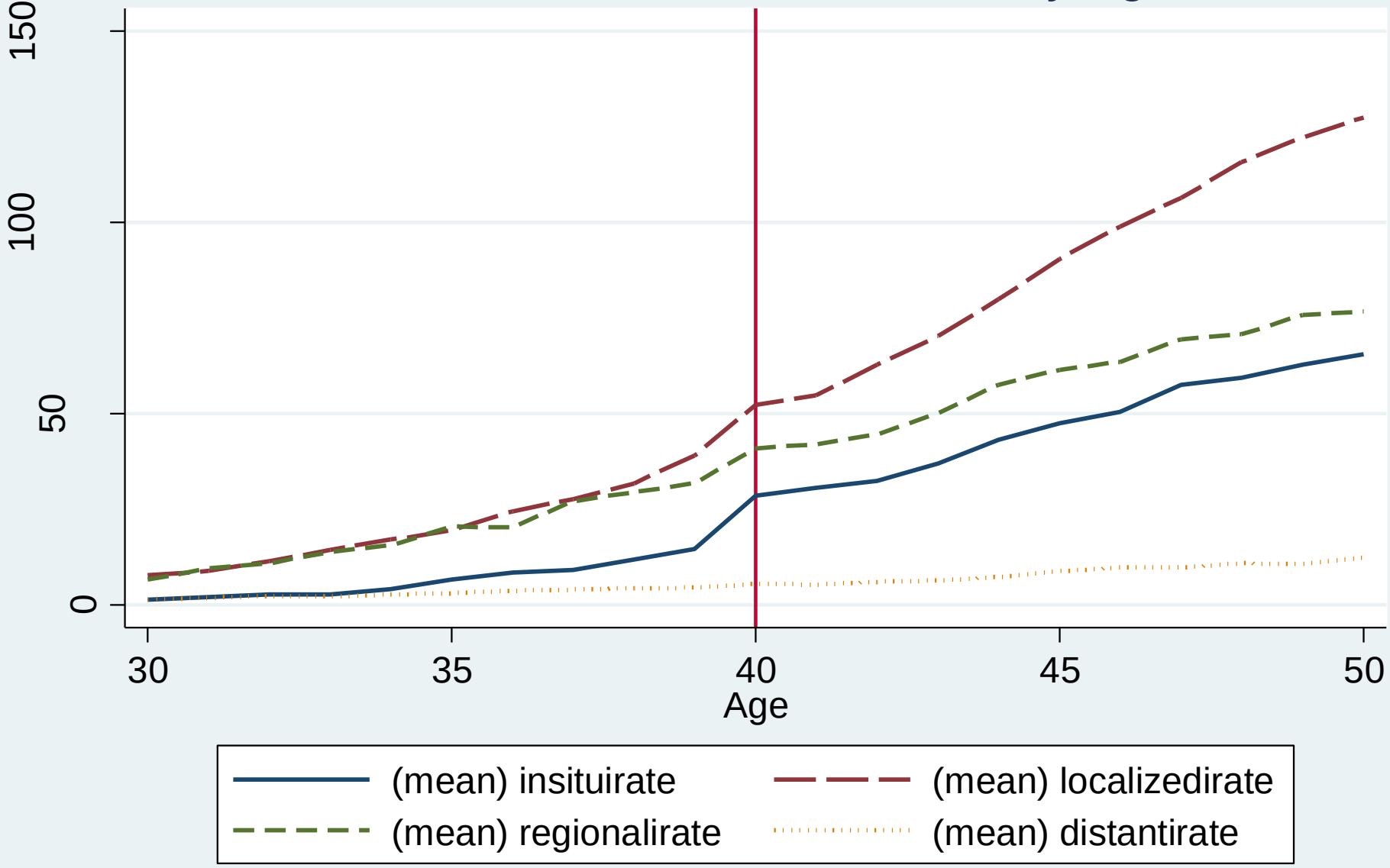
	Mammogram (% points)	Detection (per 100,000)	IV (per 1% scrn)
Weighted Local Linear	6.618*** (1.735)	24.816** (10.453)	3.661 (2.312)
Cutoff, Control for Year	7.097*** (1.547)	17.541** (6.471)	2.472* (1.021)
Cutoff, With Year and Controls	10.354*** (2.205)	18.625* (7.257)	1.799* (0.711)

* p<=.05, ** p<=.01, *** p<=.001; Data: CCHS and CCR, 2003-2008; Demographic controls: income, education, marital status. Robust standard errors are in parentheses below coefficient estimates; N=60, bandwidth 5 (ages 45-54) (N=18 for WLL with optimal bandwidth of 3), Regressions are OLS (first & second stage) and IV. Mean screening and detection rates ages 45-49 are 31% and 181 cancers per 100,000 women, respectively. Increases at age 50 are 21% and 14%.

Other Specification Checks

- Bandwidth sensitivity
  - 3 and 10-year bandwidths give similar results
- Used CCHS questions that ask about the reason for the mammogram to verify that changes at age 50 are primarily due to asymptomatic screening

U.S. Breast Cancer Detection by Age



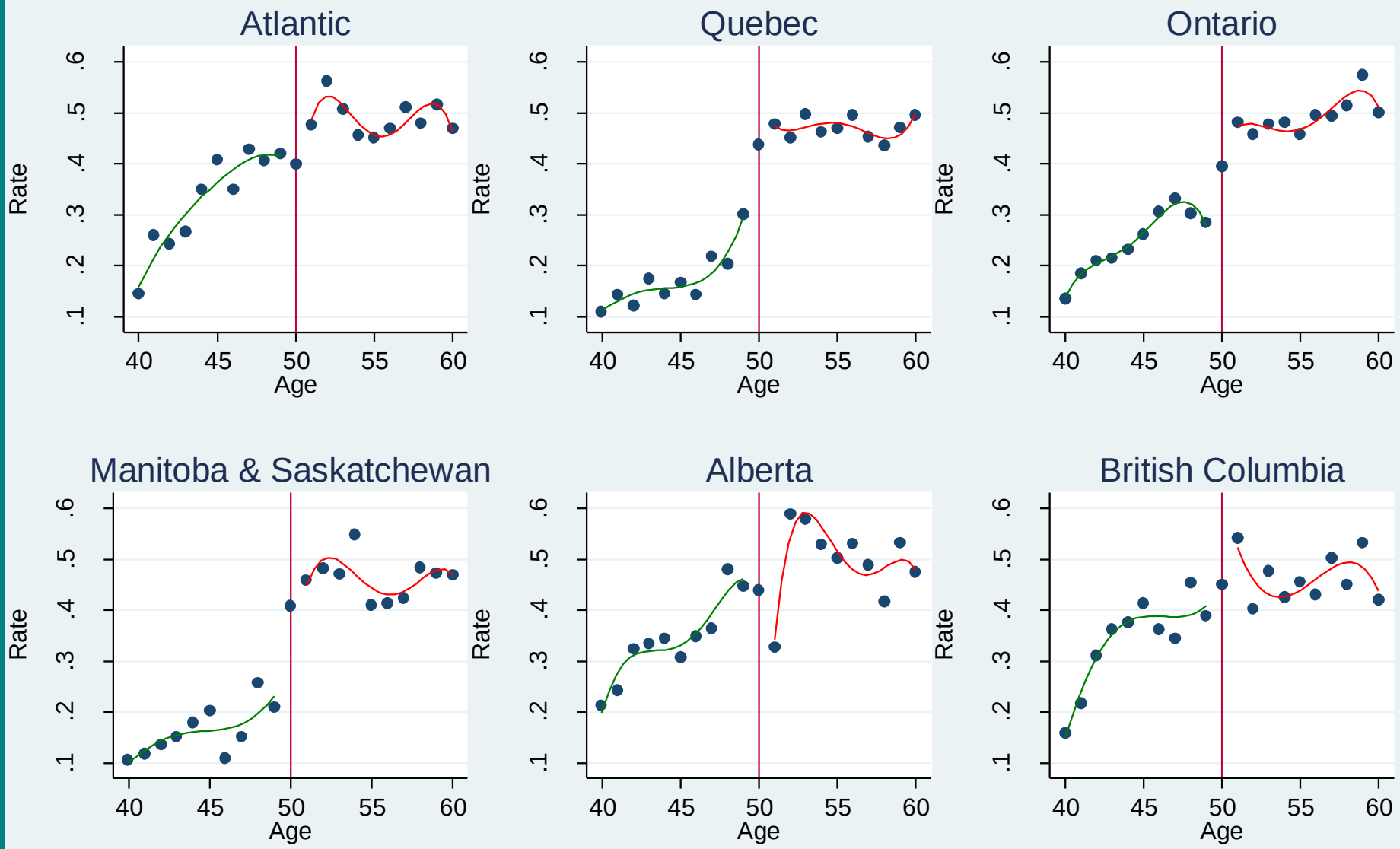
Mammography sample, SEER 2000-06, 12 states; women ages 30-50

Staging Data is Sparse in the Canadian Cancer Registry

- Nova Scotia, PEI, and the North West Territories include staging information most consistently (at least 75% of cases) from 2004-2008 – but small number of cases
- BC and Ontario have little staging data until 2008
- Alberta and Manitoba may provide the best hope: larger populations and staging data on par with NS, PEI, NWT.

- Currently working on some breast cancer staging analysis for Alberta, Manitoba, and Ontario, but data are fairly sparse
  - Need good staging data over same time period as CCHS, and need the cancer screening modules in the CCHS to be run!

Mammography Rates by Age and Province, Weighted



Mammography sample, CCHS 2003, 05, 07, 08; women ages 40-60

QC 79%, ON 38%, MB/SK 116%

Additional Results

- Only QC and MB/SK yield statistically significant estimates of breast cancer screening on detection
  - About 3 cases per 100,000 for a 1% increase in screening
- Parallel analyses for colorectal cancer screening and detection
  - Same provinces except QC; 2005-08
  - Screening increases by 6 percentage points at age 50 in Ontario (76%)
  - A 1% increase in screening in ON detects about 1 new case per 100,000 adults
- Contrast with U.S. results:
  - Increasing screening rates by 1 percentage point at age 40 detects approximately 1.3 cases of breast cancer per 100,000 women
  - Increasing screening rates by 1 percentage point at age 50 detects approximately 2 cases of colorectal cancer per 100,000 adults (higher rates of colonoscopy)

Summary of Findings and Next Steps

- We observe adherence to Canadian breast cancer screening guidelines and important effects of screening on detection
  - These “national” estimates are really concentrated in Quebec and Manitoba/Saskatchewan
- Ontario demonstrates adherence to CRC screening guidelines and shows that increases in screening at age 50 significantly increase detection
- Lack of staging data limits our ability to understand the value of the increase in detection driven by screening
  - Are most new cases early- and middle-stage cancers and amenable to treatment?
- Estimates of direct screening costs, rates of false positive results, and costs associated with adverse events and follow-up for false positives can be used to calculate costs per case detected

Acknowledgements

- Financial support from:
  - Fonds de la Recherche du Québec - Santé and the Quebec Ministry of Health and Social Services (Chercheur Boursier Junior 1)
  - McGill University
- Thanks to Kimberley Boyuk, Donna Dosman, Danielle Forest, Jim Hanley

- Poster #3 at CAHSPR, Tuesday 6:00-7:15pm

Fonds de la recherche en santé du Québec

Québec

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