# Do wait times change referral decisions?

# Evidence from cataract referral patterns in Ontario

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# Background: Cataracts

- **Cataract: progressive opacity of the lens resulting in blurred vision**

- Procedure: removal of the lens and replacement with an artificial intra-ocular lens

**Cataracts have three notable criteria**

**(which happen to lead to good quality referral data)**

- Common
- Easily diagnosed & easily corrected
- Not too urgent
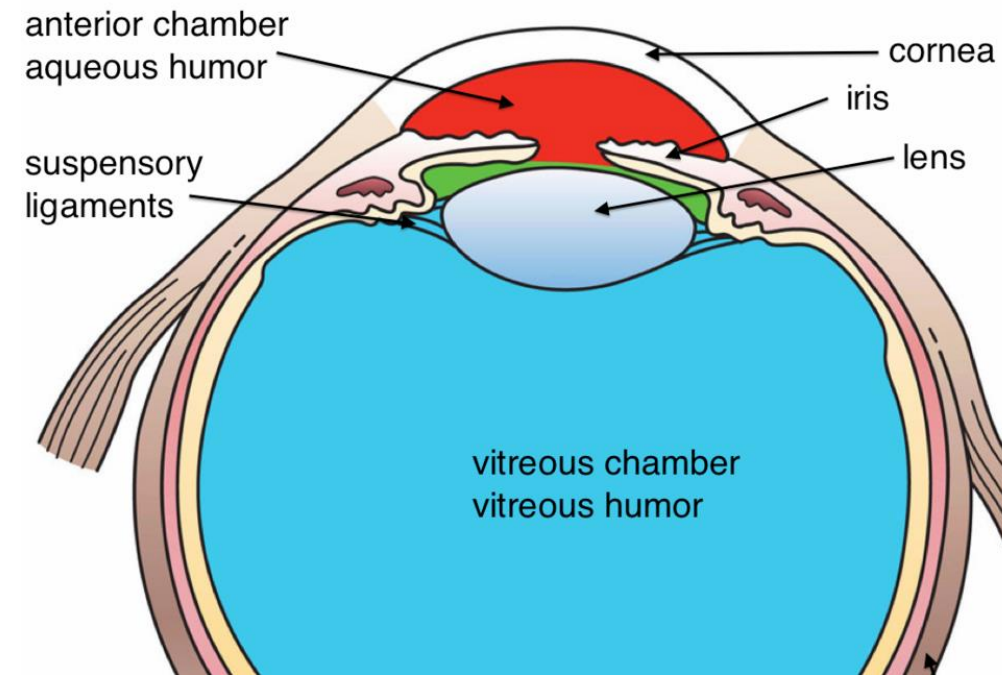
# Background: Cataracts Surgery in Ontario

- Cataract procedures are completed by an Ophthalmic **Surgeon**

- A Surgeon's patients with cataracts come from:
  - Their own practice
  - **Referrers**: primary care, optometrists and ophthalmologists

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┌─────────────────────┐
│ Referrer:           │
│ Diagnosis/Referral  │
├─────────────────────┤        ┌──────────────────┐      ┌──────────────────┐
│ Patient in practice │ ─────▶ │ Surgeon:         │ ───▶ │ Surgeon:         │
└─────────────────────┘        │ Consult/Scheduling│      │ Procedure        │
                               └──────────────────┘      └──────────────────┘
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# Cataracts Surgery in Ontario 2000-2012

Selected a time period with changes in healthcare policy & wait times

- Between 61 and 78 thousand procedures completed annually in Ontario
- **Circa 2000:** Common procedure with unacceptably **long wait times**

**Timeline**
- 2004 Start to monitor and distribute wait-times
- 2006 – E(OWT)=99 days
  - **Intervention – add 10% capacity**
- 2008 – E(OWT)=54 days
- 2012 – E(OWT)=55 days

Ontario Wait Time (OWT)

Surgeon: Consult/Scheduling → Surgeon: Procedure
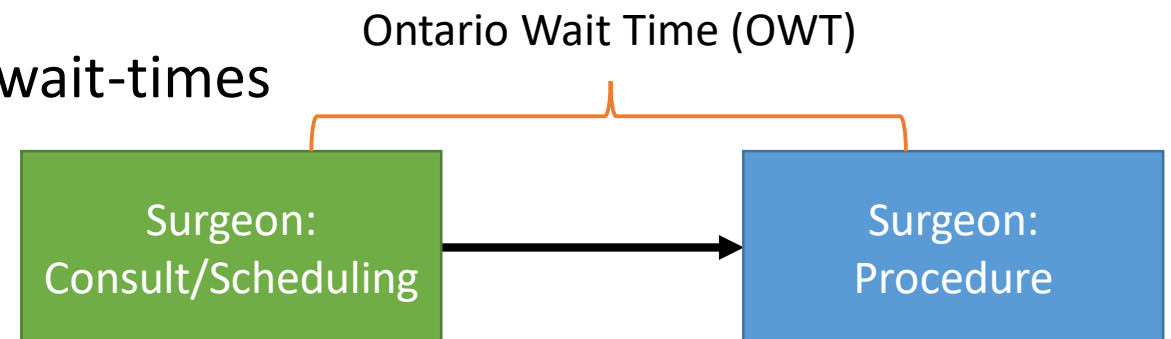
# Current Understanding of Referral Decisions

Analysis of referral patterns – clinical criteria for referrals
(Forrest et al 2006; Shea et al 1999; Ludke and Levitz 1983; Javalgi 1993; Kinchen et al 2004; Forrest et al 2002)

Analysis of decision criteria from self reported survey data (Barnett et al 2011)

- 386/616 physicians responded to a survey identifying considerations in referrals:
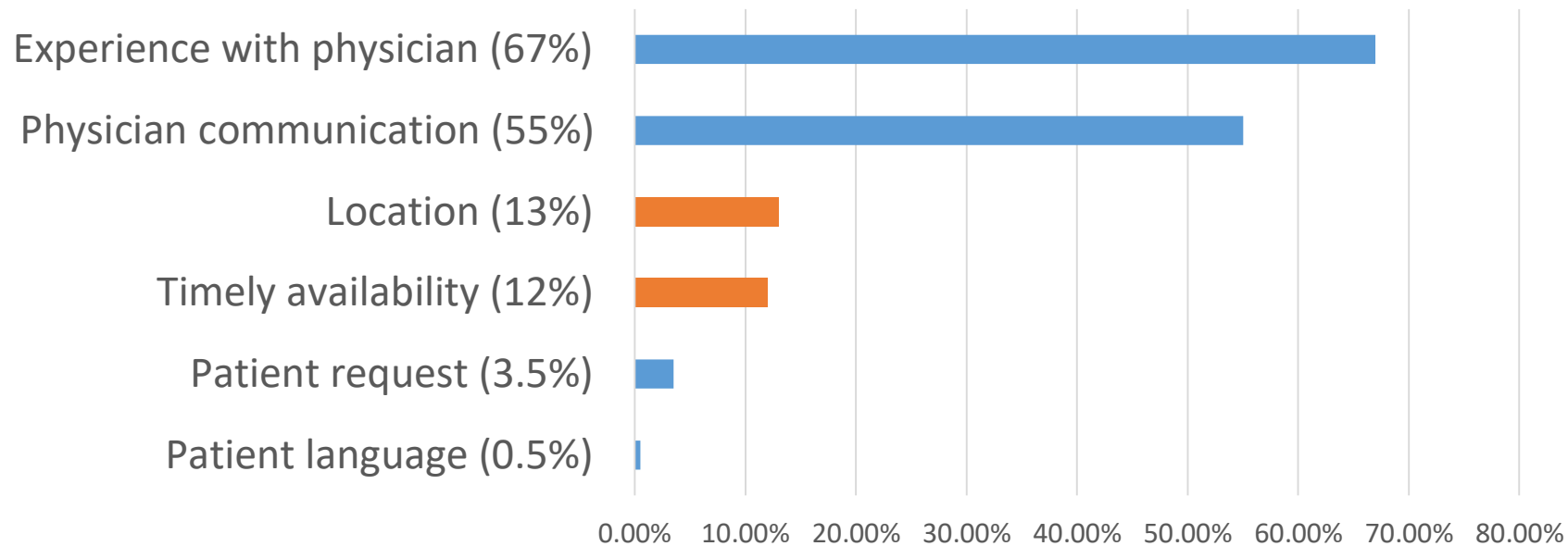


- *Patient access is an important but secondary consideration*

# Research Questions

**Aspirational research question:**

- Can decentralized referral decisions allocate specialized services in an efficient and equitable manner?

**Today's modest piece of the puzzle:**

- Which criteria factor into the decision of a physician to refer a cataract case to a particular surgeon?
  - **Historical preferences**
  - **Location**
  - **Wait times**

**Our Contribution**

Evaluate decision criteria in referral decisions using **actual observations** of referrals

# Roadmap of the Analysis

1. Data

2. Decision model
   - Propose a discrete choice model for the referral decision

3. Empirical model
   - Dealing with unobserved variable bias using a natural experiment

4. Parameter estimation results and interpretation

# Data

- Acquired from the Institute for Clinical Evaluative Sciences (DAS)
- **Billing data from Ontario Health Insurance plan**
  - Record of each cataract surgery completed from 2000-2012
    - *Surgeon information: ID, LHIN, institution, agegroup*
    - *Patient information: ID, LHIN, charlson, comorbities, agegroup*
  - Record of each prior consultation with surgeon
    - *Consultation information: diagnosis, referring physician, days prior to procedure*
  - Record of each prior consultation in year from referring physicians
    - *Referrer information: ID, LHIN, agegroup , days prior to procedure*
  - Anonymized: IDs, Dates restricted to year and days prior to surgery

# Decision Model: Wait times

Wait times are reconstructed from appointment trajectory
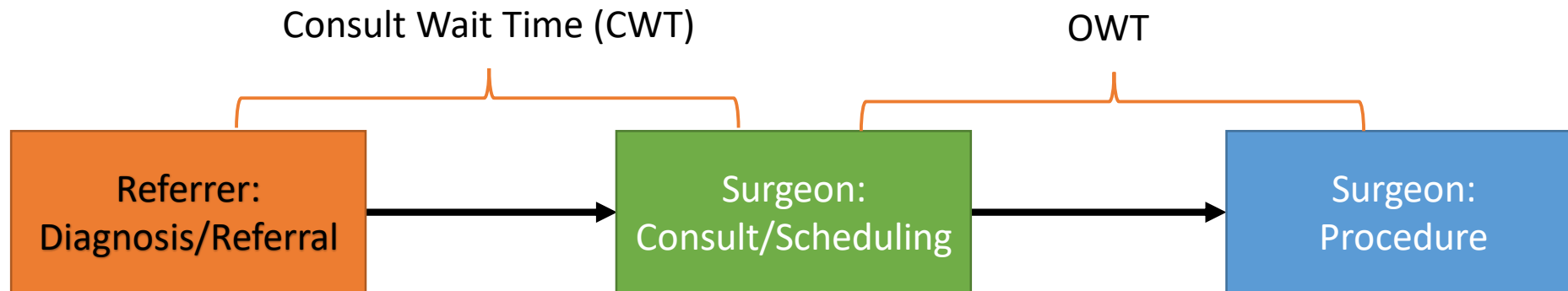


- Diagnosis/Referral date: date of earliest appointment with a cataract diagnosis
- Consult/Scheduling date: earliest ophthalmic consultation with a cataract diagnosis
- Procedure date: taken directly from data

- 8,097 of 77,031 procedures had full appointment trajectories (2006)

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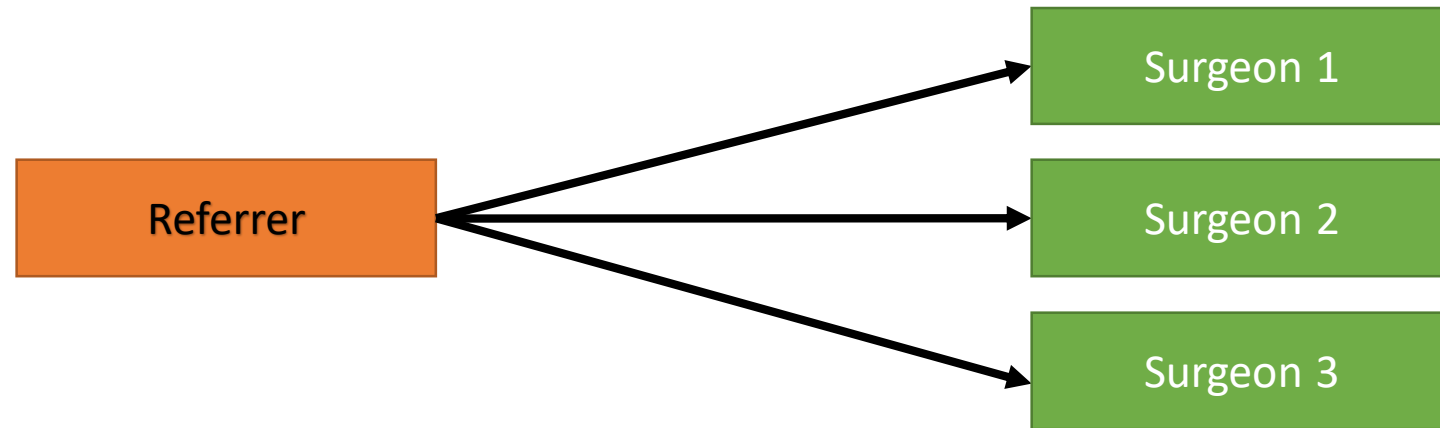
# Decision Model: Wait times



ESTIMATED AND OFFICIAL CATARACT WAIT TIMES
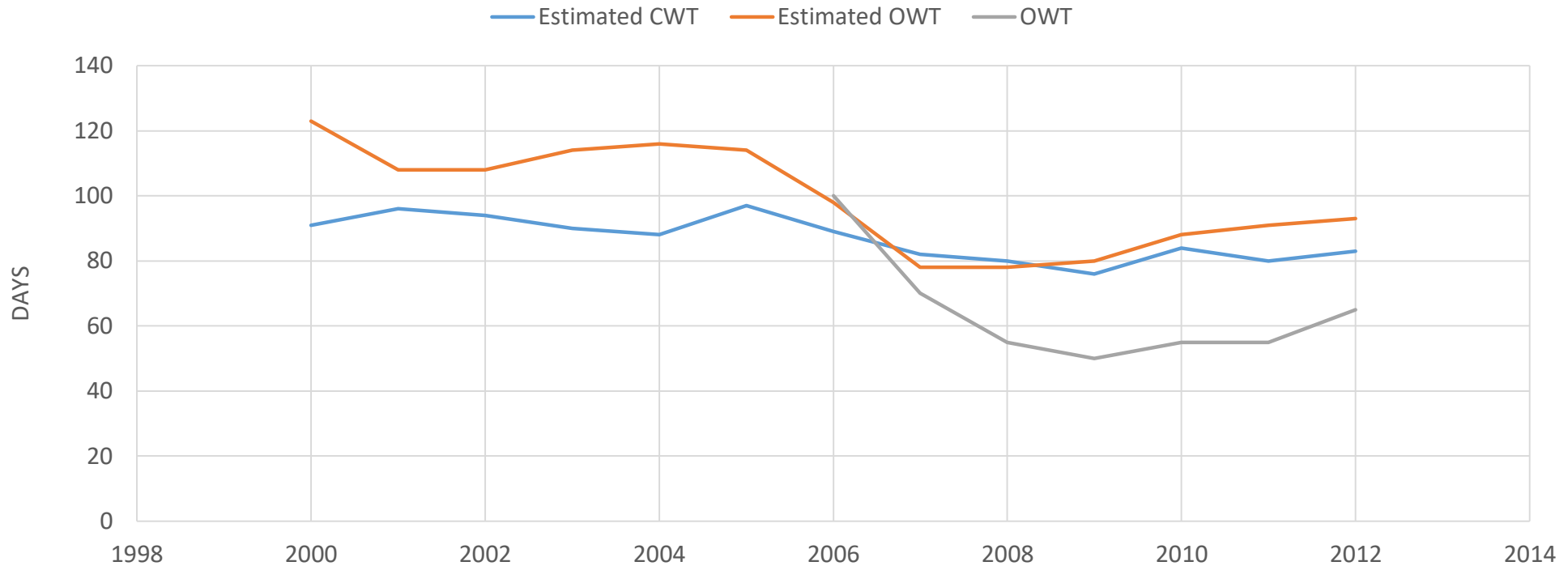
# Decision Model: Referral Options

For each referral:

A surgeon is selected from the referrer's "professional network"



The professional networks are reconstructed from data:

- A surgeon is in the referrer's network if they receive **at least one referral** in that calendar year from the referrer

# Decision Model: Decision criteria

Consult Wait Time (CWT)

OWT

| Referrer: Diagnosis/Referral | → | Surgeon: Consult/Diagnosis | → | Surgeon: Procedure |
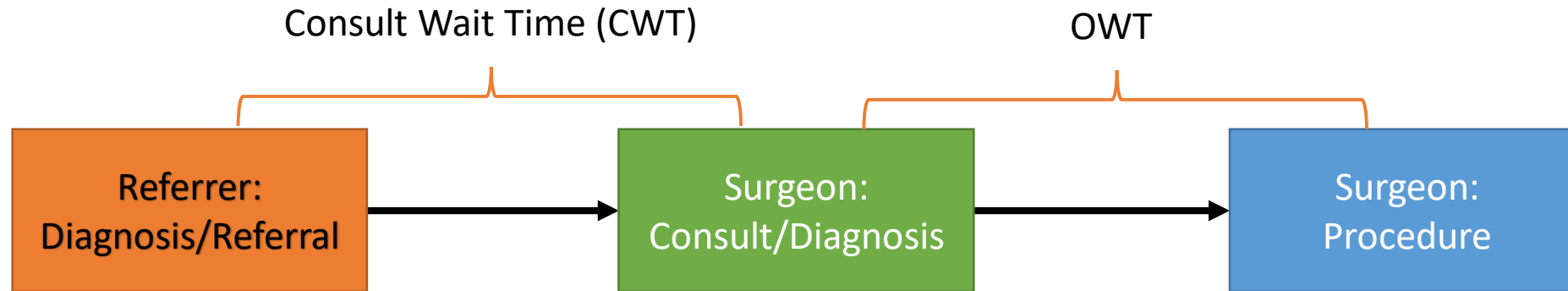
**Wait times**

- $CWT_s^{t-1}$ :  average time between referrer diagnosis and surgeon consult for previous year

- $OWT_s^{t-1}$ :  average time between surgeon diagnosis and procedure for previous year

**Location**

- $L_{rs}$ :  dummy variable equal to 1 if the referrer is in the same LHIN as surgeon

**Historical professional network**

- $P_{rs}^{t-1}$ :  fraction of patients referred to the surgeon in previous year

**Quality**

- $Q_s$ :  system wide preference for the surgeon

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# Decision Model

Probability of referring to surgeons modeled by multinomial logit

- Extensive use in marketing and economics for analysis of decisions with discrete choices

The referrer receives a particular value for referring to a particular surgeon

- Value is a weighted sum of decision criteria

$$V(r, s, t) = \beta_0 CWT_s^{t-1} + \beta_1 OWT_s^{t-1} + \beta_2 L_{rs} + \beta_3 P_{rs}^{t-1} + \beta_4 Q_s + \epsilon$$

- $\beta_i$: weights for the decision criteria
- $\epsilon$:  normally distributed noise

Probability of selecting surgeon *s* based on multinomial logit mode

$$Prob(s{:}r, t) = \frac{exp(V(r, s, t))}{\sum_{k=1}^{K} exp(V(r, k, t))}$$

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# Empirical Model

*Goal: estimate parameters in decision model using regression*

However:

- "Quality" is unobserved and endogenously related to the wait times
  - Surgeons with longer wait time may *still* be preferred due to a higher value for Q
  - Quality results in positively biased estimate for wait time parameters

# Empirical Model:
# Solution to the Omitted Variable Challenge

- Solution: Find a change in the wait times which is independent of Q

- Use a natural experiment
  - Ontario wait time strategy increased cataract surgery capacity in 2006
  - Overall capacity increased by about 10% via localized injections

Number of cataract procedures in Ontario

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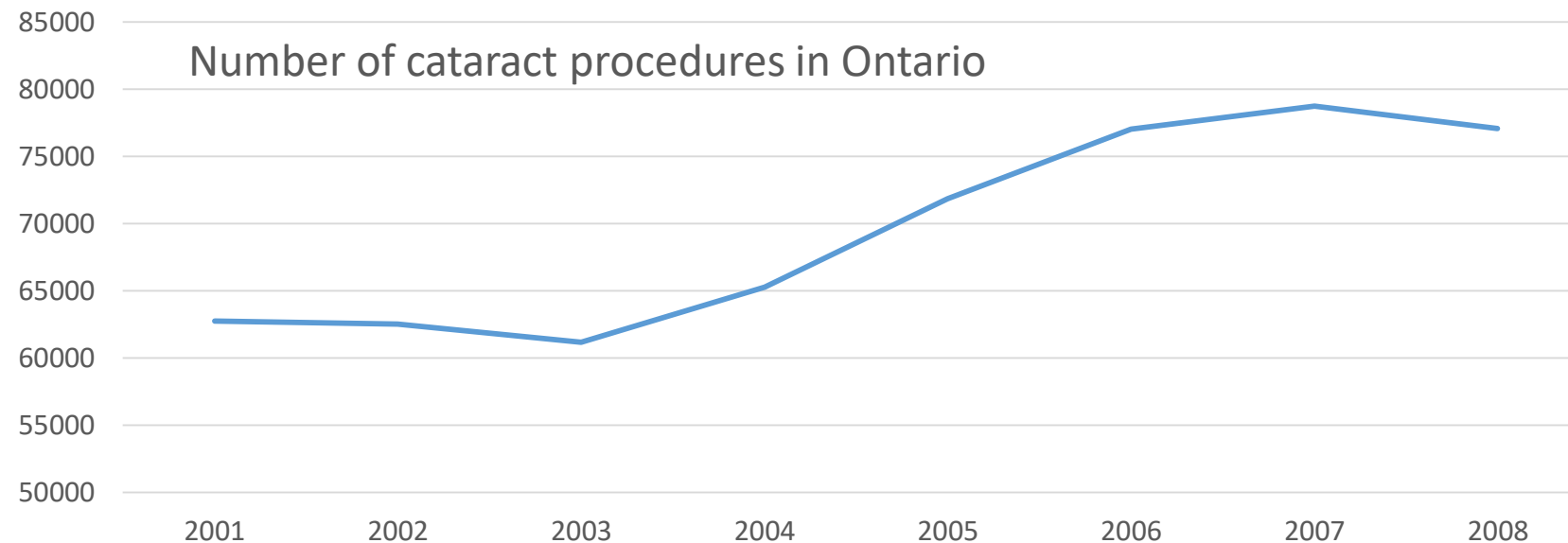
# Final Empirical Model

Key Assumption:

- Change in wait times between 2005 and 2006 are attributed to the policy intervention

$\Delta CWT_s^{2006}, \Delta OWT_s^{2006}$ may be measured independent of other decision variables

- Replace wait time parameters by these values

$$V(r, s, 2006) = \beta_0 \Delta CWT_s^{2006} + \beta_1 \Delta OWT_s^{2006} + \beta_2 L_{rs} + \beta_3 P_{rs}^{2006} + \beta_4 IW_s^{2006} + \beta_5 IP_{rs}^{2006} + \epsilon$$

# Ontario LHINs:
# Highly connected set of LHINs received majority of capacity



≥ 100 Referrals Between LHINS

Greater Than 500
New Surgeries in 2006
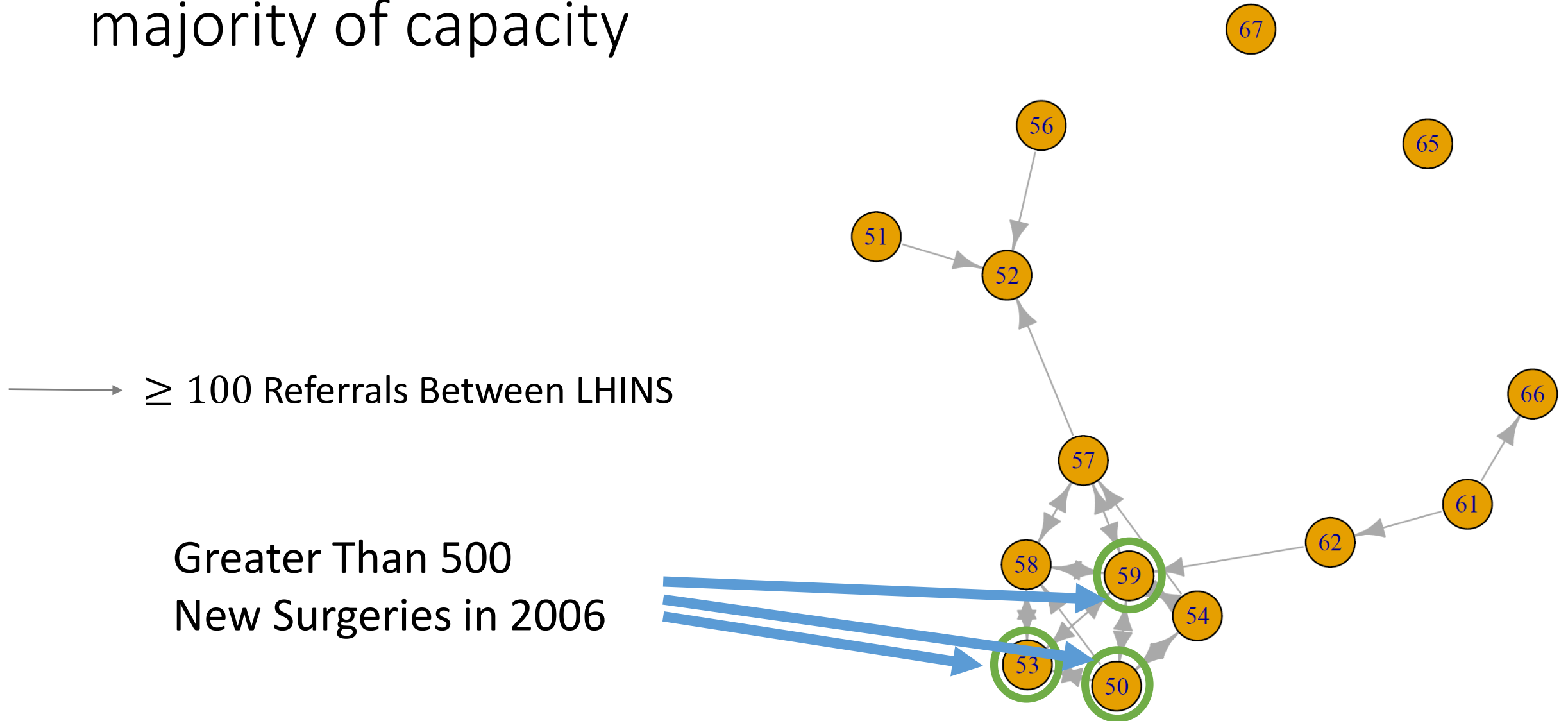
# Results

| LHINS | $\beta_{\Delta CWT}$ | $\beta_{\Delta OWT}$ | $\beta_L$ | $\beta_R$ | $\beta_N$ | # new procedures |
|---|---|---|---|---|---|---|
| 50, 53,59 Large Increase | -0.0094 (<0.01) | 0.0020 (0.08) | 0.82 (<0.01) | 5.28 (<0.01) | -0.66 (<0.01) | 3,555 (19.5%) |
| 50,53,59, 54,58,57,62 | -0.0039 (<0.01) | 0.0032 (<0.01) | 0.93 (<0.01) | 6.10 (<0.01) | -0.28 (<0.01) | 4,528 |
| ALL | 0.0007 (0.08) | -0.0012 (<0.01) | 0.91 (<0.01) | 5.25 (<0.01) | -0.61 (<0.01) | 5,176 |

p-values in parentheses, unobserved heterogeneity may be attenuating coefficients

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# How important are decision criteria?

- **Consider referrer with an "average" professional network**
  - Referrer connected to 5 average surgeons

Affect of decision criteria on referral probabilities

- **Consult Wait time:** Reduction by one week          1.7%

- **Location:** Not in the same LHIN                         -11%

- **Historical preferences:** 5% more                        6%

# Conclusions

- Proposed methodology to assess role of wait times in referral decisions
    - *Natural experiment to manage omitted variable bias*


- Results indicate the Consult Wait-Time impacts referrals
    - *The Ontario Wait Time does not!*


- Magnitude of parameters confirms previous survey research
    - *Wait time and location contribute modestly to the referral decision*