The External Cost of Prostitution: Evidence from Closing Brothels in the Netherlands

Erasmo Giambona
Syracuse University

Rafael P. Ribas
University of Amsterdam

53rd AREUEA-ASSA Conference, Philadelphia

January 5, 2018

Motivation

- Prostitution has always been a controversial activity
- One may see prostitution as a human right and inevitable
- Others may attach a negative connotation to it
  - Paid sex is often associated with many forms of violence (Outshoorn, 2005; Limoncelli, 2009)
- A 2015 vote by Amnesty International gave the debate a new momentum and revealed a split among activists.

Motivation

- Prostitution has always been a controversial activity
- One may see prostitution as a human right and inevitable
- Others may attach a negative connotation to it
  - Paid sex is often associated with many forms of violence (Outshoorn, 2005; Limoncelli, 2009)
- A 2015 vote by Amnesty International gave the debate a new momentum and revealed a split among activists.

The New York Times | https://nyti.ms/1MinM2M

EUROPE

Amnesty International Votes for Policy Calling for Decriminalization of Prostitution

By DOREEN CARVAJAL AUG. 11, 2015

PARIS — After days of emotional debates and intense lobbying, delegates from Amnesty International voted on Tuesday to support a policy that calls for decriminalization of the sex trade, including prostitution, payment for sex and brothel ownership.

theguardian

Tuesday 28 July 2015 21.41 BST

Amnesty International says prostitution is a human right - but it's wrong

If the organization endorses prostitution as a human right, it won't be supporting the women who might have no choice, but rather the pimps and buyers of sex who have all the choice in the world

Motivation

- **Is the sex industry harmful to society?**
- In principle, we could survey individuals' willingness to accept prostitution.
- But preferences may diverge from opinions
  - A liberal endorser might pay the cost to never get involved.
- For example, sex workers can be discriminated even in a liberal society, where paid sex is legalized.

Motivation

- **Is the sex industry harmful to society?**
- In principle, we could survey individuals' willingness to accept prostitution.
- But preferences may diverge from opinions
  - A liberal endorser might pay the cost to never get involved.
- For example, sex workers can be discriminated even in a liberal society, where paid sex is legalized.

Motivation

- **Is the sex industry harmful to society?**
- In principle, we could survey individuals' willingness to accept prostitution.
- But preferences may diverge from opinions
  - A liberal endorser might pay the cost to never get involved.
- For example, sex workers can be discriminated even in a liberal society, where paid sex is legalized.

The Economist

Sex and finance in Amsterdam

Full disclosure

The Dutch central bank fires an inspector who failed to report her part-time job

Europe Apr 17th 2015 | AMSTERDAM

Amsterdam's Red Light District, an area dominated by other trades long considered disreputable but which the city's liberal government has tried to bring above-board. But even in Amsterdam, sex work has not shed its stigma, as a former supervisor at the Dutch Central Bank (DNB) discovered last year. The Dutch magazine *Quote*

Objective

- We attempt to **value prostitution externalities**.
  - By estimating households' willingness to accept (WTA) living next to a brothel.
- If brothels are harmful to households nearby, they will require a discount on their rents.
  - If brothels benefit them, they will pay a premium.
- As for many non-market goods, the prostitution externality can be valued through **housing demand**.
  - Revealed preferences for amenities
  - Black (*QJE*, 1999), Linden and Rockhoff (*AER*, 2008), Kuminoff, Smith and Timmins (*JEL*, 2013), Adda, McConnell and Rasul (*JPE*, 2014).

Objective

- We attempt to **value prostitution externalities**.
  - By estimating households' willingness to accept (WTA) living next to a brothel.
- If brothels are harmful to households nearby, they will require a discount on their rents.
  - If brothels benefit them, they will pay a premium.
- As for many non-market goods, the prostitution externality can be valued through **housing demand**.
  - Revealed preferences for amenities
  - Black (*QJE*, 1999), Linden and Rockhoff (*AER*, 2008), Kuminoff, Smith and Timmins (*JEL*, 2013), Adda, McConnell and Rasul (*JPE*, 2014).

Identification Strategies

- Identifying WTA is difficult because prostitution often emerges in inexpensive areas (reverse causality).
- Using house price data (NVM), we exploit unique settings in Red Light Districts (RLD) of two Dutch cities.
- In **Amsterdam**, RLDs are naturally delimited by canals
  - With no "red" window operating outside.
  - **Boundary discontinuity** of house price at the canals.
  - And **difference in discontinuity** (DiD) after sex windows are forcibly closed.
- **Utrecht** has closed all RLDs since July 2013.
  - We compare houses as a function of distance to RLDs **before** and **after**.
  - Non-parametric **difference-in-slope** (DiS) estimator.

Identification Strategies

- Identifying WTA is difficult because prostitution often emerges in inexpensive areas (reverse causality).
- Using house price data (NVM), we exploit unique settings in Red Light Districts (RLD) of two Dutch cities.
- In **Amsterdam**, RLDs are naturally delimited by canals
  - With no "red" window operating outside.
  - **Boundary discontinuity** of house price at the canals.
  - And **difference in discontinuity** (DiD) after sex windows are forcibly closed.
- **Utrecht** has closed all RLDs since July 2013.
  - We compare houses as a function of distance to RLDs **before** and **after**.
  - Non-parametric **difference-in-slope** (DiS) estimator.

Identification Strategies

- Identifying WTA is difficult because prostitution often emerges in inexpensive areas (reverse causality).
- Using house price data (NVM), we exploit unique settings in Red Light Districts (RLD) of two Dutch cities.
- In **Amsterdam**, RLDs are naturally delimited by canals
  - With no "red" window operating outside.
  - **Boundary discontinuity** of house price at the canals.
  - And **difference in discontinuity** (DiD) after sex windows are forcibly closed.
- **Utrecht** has closed all RLDs since July 2013.
  - We compare houses as a function of distance to RLDs **before** and **after**.
  - Non-parametric **difference-in-slope** (DiS) estimator.

Identification Strategies

- Identifying WTA is difficult because prostitution often emerges in inexpensive areas (reverse causality).
- Using house price data (NVM), we exploit unique settings in Red Light Districts (RLD) of two Dutch cities.
- In **Amsterdam**, RLDs are naturally delimited by canals
  - With no "red" window operating outside.
  - **Boundary discontinuity** of house price at the canals.
  - And **difference in discontinuity** (DiD) after sex windows are forcibly closed.
- **Utrecht** has closed all RLDs since July 2013.
  - We compare houses as a function of distance to RLDs **before** and **after**.
  - Non-parametric **difference-in-slope** (DiS) estimator.

Identification Strategies

- Identifying WTA is difficult because prostitution often emerges in inexpensive areas (reverse causality).
- Using house price data (NVM), we exploit unique settings in Red Light Districts (RLD) of two Dutch cities.
- In **Amsterdam**, RLDs are naturally delimited by canals
  - With no "red" window operating outside.
  - **Boundary discontinuity** of house price at the canals.
  - And **difference in discontinuity** (DiD) after sex windows are forcibly closed.
- **Utrecht** has closed all RLDs since July 2013.
  - We compare houses as a function of distance to RLDs **before** and **after**.
  - Non-parametric **difference-in-slope** (DiS) estimator.

Related Literature on Housing and Amenities

- **Housing demand** have been broadly used to assess the value of amenities, externalities and public goods.
- These estimates help to determine the **monetary benefit of public policies** (cost-benefit analysis).
- For example:
  - Education and school investment (Black, 1999; Cellini, Ferreira, Rothstein, 2010; Gibbons, Machin and Silva, 2013).
  - Toxic waste and health risk (Bui and Mayer, 2003; Davis, 2004; Greenstone and Gallagher, 2008; Currie et al., 2015).
  - Quality of neighborhood (Rossi-Hansberg, Sarte, Owens III, 2010).
  - Drug policy (Adda, McConnell, Rasul, 2014).
  - Crime risk and law enforcement (Thaler, 1978; Gibbons, 2004; Linden and Rockhoff, 2008).

Related Literature on Housing and Amenities

- **Housing demand** have been broadly used to assess the value of amenities, externalities and public goods.
- These estimates help to determine the **monetary benefit of public policies** (cost-benefit analysis).
- For example:
  - Education and school investment (Black, 1999; Cellini, Ferreira, Rothstein, 2010; Gibbons, Machin and Silva, 2013).
  - Toxic waste and health risk (Bui and Mayer, 2003; Davis, 2004; Greenstone and Gallagher, 2008; Currie et al., 2015).
  - Quality of neighborhood (Rossi-Hansberg, Sarte, Owens III, 2010).
  - Drug policy (Adda, McConnell, Rasul, 2014).
  - Crime risk and law enforcement (Thaler, 1978; Gibbons, 2004; Linden and Rockhoff, 2008).

Related Literature on the Economics of Prostitution

- Most studies on prostitution are focused on the determinants of supply and demand.
  - E.g., Edlund and Korn (2002), Rao et al. (2003), Gertler, Shah and Bertozzi (2005), and Li, Lang and Leong (2017).
  - See Cunningham and Shah (2016) for a review.
- Just a few investigate the effects of prostitution policy:
  - On people's **acceptance** (Kotsadam and Jakobsson, 2011);
  - **Human trafficking** (Cho, Dreher and Neumayer, 2013; Lee and Persson, 2015); and
  - **Sexual violence** (Cunningham and Shah, 2014; Bisschop, Kastoryano, van der Klaauw, 2017).
- To our knowledge, ours is the first to assess the monetary value of externalities from the sex industry.

Related Literature on the Economics of Prostitution

- Most studies on prostitution are focused on the determinants of supply and demand.
  - E.g., Edlund and Korn (2002), Rao et al. (2003), Gertler, Shah and Bertozzi (2005), and Li, Lang and Leong (2017).
  - See Cunningham and Shah (2016) for a review.
- Just a few investigate the effects of prostitution policy:
  - On people's **acceptance** (Kotsadam and Jakobsson, 2011);
  - **Human trafficking** (Cho, Dreher and Neumayer, 2013; Lee and Persson, 2015); and
  - **Sexual violence** (Cunningham and Shah, 2014; Bisschop, Kastoryano, van der Klaauw, 2017).
- To our knowledge, ours is the first to assess the monetary value of externalities from the sex industry.

(Very) Brief History of Prostitution Policy

- Since the Middle Ages, brothels have been allowed in Dutch cities, but **confined into RLDs**.
  - It is how local authorities have kept them under control.
  - A system of regulation through toleration (*gedogen*).
- Although **illegal** (and **unregulated**), brothels were **tolerated**.
- They became vehicles to cover criminal activities, including tax fraud and human trafficking.
- To combat them:
  - Brothels and prostitution were legalized in 2000
  - Local authorities gained more power to close brothels under investigation in 2003 (BIBOB law).

(Very) Brief History of Prostitution Policy

- Since the Middle Ages, brothels have been allowed in Dutch cities, but **confined into RLDs**.
  - It is how local authorities have kept them under control.
  - A system of regulation through toleration (*gedogen*).
- Although **illegal** (and **unregulated**), brothels were **tolerated**.
- They became vehicles to cover criminal activities, including tax fraud and human trafficking.
- To combat them:
  - Brothels and prostitution were legalized in 2000
  - Local authorities gained more power to close brothels under investigation in 2003 (BIBOB law).

(Very) Brief History of Prostitution Policy

- Since the Middle Ages, brothels have been allowed in Dutch cities, but **confined into RLDs**.
  - It is how local authorities have kept them under control.
  - A system of regulation through toleration (*gedogen*).
- Although **illegal** (and **unregulated**), brothels were **tolerated**.
- They became vehicles to cover criminal activities, including tax fraud and human trafficking.
- To combat them:
  - Brothels and prostitution were legalized in 2000
  - Local authorities gained more power to close brothels under investigation in 2003 (BIBOB law).

Recent Developments

- Amsterdam has used the BIBOB law since the end of 2006.
  - 108 sex businesses were investigated and 58 were closed.
- The city also decided to buy properties and reduce the size of the RLDs.
  - Part of Project 1012, launched in 2007.
  - The goal was to reduce the number of windows by half.
  - But only 27% were closed so far (out of 477).
- The city of Utrecht started to investigate sex businesses in 2008 and shut down all brothels and windows in May-July 2013.
  - A new RLD was approved in 2016, but it has been delayed.
- In the Netherlands, the number of red windows decreased from 2,096 in 1999 to 1,272 in 2016.

Recent Developments

- Amsterdam has used the BIBOB law since the end of 2006.
  - 108 sex businesses were investigated and 58 were closed.
- The city also decided to buy properties and reduce the size of the RLDs.
  - Part of Project 1012, launched in 2007.
  - The goal was to reduce the number of windows by half.
  - But only 27% were closed so far (out of 477).
- The city of Utrecht started to investigate sex businesses in 2008 and shut down all brothels and windows in May-July 2013.
  - A new RLD was approved in 2016, but it has been delayed.
- In the Netherlands, the number of red windows decreased from 2,096 in 1999 to 1,272 in 2016.

Theoretical Framework

- The settings for Amsterdam and Utrecht have distinct interpretation:
  1. **Boundary discontinuity** in Amsterdam assesses the **environmental externality**
     - Such as noise, crowdedness, liveliness, and presence of sex workers itself.
     - On the most receptive (lower bound).
  2. **Distance function** in Utrecht assesses the **economic impact** away from the RLD.
     - If the RLD creates jobs and/or attract customers, some households will pay to live as close as possible.
     - If they don't feel safe in the RLD, they will pay to live far away.

Theoretical Framework

- The settings for Amsterdam and Utrecht have distinct interpretation:
  1. **Boundary discontinuity** in Amsterdam assesses the **environmental externality**
     - Such as noise, crowdedness, liveliness, and presence of sex workers itself.
     - On the most receptive (lower bound).
  2. **Distance function** in Utrecht assesses the **economic impact** away from the RLD.
     - If the RLD creates jobs and/or attract customers, some households will pay to live as close as possible.
     - If they don't feel safe in the RLD, they will pay to live far away.

Theoretical Framework

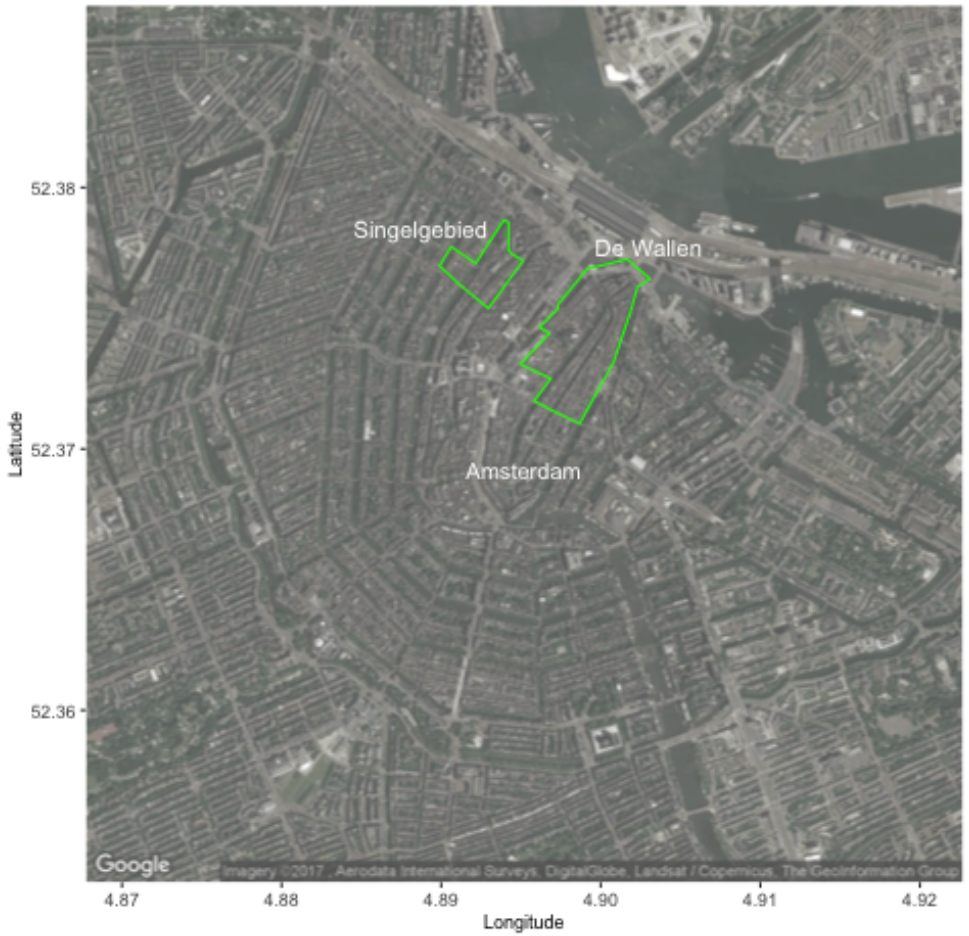
- The settings for Amsterdam and Utrecht have distinct interpretation:
  1. **Boundary discontinuity** in Amsterdam assesses the **environmental externality**
     - Such as noise, crowdedness, liveliness, and presence of sex workers itself.
     - On the most receptive (lower bound).
  2. **Distance function** in Utrecht assesses the **economic impact** away from the RLD.
     - If the RLD creates jobs and/or attract customers, some households will pay to live as close as possible.
     - If they don't feel safe in the RLD, they will pay to live far away.

Assumptions

Amsterdam

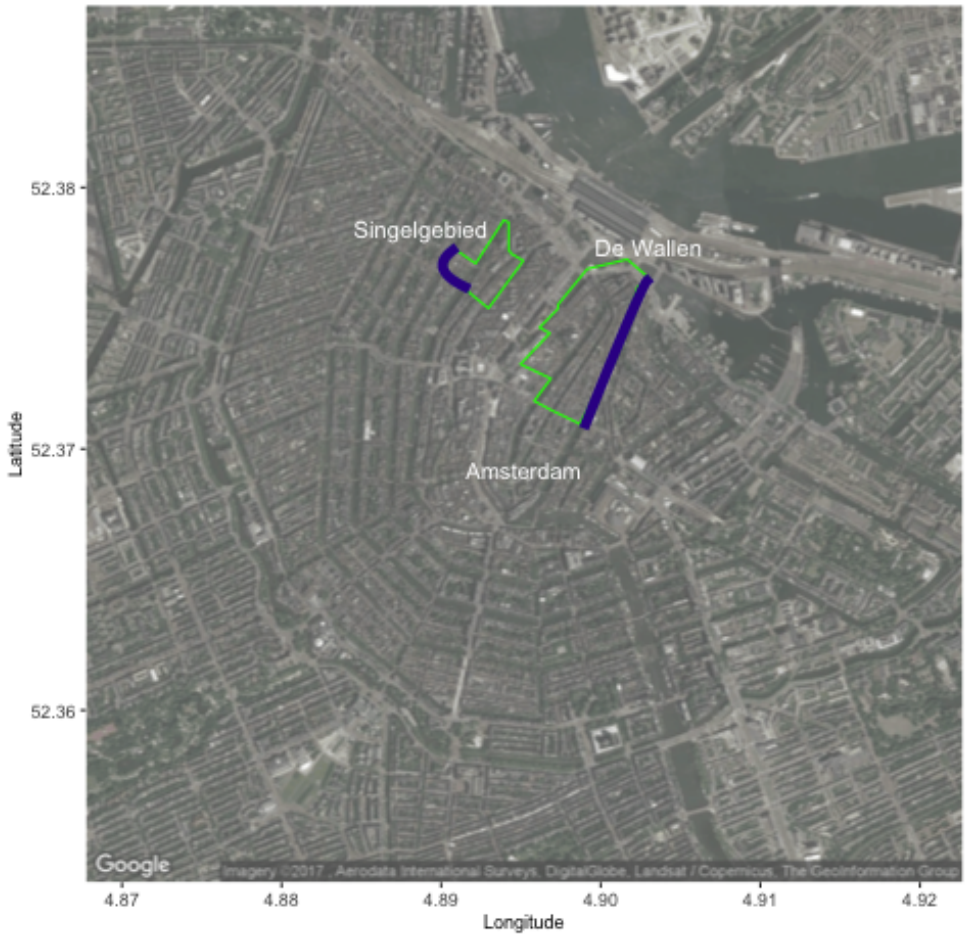
RLDs in Amsterdam

- Amsterdam has two RLDs:
  - ***De Wallen***, the biggest and most famous
  - ***Singelgebied***
- Well-defined, tolerance zones since the postwar, with almost no red window operating out of their limits.
  - There is also a small RLD (*Ruysdaelkade*) located in the South district.



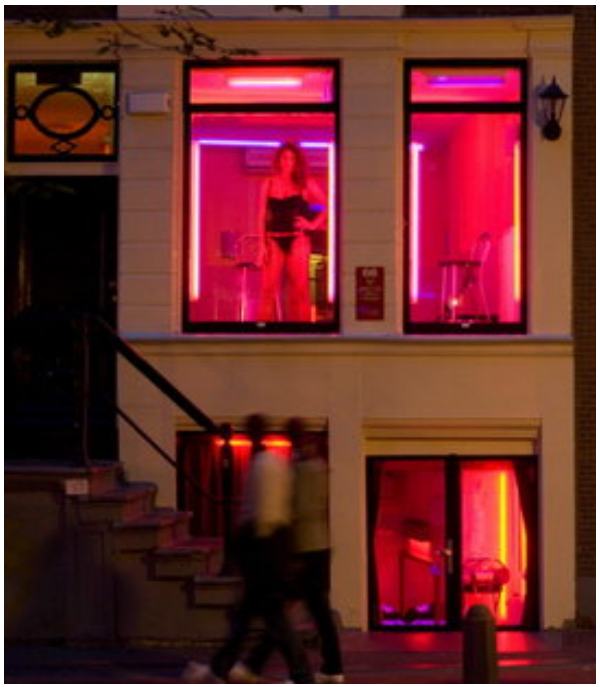
RLDs in Amsterdam

- Amsterdam has two RLDs:
  - ***De Wallen***, the biggest and most famous
  - ***Singelgebied***
- Well-defined, tolerance zones since the postwar, with almost no red window operating out of their limits.
  - There is also a small RLD (*Ruysdaelkade*) located in the South district.



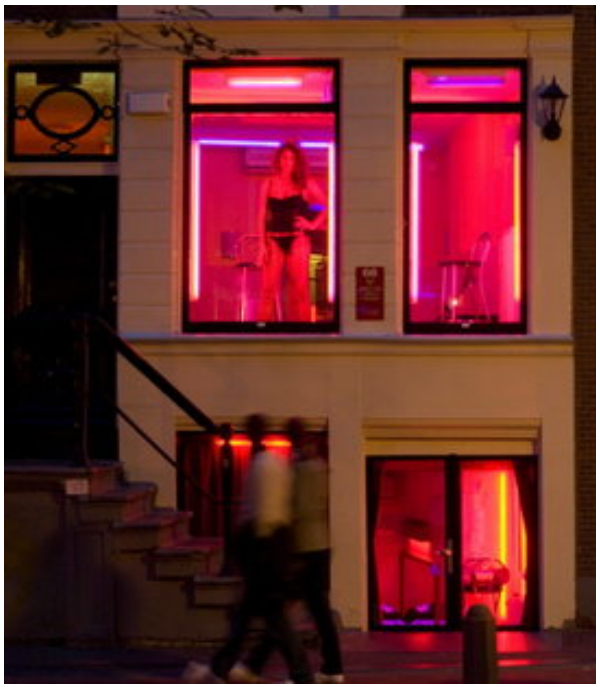
Houses and Red Windows in Amsterdam

Operating window



Houses and Red Windows in Amsterdam

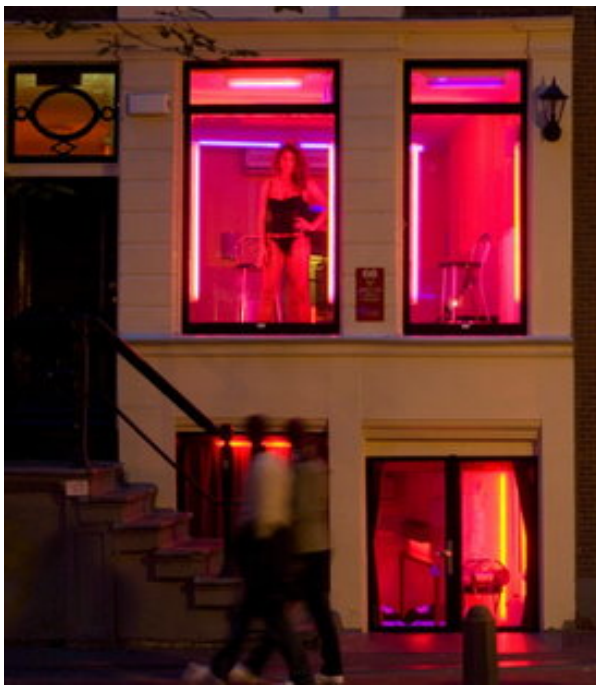
Operating window



Closed window at the canal

Houses and Red Windows in Amsterdam

Operating window



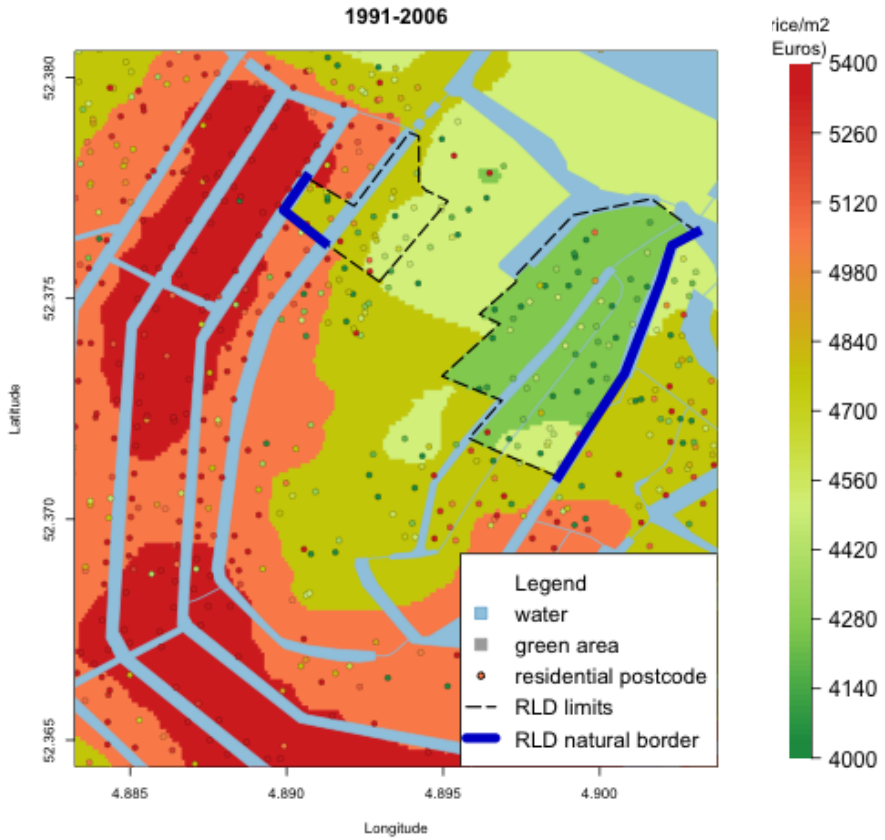
Closed window at the canal

House on the other side

Houses and Red Windows in Amsterdam

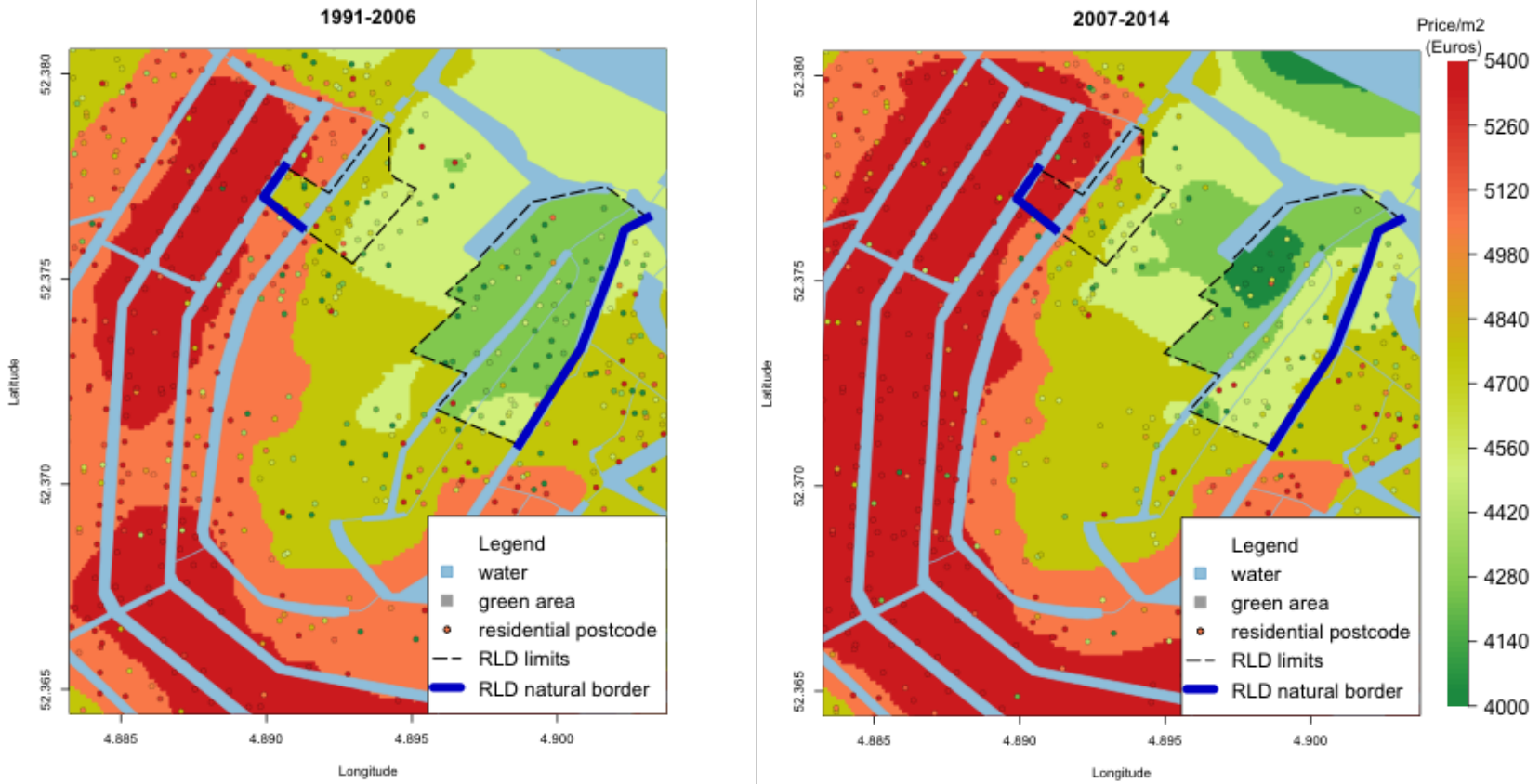
House Prices in Amsterdam

- Prices are different across the canals and a house can cost 400 euros/m^2 less in the RLD.
- Since 2007, prices at the canals have practically equalized.



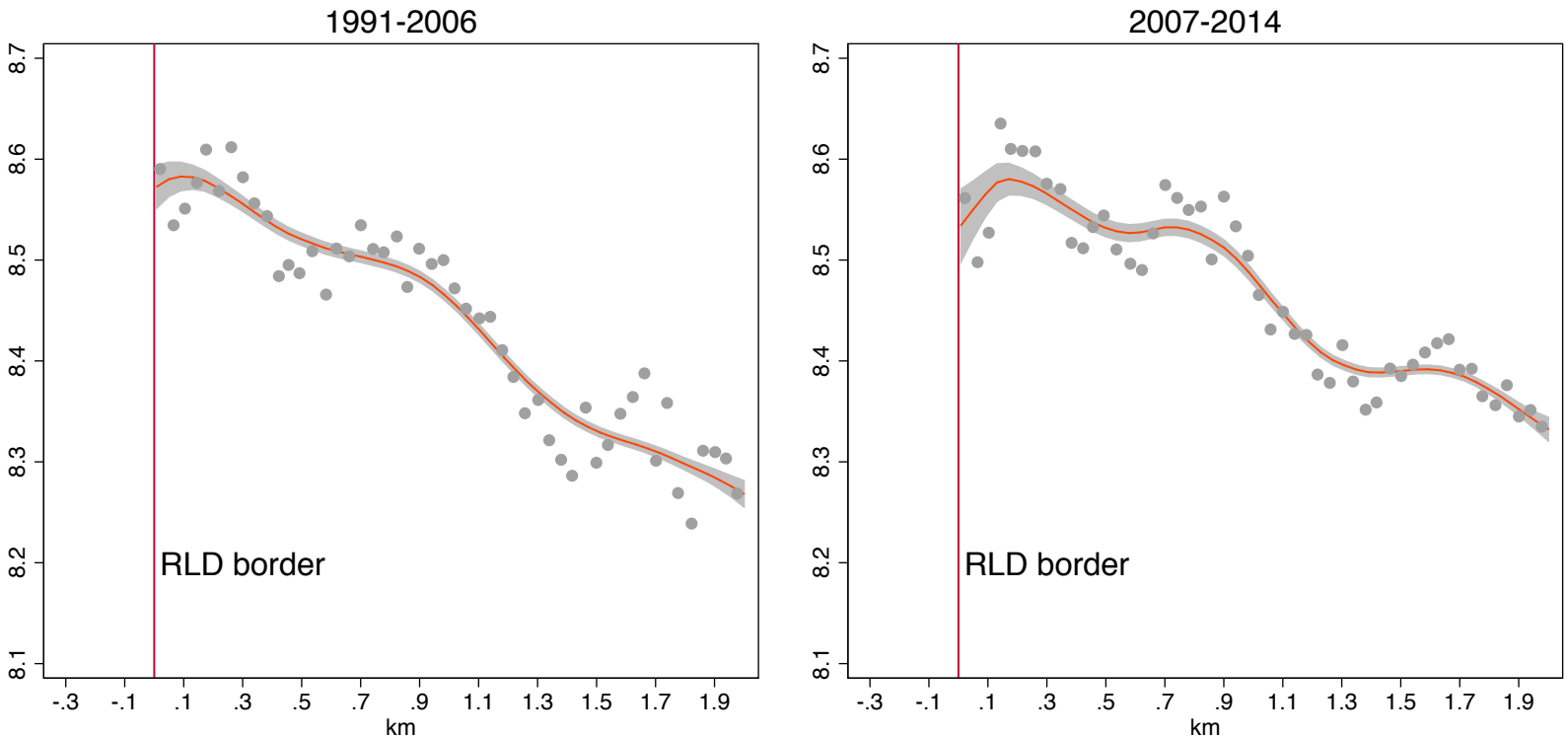
House Prices in Amsterdam

- Prices are different across the canals and a house can cost 400 euros/m^2 less in the RLD.
- Since 2007, prices at the canals have practically equalized.



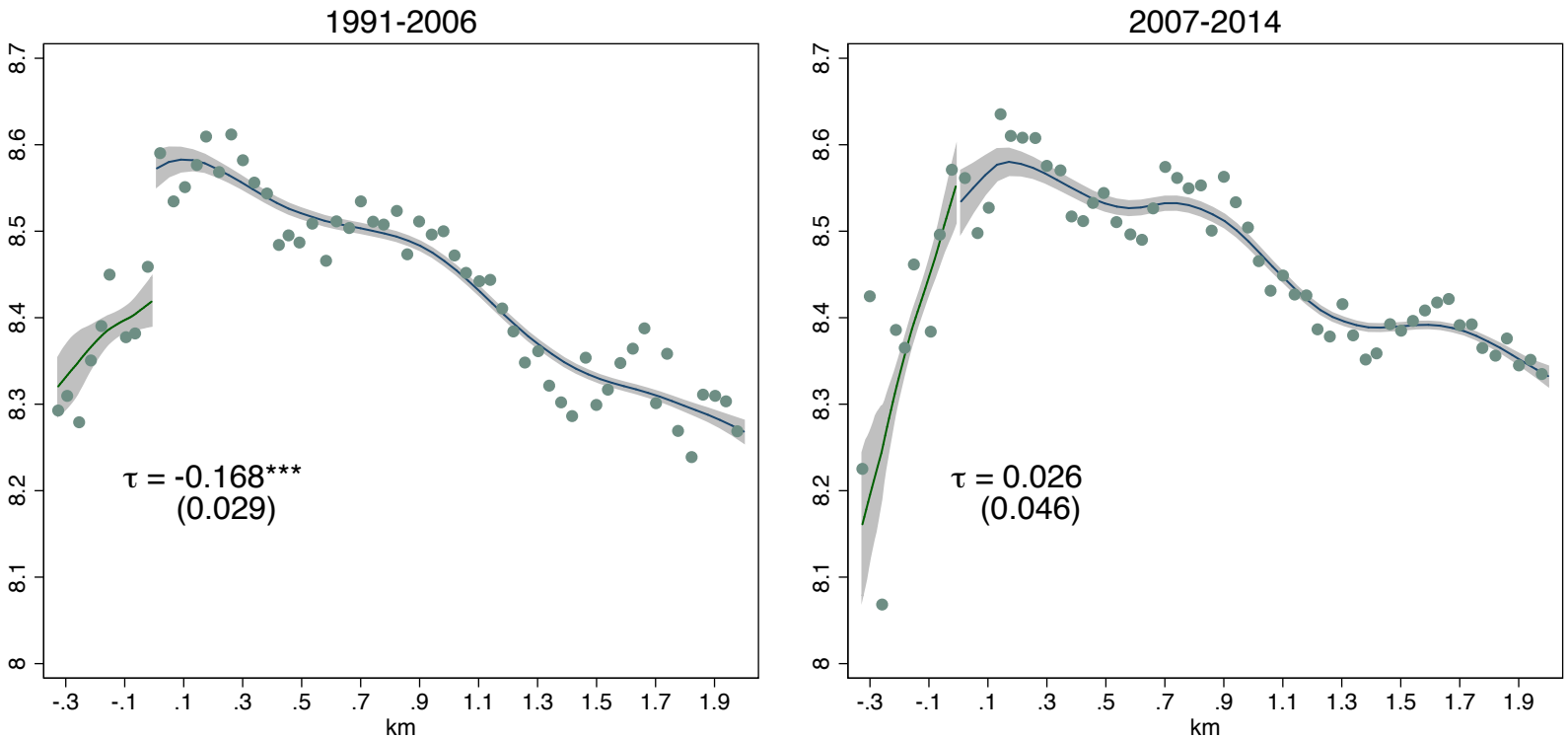
Average Discontinuity

- First, we use only the **minimum distance** to the border
- Prices decline with distance to center.
- But prices were 17% lower in the RLD in 1991-2006
- Later, the discount disappears



Average Discontinuity

- First, we use only the **minimum distance** to the border
- Prices decline with distance to center.
- But prices were 17% lower in the RLD in 1991-2006
- Later, the discount disappears

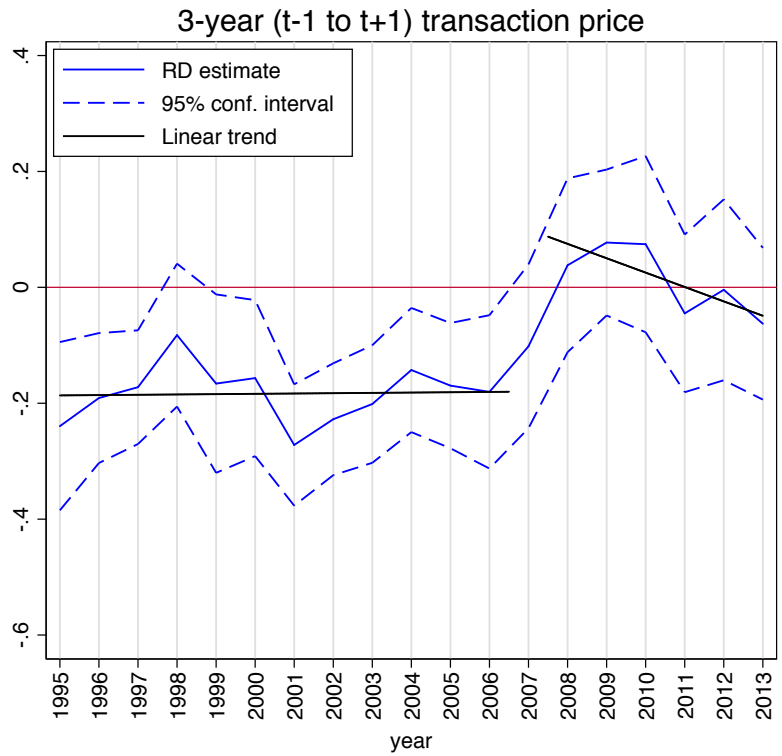


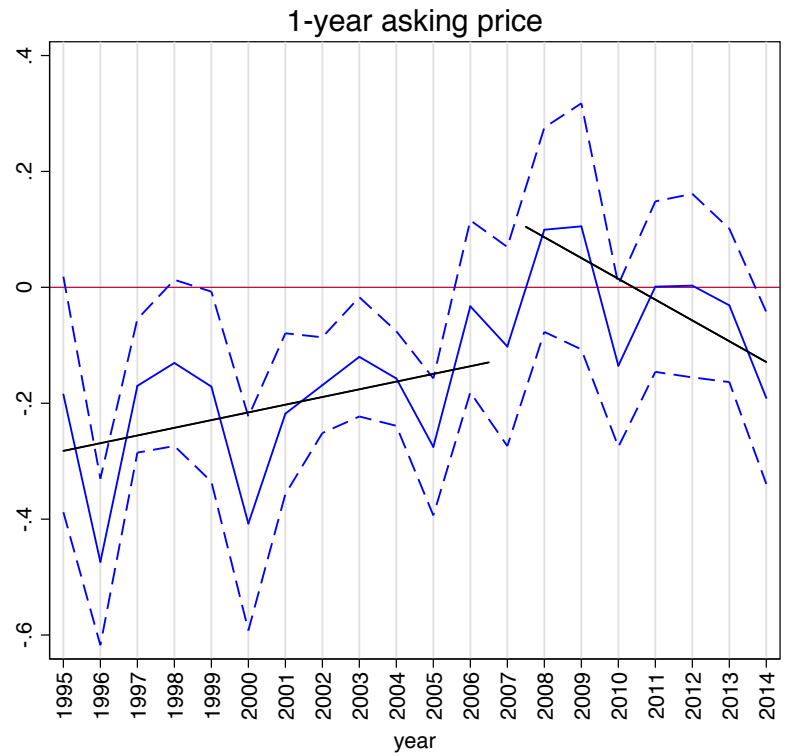
Discontinuity per Year

- Is 2007 the year of change?
- We use 3-year intervals and 1-year asking prices (bigger sample)
- Prices on the RLD side start growing in 2006-2008

Discontinuity per Year

- Is 2007 the year of change?
- We use 3-year intervals and 1-year asking prices (bigger sample)
- Prices on the RLD side start growing in 2006-2008





Empirical Strategy, Difference-in-Discontinuity

- Red windows are not equally spread within RLDs.
- To account for that, the **cut-off point** is not unique.
- The **log price per square meter** is a function of **longitude**, s_{1i}, and **latitude**, s_{2i}.
- The price discontinuity at point l and time t:

$$\tau_{lt} \equiv \lim_{\tilde{d}(\boldsymbol{c}_l,\boldsymbol{s})\uparrow 0} \mu_{1t}(s_1, s_2) - \lim_{\tilde{d}(\boldsymbol{c}_l,\boldsymbol{s})\downarrow 0} \mu_{0t}(s_1, s_2)$$

- Difference in discontinuity (DiD) for each point of the border:

$$\Delta\tau_l \equiv \tau_{l0} - \tau_{l1}$$

- And everywhere else in the RLD:

$$\Delta\tau(\boldsymbol{s}) = \mu_{10}(\boldsymbol{s}) - \mu_{11}(\boldsymbol{s}) - \{\mu_{00}(\boldsymbol{c}_l) - \mu_{01}(\boldsymbol{c}_l) \,|\, \boldsymbol{c}_l \in \mathbf{c} \text{ and } \boldsymbol{c}_l = \operatorname{argmin} d(\boldsymbol{c}_l, \boldsymbol{s})\}.$$

Empirical Strategy, Difference-in-Discontinuity

- Red windows are not equally spread within RLDs.
- To account for that, the **cut-off point** is not unique.
- The **log price per square meter** is a function of **longitude**, s_{1i}, and **latitude**, s_{2i}.
- The price discontinuity at point l and time t:

$$\tau_{lt} \equiv \lim_{\tilde{d}(\boldsymbol{c}_l,\boldsymbol{s})\uparrow 0} \mu_{1t}(s_1, s_2) - \lim_{\tilde{d}(\boldsymbol{c}_l,\boldsymbol{s})\downarrow 0} \mu_{0t}(s_1, s_2)$$

- Difference in discontinuity (DiD) for each point of the border:

$$\Delta\tau_l \equiv \tau_{l0} - \tau_{l1}$$

- And everywhere else in the RLD:

$$\Delta\tau\left(\boldsymbol{s}\right) = \mu_{10}(\boldsymbol{s}) - \mu_{11}(\boldsymbol{s}) - \left\{\mu_{00}(\boldsymbol{c}_l) - \mu_{01}(\boldsymbol{c}_l) \,|\, \boldsymbol{c}_l \in \mathbf{c} \;\text{ and }\; \boldsymbol{c}_l = \operatorname{argmin} d\left(\boldsymbol{c}_l, \boldsymbol{s}\right)\right\}.$$

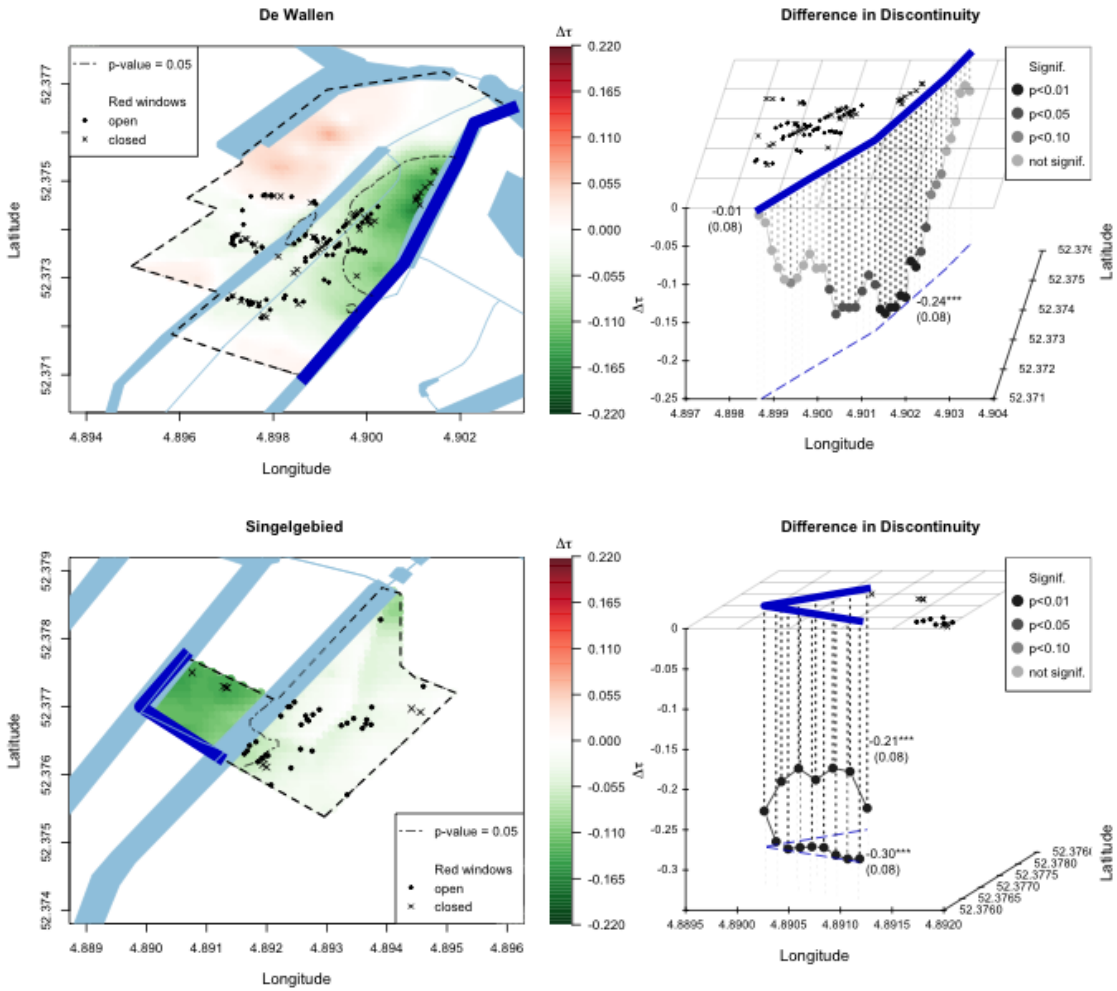
Estimator

Main Findings, Difference-in-Discontinuity

Do differences in discontinuity coincide with closing of windows?

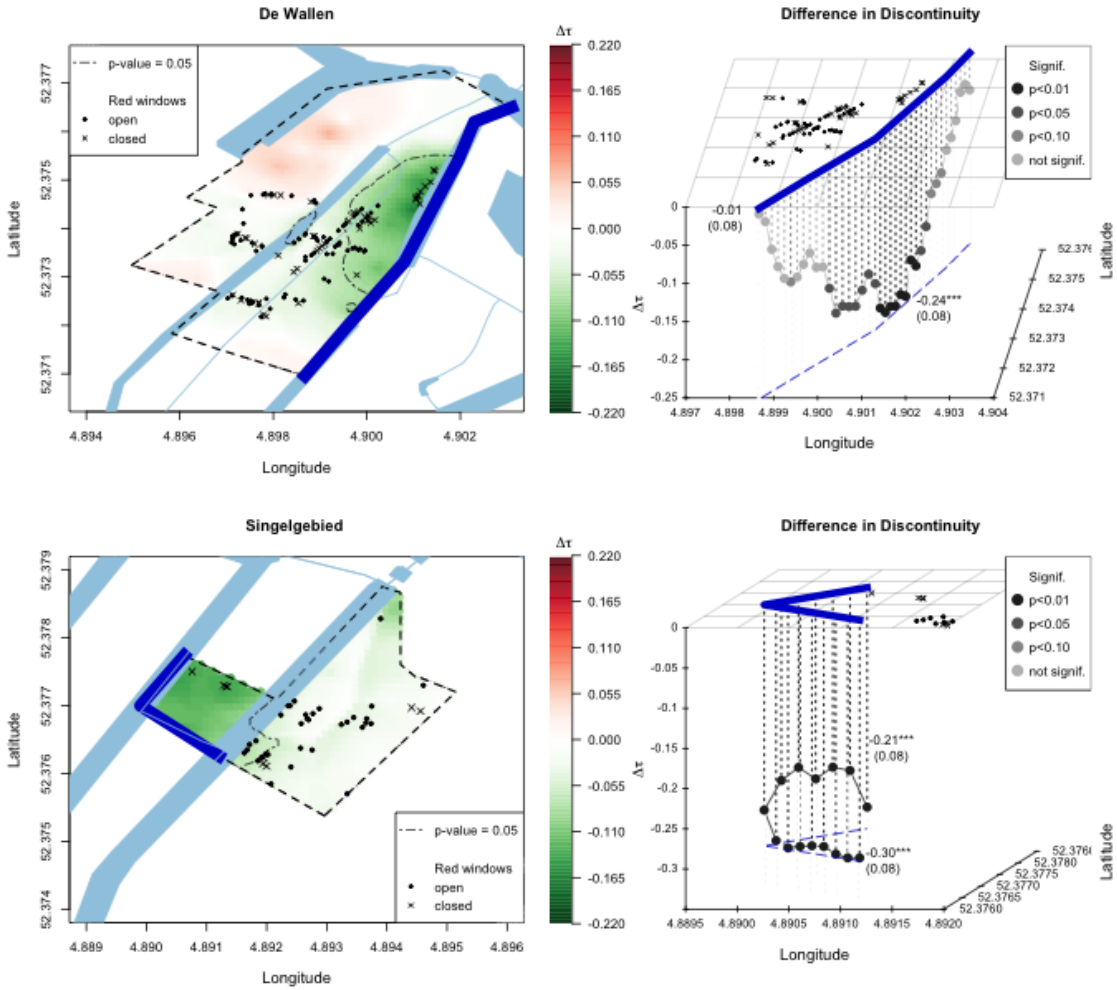
Main Findings, Difference-in-Discontinuity

- Prices increased particularly by the border, where they were closed.
- Discount is 21-30% if the house is right next to a red window.
- Or 4,100-7,100 euros/year.
- In total, properties have appreciated by 31 million euros.
  - The buyouts have costed 25 million euros.



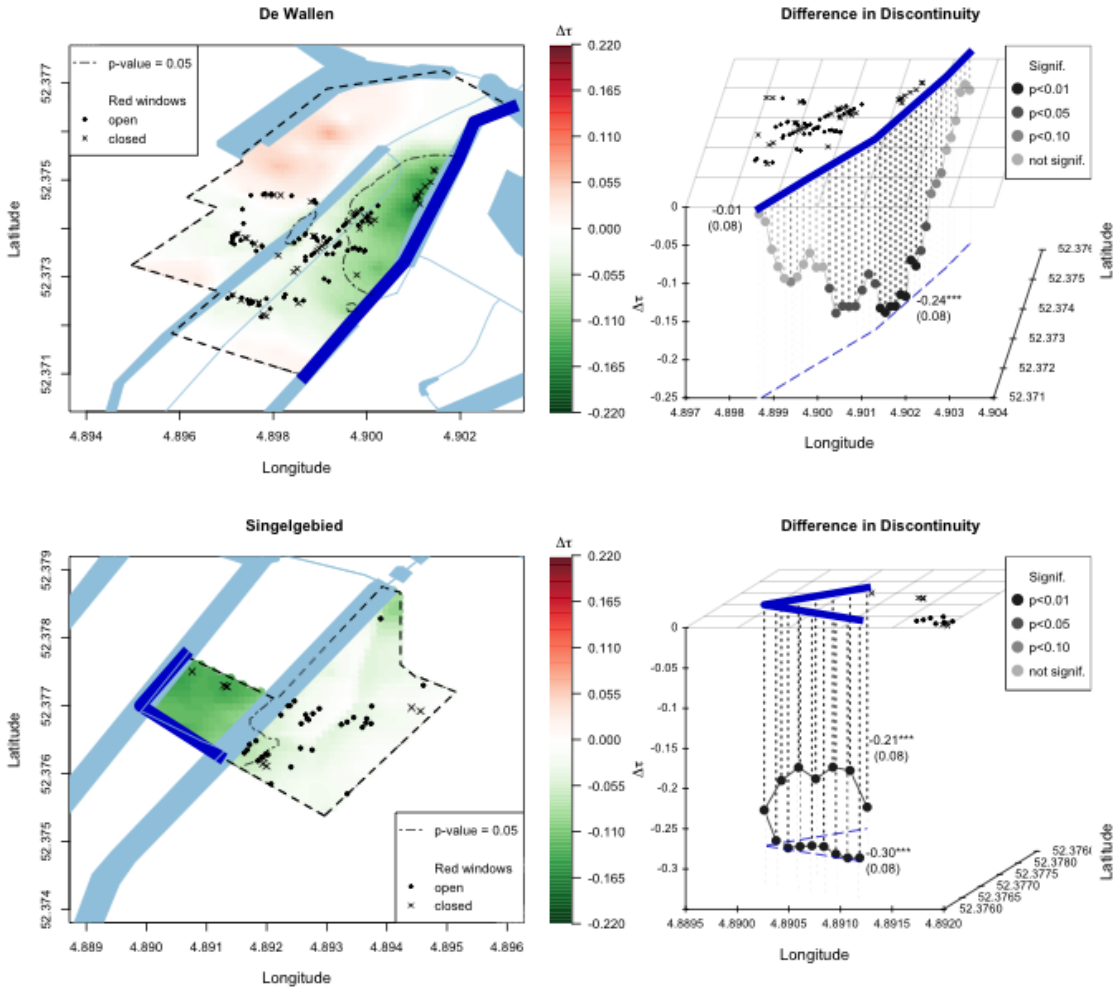
Main Findings, Difference-in-Discontinuity

- Prices increased particularly by the border, where they were closed.
- Discount is 21-30% if the house is right next to a red window.
- Or 4,100-7,100 euros/year.
- In total, properties have appreciated by 31 million euros.
  - The buyouts have costed 25 million euros.



Main Findings, Difference-in-Discontinuity

- Prices increased particularly by the border, where they were closed.
- Discount is 21-30% if the house is right next to a red window.
- Or 4,100-7,100 euros/year.
- In total, properties have appreciated by 31 million euros.
  - The buyouts have costed 25 million euros.



Cross-section

Project 1012

Empirical Strategy, Conditional DiD

- So far we assume that expected change (DiD) is only driven by closing windows.
- House **location** is now defined by minimum distance to the border, s_i, and initial distance to a red window, r_{i0}.
- The DiD is approximately given by:

$$\Delta\tau_l \approx \delta^0 \Delta r_l + \delta^1 \left(r_{l0} \cdot \Delta r_l\right) + \delta^2 + \delta^3 r_{l0},$$

where

δ^0 = MWTA,

δ^1 = derivative of MWTA w.r.t. r,

δ^2 = average effect of other events (at $r_0 = 0$),

δ^3 = derivative of other effects w.r.t. r.

- If $\delta^2 = \delta^3 = 0$, then **DiD does not depend on other events**.

Empirical Strategy, Conditional DiD

- So far we assume that expected change (DiD) is only driven by closing windows.
- House **location** is now defined by minimum distance to the border, s_i, and initial distance to a red window, r_{i0}.
- The DiD is approximately given by:

$$\Delta\tau_l \approx \delta^0 \Delta r_l + \delta^1 \left(r_{l0} \cdot \Delta r_l\right) + \delta^2 + \delta^3 r_{l0},$$

where

δ^0 = MWTA,

δ^1 = derivative of MWTA w.r.t. r,

δ^2 = average effect of other events (at $r_0 = 0$),

δ^3 = derivative of other effects w.r.t. r.

- If $\delta^2 = \delta^3 = 0$, then **DiD does not depend on other events**.

Estimator

Estimated MWTA (Conditional DiD)

- We find that the MWTA is 16.6-19.3% per 100 meters.
  - It means 3,200-4,500 euros a year
- Other events have no significant effect on the average DiD.

	Bandwidth selection procedure	
	CCT	IK
1991/2006-2007/2014		
Difference in distance to red window (δ^0)	0.194 (3.30)	0.193 (3.28)
Difference × initial distance (δ^1)	-0.094 (-2.03)	-0.094 (-2.02)
Intercept (δ^2)	0.024 (0.57)	0.016 (0.32)
Initial distance to red window (δ^3)	-0.010 (-0.47)	-0.010 (-0.48)
2001/2006-2007/2014		
Difference in distance to red window (δ^0)	0.166 (2.46)	0.177 (2.67)
Difference × initial distance (δ^1)	-0.089 (-1.76)	-0.096 (-1.91)
Intercept (δ^2)	0.058 (1.20)	0.056 (0.81)
Initial distance to red window (δ^3)	-0.002 (-0.11)	0.003 (0.13)

MWTA from Unconditional DiD

Estimated MWTA (Conditional DiD)

- We find that the MWTA is 16.6-19.3% per 100 meters.
  - It means 3,200-4,500 euros a year
- Other events have no significant effect on the average DiD.

	Bandwidth selection procedure	
	CCT	IK
1991/2006-2007/2014		
Difference in distance to red window (δ^0)	0.194 (3.30)	0.193 (3.28)
Difference × initial distance (δ^1)	-0.094 (-2.03)	-0.094 (-2.02)
Intercept (δ^2)	0.024 (0.57)	0.016 (0.32)
Initial distance to red window (δ^3)	-0.010 (-0.47)	-0.010 (-0.48)
2001/2006-2007/2014		
Difference in distance to red window (δ^0)	0.166 (2.46)	0.177 (2.67)
Difference × initial distance (δ^1)	-0.089 (-1.76)	-0.096 (-1.91)
Intercept (δ^2)	0.058 (1.20)	0.056 (0.81)
Initial distance to red window (δ^3)	-0.002 (-0.11)	0.003 (0.13)

MWTA from Unconditional DiD

Deadweight Loss

- About **125-200 million euros** was lost in property value until 2007.
  - Out of 920 million euros.
- All households together, required **7-13 million euros a year** to live in the RLD
  - Considering a 30-year mortgage rate of 3.5%-5% p.a.
  - Close to the annual budget of Project 1012.
- **Other findings:**
  - No significant effect on housing supply See
  - No significant change in other businesses See

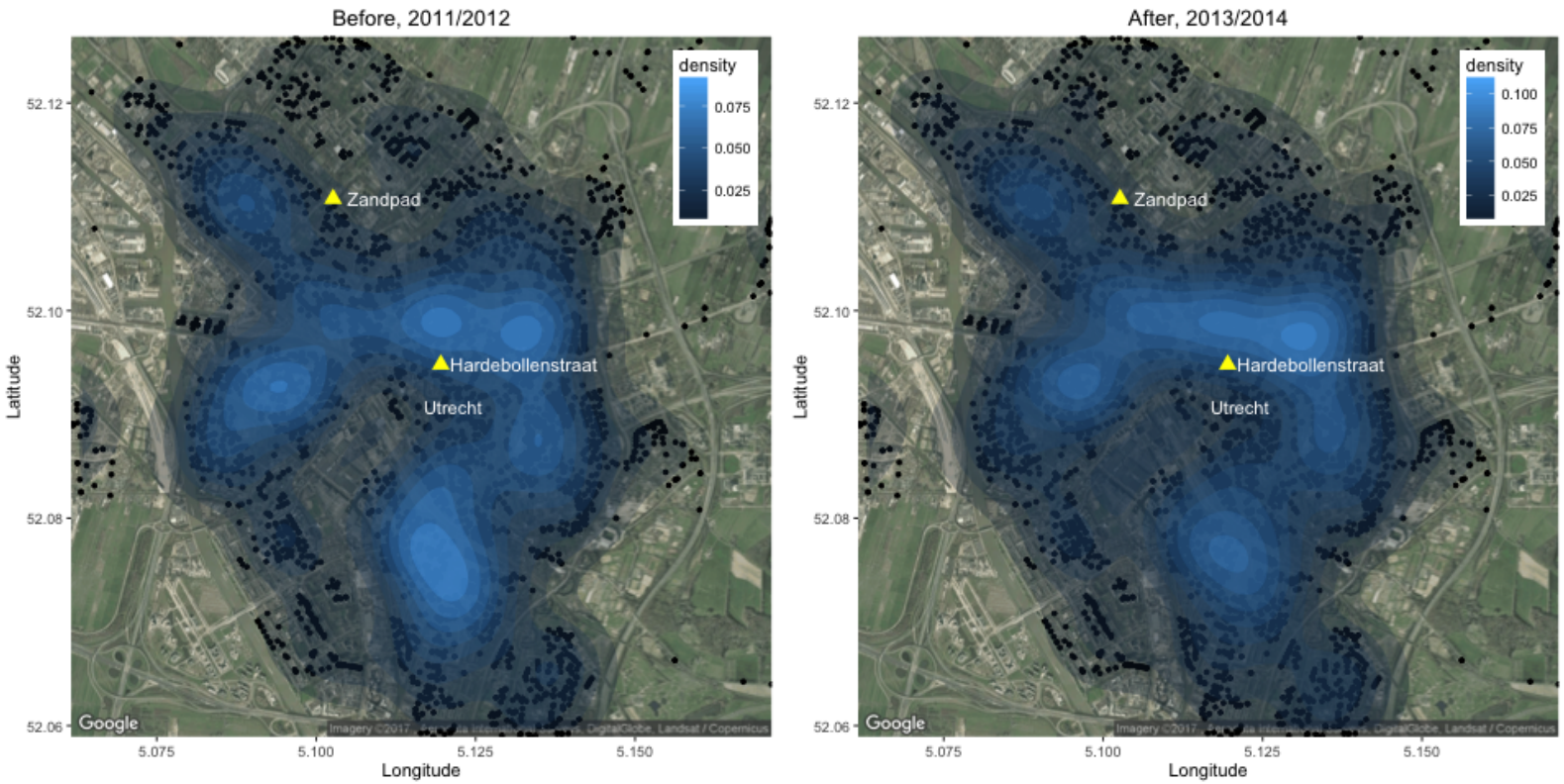
Deadweight Loss

- About **125-200 million euros** was lost in property value until 2007.
  - Out of 920 million euros.
- All households together, required **7-13 million euros a year** to live in the RLD
  - Considering a 30-year mortgage rate of 3.5%-5% p.a.
  - Close to the annual budget of Project 1012.
- **Other findings:**
  - No significant effect on housing supply See
  - No significant change in other businesses See

Utrecht

Red Light Districts in Utrecht

- ***Hardebollenstraat***, a two-block street in the central area.
- ***Zandpad***, 3km away, where prostitutes worked in houseboats.



Red Light Districts in Utrecht

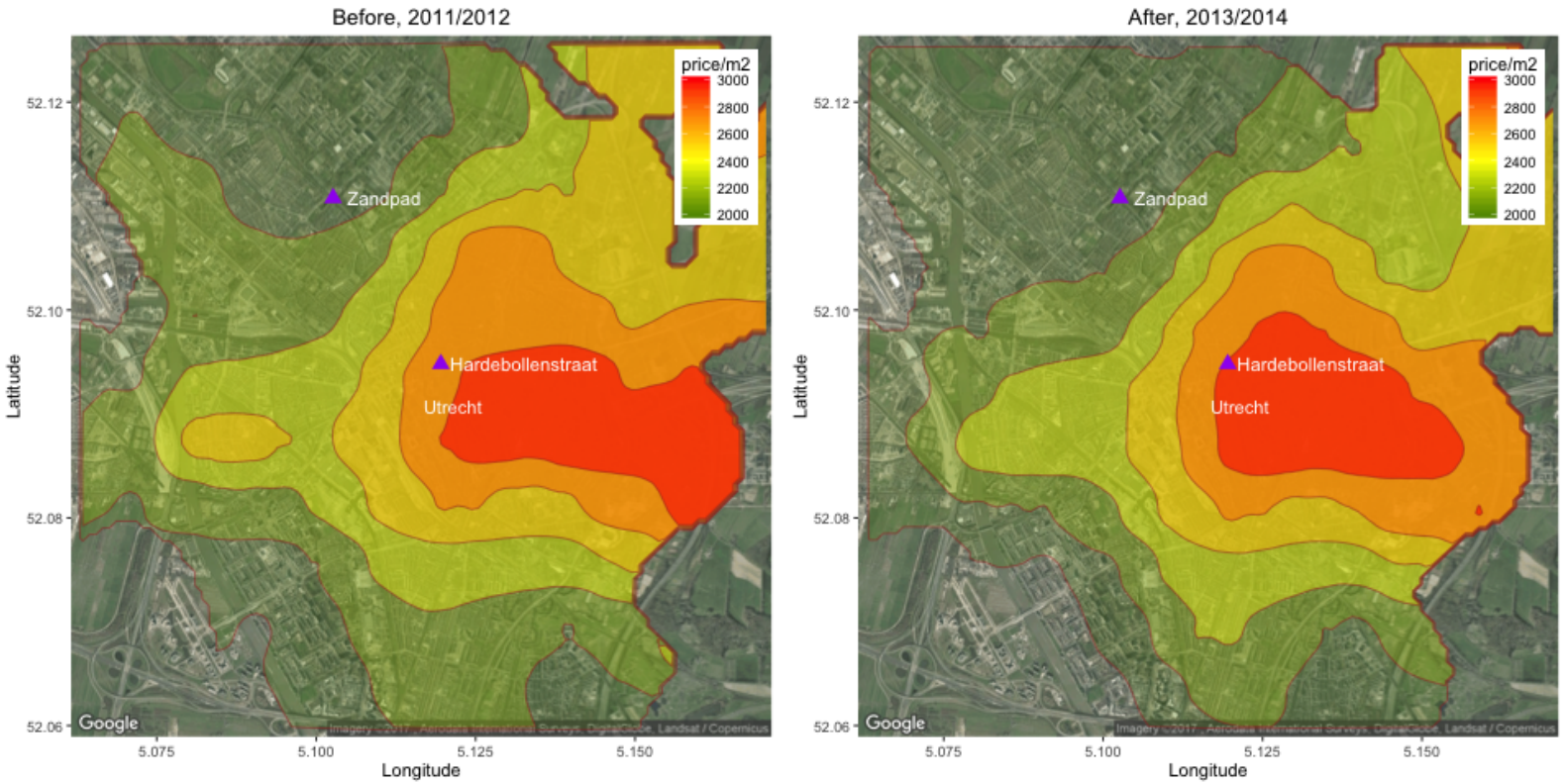
Hardebollenstraat

Red Light Districts in Utrecht

Zandpad

House Prices in Utrecht

- On July 25, 2013, the last red windows and sex boats were close.
  - On suspicion of human trafficking.
- Prices on *Hardebollenstraat* became as high as in the center.



Empirical Strategy

- To test for changes in house prices, we use a nonparametric **difference-in-slope** (DiS) approach.
- The distance to the RLD is a **continuous** "treatment"
- Systematic differences across locations is captured by the distance function after the shutdown.
- Identification works as follows:
  - If prices change in all locations, the distance function just moves upward or downward.
  - But if prices are affected by the RLD, then the slope should change too.

Empirical Strategy

- To test for changes in house prices, we use a nonparametric **difference-in-slope** (DiS) approach.
- The distance to the RLD is a **continuous** "treatment"
- Systematic differences across locations is captured by the distance function after the shutdown.
- Identification works as follows:
  - If prices change in all locations, the distance function just moves upward or downward.
  - But if prices are affected by the RLD, then the slope should change too.

Empirical Strategy

- Let $\boldsymbol{s}_i = (s_{1i}, s_{2i})$ be coordinates of house i and h_i be the distance to the RLD. Then:

$$y_{it} = \mu_t(\boldsymbol{s}_i) + \gamma_t(\boldsymbol{s}_i)\, h_i + x_i'\beta + \varepsilon_{it}$$

  where μ_t and γ_t are estimated using triangular kernel functions.

- $\Delta\mu = (\mu_0 - \mu_1)$ controls for spatial changes unrelated to the RLD.
- $\Delta\gamma = (\gamma_0 - \gamma_1)$ captures the marginal treatment effect (DiS):

$$\Delta\gamma\,(\boldsymbol{s}) \begin{cases} > 0 & \text{if prostitution has a } \textbf{negative} \text{ net value,} \\ < 0 & \text{if prostitution has a } \textbf{positive} \text{ net value} \end{cases}$$

Empirical Strategy

- Let $\boldsymbol{s}_i = (s_{1i}, s_{2i})$ be coordinates of house i and h_i be the distance to the RLD. Then:

$$y_{it} = \mu_t(\boldsymbol{s}_i) + \gamma_t(\boldsymbol{s}_i)\, h_i + x_i'\beta + \varepsilon_{it}$$

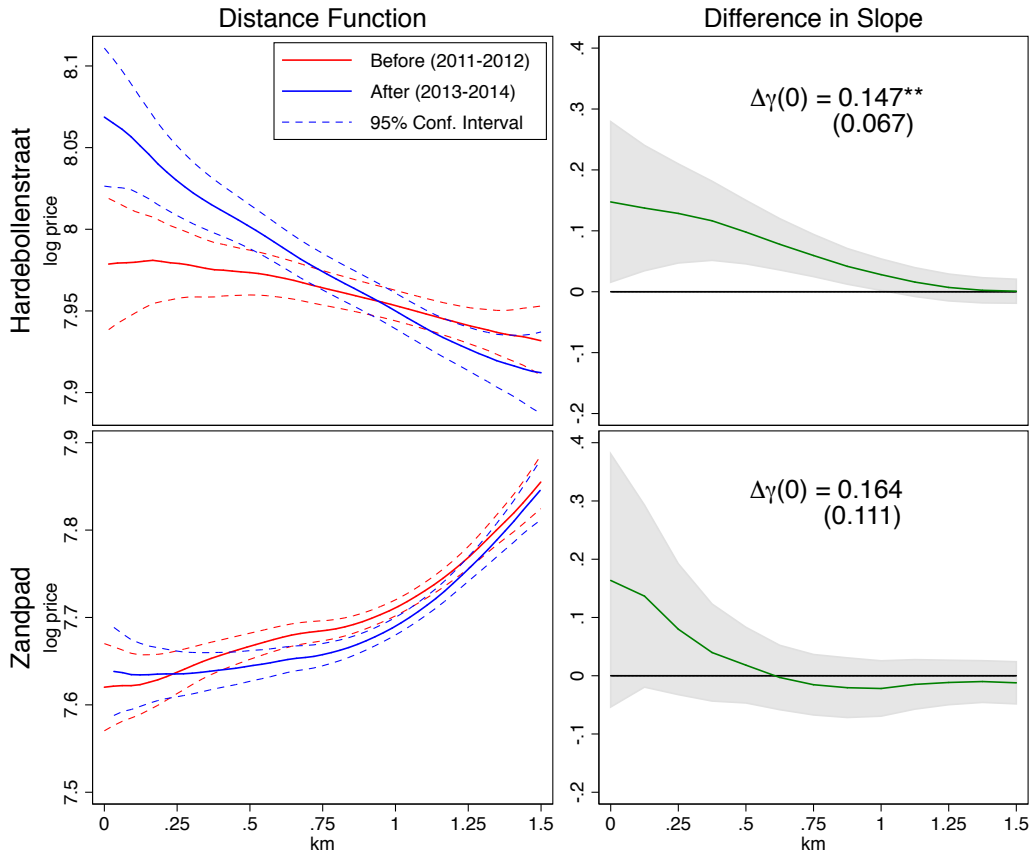
  where μ_t and γ_t are estimated using triangular kernel functions.
- $\Delta\mu = (\mu_0 - \mu_1)$ controls for spatial changes unrelated to the RLD.
- $\Delta\gamma = (\gamma_0 - \gamma_1)$ captures the marginal treatment effect (DiS):

$$\Delta\gamma\,(\boldsymbol{s}) \begin{cases} > 0 & \text{if prostitution has a } \textbf{negative} \text{ net value,} \\ < 0 & \text{if prostitution has a } \textbf{positive} \text{ net value} \end{cases}$$

Estimator

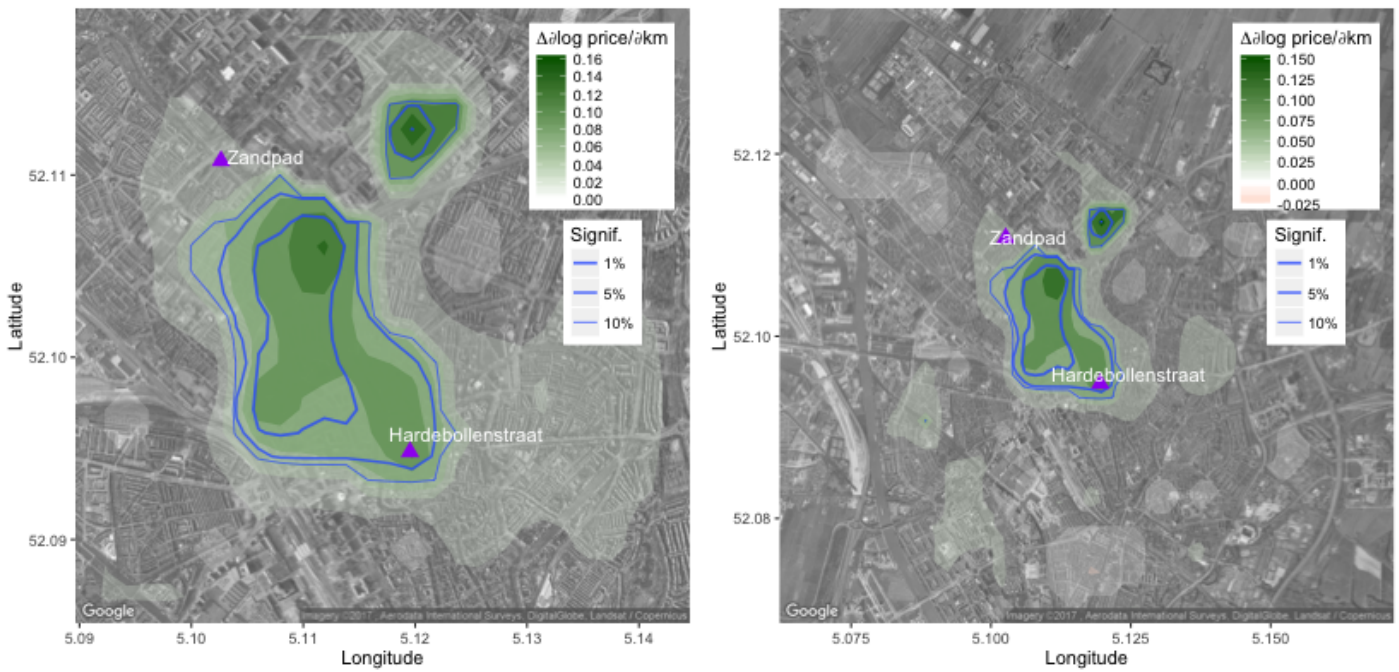
Main Findings, One Dimension

- Prices in the RLDs are higher in the absence of brothels.
- Before, prices increase with distance to prostitution (positive slope).



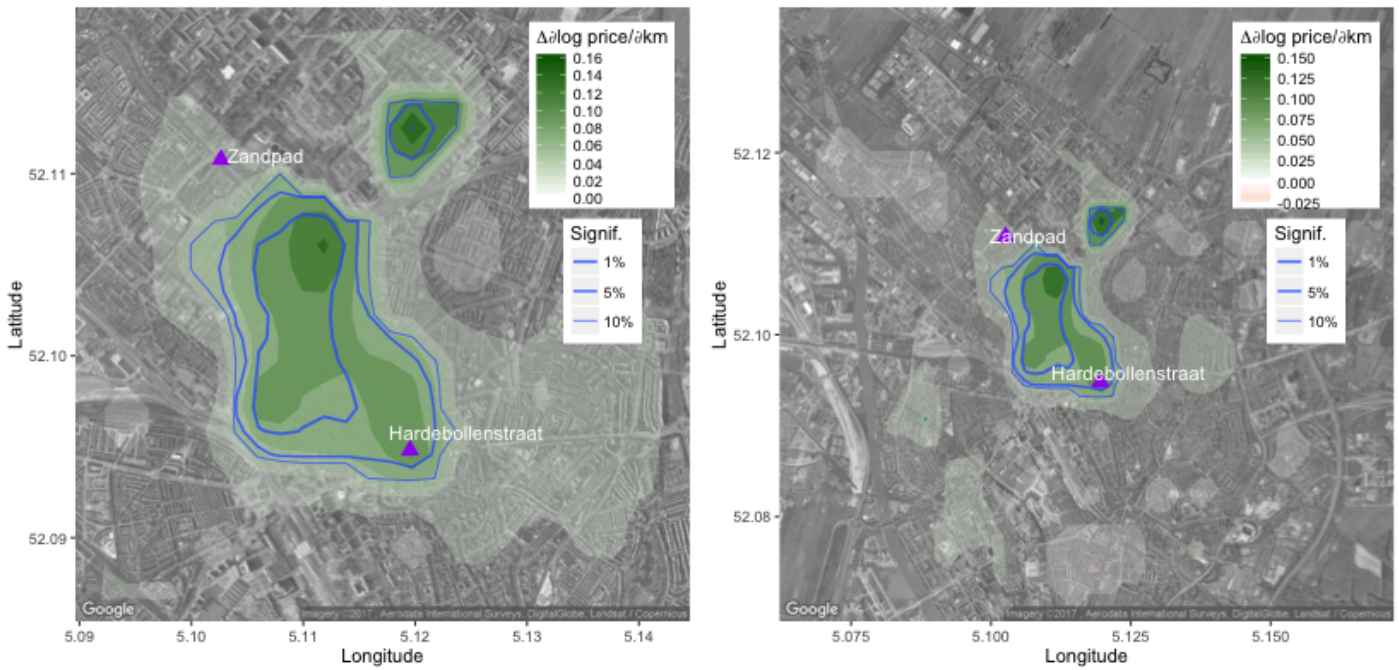
Main Findings, Two Dimensions

- Two-dimensional approach identifies where prices changed.
  - Households are spatially sorted based on their tastes.
- No effect towards the city center, where prices were high.
  - No room for a premium to stay away from the RLD



Main Findings, Two Dimensions

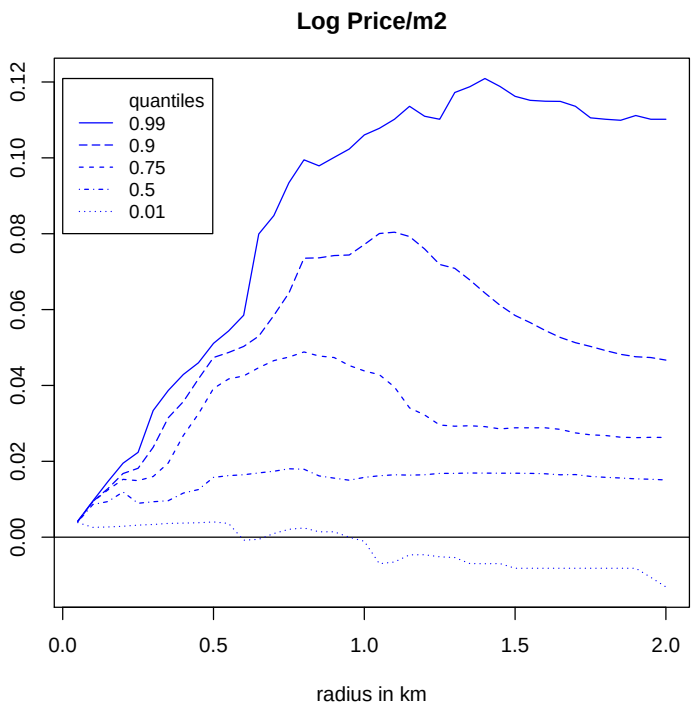
- Effect concentrates between the two RLD.
  - The least tolerant households raise rents in between.
  - By moving closer to either RLD, they apply a discount.
- The discount goes up to 1.5% per 100m in some areas.
  - And up to 500 euros per year for a household

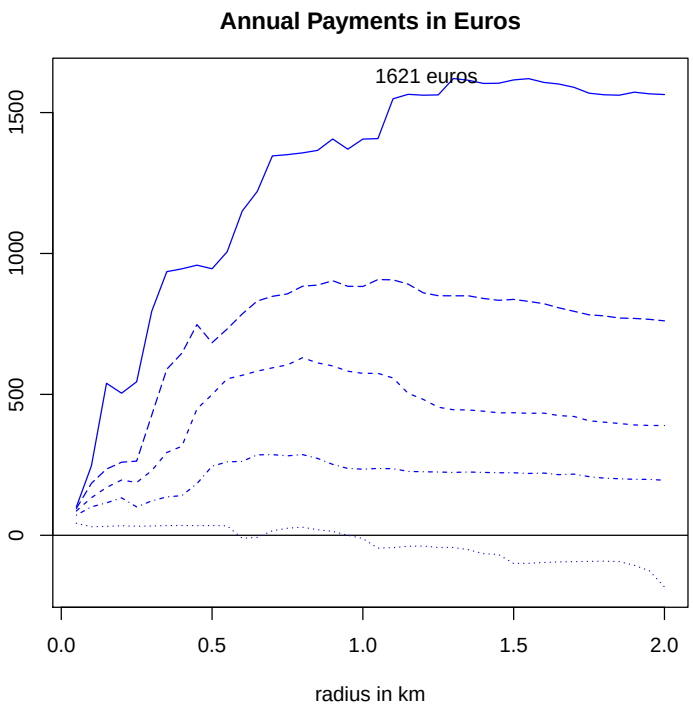


Quantiles Random locations DiS before 2013

Quantiles of Price Effects

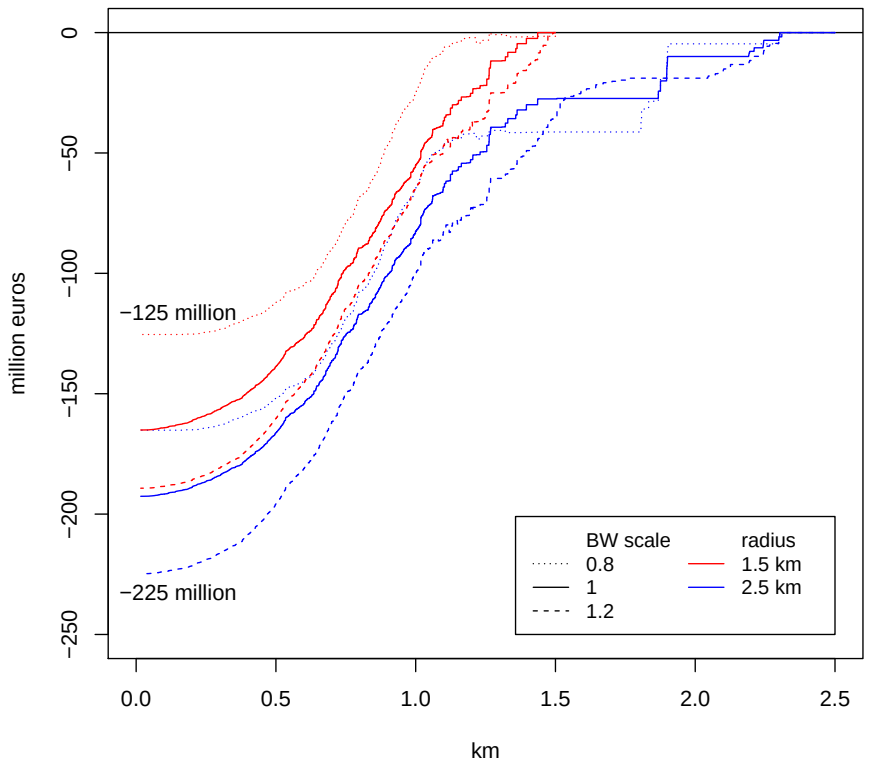
- Based on their location, we calculate the change in households' disposable income





Deadweight Loss

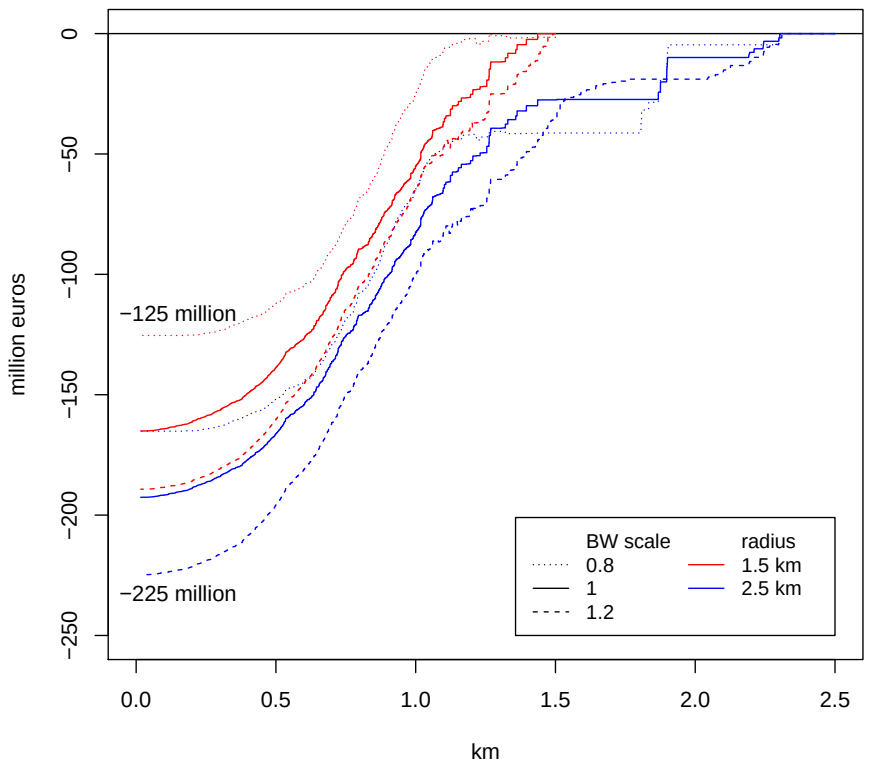
- Price effect is integrated over distance.
  - Only DiS significant at 10%.
- Most of the impact is within 1.5km.
- Total loss is 125-225 million euros.
  - Or 7-14.5 million euros/year
- Other findings:
  - Positive effect on employment



Deadweight Loss

- Price effect is integrated over distance.
  - Only DiS significant at 10%.
- Most of the impact is within 1.5km.
- Total loss is 125-225 million euros.
  - Or 7-14.5 million euros/year
- **Other findings:**
  - Positive effect on employment

See



Safety in the Red Light Districts

Crime Rates Near RLDs

- The externality can be explained by the criminal activities attached to the sex industry.
  - Such as drug trafficking, sexual assaults, and misbehaving clients.
- We use data on crime rates, nuisances complaints, and subjective safety at neighborhood level.
  - To verify whether safety has improved in RLDs more than in other areas of Amsterdam and Utrecht.

Crime Rates Near RLDs

- The externality can be explained by the criminal activities attached to the sex industry.
  - Such as drug trafficking, sexual assaults, and misbehaving clients.
- We use data on crime rates, nuisances complaints, and subjective safety at neighborhood level.
  - To verify whether safety has improved in RLDs more than in other areas of Amsterdam and Utrecht.

Crime and Distance to RLD in Amsterdam

- In Amsterdam, crime rates decline 18% more in the RLDs.
  - Or 1,250 crimes/year (930 crimes/year with displacement)
- Some displacement in violence, minor thefts, and other nuisances.
- Safety perception has also improved.

	Crime rate						log
	total	violence	nuisances	major thefts	minor thefts	drug dealing	unsafety index
$(t \geq 2007)\cdot(\text{dist} \leq 50\text{m})$	-0.182	-0.129	-0.108	-0.138	-0.222	-0.674	-0.18
	(-4.65)	(-2.69)	(-2.24)	(-2.63)	(-5.16)	(-4.96)	(-3.31)
$(t \geq 2007)\cdot(50\text{m} < \text{dist} \leq 200\text{m})$	0.096	0.124	0.112	0.085	0.200	0.009	0.03
	(1.83)	(1.80)	(1.69)	(1.21)	(3.49)	(0.05)	(0.90)
$(t \geq 2007)\cdot(200\text{m} < \text{dist} \leq 500\text{m})$	0.116	-0.022	0.124	0.117	-0.064	-0.258	-0.15
	(1.64)	(-0.24)	(1.42)	(1.22)	(-0.80)	(-1.01)	(-5.73)

Crime and Distance to RLD in Utrecht

- In Utrecht, crime rates decline 11% more in the RLDs.
  - Or 210 crimes/year.
- Particularly violence, minor thefts, and drug dealing.
- Safety perception has also improved nearby.

	Crime rate						%
	total	violence	nuisances	major thefts	minor thefts	drug dealing	who feel unsafe
$(t \geq 2013)\cdot(\text{dist} \leq 50\text{m})$	-0.114	-0.251	-0.141	0.055	-0.430	-0.507	-2.71
	(-1.86)	(-2.56)	(-1.82)	(0.60)	(-3.21)	(-1.73)	(-1.25)
$(t \geq 2013)\cdot(50\text{m} < \text{dist} \leq 200\text{m})$	-0.103	-0.061	0.047	-0.264	-0.101	0.190	-6.04
	(-1.59)	(-0.53)	(0.54)	(-2.73)	(-0.76)	(0.74)	(-3.66)
$(t \geq 2013)\cdot(200\text{m} < \text{dist} \leq 500\text{m})$	-0.004	0.085	0.067	-0.098	-0.008	0.327	-1.88
	(-0.09)	(1.03)	(1.10)	(-1.41)	(-0.09)	(1.21)	(-1.14)

per Area

Conclusion

- Despite being a human right and the individual benefits that it provides to clients and workers, **on-site prostitution** is found to be **costly to residents**.
- Households have a strong distaste for living in next to a brothel.
  - Even the most tolerant requires 4,000 euros a year to accept sex workers on their doorstep.
- Because some households pay to live far away, the economic impact spreads to other areas.
- Economic benefits don't seem to offset social nuisances.
  - Or the negative effect on safety.

Conclusion

- Despite being a human right and the individual benefits that it provides to clients and workers, **on-site prostitution** is found to be **costly to residents**.
- Households have a strong distaste for living in next to a brothel.
  - Even the most tolerant requires 4,000 euros a year to accept sex workers on their doorstep.
- Because some households pay to live far away, the economic impact spreads to other areas.
- Economic benefits don't seem to offset social nuisances.
  - Or the negative effect on safety.

Conclusion

- Despite being a human right and the individual benefits that it provides to clients and workers, **on-site prostitution** is found to be **costly to residents**.
- Households have a strong distaste for living in next to a brothel.
  - Even the most tolerant requires 4,000 euros a year to accept sex workers on their doorstep.
- Because some households pay to live far away, the economic impact spreads to other areas.
- Economic benefits don't seem to offset social nuisances.
  - Or the negative effect on safety.

Thank you!

Multidimensional Difference in Discontinuity package available for Stata:

```
net de mdrd, from(https://sites.google.com/site/r4ribas/codes/packages)
```

Theoretical Assumptions

- There is a continuum of individual types.
- Exogenous wealth is unrelated to individual tastes.
- Housing supply is continuous and inelastic
- Competitive housing market
  - Improvements have zero profit
- Single-crossing restriction
  - Households are ordered by their MWTA and the ordering is the same at any level of externality.
  - If violated, capitalization effect is a lower bound of the deadweight loss (Banzhaf, 2015).

Back

Multidimensional DiD Estimator

- Let $Z_i = 1$ if inside the RLD and $Z_i = 0$ otherwise; and $d_{li} = d(\boldsymbol{c}_l, \boldsymbol{s}_i)$ be the distance of house i to border point l.
- For $z = \{0, 1\}$:

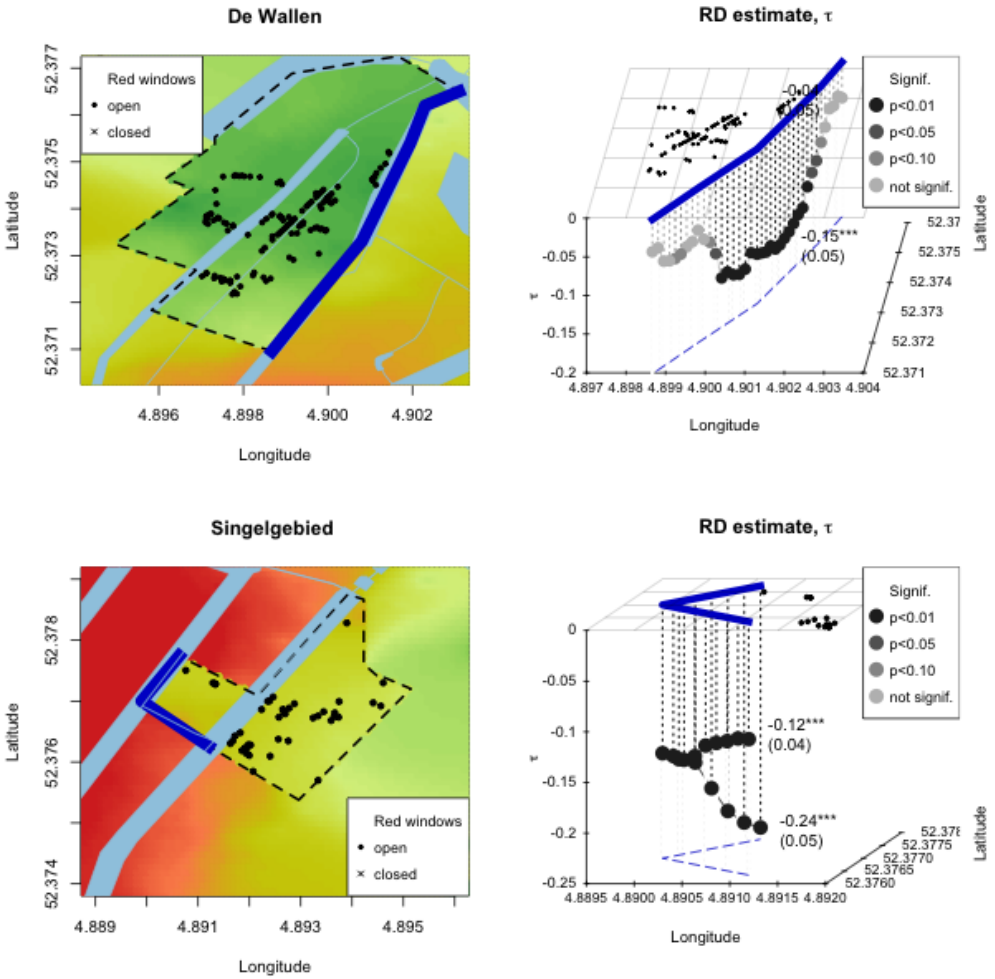
$$\hat{\mu}_{zlt}(h, b) = \arg\min_{a} \sum_{i=1}^{n} \mathbf{1}(Z_i = z) \left(Y_{it} - a - X_{it}\hat{\beta}\right) K\left(\frac{d_{li}}{h}\right) - h^2 \hat{B}_{zlt}(h, b)$$

  where $\hat{B}_{zlt}(.)$ is the bias correction proposed by Calonico, Cattaneo, and Titiunik (2014, CCT), $K(.)$ is a triangular kernel function, h and b are MSE-optimal main and pilot bandwidths (CCT and IK), and $\hat{\beta}$ is a 2-stage FWL estimator.

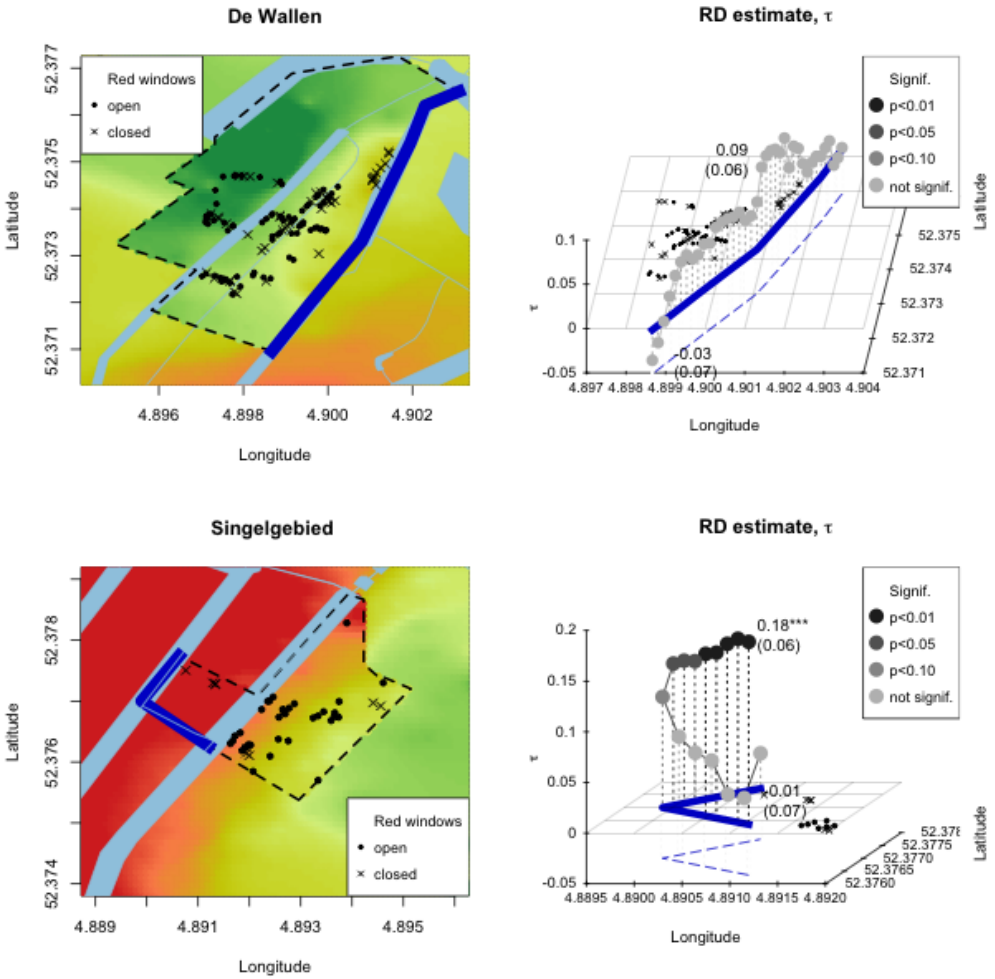
- Then, $\hat{\tau}_{lt} = (\hat{\mu}_{1lt} - \hat{\mu}_{0lt})$ and $\Delta\hat{\tau}_l = (\hat{\tau}_{l0} - \hat{\tau}_{l1})$

Back

2D Regression Discontinuity, 1991-2006 (Before)



2D Regression Discontinuity, 2007-2014 (After)



Interventions from Project 1012

Back

Conditional DiD Estimator

- Let $Z_i = 1$ if inside the RLD and $Z_i = 0$ otherwise; and $d_i = \min_l d(\boldsymbol{c}_l, \boldsymbol{s}_i)$ be the shortest distance to the border.
- For $z = \{0, 1\}$:

$$\hat{\boldsymbol{a}}_{zt} = \arg\min_{\boldsymbol{a}} \sum_{i=1}^{n} \mathbf{1}(Z_i = z) \left(Y_{it} - a^0 \Delta r_i - a^1 \left(r_{i0} \Delta r_i \right) - a^2 - a^3 r_{i0} - X_{it} \hat{\beta} \right) K\left(\frac{d_i}{h} \right) - h^2 \hat{B}_{zt}(h, b)$$

where $\hat{B}_{zt}(.)$ is the bias correction proposed by Calonico, Cattaneo, and Titiunik (2014, CCT), $K(.)$ is a triangular kernel function, h and b are MSE-optimal main and pilot bandwidths (CCT and IK), and $\hat{\beta}$ is a 2-stage FWL estimator.

- Then, $\hat{\delta}^k = \hat{\alpha}^k_{10} - \hat{\alpha}^k_{00} - \left(\hat{\alpha}^k_{11} - \hat{\alpha}^k_{01} \right)$.

Back

Empirical Strategy, Marginal Willingness to Accept (IV)

- Assume that the expected DiD is **only** driven by the closing of red windows.
- Then a Wald/IV estimator is applied:

$$\hat{v}_r\left(r, g, \boldsymbol{x}\right) = \frac{\sum_l \hat{f}\left(\boldsymbol{c}_l\right) \Delta\hat{\tau}_l}{\sum_l \hat{f}\left(\boldsymbol{c}_l\right) \Delta\hat{r}_l},$$

where $\hat{f}(.)$ is the estimated density of dwellings and $\Delta\hat{r}_l$ is the change in distance to a window:

$$\Delta r_l = \lim_{d(\boldsymbol{c}_l, \boldsymbol{s}_i)\to 0} \mathbb{E}\left[r_{it} | \boldsymbol{x}, t=0\right] - \lim_{d(\boldsymbol{c}_l, \boldsymbol{s}_i)\to 0} \mathbb{E}\left[r_{it} | \boldsymbol{x}, t=1\right].$$

Estimated MWTA (Unconditional DiD)

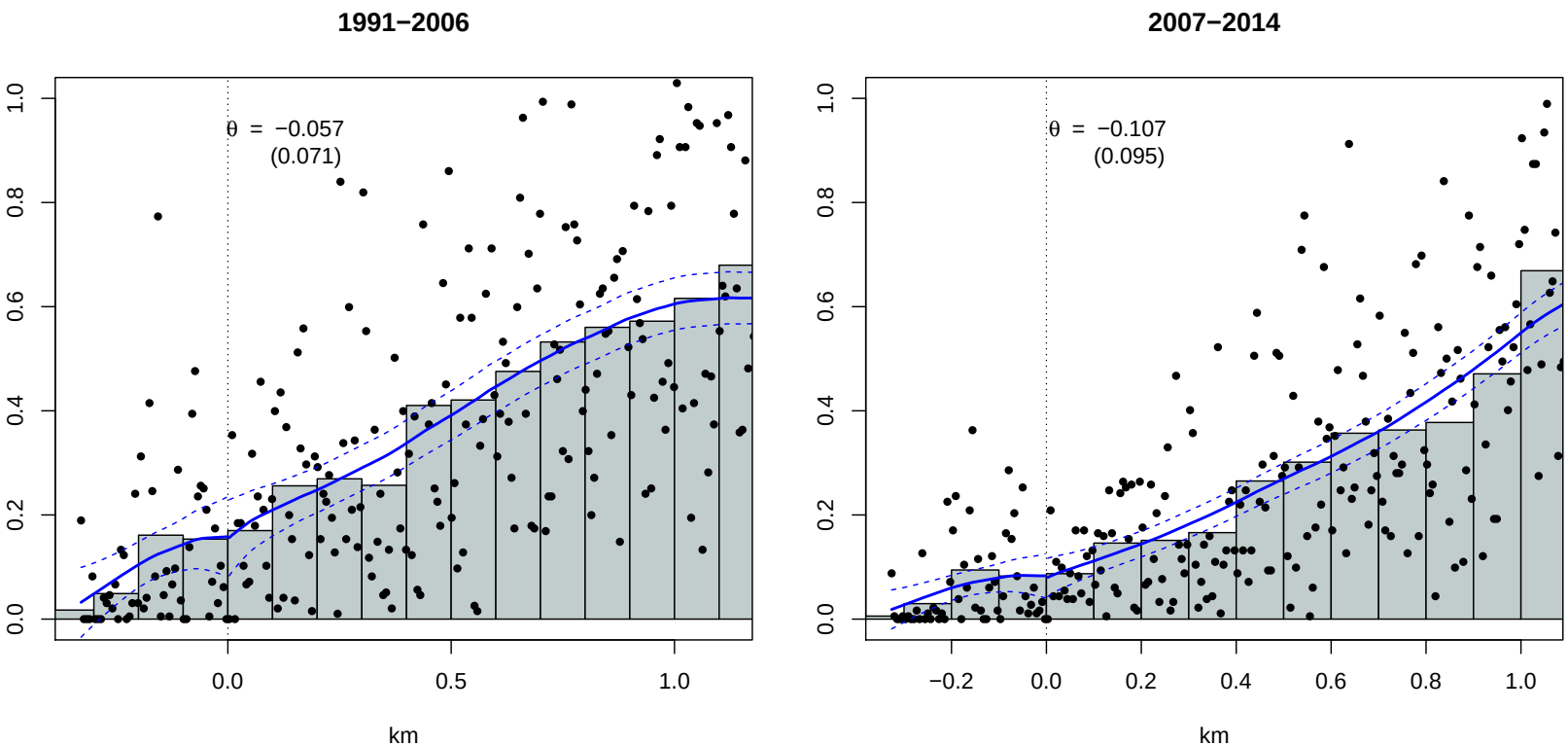
- We find that the MWTA is 16.5-21.5% per 100 meters.
  - It means 3,200-5,000 euros a year

	Bandwidth selection procedure	
	CCT	IK
Reduced-form - DiD		
1991/2006-2007/2014	-0.213 (-3.97)	-0.163 (-2.71)
2001/2006-2007/2014	-0.153 (-2.54)	-0.192 (-3.60)
1991/2000-2001/2006	-0.038 (-0.67)	0.062 (0.71)
1st Stage - Difference in distance to red window		
1991/2006-2007/2014	-0.999 (-12.41)	-0.803 (-7.95)
2001/2006-2007/2014	-0.931 (-9.31)	-0.893 (-8.49)
1991/2000-2001/2006	-0.375 (-4.05)	-0.426 (-3.58)
2nd stage - MWTP per 100 meters		
1991/2006-2007/2014	0.213 (3.88)	0.202 (2.78)
2001/2006-2007/2014	0.165 (2.48)	0.215 (3.28)
1991/2000-2001/2006	0.100 (0.67)	-0.146 (-0.64)

Back

Density of Offers in Amsterdam

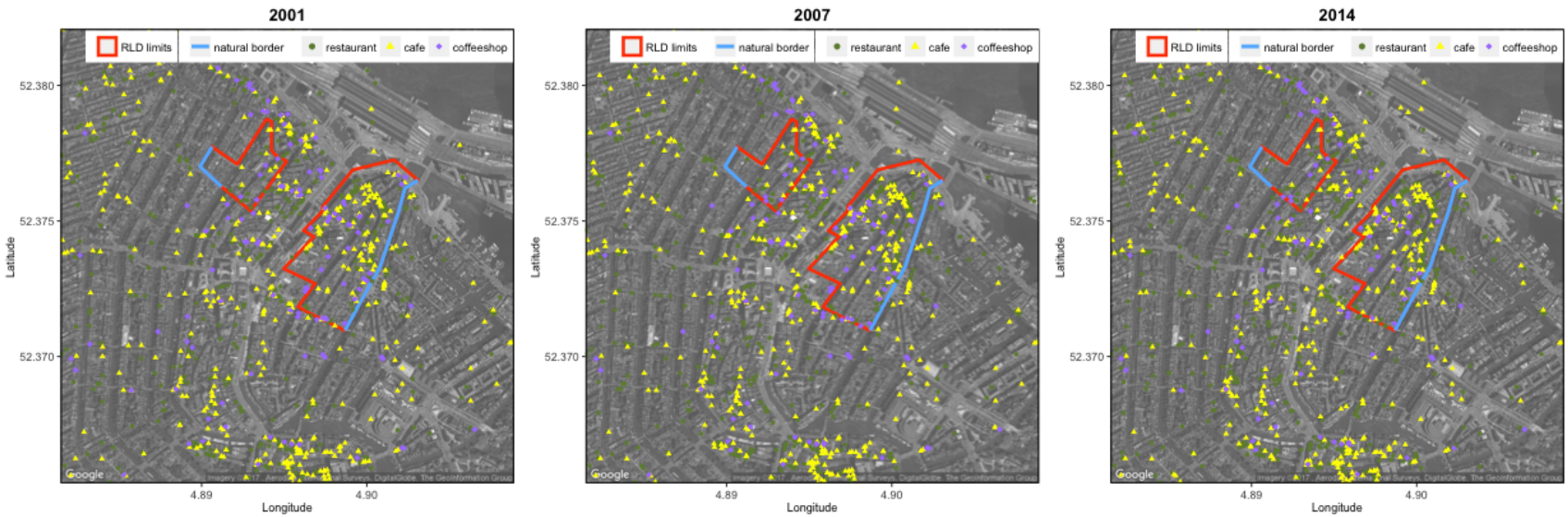
- Supply looks **continuous** around the border and don't change over time.
- McCrary's test don't reject it, even under several bin widths.



Back

Other Businesses in Amsterdam

- Data from Orbis/BvD for 2001-2014



Back

Coffeshops in Amsterdam

- McCrary's test for density of **coffeeshops**

	Bin width (in km)									
	0.02		0.03		0.04		0.05		0.06	
	θ	p-value	θ	p-value	θ	p-value	θ	p-value	θ	p-value
2001	1.300	0.028	1.361	0.013	1.296	0.030	1.317	0.020	1.559	0.000
	(0.592)		(0.548)		(0.597)		(0.565)		(0.446)	
2007	0.941	0.076	1.066	0.025	0.902	0.072	0.978	0.049	1.156	0.001
	(0.531)		(0.475)		(0.502)		(0.497)		(0.357)	
2014	0.744	0.141	1.066	0.013	0.754	0.161	1.020	0.015	1.006	0.014
	(0.505)		(0.427)		(0.538)		(0.421)		(0.411)	
2007-2001	-0.359	0.652	-0.294	0.685	-0.394	0.614	-0.339	0.652	-0.403	0.481
	(0.796)		(0.725)		(0.780)		(0.752)		(0.571)	
2014-2007	-0.198	0.787	0.000	1.000	-0.149	0.840	0.042	0.949	-0.150	0.783
	(0.733)		(0.639)		(0.736)		(0.651)		(0.544)	
2014-2001	-0.556	0.475	-0.295	0.672	-0.542	0.500	-0.298	0.672	-0.553	0.362
	(0.778)		(0.695)		(0.803)		(0.704)		(0.606)	

Back

Cafes in Amsterdam

- McCrary's test for density of **cafes** (bars and nightclubs)

	Bin width (in km)									
	0.02		0.03		0.04		0.05		0.06	
	θ	p-value	θ	p-value	θ	p-value	θ	p-value	θ	p-value
2001	1.028	0.002	1.021	0.001	0.969	0.003	1.068	0.001	0.946	0.003
	(0.326)		(0.321)		(0.331)		(0.315)		(0.316)	
2007	1.020	0.002	1.028	0.002	0.853	0.013	1.075	0.001	0.933	0.004
	(0.331)		(0.327)		(0.343)		(0.315)		(0.323)	
2014	1.229	0.001	1.234	0.001	1.086	0.005	1.313	0.000	1.129	0.001
	(0.371)		(0.367)		(0.383)		(0.350)		(0.352)	
2007-2001	-0.008	0.987	0.007	0.987	-0.116	0.807	0.007	0.988	-0.013	0.977
	(0.464)		(0.458)		(0.477)		(0.445)		(0.452)	
2014-2007	0.209	0.673	0.206	0.675	0.233	0.651	0.238	0.613	0.196	0.682
	(0.497)		(0.492)		(0.514)		(0.471)		(0.478)	
2014-2001	0.202	0.683	0.214	0.661	0.117	0.818	0.245	0.602	0.183	0.699
	(0.494)		(0.488)		(0.507)		(0.470)		(0.473)	

Back

Restaurants in Amsterdam

- McCrary's test for density of **restaurants**

	Bin width (in km)									
	0.02		0.03		0.04		0.05		0.06	
	θ	p-value	θ	p-value	θ	p-value	θ	p-value	θ	p-value
2001	0.681	0.014	0.691	0.013	0.909	0.000	1.093	0.000	1.177	0.000
	(0.277)		(0.279)		(0.260)		(0.265)		(0.267)	
2007	1.017	0.000	1.009	0.000	1.242	0.000	1.421	0.000	1.398	0.000
	(0.269)		(0.271)		(0.254)		(0.259)		(0.261)	
2014	0.935	0.000	0.919	0.000	0.971	0.000	0.932	0.000	1.257	0.000
	(0.230)		(0.231)		(0.221)		(0.219)		(0.232)	
2007-2001	0.336	0.385	0.318	0.413	0.333	0.358	0.328	0.376	0.221	0.554
	(0.386)		(0.389)		(0.363)		(0.371)		(0.373)	
2014-2007	-0.082	0.818	-0.090	0.801	-0.271	0.421	-0.489	0.150	-0.141	0.687
	(0.354)		(0.356)		(0.337)		(0.340)		(0.349)	
2014-2001	0.254	0.480	0.228	0.528	0.062	0.855	-0.161	0.640	0.080	0.821
	(0.360)		(0.362)		(0.341)		(0.344)		(0.354)	

Back

Retailers in Amsterdam

- McCrary's test for density of **specialized retail stores**

	Bin width (in km)									
	0.02		0.03		0.04		0.05		0.06	
	θ	p-value	θ	p-value	θ	p-value	θ	p-value	θ	p-value
2001	-0.120	0.580	-0.059	0.816	-0.113	0.593	-0.097	0.697	-0.120	0.619
	(0.217)		(0.252)		(0.211)		(0.250)		(0.242)	
2007	0.132	0.520	0.187	0.401	0.086	0.665	0.220	0.356	0.193	0.399
	(0.206)		(0.223)		(0.198)		(0.238)		(0.229)	
2014	0.100	0.611	0.098	0.658	0.061	0.743	0.090	0.691	0.086	0.691
	(0.197)		(0.221)		(0.187)		(0.226)		(0.217)	
2007-2001	0.252	0.399	0.246	0.465	0.198	0.492	0.317	0.358	0.314	0.347
	(0.299)		(0.336)		(0.289)		(0.345)		(0.333)	
2014-2007	-0.032	0.910	-0.090	0.776	-0.024	0.929	-0.130	0.691	-0.107	0.734
	(0.285)		(0.314)		(0.272)		(0.328)		(0.316)	
2014-2001	0.220	0.452	0.157	0.640	0.174	0.537	0.187	0.579	0.207	0.525
	(0.293)		(0.335)		(0.282)		(0.336)		(0.325)	

Back

Difference-in-Slope Estimator

- Let $d_{li} = d(\boldsymbol{c}_l, \boldsymbol{s}_i)$ be the distance between house i and location l.
- For $t = \{0, 1\}$:

$$(\hat{\mu}_{lt}, \hat{\gamma}_{lt})' = \arg\min_{a,b} \sum_{i=1}^{n} \mathbf{1}(T_i = t) \left(Y_{it} - a - bh_i - X_{it}\hat{\beta} \right) K\left(\frac{d_{li}}{h} \right) - h^2 \hat{B}_{lt}(h, b)$$

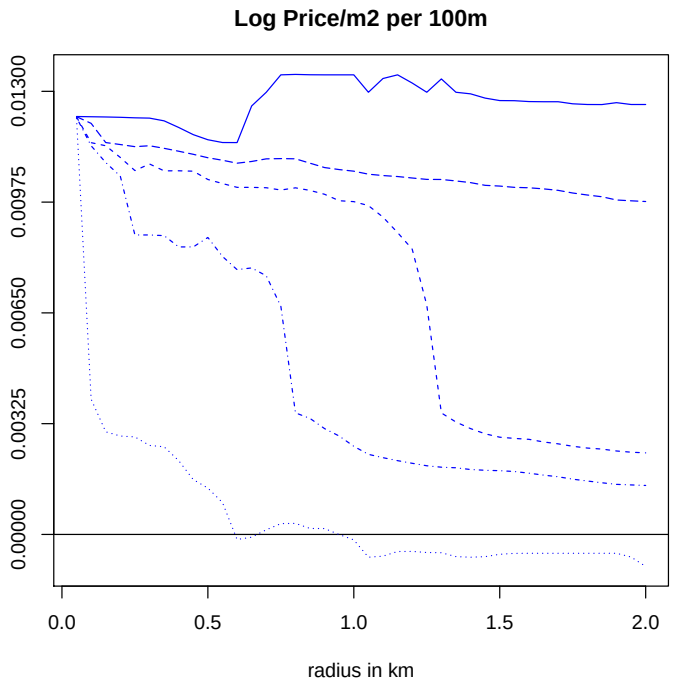
where $\hat{B}_{lt}(.)$ is the bias correction adapted from Calonico, Cattaneo, and Titiunik (2014, CCT), $K(.)$ is a triangular kernel function, h and b are MSE-optimal main and pilot bandwidths (CCT), and $\hat{\beta}$ is a 2-stage FWL estimator.

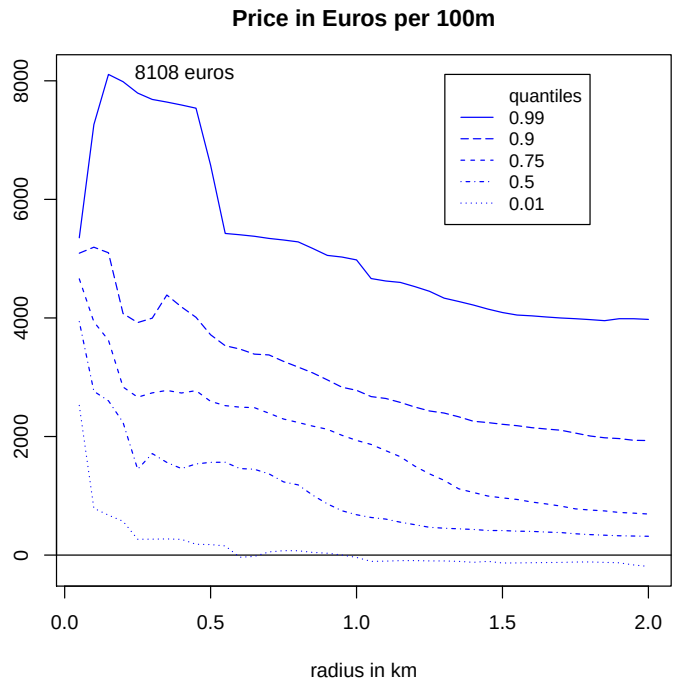
- Then, $\Delta\hat{\gamma}_l = \hat{\gamma}_{l0} - \hat{\gamma}_{l1}$.

Back

Quantiles of Difference-in-Slope

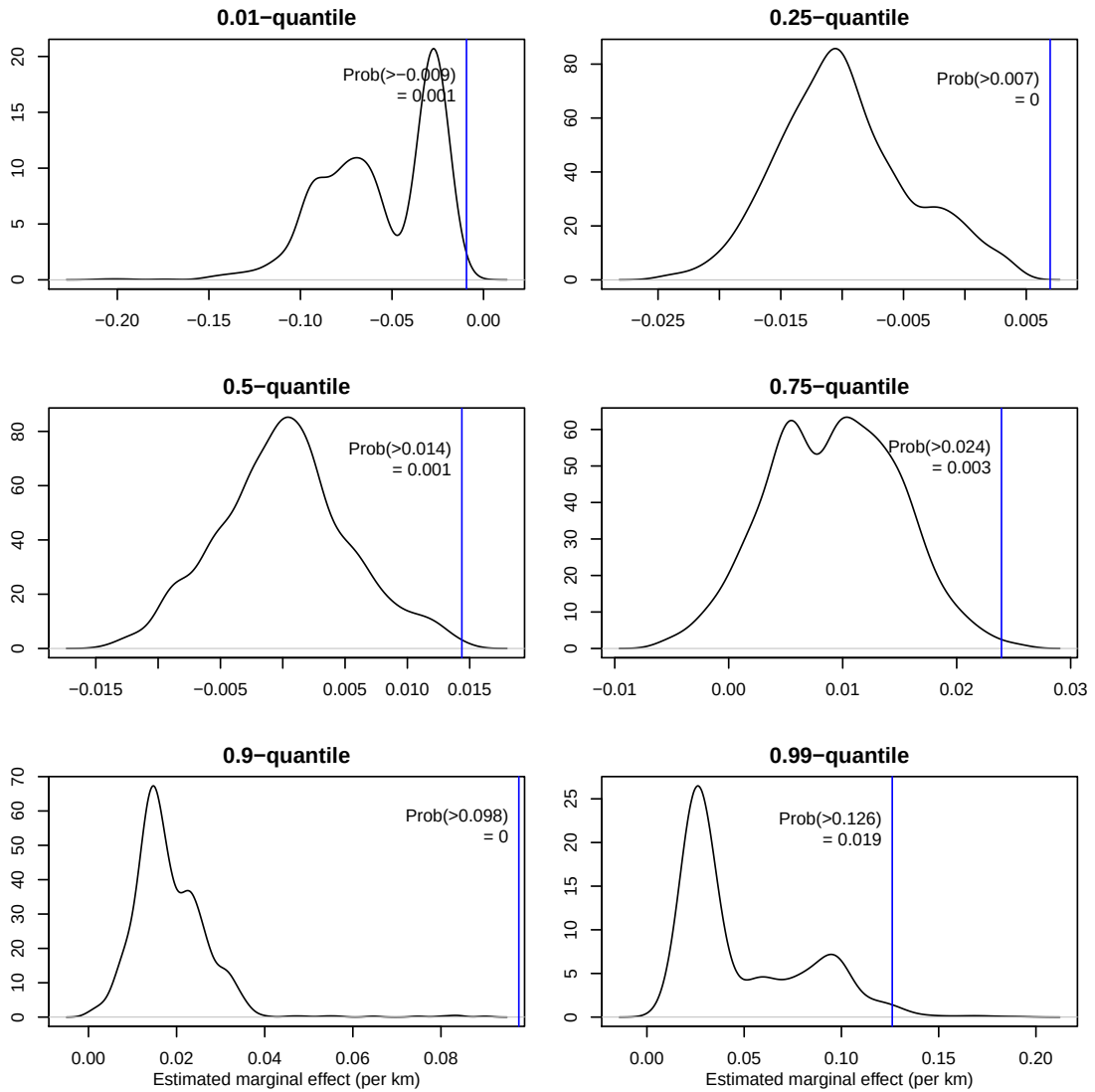
- Up to 500m, all households are willing to pay something
- The majority pays at least 0.9% per 100 meter.





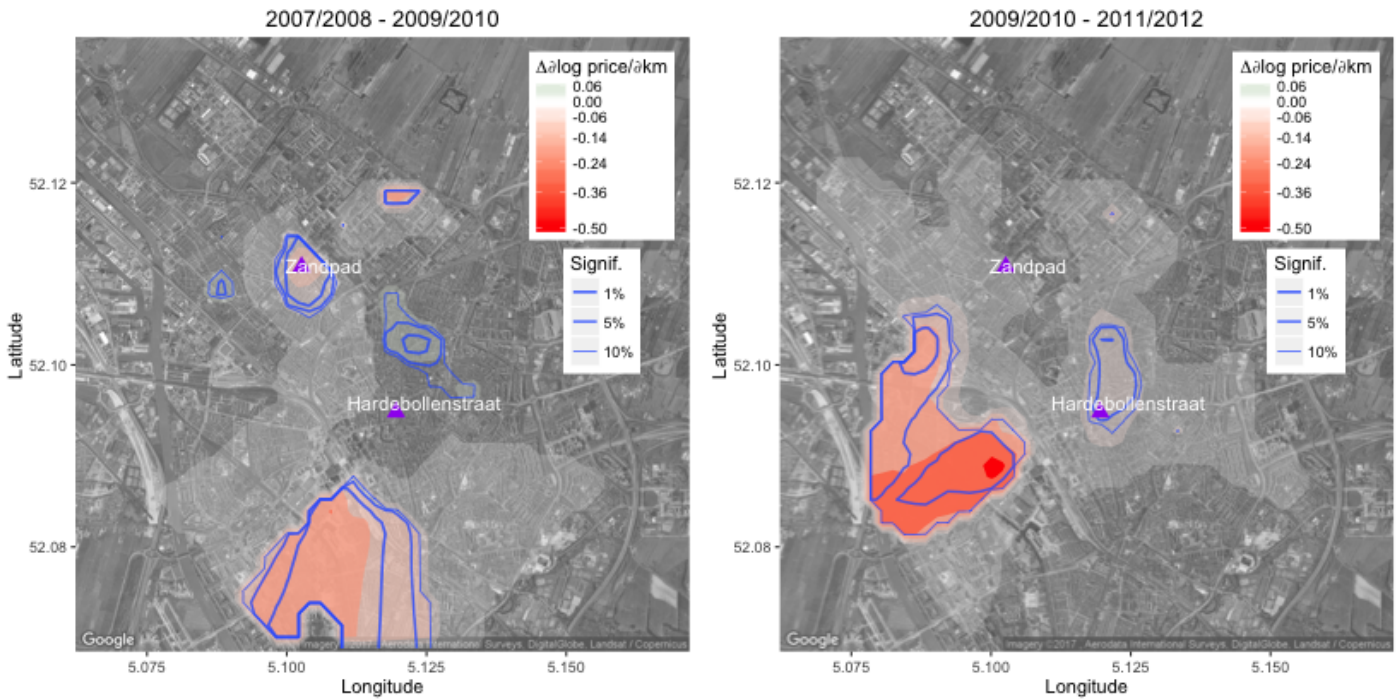
Back

Quantiles of DiS in Random Locations



DiS Before Closing of RLDs, 2009/2010 - 2011/2012

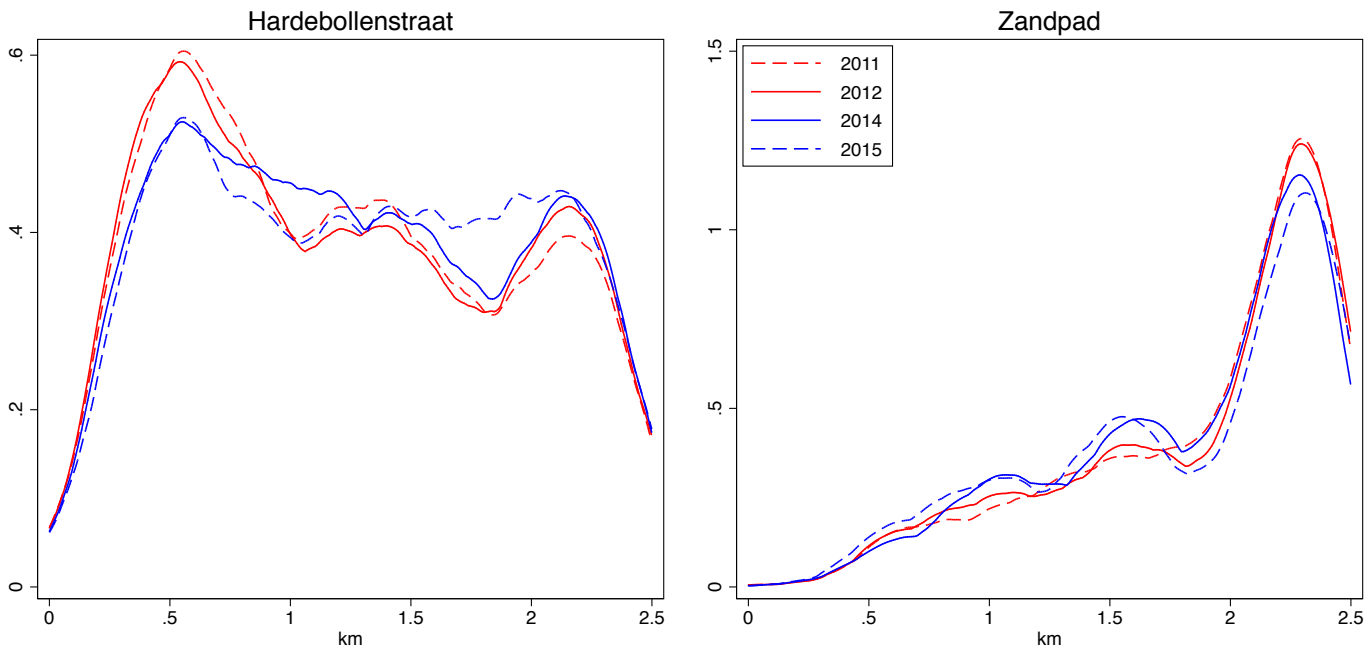
- Price were in an opposite trend before 2013.
  - Growth of RLDs in Utrecht after Amsterdam and Rotterdam downsized their soliciting zones.



Back

Employment in Utrecht

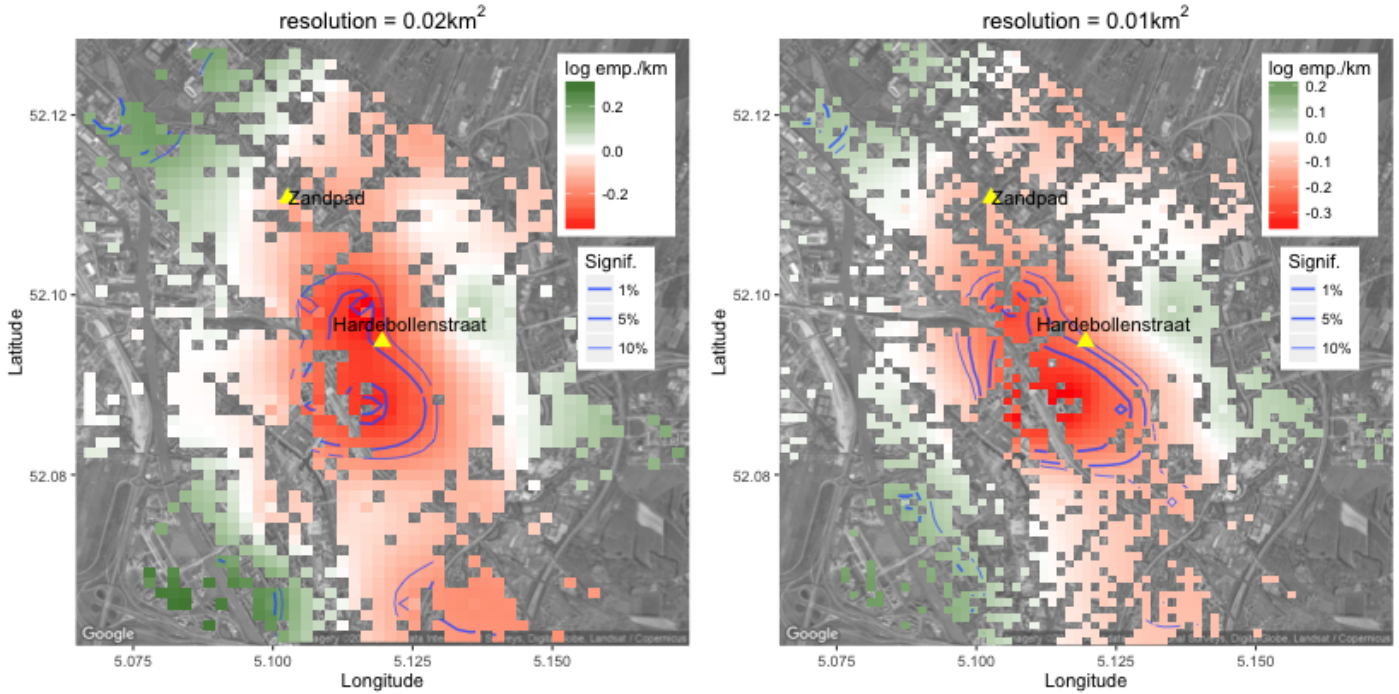
- We use data from Orbis/BvD for 2011-2015 and estimate the density per distance to RLDs.



Back

Marginal Effect of RLDs on Employment

- DiS is negative, so employment decreases with distance to prostitution.



Back

Crime and Distance to RLDs in Utrecht

- Crimes declined mostly in *Hardbollenstraat*, in the center of the city
- But violence is a common factor.

	Crime rate						%
	total	violence	nuisances	major thefts	minor thefts	drug dealing	who feel unsafe
Hardbollenstraat							
$(t \geq 2013)\cdot(\text{dist} \leq 50\text{m})$	-0.271	-0.210	-0.281	-0.120	-0.678	-0.582	-4.58
	(-3.32)	(-1.74)	(-2.86)	(-0.91)	(-3.71)	(-1.56)	(-2.45)
$(t \geq 2013)\cdot(50\text{m} < \text{dist} \leq 200\text{m})$	-0.226	-0.029	-0.085	-0.463	-0.333	0.289	-6.33
	(-2.60)	(-0.18)	(-0.72)	(-3.43)	(-1.90)	(0.89)	(-4.82)
Zandpad							
$(t \geq 2013)\cdot(\text{dist} \leq 50\text{m})$	0.068	-0.357	0.022	0.247	-0.111	-0.510	-0.08
	(0.85)	(-2.33)	(0.20)	(2.14)	(-0.63)	(-1.06)	(-0.05)
$(t \geq 2013)\cdot(50\text{m} < \text{dist} \leq 200\text{m})$	0.029	-0.122	0.153	-0.005	0.256	-0.088	-5.33
	(0.35)	(-0.77)	(1.33)	(-0.04)	(1.34)	(-0.21)	(-3.90)

Back