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Unveiling the Price of Obscenity: Evidence from Closing Prostitution Windows in the Netherlands*

Erasmus Giambona[†] and Rafael P. Ribas[‡]

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Abstract

This paper quantifies the aversion of residents to on-site prostitution. To establish causality, we first exploit the fact that Amsterdam's Red Light Districts (RLDs) are delimited by canals, together with a policy that closed several prostitution windows since 2007. Using a two-dimensional difference-in-discontinuity estimator, we find that households require at least 6,000 euros/year to be right next to a brothel. To estimate the economic impact outside the RLD, we also look at the closings of all brothels in Utrecht in 2013. Using a spatial difference-in-slope estimator, the effect on house prices is found to be heterogeneous and some households pay up to 1,600 euros/year to be distant from prostitution. Both cities also experienced crime reduction in the RLDs, but the explained changes in house prices are mostly driven by drug-related crimes and minor nuisances. In Amsterdam, more than 70% of the discount applied to houses beside brothels remains unexplained.

JEL: C31, H41, K42, L83, R21.

Keywords: Prostitution, Disamenity, House Prices, Willingness to Pay, Spatial Regression Discontinuity, Difference-in-Slope.

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1 Introduction

The world's oldest profession has always been controversial. The controversy is fed by those who claim prostitution is a human right, those who consider it a form of exploitation, and those who find it immoral.¹ Despite the legal efforts to treat sex workers with dignity, this market may be constrained not only because prostitution is a taboo to some people, but also because it has negative externalities. The resulted constraints reinforce the stigma of sex workers, hindering their integration into ordinary life.^{2,3} As pointed out by Roth (2007), these constraints are hard to predict, but being aware of people's aversion is an important step in the design of vice markets.

This paper attempts to value the aversion to prostitution by measuring individuals' willingness to accept (WTA) living next to a brothel and their willingness to pay (WTP) to move far away, particularly in a context where it is legal and regulated. To do so, we look at differences in houses prices as a mechanism to reveal preferences (Rosen, 1974).⁴ However, since prostitution often emerges in declining areas, where rents are lower, the identification of causal effects on house prices is rather difficult.⁵ To infer causality, we exploit two unique settings observed in the Netherlands.

In the first case, the Red Light Districts (RLDs) in Amsterdam are located inside a perimeter naturally delimited by canals, where private homes share the space with brothel windows. We use these bordering canals to compare similar houses that are

¹See Larson (2004) for a review on the legal debate.

²For instance, Hubbard (2017) argues that retail gentrification is a form of moral constraint that excludes sex workers from common spaces.

³In an anecdotal case, the Dutch Central Bank (DNB) fired a supervisor in 2014 for secretly being self-employed as a sex worker. She was officially dismissed for failing to inform her superiors of her second job and making herself vulnerable to blackmail (The Economist, Apr 17, 2015).

⁴The relationship between amenities and house prices has been broadly used to measure WTP and assess the monetary benefit of public policies. A non-exhaustive list includes studies on the value of school quality (Black, 1999; Cellini et al., 2010), industrial pollution and health risk (Greenstone and Gallagher, 2008; Currie et al., 2015), air quality (Chay and Greenstone, 2005), and quality of neighbor properties (Rossi-Hansberg et al., 2010).

⁵See Kuminoff et al. (2010) for the limitations of hedonic models.

equally distant to any amenity, except that one of them is on the RLD side. This discontinuity design is combined with a city policy that reduced the number of “red” windows and rezoned their location. Then by applying a two-dimensional difference-in-discontinuity (DiD) estimator, we not only control for systematic differences across the canals, but also verify whether changes in price discontinuities coincide with the location of closed windows. On average, we find that the homes on the RLD side are sold at 10% less. However, if the house is right next to a brothel, the discount can be as high as 30%. This discount implies that households require 6,000-7,100 euros per year to accept sex workers on their doorsteps.

The changes in price discontinuities might be explained by other events that took place in the same period, such as investments in the public space, business enhancements, and improvements in law enforcement. In addition to comparing similar houses at the border, which are equally affected by broader developments, we also estimate the fine relationship between DiD in prices and the varying distance to a red window. The result confirms that the price discontinuity declines with distance to brothels. Moreover, in areas where the distance has not changed, the DiD is nearly zero. That is, the average DiD of 10% does not seem to be driven by gentrification.⁶

In the second setting, we turn to the closing of all the RLDs in Utrecht, the fourth largest city in the Netherlands, which occurred in 2013. Accordingly, we compare the relationship between house prices and distance to an RLD before and after its end. Since the relationship after the event controls for systematic differences across locations, the before-after difference in the relationship captures the households’ willingness to live closer to (or farther from) an RLD. By applying a non-parametric difference-in-slope (DiS) estimator, the effect is found to be spatially heterogeneous.

⁶Additional tests, presented in the Online Appendix, confirm that the distribution of other businesses, such as bars and cannabis retailers, has not changed over time at the RLD borders.

While some households were barely affected, others paid up to 1.5% of their property value to be 100 meters farther away from the RLDs. This distaste for living close to brothels made them overpay for homes as far as two kilometers away.

The two empirical settings — DiD in Amsterdam and DiS in Utrecht — have distinct interpretations, so the findings are not comparable. The former setting assesses only the presence of sex workers, along with specific disamenities with little spillover. The latter assess the net value of the RLDs for those living out of the area. For instance, someone who do not want to live beside brothels could still prefer to live near the RLD to reduce her commute. In either case, however, households are found to dislike prostitution.⁷ To illustrate the counterfactual differences, we outline a simple housing model in the Online Appendix.

To understand the distaste for on-site prostitution, we investigate changes in crime and complaints after the closing of brothels.⁸ In Amsterdam's RLDs, crime declined by 18%. Yet 73% of the price discontinuity remained unexplained after controlling for all forms of misbehavior. In Utrecht, on the other hand, almost the entire price effect is explained by drug-related crimes and minor nuisances, such as vandalism and drunkenness. Thus, households seem to have a specific aversion to prostitution windows, but the willingness to stay far from the RLDs is only due to related nuisances.

Although much has been written about prostitution, the focus has been on the determinants of supply and demand in the sex industry.⁹ A few studies investigate the consequences of legalizing prostitution on people's acceptance (Kotsadam and Jakobsson, 2011), human trafficking (Cho et al., 2013; Lee and Persson, 2015), and

⁷Neither setting is intended to identify the WTA/WTP of the whole population (Kuminoff et al., 2013). Given the equilibrium sorting, the WTA/WTP is estimated for those who are the least bothered by the RLD.

⁸For Utrecht, we also estimate the effect of RLDs on employment. See Online Appendix.

⁹See, for instance, Edlund and Korn (2002), Rao et al. (2003), Gertler et al. (2005), Della Giusta et al. (2009), Cunningham and Kendall (2011, 2017), Arunachalam and Shah (2012), and Li et al. (2017). See also Cunningham and Shah, eds (2016) for an overall view of this topic.

sexual violence (Cunningham and Shah, 2017; Bisschop et al., 2017). Another related thread in the literature studies the influence of perceived risk, discrimination, and liberal policies on house prices (Gibbons, 2004; Pope, 2008; Linden and Rockoff, 2008; Gautier et al., 2009; Funderburg and MacDonald, 2010; Ihlanfeldt and Mayock, 2010; Adda et al., 2014). To the best of our knowledge, however, our study is the first to assess the monetary value of the externalities from prostitution.

The remainder of the paper is organized as follows. Section 2 describes the data. Sections 3 and 4 present the empirical strategy and the results for house prices in Amsterdam and Utrecht, in turn. Section 5 shows how safety and nuisances have changed in the RLDs and how these changes explain our main findings. Section 6 concludes the paper. In addition, the Online Appendix provides: a brief history of prostitution policy in the Netherlands, which helps to understand the creation and evolution of RLDs; a model of housing prices in the context of an RLD; a description of estimation procedures; additional findings on housing supply, distribution of other businesses and employment level; and robustness tests.

2 Data Sources

2.1 House prices

Our main data source is the Dutch Association of Real Estate Brokers and Experts (*Nederlandse Vereniging van Makelaars en Taxateurs*, NVM), which has more than 4,000 members. Its members handle approximately 70% of all transactions of owner-occupied homes in the Netherlands. In cities such as Amsterdam and Utrecht, their market share is about 90%.¹⁰ According to de Wit et al. (2013), the NVM sample is

¹⁰Market share is calculated by comparing sales numbers from NVM and Kadaster, available at statline.cbs.nl, from 2001 to 2014.

unbiased and gives a reliable picture of the Dutch housing market.

NVM members are required to report all dwellings offered for sale. The report includes geocoded location, transaction price and the date of sale, as well as initial asking price and first day on the market. Location refers to the centroid of six-digit postal codes, which is a narrow range of about six house numbers on the same street. For dwellings located within one kilometer from an RLD, the exact coordinates were obtained using Google Maps API. For the purpose of this paper, we exclude houses that were either withdrawn from the market or remained unsold for more than six years, and had either more than 500 square meters or less than 20 square meters.

The NVM records also include an exhaustive list of characteristics of the dwellings. Table 1 reports the descriptive statistics of some characteristics for two different samples. Statistics of the remaining characteristics are in Table S1 of the Online Appendix. The first sample is of sold houses within two kilometers from the RLDs in Amsterdam between 1991 and 2014. This sample does not include houses in Amsterdam Noord, an area detached from the rest of the city by the IJ bay. The second sample is of dwellings within three kilometers from the RLDs in Utrecht in 1991-2014.

TABLE 1 ABOUT HERE

Overall, prices are higher in Amsterdam than in Utrecht. They are also higher in our sample than in the excluded parts of these cities. Because of our design, the sampled dwellings are close to the city centers, so they are smaller and more likely to be apartments than in the rest of the city. Buildings in the sample are also older, most being built before 1931, and less likely to have a lift and parking space.

2.2 Other data sources

The data on prostitution windows come from two different sources. The first is a website created in 2008 that contains information on RLDs in Europe, www.amsterdam-red-light-district-maps.com. This website provides maps of RLDs with the location of each red window, including the closed ones. The second is the city of Amsterdam, which provided the zoning plans, the location of properties with brothels, and the dates when these properties were bought and when red windows were closed.

Registered crime data were obtained from the Department of Research and Statistics of the city of Amsterdam and from Utrecht's police department. In Amsterdam, these data are publicly available at neighborhood (*buurt*) level from 2003 to 2014. In Utrecht, data were provided at the sub-neighborhood (*subbuurt*) level from 2011 to 2015. For both cities, we observe the number of several kinds of reported felonies, such as burglary, motor vehicle theft, pick-pocketing, assaults, and drug trafficking. Moreover, the city of Amsterdam provides risk perception indices per neighborhood from 2003 to 2013. For Utrecht, data on risk perception are available for sub-districts (*subwijk*) from 2006 to 2015 on the municipality website.¹¹

3 Prostitution and House Prices in Amsterdam

In Amsterdam, the first licensed brothels appeared in 1413. However, the city council legislated that all brothels must be within a restricted area close to the harbor, called *De Wallen* — Amsterdam's biggest and most famous RLD. Anyone pandering a sex worker outside this area would be subject to fines and imprisonment (Brants, 1998). Over the centuries, this system of regulation through tolerance and discretion was

¹¹Amsterdam is divided into 16 districts (*wijken*) and 98 neighborhoods (*buurten*); a *buurt* has about 8,000 inhabitants on average. Utrecht is divided into 10 *wijken*, 34 *subwijken*, 111 *buurten*, and 193 *subbuurten*; a *buurt* has about 3,000 inhabitants on average.

implemented not only in Amsterdam, but throughout the Netherlands (Pol, 2011).¹²

In addition to *De Wallen*, Amsterdam has two other RLDs: *Singelgebied*, also located in the central area; and *Ruysdaelkade*, the smallest, located in the South District (*Amsterdam-Zuid*). Because of their size and location, we focus our analysis on *De Wallen* and *Singelgebied*.¹³ These areas have been well-defined, tolerance zones since the postwar period, with no prostitution window operating out of their limits.

A “red” window is typically one by two and a half meters, with a small bedroom inside (see Figure S1 of the Online Appendix), and a brothel is just a company that rents out windows to sex workers. According to Wagenaar et al. (2013), on a normal day all windows are rented out in two shifts, from 8 am to 6 am.

With 476 red windows and a high density of adult theaters, Amsterdam’s RLDs became world famous. At the same time, the “legitimate” sex businesses increasingly turned into a cover for criminal activities involving illegal drugs, human trafficking, and tax frauds (Huisman and Nelen, 2014). The urge to clean up the industry resulted in a new law in 2000, which legalized brothels and recognized prostitution as a legitimate profession. The Public Administration Probity in Decision-Making Act of 2003 (*Bevordering Integriteitsbeoordelingen door het Openbaar Bestuur*, BIBOB) also gave local governments the power to refuse licenses to firms under investigation.

The city of Amsterdam started to close suspicious brothels at the end of 2006. At the same time, the city decided to rezone the prostitution areas and buy 26 prostitution-related properties. This buyout was part of Project 1012, launched in 2007 and intended to reduce crime and the presence of businesses with little economic value in the central area.¹⁴ Between 2007 and 2014, 27% of the red windows were

¹²Table S2 of the Online Appendix presents a timeline of events regarding prostitution policy.

¹³*Ruysdaelkade* is hardly noticeable given its size and the absence of related businesses around. Moreover, there has been no significant change in its location.

¹⁴Project 1012 has been executed along three lines: ten key projects intended to boost the district’s economy; investments in public areas; and improvements to activities in a number of streets by

closed either by applying the BIBOB law or by buying out. While the majority of closed brothels were occupied by other businesses, mostly retailers, a few of them were converted into homes. Unfortunately, details on the occupancy was not disclosed.

Figure 1 shows the location of the two largest RLDs, which are about 300 meters apart, along with the heat maps of house prices in 1991-2006 (on the center) and 2007-2014 (on the right). The boundaries of the RLDs delineate the smallest area containing all blocks in which window prostitution has been allowed since 1991. These limits are defined by streets and alleys (dashed lines) and by canals (dark blue lines). Although the “land” borders are debatable, the canals, or “natural” borders, clearly put a limit to what belongs to the area and what does not. Each bordering canal — namely, *Geldersekade* on the east side of *De Wallen* and *Herengracht* on the west side of *Singelgebied* — is 30 meters wide; see Figure S3 of the Online Appendix.¹⁵

FIGURE 1 ABOUT HERE

The heat maps in Figure 1 confirm that prices are lower in the RLDs than in nearby areas. Most of *Singelgebied* is either yellow or green, indicating prices below 5,000 euros/m², and *De Wallen* is “greener” than other areas, indicating prices below 4,250 euros/m² in most parts. To estimate and test the effect of the RLDs on housing values, we use the natural borders as a spatial cutoff where prices are presumably discontinuous. In Figure 1, we observe that up to 2007 prices are different across these borders (dark blue lines). On the west border of *Singelgebied*, prices go from above 5,500 euros/m² (dark red) to below 5,250 euros/m² (golden yellow) just by crossing the canal; on the east border of *De Wallen*, prices go from above 4,500 euros/m² (light green) to below 4,250 euros/m² (dark green). After 2006, however,

closing or relocating coffeeshops and brothels. Figure S2 of the Online Appendix shows the location of all the investments made by this project. More details on Project 1012 are in the Online Appendix.

¹⁵*Geldersekade* is discontinued by a 55-meter wide plaza, named *Nieuwmarkt*, which we consider part of the natural border.

prices practically equalized along the canals — i.e., the dark red area crosses the west border and the light green area crosses the east border. The equalization coincides with the closing of prostitution windows (marked with an ‘x’).

3.1 Empirical Strategy

The difference between house prices at the RLD borders is estimated using a Regression Discontinuity (RD) design. Unlike the conventional RD design, the cutoff point is not unique, but it is the set of coordinates that defines the border. Since red windows are not evenly spread in the RLDs, we can identify where the discontinuity is stronger and verify whether its strength is related to their location. Because the location of red windows change over time, so do the RD estimates.

The Difference in Discontinuities (DiD) is estimated in two different ways. In the first approach, we let the DiDs freely vary by latitude and longitude and compare them with the location of closing windows. In the second approach, we estimate the DiD as a function of the changing distance to prostitution windows. This approach allows us to identify the MWTA for living next to brothels by looking at the discontinuity in the relationship between house prices and distance to windows. As a result, the identification of causal effects is not only through a simple RD comparing two areas, but through the fine relationship between changes in RDs and the closing of brothels. All estimators are described in the Online Appendix.

3.1.1 Two-Dimensional Regression Discontinuity

Let y_{it} be the log price per square meter at which house i is sold at period t . Consider this variable a function of longitude, s_{1i} , and latitude, s_{2i} , as follows:

$$y_{it} = (1 - z_i) \mu_{0t}(s_{1i}, s_{2i}) + z_i \mu_{1t}(s_{1i}, s_{2i}) + x'_{it} \beta_t + \varepsilon_{it}, \quad (1)$$

where x_{it} is a vector of dwelling characteristics, z_i indicates whether property i is in the RLD, and μ_{1t} and μ_{0t} are functions mapping locations to prices in and out of the RLD, respectively. The estimates for β_t are reported in Table S3 of the Appendix.

Let $\mathbf{c} = \{(c_{11}, c_{21}), \dots, (c_{1L}, c_{2L})\}$ be the set of points that defines the RLD border and $d(\cdot)$ be the distance function between two coordinates. Also let $\tilde{d}(\mathbf{c}_l, \mathbf{s}, z(\mathbf{s})) = (1 - 2z) \cdot d(\mathbf{c}_l, \mathbf{s})$, which is negative if $\mathbf{s} = (s_1, s_2)$ is in the RLD ($z = 1$) and positive otherwise ($z = 0$). At any location l on the border, the estimand of interest is:

$$\tau_{lt} \equiv \lim_{\tilde{d}(\mathbf{c}_l, \mathbf{s}) \uparrow 0} \mu_{1t}(s_1, s_2) - \lim_{\tilde{d}(\mathbf{c}_l, \mathbf{s}) \downarrow 0} \mu_{0t}(s_1, s_2), \quad (2)$$

i.e., the difference between limits of a conditional expectation approaching the border from inside and from outside. According to Hahn et al. (2001), τ_{lt} is identifiable as the treatment effect at l under a few smoothing assumptions.

At the limit, households on both sides have similar taste and access to other amenities, such as museums and schools. Thus, the discontinuity derives from their non-marginal WTA, which is how much they require to accept the presence of sex workers and related nuisances. However, we cannot make any inference about the economic impact out of the RLD, which will be investigated in section 4.

3.1.2 Difference in Discontinuity

If either households or properties are not similar at the border, then the discontinuity, τ_{lt} , would also respond to these differences. To control for potential unobservables, we calculate changes in the price discontinuity over time:

$$\Delta\tau_l \equiv \tau_{l0} - \tau_{l1}, \quad (3)$$

where $t = 0$ is when all windows are open and $t = 1$ is when some are closed.

Moreover, assuming that other amenities remain constant, we can identify the

price effect in other parts of the RLD. In this case, we compare the price change in any location in the RLD with the price change at the closest point of the border:

$$\Delta\tau(\mathbf{s}) = \mu_{10}(\mathbf{s}) - \mu_{11}(\mathbf{s}) - \left\{ \mu_{00}(\mathbf{c}_l) - \mu_{01}(\mathbf{c}_l) \mid \mathbf{c}_l \in \mathbf{c} \text{ and } \mathbf{c}_l = \operatorname{argmin} d(\mathbf{c}, \mathbf{s}) \right\}, \quad (4)$$

which allows us to visualize price effects around the location of closed windows.

After estimating $\Delta\tau_l$ for different points on the border line, we calculate the MWTA of the externality by applying the following Wald estimator:

$$\hat{v}_r(r, g, \mathbf{x}) = \frac{\sum_l \hat{f}(\mathbf{c}_l) \Delta\hat{\tau}_l}{\sum_l \hat{f}(\mathbf{c}_l) \Delta\hat{r}_l}, \quad (5)$$

where $\hat{f}(\cdot)$ is the estimated density of dwellings, r_{lt} is the shortest distance to a red window, and $\Delta\hat{r}_l$ is the estimator for the change in this distance at location l :

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

3.1.3 Conditional Difference in Discontinuity

Estimator (5) is unbiased if the average DiD depends on no event other than the closing of red windows. Another approach to estimating the MWTA is the conditional DiD design. Consider price a function of the shortest distance to a red window, r_{it} :

$$y_{it} = \alpha_i \cdot r_{it} + x'_{it}\beta_t + \kappa_{it} + \varepsilon_{it}, \quad (6)$$

where α_i is the hedonic price that house i 's occupant pays for r_{it} , κ_{it} is the effect of unobservables at time t , and ε_{it} is a zero-mean random term.

Unlike equation (1), location is defined by the shortest distance to the RLD border, s_i , and the initial distance to a red window, r_{i0} . If $s_i \leq 0$, then house i is in the RLD ($z_i = 1$). Otherwise, house i is out of the RLD ($z_i = 0$). Then we assume that α_i and

κ_{it} depend on location (s_i, r_{i0}) , as follows:

$$\begin{aligned}\alpha_i &= z_i \cdot \alpha_1(s_i, r_{i0}) + (1 - z_i) \cdot \alpha_0(s_i, r_{i0}) \quad \text{and} \\ \kappa_{it} &= z_i \cdot \kappa_{1t}(s_i, r_{i0}) + (1 - z_i) \cdot \kappa_{0t}(s_i, r_{i0}).\end{aligned}$$

Both functions are continuous everywhere but at the border ($s = 0$).

From equation (6), the price discontinuity at the RLD border is:

$$\tau_{lt} = \lim_{s \uparrow 0} [\alpha_1(s, r_{l0}) \cdot r_{lt} + \kappa_{1t}(s, r_{l0})] - \lim_{s \downarrow 0} [\alpha_0(s, r_{l0}) \cdot r_{lt} + \kappa_{0t}(s, r_{l0})]; \quad (7)$$

and the DiD is approximately given by:

$$\Delta \tau_l \approx \delta^0 \Delta r_l + \delta^1 (r_{l0} \cdot \Delta r_l) + \delta^2 + \delta^3 r_{l0}, \quad (8)$$

where $\delta^0 \equiv \lim_{s \uparrow 0} [\partial \alpha_1(s, 0) / \partial r] - \lim_{s \downarrow 0} [\partial \alpha_0(s, 0) / \partial r]$,

$$\delta^1 \equiv \lim_{s \uparrow 0} [\partial^2 \alpha_1(s, 0) / \partial r_0 \partial r] - \lim_{s \downarrow 0} [\partial^2 \alpha_0(s, 0) / \partial r_0 \partial r],$$

$$\delta^2 \equiv \lim_{s \uparrow 0} \Delta \kappa_1(s, 0) - \lim_{s \downarrow 0} \Delta \kappa_0(s, 0), \text{ and}$$

$$\delta^3 \equiv \lim_{s \uparrow 0} [\Delta \partial \kappa_1(s, 0) / \partial r_0] - \lim_{s \downarrow 0} [\Delta \partial \kappa_0(s, 0) / \partial r_0].$$

δ^0 represents the MWTA of the household right next to a window ($r = 0$) and δ^1 is its derivative with respect to r . For $\Delta r = 0$, if $\delta^2 = \delta^3 = 0$, then the average DiD, as in equation (3), is only driven by the closing of red windows.

To recover the non-marginal WTA from the parameters above, we look at δ^1 to find how far the marginal effect goes, say $r^* = -\delta^0 / \delta^1$. Then the expected WTA right next to a window ($r = 0$) will be

$$WTA = -[r^* \delta^0 + (r^{*2} / 2) \delta^1] = (\delta^0)^2 / 2 \delta^1. \quad (9)$$

Estimating δ^0 and δ^1 demands more variation in the distance to a red window than estimating the DiD. Accordingly, to estimate equation (8) we extend the border lines, including the whole course of the two bordering canals.

3.2 Estimation Results

3.2.1 Price Discontinuity at the Canals

In Figure 2, we compare properties in and out of the RLD that are separated by a canal. By applying a one-dimensional RD design, which takes only the shortest distance to the border as the running variable, we find that households until 2007 were paying 10.6% less to live on the RLD side.¹⁶ Beyond the average, we also find that the discontinuity is quite heterogeneous along the borders. Figure S5 of the Online Appendix shows that it ranges from 0.13 to -0.26 .

FIGURE 2 ABOUT HERE

In 2007-2014, the period when the municipality closed some windows and rezoned the RLDs, the gap between house prices at those canals disappeared. Both Figure 2 and Figure S5 confirm that prices equalized at the border, where windows were closed, but they remained low towards the center, where windows were still open.

One concern is that prices in the RLDs were rising before 2006, so the government closed brothels to free up valuable land. To confirm that the discontinuity changed after 2006, we also estimate RDs for three-year periods using transaction prices and for one-year periods using asking prices. Despite the bias, the sample of asking prices is 60% larger than the sample of transaction prices, so it provides narrower confidence intervals per year. The estimates in Figure 3 show that the difference is negative until 2006. Prices on the RLD side increased in 2006-2008 and the difference remained close to zero afterwards. Not even the legalization of brothels in 2000 has an effect as clear as the use of the BIBOB Act and the buyout policy, started at the end of 2006.

FIGURE 3 ABOUT HERE

¹⁶We also find a similar discontinuity if we look at all RLD borders, including the land borders (dashed lines in Figure 1). See Figure S4 in the Online Appendix.

3.2.2 Difference in Price Discontinuity

To verify whether the price equalization at the border coincides with the closing of windows, we present DiD estimates that vary along the canals. Figure 4 shows on the right the estimates for equation (3) and on the left the ones for equation (4). These estimates confirm that from 1991-2006 to 2007-2014, prices increased more in the RLD than outside. The DiD is particularly significant near the natural borders, where most of the closings took place.

FIGURE 4 ABOUT HERE

The estimates go from nearly zero if the house was far from the prostitution windows to -0.32 if the house was directly beside a closed one. For part of the border in *Singelgebied*, however, the DiD is found insignificant even with the closing of windows nearby — particularly, on *Bergstraat*. In fact, the last brothel on *Bergstraat* was operating until late 2012. Thus, even though some brothels were closed, the shortest distance to one had not changed as much as in other parts of the border.

To compare the location of the closed windows in Figure 4 with other developments, Figure S2 of the Online Appendix shows the map of investments made by Project 1012. This map confirms that the developments are spread over several places. Yet they do not coincide with the window closings at the bordering canals. Hence, other developments either have no immediate effect on house prices or equally affect values on both sides of the border. In terms of identification, the DiD captures a very specific difference between houses that are just 30 meters apart. Any bigger project intended to redesign public spaces would affect prices on both sides.

Table 2 presents the average DiD, along with changes in the distance to a red window and estimates for the MWTA, as in equation (5). Under several bandwidths, the average DiD ranges between -0.126 and -0.09 . Even if we change the initial

period to 2001-2006, the estimates remain similar. We also confirm that there was no significant change in the price discontinuity from 1991-2000 to 2001-2006. The estimated MWTa lies between 9.1% and 23.5% per 100 meters.

TABLE 2 ABOUT HERE

The alternative to estimating the MWTa is the conditional DiD design, as in equation (8). Table 3 shows that these estimates are higher than, but still close to the ones in Table 2, ranging between 17% and 26% per 100 meters. It also shows that the MWTa declines with distance, dropping by 40% for each 100 meters and hence going to zero after 250 meters. By integrating the MWTa from zero to this point, as in equation (9), we find a non-marginal WTA around 30% of the property value, which is consistent with Figure 4.

TABLE 3 ABOUT HERE

Furthermore, both the intercept and the coefficient of initial distance are close to zero in Table 3. Then it is unlikely that an event other than the closing of windows affected the average DiD — i.e., the unconditional DiD is negative due to the change in the average distance to a brothel. This finding suggests that other components of Project 1012, spread in the central area, did not affect the observed discontinuity.

3.2.3 Willingness to Accept Prostitution in Amsterdam

Our findings indicate that households require about 30% of their home's value to live next to a red window. To calculate the WTA in annual outflows, we consider that in 2014 the median property within 100 meters from the RLD border was worth 370,000 euros. With a mortgage rate of 3.5%-5% per annum for a 30-year loan, we estimate that brothels cost 6,000-7,100 euros per year to a household next door. This cost

represents 24-30% of the median household income in Amsterdam.

Moreover, considering that all homes in the RLD are worth 1.5 billion euros, we calculate that up until 2007 about 270-325 million euros used to be lost in property values.¹⁷ This figure means that to live in the RLD all households together required 15-21 million euros a year, which is ten times the annual cost of Project 1012.

Based on the estimates in Figure 4, we calculate that all houses in the RLDs have appreciated by at least 45 million euros, which lies between 14% and 17% of the initial loss. Although the number is not publicly available, a local source claims that Project 1012 had spent almost 25 million euros in property buyouts up to 2015.¹⁸

3.2.4 Other Findings

Since a few brothels have been converted into homes, the above results could also be affected by a shock in the housing supply. In addition, the price difference on the canal borders might be driven by housing developments on either side. A simple way of testing these shocks is verifying whether the density of houses for sale is continuous at the border.¹⁹ Figure S6 of the Online Appendix presents the McCrary's (2008) test and confirms that the density is fairly continuous in any period. Table S4 presents results under several bin widths and the continuity hypothesis is never rejected.

Although housing supply is constrained, landlords may respond to the discount in the RLD by investing in their dwellings. Table S5 of the Appendix confirms that there are some differences in housing features at the RLD border. Accordingly, we

¹⁷These numbers take into account several linear and non-linear specification derived from Tables 2 and 3. The aggregation is made through a sample of houses on the market in the last 30 years, whose price is deflated using annual hedonic regressions. The aggregate amount is also divided by 46%, which is the percentage of the dwelling stock in the center of Amsterdam that has been offered for sale through a NVM member.

¹⁸Source: De Telegraaf (Mar 19, 2015).

¹⁹Another hypothesis is that lenders deny mortgages to properties in the RLD, making sales less frequent. We also test for discontinuity in sales and find no significant evidence.

control for all these characteristics in equations (1) and (6) so that our estimates get closer to the true WTA. Nevertheless, all the observed differences account for a small price gap. Without controls, the average DiD would be underestimated by 0.024.

Another concern is that the RLDs concentrate other businesses with (dis)amenities, such as coffeeshops (cannabis retailers). The McCrary's test, shown in Table S6 of the Appendix, confirms that the density of coffeeshops, bars, and restaurants is higher on the RLD side, whereas the density of retailers is similar. Yet these differences have not significantly changed over time, so they cannot explain our DiD estimates.²⁰

4 Prostitution and House Prices in Utrecht

Utrecht used to have two RLDs, 2.3km apart: *Hardebollenstraat*, a two-block street in the center; and *Zandpad*, also known as *Rode Brug*, where window prostitutes worked in houseboats. Although these areas are much smaller than Amsterdam's RLDs, they have witnessed many disputes between residents and sex workers in the last decade.

On 25 July 2013 all the brothels on *Hardebollenstraat* and *Zandpad* were closed on suspicion of human trafficking and other crimes. Although both areas remain closed, there is still a chance the latter will re-open. A new RLD in *Zandpad* was approved at the end of 2016, but the project has been delayed. On *Hardebollenstraat*, the plan, announced in 2017, is to replace the former brothels with cafes and restaurants.

FIGURE 5 ABOUT HERE

The location of the RLDs is shown in Figure 5, along with heat maps of sales density and price. Figure S8 of the Online Appendix shows a picture of each one. *Hardebollenstraat* is in a dense and expensive area, with prices above 2,800 euros/m².

²⁰We also re-estimate the DiD in house prices, controlling for the varying distance to those establishments. Table S8 of the Online Appendix confirms that our previous finding is robust.

In contrast, *Zandpad* is in a sparse and low-priced area, with prices below 2,200 euros/m². The higher density can make prices in the former more sensitive. In fact, after the closings, the red area, with prices above 3,000 euros/m², expanded towards *Hardebollenstraat*, while in *Zandpad* prices remained low.

4.1 Empirical Strategy

To estimate the effect of the RLDs on house prices, we use a non-parametric difference-in-slope (DiS) approach. In this approach, the systematic differences across locations are captured by the distance function after the shutdown. If prices increase or decrease everywhere, this function should shift up or down. But if prices are affected by the RLDs, then the shape of the function before the shutdown must be different.

The change in the function's shape is measured by the difference in its first derivative, which yields the marginal effect — i.e., how much the price changes by increasing the distance. Moreover, since households tend to sort themselves by taste, we allow the DiS be spatially heterogeneous. Finally, the non-marginal effect — i.e., the difference between having and not having the RLDs — results from integrating the DiS. Details of the estimator are in the Online Appendix.

4.1.1 Two-Dimensional Difference-in-Slopes

Let y_{it} be the log price per square meter at which house i is sold at period t and $\mathbf{s}_i = (s_{1i}, s_{2i})$ be the coordinates of its location. The RLDs' centroids are at $\mathbf{c} = \{(c_{11}, c_{21}), (c_{12}, c_{22})\}$, so $d(\mathbf{c}, \mathbf{s}_i)$ is the shortest distance between house i and an RLD. To simplify our notation, let $h_i = d(\mathbf{c}, \mathbf{s}_i)$. Hence, the estimating equation is:

$$y_{it} = \mu_t(\mathbf{s}_i) + \gamma_t(\mathbf{s}_i) h_i(\mathbf{s}_i) + x_i' \beta + \varepsilon_{it}, \quad (10)$$

where x_i is a vector of dwelling characteristics and ε_{it} is the error term. This equation is estimated for two periods: from January 2011 to December 2012 (before) and from August 2013 to December 2014 (after). We also use periods 2007-2008 and 2009-2010 to verify the changes before the shutdown.

Consider the RLDs open at time 0 and closed at time 1. While $\Delta\mu = (\mu_0 - \mu_1)$ controls for unrelated changes in price (time effect), $\Delta\gamma = (\gamma_0 - \gamma_1)$, named DiS, captures the marginal treatment effect. If households want to stay as far as possible from the RLDs, then $\gamma_0(\mathbf{s}) > 0$ as long as there is no confounding amenity. When RLDs are closed, the distance function becomes flat: $\gamma_1(\mathbf{s}) = 0$.

With confounding factors, the latter function need not be flat. Yet the before-after difference should eliminate these factors. Then the DiS is interpreted as follows:

$$\Delta\gamma(\mathbf{s}) \begin{cases} > 0 & \text{if households dislike the RLDs and pay to be far away,} \\ < 0 & \text{if households enjoy the RLDs and pay to move closer.} \end{cases} \quad (11)$$

To test the effects of RLDs, it is enough to verify whether $\Delta\gamma(\mathbf{s})$ is different from zero. But to calculate the non-marginal effect, we assume counterfactuals derived from a linear approximation. That is, the price effect at location $\mathbf{s}$ is given by a second-order approximation:

$$\tau(\mathbf{s}) \approx \Delta\gamma(\mathbf{s}) \cdot h(\mathbf{s}) + \frac{1}{2} \Delta\gamma'(\mathbf{s}) \cdot h(\mathbf{s})^2. \quad (12)$$

where γ' is the second derivative of the log price with respect to distance. The second term in (12) is considered only if $\Delta\gamma'(\mathbf{s})$ is significant at 10%.

4.2 Estimation Results

4.2.1 Marginal Effect of the RLDs

We start by defining location as a one-dimensional variable — i.e., by the distance to the RLD. The graphs on the left of Figure 6 show that the relationship between price and distance to RLD is negative for *Hardebollenstraat* (upper graph), but positive for *Zandpad* (lower graph). That is, houses are more expensive in the former area than the average house in the city and cheaper in the latter. After closing the RLDs, the first curve became considerably steeper, while the second became slightly flatter.

FIGURE 6 ABOUT HERE

Since the marginal effect is identified by the DiS, both changes suggest that the relationship between prices and distance to RLDs is positive — see the right panels in Figure 6. Hence, households were willing to pay more to be farther from the RLDs. Given the low sales density in *Zandpad*, confidence intervals are wider and the DiS is not significant. On *Hardebollenstraat*, however, we find that prices tend to increase by almost 1.5% for 100 meters distance from brothels.

Because households are sorted by their taste, the effect of brothels can be spatially heterogeneous. In this case, the one-dimensional approach is limited, not showing where the slope has changed. Figure 7 indicates that the marginal effect varies from 0% to 1.6% per 100 meters and is higher in the area between the two RLDs than anywhere else. Since households in the green area were paying more for each meter away from the “triangles,” their houses were more expensive before the shutdown.

FIGURE 7 ABOUT HERE

There are two possible reasons the effect in the city center is insignificant: 1) houses were already expensive due to other amenities and there is no room for a

premium; and 2) its residents are less concerned by the RLD. These two reasons are not mutually exclusive; in fact they may explain one another. Furthermore, we do not observe any area where households are willing to live closer to an RLD. Figure S9 of the Online Appendix shows the distribution of marginal effects conditional on the radius around the RLDs. Up to 500 meters from an RLD, practically all households are willing to pay at least a slight premium to move farther away.

One concern is that the distance function to RLDs had become progressively flatter before the shutdown. That is, house prices may have anticipated the closing of brothels. Figure S10 of the Online Appendix shows the distribution of estimated DiS for two other periods before the shutdown. These estimates confirm that our findings do not result from a previous trend. In fact, before 2013 marginal prices had changed in the opposite direction. This trend may have been due to an inflow of sex workers to Utrecht after Amsterdam and Rotterdam downsized their soliciting areas.

For robustness, we also applied different bandwidths, as reported in Table S9 of the Online Appendix. Overall, the distribution of DiS is very similar for a range of bandwidths around the optimal one. We also estimate the DiS for 1,000 random locations within the city limits. Figure S11 confirms that our findings have a very small chance of being replicated by a random pair of points.

4.2.2 Welfare Effect of Prostitution in Utrecht

The previous part indicates that some households pay more for their homes so as to live far from prostitution. In Figure 8, we present the distribution of premiums that households pay, based on a linear approximation — see equation (12). Up to one kilometer, 25% of the households pay at least 4% more for their homes. With a mortgage rate of 3.5% per annum for 30 years, this premium represents around 500

euros a year. Overall, the premium can be as high as 12%, or 1,600 euros a year.

FIGURE 8 ABOUT HERE

By using information about the houses on the market in the last 30 years and deflating their prices using annual hedonic models, we calculate the total value of the dwelling stock in Utrecht.²¹ Then we integrate the price effects, as in Figure 8, over this stock to obtain the deadweight loss caused by prostitution in the RLDs. For this integration, presented in Figure 9, we consider only the DiS estimates that are significant at 10%. Depending on the radius for the integration — a wider radius may lead to noisy estimates — and the chosen bandwidth for the DiS, the aggregate loss ranges between 125 and 225 million euros. In other words, taxpayers were spending 6.75-14.5 million euros per year to stay away from prostitution.

FIGURE 9 ABOUT HERE

One way in which prostitution yields this willingness to pay is by changing the distribution of jobs in the city. Accordingly, we also estimate the DiS for the density of jobs. The findings, shown in Figure S13 of the Online Appendix, suggest that the RLD, if located in a dense area, raises the employment level nearby — i.e., the DiS is negative, so the density declines with distance. According to Glaeser and Gyourko (2005), the farther the households are from work, the lower the house prices, which contradicts our main result. Thus an economic disruption does not seem to be the reason households pay to stay away from prostitution.

²¹We also divide the amount by the percentage of the stock that has been offered for sale through a NVM member, which ranges between 1% and 73%.

5 Safety and Nuisances in the RLDs

The distaste for prostitution can in part be explained by related criminal activities. In this section, we first present estimates for changes in crime rates and nuisances in the RLDs after brothels are closed. Then we re-estimate the effects on house prices in Amsterdam and Utrecht, controlling for those changes.

5.1 Changes in Crime Rates and Other Nuisances

Since the crime data are at the neighborhood level, we cannot apply the same identification strategies as for house prices. Although it cannot be interpreted as causal, this analysis can help us understand the particular changes that took place in the RLDs. Table 4 presents difference-in-difference estimates that compare neighborhoods where the RLDs are located with those up to 200m distant, up to 500m, and up to 2km.

TABLE 4 ABOUT HERE

In Amsterdam, the overall crime rate has declined 18% more in the RLDs than in more distant areas after 2006. Also an increase of 9-10% in close areas (up to 500m) suggests that crime has been displaced. While the direct effect represents 1,250 fewer crimes/year in the RLDs, the displacement counts for only 320 more crimes/year in these areas. In Utrecht, crime declined 11% (or 210 crimes/year) in the RLDs and 10% (or 110 crimes/year) in areas within 200m after 2013.²²

In both cities, the reduction was not only in violence and minor nuisances, such as vandalism, drunkenness and excessive noise, but also in major property crimes. These felonies are arguably unrelated to prostitution, but the reduction in petty crimes may free up police resources to prevent those cases (Adda et al., 2014).

²²Table S10 of the Online Appendix shows that the crime rate has declined most on *Hardbollenstraat*. Although *Zandpad* is a less dense area, cases of violence have also declined by 36%.

5.2 Can Safety and Nuisances Explain the Effect on House Prices?

5.2.1 Price Discontinuity in Amsterdam

Table 5 shows how the average DiD in house prices varies when we add covariates, such as risk perception, violence, property crimes and other nuisances, to our model in Amsterdam.²³ Since the data on reported felonies and risk perception are available only from 2003 to 2013, the sample period is shorter than before. Still, the average DiD in column (1), which is 0.09, is close to the ones presented in Table 2.

TABLE 5 ABOUT HERE

In column (2), we find that adding violence does not change the DiD. Also, with risk perception, the DiD decreases by only 10%, remaining above 0.08 in column (3). Drug-related crimes and minor nuisances have the highest influence, reducing the DiD by up to 27% — i.e., making it below 0.075 in columns (4), (5), (6), (7) and (9). Finally, property crimes seem to not explain the previous findings — see column (8). These findings suggest that the distaste for prostitution is explained partially by petty crimes, but more than 73% of the price discount remains unexplained.

Violence and property crimes do not affect the discontinuity because they are not restricted to the RLD-side of the border and may also affect households just across the canals. Table 5 also shows that the MWTA for living close to red windows barely changes after including any of these covariates. That is, the nuisances that explain the price discontinuity are highly concentrated around the brothels.

²³If crime is discontinuous at the border, differences between neighborhoods will be overestimated.

5.2.2 Price Effect in Utrecht

For Utrecht, we perform a similar exercise, re-estimating the DiS after controlling for time-varying rates within the following radii around the houses: 200 meters, 700 meters, 1.5 kilometers, and above 1.5 kilometers. This exercise reveals how much of the price effect out of the RLDs could be attributed to crimes, nuisances, and risk perception. Since the price effects are spatially heterogeneous, as shown in Figure 7, we only present the changes in the aggregate effect, as in Figure 9. Changes in the distribution of price effects are presented in Figure S14 of the Online Appendix.

FIGURE 10 ABOUT HERE

The blue line in Figure 10 represents the benchmark effect, which is around 183 million euros. After controlling risk perception, the effect drops to 130 million euros — i.e., it explains at most 30% of the aggregate impact of RLDs. Actual violence explains at most 17%, and major property crimes at most 31%. The largest drops are observed after controlling for nuisances, which alone explain more than 65%, and for the combination of nuisances and drug-related crimes, with more than 90%. The aggregate effect of RLDs almost disappears after we control for all the covariates.

6 Conclusion

The legitimacy of prostitution depends on how costly it is to other citizens. Part of this subjective cost is internalized in property values. To pin down the effect of on-site prostitution on house prices, we present a few spatial estimators that identify the relationship between average treatment effect and the varying distance to brothels.

Our results suggest that households have a strong distaste for living next to brothels. In Amsterdam, we calculate that they require at least 6,000 euros a year to accept

sex workers on their doorstep. Even after controlling for risk perception and all sorts of misbehavior, we still observe a strong aversion to brothels. This aversion may explain why prostitution, even if legal, tends to be pushed into the shadows in a gentrifying city (Hubbard, 2017); a movement that reinforces the stigma of sex workers as second-class citizens.²⁴

Although the concentration of sex workers may raise the labor demand from businesses close by, the presence of prostitution in the heart of the city is related to nuisances, such as drug-related crimes (e.g., Bisschop et al., 2017). In Utrecht, we find that the positive externalities of RLDs do not offset the cost of petty crimes. In fact, a household living 1.5km from the RLD may pay up to 1,600 euros more per year than if it were next to a brothel.

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²⁴As shown by Cunningham et al. (2017), this stigma place sex workers at considerable risk.

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Figure 1: Location of RLDs and House Prices in Amsterdam

This figure shows the location of the two main Red Light Districts (RLDs) in Amsterdam (on the left), and the average price per square meter of dwellings per postal code in 1991-2006 (in the center) and 2007-2014 (on the right). It also shows the location of operating and closed red windows. Dwelling characteristics are controlled for using a hedonic model, equation (1), and prices are deflated to values of 2014. The heat map shows the predicted values estimated using a two-variable kernel-weighted regression, holding all characteristics constant. The bandwidth is selected using a procedure adapted from [Calonico et al. \(2014\)](#).

Figure 2: House Prices per Distance to RLD Border in Amsterdam and Regression Discontinuity Estimates

This figure shows the log price per square meter as a function of the minimum distance in km to the closest natural border of a Red Light District (RLD) in Amsterdam. The sample includes properties located up to 2km from the closest border and it excludes properties outside an RLD that are not separated by a natural border. Dwelling characteristics are controlled for as shown in equation (1). Distance functions are estimated using triangular kernel with the bandwidth selection procedure proposed by [Calonico et al. \(2014\)](#). τ is the regression discontinuity estimate, with robust standard errors in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Figure 3: Regression Discontinuity Estimates per Year in Amsterdam

This figure shows one-dimensional regression discontinuity estimates at the natural border of Amsterdam's Red Light Districts (RLDs). The graph on the left uses a moving sample of transaction prices for three years, centered at the middle one. The graph on the right uses annual samples of asking prices. Both samples include properties located up to 2km from the closest border and it excludes properties outside an RLD that are not separated by a natural border. Dwelling characteristics are controlled for as shown in equation (1). Distance functions are estimated using triangular kernel with the bandwidth selection procedure proposed by [Calonico et al. \(2014\)](#). The dashed lines represent the 95% robust confidence interval.

Figure 4: Difference in Price Discontinuity in Amsterdam's RLDs, 1991/2006 – 2007/2014

This figure presents difference-in-discontinuity (DiD) estimates as shown in equations (3), on the right, and (4), on the left. The sample includes properties located up to 2km from the closest Red Light District (RLD). Dwelling characteristics are controlled for as shown in equation (1). Log prices are estimated using triangular kernel with the bandwidth selection procedure proposed by Calonico et al. (2014). On the left, the contour lines delimit the areas where the DiD is significant at 5% and 10%. On the right, minimum and maximum values are highlighted, with robust standard errors in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively. The figure also shows the location of operating and closed red windows.

Figure 5: Sales Density and House Prices in Utrecht, Before and After Closing RLDs

(a) Sales Density

(b) House Prices

This figure presents heat maps of house prices and sales density in Utrecht in 2011-2012, ‘before’ the Red Light Districts (RLDs) were closed, and between August 2013 and December 2014, ‘after’ they were closed. The two upper maps show the density of house sales, estimated using a bivariate normal kernel, with bandwidth selected using [Silverman’s \(1986\)](#) procedure. The two lower maps show the price per square meter predicted by a two-variable kernel-weighted regression. The bandwidth is the same in these maps and is selected using the procedure adapted from [Calonico et al. \(2014\)](#). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014.

Figure 6: House Prices per Distance to RLDs and Difference-in-Slope in Utrecht

The first graphs on the left show the relationship between log price per square meter and distance to the Red Light District (RLD) on *Hardebollenstraat* (top) and *Zandpad* (bottom), Utrecht, in January 2011–December 2012 (before) and August 2013–December 2014 (after). The graphs on the right show the first derivative of the distance functions before minus the first derivative after the RLDs are closed (DiS). The bandwidth is selected using the procedure adapted from [Calonico et al. \(2014\)](#). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs. For DiS estimates at distance zero, $\Delta\gamma(0)$, robust standard errors are in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Figure 7: Spatial Marginal Effect of RLDs on House Prices in Utrecht

This figure shows the location of changes in the relationship between log price per square meter and distance to a Red Light District (RLD) in Utrecht. See equation (10). The ‘marginal effect’, or Difference-in-Slope (DiS), is the difference in the first derivative of the distance functions in January 2011-December 2012 and August 2013-December 2014. For better illustration, we apply an empirical Bayes shrinkage to estimates that are not significant at 10%. The bandwidth is selected using the procedure adapted from [Calónico et al. \(2014\)](#). See Table S9 in the Online Appendix (scale 1). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs.

Figure 8: Quantiles of Price Effects of RLDs in Utrecht

This figure shows the distribution (quantiles) of non-marginal effects in log price (on the left) and annual payments in euros (on the right) as a function of the radius to the center of the Red Light Districts (RLDs) in Utrecht. The effects are calculated through a second-order approximation, equation (12), using the estimated Difference-in-Slope (DiS) presented in Figure S9. Annual payments are calculated considering the total value of properties and a mortgage interest rate of 3.5% per annum for a 30-year loan. The DiS is the difference in the first derivative of the distance functions in January 2011-December 2012 and August 2013-December 2014. The distribution of effects is weighted by the density of houses for sale in 2011-2012. For better illustration, we apply an empirical Bayes shrinkage to estimates that are not significant at 10%. The bandwidth is selected using the procedure adapted from Calonico et al. (2014). See Table S9 in the Online Appendix (scale 1). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs.

Figure 9: Aggregate Effect of RLDs on House Prices in Utrecht

This figure shows the cumulative effect of the Red Light Districts (RLDs) on house prices. The effects are integrated over the distance to the RLDs within two radii: 1.5km (in red) and 2.5km (in blue). The effects are calculated through a second-order approximation, equation (12), using the estimated Difference-in-Slope (DiS) from Table S9 in the Online Appendix. We consider only estimates that are significant at 10%. The value of dwellings per postal code is obtained by deflating, based on their characteristics, the prices of all houses in the market since 1984. This value is also divided by the share of houses for sale per postal code.

Figure 10: Aggregate Effect of RLDs on House Prices in Utrecht,
Controlling for Safety and Nuisances

This figure shows the cumulative effect of the Red Light Districts (RLDs) on house prices. The effects are integrated over the distance to the RLDs within 2km. Control variables are gradually added to the benchmark model (blue line) and are measured the year before. Cases of ‘violence’ include declarations of abuses, threats, sexual offenses, fights, assaults, and street robbery, but they exclude cases of domestic violence. ‘Nuisances’ include complaints against neighbors and cases of drug and alcohol abuse registered by the police. ‘Major property’ crimes include burglaries and motor vehicle thefts. ‘Minor thefts’ include bike thefts, shoplifting, pickpocketing and other property crimes. The effects are calculated through a second-order approximation, equation (12), using the estimated Difference-in-Slope (DiS). The DiS is the difference in the first derivative of the distance functions in January 2011-December 2012 and August 2013-December 2014. We consider only estimates that are significant at 10%. The value of dwellings per postal code is obtained by deflating, based on their characteristics, the prices of all houses in the market since 1984. This value is also divided by the share of houses for sale per postal code.

Table 1: Descriptive Statistics of House Characteristics

	Amsterdam				Utrecht area			
	in sample		out of sample		in sample		out of sample	
	mean	std.dev.	mean	std.dev.	mean	std.dev.	mean	std.dev.
Price/m ² (euros)	4,005	1,103	3,113	1,045	2,660	713	2,626	824
In the RLD	0.033	0.178	0.000	0.000	0.000	0.000	0.000	0.000
Distance to RLD border	1.133	0.575	4.019	1.952	1.494	0.682	5.530	1.504
Distance to red window	1.226	0.576	4.117	1.950	1.494	0.682	5.530	1.504
Size (m ²)	87.3	47.5	89.7	40.2	98.1	38.5	121.1	41.7
Number of rooms	2.968	1.457	3.392	1.346	3.874	1.453	4.481	1.349
Top-level apartment	0.591	0.492	0.446	0.497	0.134	0.341	0.022	0.148
Ground-level apartment	0.145	0.352	0.128	0.334	0.127	0.333	0.019	0.137
Staircase-access flat	0.090	0.286	0.104	0.305	0.158	0.365	0.093	0.291
Maisonnette	0.034	0.181	0.037	0.189	0.034	0.182	0.035	0.183
Gallery	0.073	0.259	0.121	0.326	0.076	0.265	0.085	0.279
Townhome	0.031	0.173	0.085	0.280	0.334	0.472	0.337	0.473
Semi-detached house	0.004	0.060	0.036	0.187	0.064	0.244	0.267	0.443
Detached house	0.003	0.058	0.010	0.100	0.005	0.069	0.055	0.229
Attached mansion	0.028	0.165	0.022	0.148	0.052	0.221	0.030	0.169
Detached mansion	0.003	0.051	0.011	0.103	0.016	0.125	0.056	0.230
Built before 1906	0.433	0.495	0.070	0.255	0.170	0.375	0.014	0.117
Built 1906-1930	0.240	0.427	0.315	0.465	0.320	0.467	0.083	0.276
Built 1931-1944	0.062	0.242	0.098	0.297	0.143	0.350	0.094	0.291
Built 1945-1970	0.021	0.142	0.201	0.401	0.197	0.398	0.268	0.443
Built 1971-1990	0.103	0.303	0.153	0.360	0.056	0.230	0.277	0.447
Built after 1990	0.142	0.349	0.164	0.371	0.114	0.318	0.265	0.441
Heritage listed	0.098	0.297	0.008	0.091	0.014	0.119	0.003	0.050
Interior maintenance*	2.655	1.303	2.871	1.225	3.052	1.141	2.884	1.170
Exterior maintenance*	2.604	1.069	2.756	0.883	2.986	0.981	2.824	1.012
Luxury	0.232	0.422	0.119	0.324	0.058	0.234	0.033	0.180
Lift	0.143	0.351	0.206	0.404	0.092	0.289	0.106	0.308
Parking available	0.052	0.222	0.118	0.323	0.078	0.269	0.360	0.480
Number of observations	37,355		85,672		54,148		27,466	

'In sample' comprises dwellings within 2km from the Red Light Districts (RLDs) in the center of Amsterdam and within 3km from RLDs in Utrecht. In Amsterdam, 'in sample' excludes Amsterdam Noord. The Utrecht area includes dwellings from Utrecht, De Bilt, Bunnik and Zeist. Prices are deflated to values of 2014. *Interior and exterior maintenance conditions are assessed on a scale from 1 (excellent) to 9 (bad). The descriptive characteristics of the remaining variables are shown in Table S1 of the Online Appendix.

Table 2: Average Difference-in-Discontinuity and MWTA of Prostitution Externality in Amsterdam

	Bandwidth selection procedure									
	CCT					IK				
	1.0	0.8	0.9	1.1	1.2	1.0	0.8	0.9	1.1	1.2
Reduced-form - DiD										
1991/2006-2007/2014	-0.102 (-3.14)	-0.112 (-3.10)	-0.105 (-2.99)	-0.096 (-3.11)	-0.090 (-3.13)	-0.094 (-1.81)	-0.126 (-1.99)	-0.098 (-1.77)	-0.093 (-2.04)	-0.101 (-2.43)
2001/2006-2007/2014	-0.105 (-2.87)	-0.100 (-2.45)	-0.106 (-2.67)	-0.104 (-3.02)	-0.103 (-3.15)	-0.117 (-2.07)	-0.050 (-0.73)	-0.077 (-1.27)	-0.149 (-2.97)	-0.172 (-3.76)
1991/2000-2001/2006	0.017 (0.50)	-0.001 (-0.02)	0.010 (0.28)	0.011 (0.36)	0.009 (0.31)	0.051 (1.14)	0.021 (0.39)	0.043 (0.88)	0.047 (1.09)	0.023 (0.57)
1st Stage - Difference in distance (in 100m) to red window										
1991/2006-2007/2014	-0.685 (-10.7)	-0.800 (-13.3)	-0.785 (-12.4)	-0.550 (-8.90)	-0.384 (-6.24)	-1.010 (-9.05)	-1.268 (-11.2)	-1.078 (-9.75)	-0.898 (-8.08)	-0.642 (-5.75)
2001/2006-2007/2014	-0.717 (-9.64)	-0.799 (-11.2)	-0.798 (-10.9)	-0.588 (-8.14)	-0.433 (-5.94)	-1.114 (-8.12)	-1.572 (-11.1)	-1.326 (-9.65)	-0.890 (-6.75)	-0.459 (-3.48)
1991/2000-2001/2006	-0.404 (-6.75)	-0.394 (-6.82)	-0.422 (-7.21)	-0.344 (-5.70)	-0.233 (-3.93)	-0.561 (-4.36)	-0.579 (-4.64)	-0.614 (-4.79)	-0.333 (-2.62)	-0.243 (-1.90)
2nd stage - MWTA per 100m										
1991/2006-2007/2014	0.149 (3.05)	0.140 (3.05)	0.133 (2.94)	0.175 (2.98)	0.235 (2.84)	0.093 (1.77)	0.099 (1.99)	0.091 (1.75)	0.103 (1.96)	0.157 (2.23)
2001/2006-2007/2014	0.147 (2.68)	0.126 (2.35)	0.132 (2.53)	0.176 (2.75)	0.237 (2.70)	0.105 (1.91)	0.032 (0.71)	0.058 (1.21)	0.167 (2.54)	0.375 (2.44)
1991/2000-2001/2006	-0.041 (-0.49)	0.002 (0.02)	-0.023 (-0.27)	-0.033 (-0.36)	-0.039 (-0.30)	-0.091 (-1.04)	-0.037 (-0.37)	-0.071 (-0.82)	-0.142 (-0.92)	-0.095 (-0.51)
Bandwidth in km										
1991-2006	main pilot	main pilot	main pilot	main pilot	main pilot	main pilot	main pilot	main pilot	main pilot	main pilot
	0.429 0.649	0.343 0.519	0.386 0.584	0.472 0.714	0.515 0.779	0.846 0.746	0.677 0.597	0.762 0.671	0.931 0.821	1.016 0.895
1991-2000	0.399 0.568	0.319 0.454	0.359 0.511	0.439 0.624	0.479 0.681	0.734 0.679	0.587 0.543	0.660 0.611	0.807 0.747	0.881 0.815
2001-2006	0.447 0.651	0.358 0.521	0.403 0.586	0.492 0.716	0.537 0.781	0.709 0.754	0.568 0.603	0.638 0.679	0.780 0.830	0.851 0.905
2007-2014	0.393 0.576	0.314 0.461	0.353 0.519	0.432 0.634	0.471 0.691	0.705 0.639	0.564 0.511	0.634 0.575	0.775 0.703	0.845 0.767

This table presents the average difference-in-discontinuity (DiD) estimates of house prices on the top, followed by the average difference in distance from the Red Light District (RLD) border to a red window (1st stage), and the estimated marginal willingness to accept (MWTA) the externality (2nd stage), as in equation (5). The sample includes properties located up to 2km from the closest RLD. Robust z-statistics are in parentheses. Bandwidths, shown at the bottom, are selected using the procedures proposed by [Calonico et al. \(2014\)](#), CCT, and by [Imbens and Kalyanaraman \(2012\)](#), IK. We also multiply the optimal bandwidths by several scales, from 0.8 to 1.2.

Table 3: Conditional Difference in Price Discontinuity in Amsterdam's RLDs

		Bandwidth selection procedure									
		CCT					IK				
scale		1.0	0.8	0.9	1.1	1.2	1.0	0.8	0.9	1.1	1.2
1991/2006-2007/2014											
Difference in distance	δ^0	0.257 (3.67)	0.232 (3.14)	0.243 (3.40)	0.264 (3.82)	0.262 (3.84)	0.239 (3.31)	0.224 (2.90)	0.230 (3.09)	0.250 (3.54)	0.261 (3.75)
Diff. $\times$ initial distance	δ^1	-0.107 (-2.27)	-0.090 (-1.81)	-0.098 (-2.05)	-0.111 (-2.38)	-0.113 (-2.42)	-0.096 (-1.97)	-0.082 (-1.59)	-0.088 (-1.77)	-0.103 (-2.17)	-0.110 (-2.33)
Intercept	δ^2	0.008 (0.19)	-0.009 (-0.21)	-0.001 (-0.03)	0.014 (0.34)	0.013 (0.34)	-0.004 (-0.08)	-0.018 (-0.28)	-0.011 (-0.19)	0.003 (0.07)	0.010 (0.21)
Initial distance	δ^3	0.026 (1.30)	0.033 (1.49)	0.030 (1.41)	0.024 (1.21)	0.024 (1.26)	0.031 (1.45)	0.039 (1.61)	0.034 (1.51)	0.028 (1.36)	0.025 (1.27)
Bandwidth (main/pilot)		0.501 0.714	0.401 0.571	0.451 0.642	0.551 0.785	0.601 0.857	0.432 0.328	0.346 0.262	0.389 0.295	0.475 0.360	0.519 0.393
2001/2006-2007/2014											
Difference in distance	δ^0	0.230 (2.86)	0.183 (2.18)	0.209 (2.55)	0.235 (2.97)	0.234 (2.98)	0.221 (2.71)	0.172 (2.01)	0.196 (2.37)	0.233 (2.92)	0.235 (2.98)
Diff. $\times$ initial distance	δ^1	-0.104 (-1.95)	-0.080 (-1.44)	-0.094 (-1.75)	-0.106 (-2.01)	-0.106 (-2.02)	-0.100 (-1.86)	-0.073 (-1.29)	-0.088 (-1.60)	-0.106 (-1.99)	-0.106 (-2.02)
Intercept	δ^2	-0.015 (-0.31)	-0.042 (-0.80)	-0.029 (-0.56)	-0.009 (-0.18)	-0.008 (-0.18)	-0.022 (-0.31)	-0.046 (-0.54)	-0.036 (-0.48)	-0.012 (-0.19)	-0.008 (-0.14)
Initial distance	δ^3	0.016 (0.69)	0.028 (1.09)	0.022 (0.91)	0.013 (0.56)	0.012 (0.54)	0.019 (0.81)	0.031 (1.15)	0.026 (1.02)	0.015 (0.63)	0.012 (0.55)
Bandwidth (main/pilot)		0.510 0.747	0.408 0.597	0.459 0.672	0.561 0.821	0.612 0.896	0.482 0.326	0.386 0.261	0.434 0.294	0.530 0.359	0.578 0.392
1991/2000-2001/2006											
Difference in distance	δ^0	0.037 (0.50)	0.064 (0.82)	0.042 (0.56)	0.036 (0.49)	0.033 (0.45)	0.096 (1.12)	0.080 (0.85)	0.086 (0.96)	0.094 (1.12)	0.077 (0.96)
Diff. $\times$ initial distance	δ^1	-0.025 (-0.47)	-0.031 (-0.56)	-0.024 (-0.44)	-0.027 (-0.52)	-0.028 (-0.53)	-0.045 (-0.76)	-0.031 (-0.47)	-0.037 (-0.59)	-0.045 (-0.78)	-0.037 (-0.65)
Intercept	δ^2	0.032 (0.66)	0.047 (0.93)	0.037 (0.74)	0.029 (0.62)	0.026 (0.58)	0.046 (0.82)	0.032 (0.52)	0.038 (0.65)	0.053 (0.98)	0.051 (0.96)
Initial distance	δ^3	0.023 (1.01)	0.014 (0.57)	0.020 (0.83)	0.026 (1.18)	0.028 (1.28)	0.013 (0.46)	0.019 (0.60)	0.016 (0.54)	0.011 (0.40)	0.012 (0.48)
Bandwidth (main/pilot)		0.539 0.771	0.431 0.617	0.485 0.694	0.593 0.849	0.647 0.926	0.338 0.436	0.270 0.348	0.304 0.392	0.372 0.479	0.406 0.523

This table presents the difference-in-discontinuity (DiD) estimates of house prices conditional on the difference in the distance to a red window, initial difference to a red window, and the interaction of these two covariates, as shown in equation (8). All covariates are measured in 100m. The 'intercept' represents the average DiD if both difference in distance and initial distance are equal to zero. The three panels present the conditional DiDs for different periods. The sample includes properties located up to 2km from the closest Red Light District (RLD). Robust z-statistics are in parentheses. Main and pilot bandwidths, in the bottom row of each panel, are selected using the procedures proposed by [Calonico et al. \(2014\)](#), CCT, and by [Imbens and Kalyanaraman \(2012\)](#), IK. We also multiply the optimal bandwidths by several scales, from 0.8 to 1.2.

Table 4: Difference-in-Differences in Crime Rates and Risk Perception

	Amsterdam							
	Crime rate							log risk index
	total	violence	nuisances	major property	minor thefts	drug related		
(year $\geq$ 2007) $\cdot$ (distance $\leq$ 50m)	-0.182 (-4.65)	-0.129 (-2.69)	-0.108 (-2.24)	-0.138 (-2.63)	-0.222 (-5.16)	-0.674 (-4.96)		-0.18 (-3.31)
(year $\geq$ 2007) $\cdot$ (50m < distance $\leq$ 200m)	0.096 (1.83)	0.124 (1.80)	0.112 (1.69)	0.085 (1.21)	0.200 (3.49)	0.009 (0.05)		0.03 (0.90)
(year $\geq$ 2007) $\cdot$ (200m < distance $\leq$ 500m)	0.116 (1.64)	-0.022 (-0.24)	0.124 (1.42)	0.117 (1.22)	-0.064 (-0.80)	-0.258 (-1.01)		-0.15 (-5.73)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Neighborhood fixed effect	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Number of observations	372	372	372	372	372	372		341
Number of neighborhoods	31	31	31	31	31	31		31
	Utrecht							
	Crime rate							% who feel unsafe in the neighborhood
	total	violence	nuisances	major property	minor thefts	drug related		
(year $\geq$ 2013) $\cdot$ (distance $\leq$ 50m)	-0.114 (-1.86)	-0.251 (-2.56)	-0.141 (-1.82)	0.055 (0.60)	-0.430 (-3.21)	-0.507 (-1.73)		-2.71 (-1.25)
(year $\geq$ 2013) $\cdot$ (50m < distance $\leq$ 200m)	-0.103 (-1.59)	-0.061 (-0.53)	0.047 (0.54)	-0.264 (-2.73)	-0.101 (-0.76)	0.190 (0.74)		-6.04 (-3.66)
(year $\geq$ 2013) $\cdot$ (200m < distance $\leq$ 500m)	-0.004 (-0.09)	0.085 (1.03)	0.067 (1.10)	-0.098 (-1.41)	-0.008 (-0.09)	0.327 (1.21)		-1.88 (-1.14)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Neighborhood fixed effect	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Number of observations	268	268	268	268	268	260		66
Number of neighborhoods	67	67	67	67	67	65		22

This table presents Difference-in-Difference estimates for crime rates, estimated using a negative binomial regression, and risk perception, estimated using a linear regression. The level of observation is the neighborhood (*buurt*), except for the ‘% who feel unsafe’ in Utrecht, where it is the sub-district (*subwijk*). ‘Distance’ means the shortest distance to a red window in a Red Light District (RLD) and the sample includes only areas within 2km. The sample period in Amsterdam is 2003-2014 and in Utrecht is 2011-2015, excluding 2013. The ‘total’ crime rate do not include minor felonies, such as shoplifting, pickpocketing, and bike theft, and reported nuisances, such as complaints about neighbors and alcohol abuse. Cases of ‘violence’ include declarations of abuses, threats, sexual offenses, fights, assaults, and street robbery, but they exclude cases of domestic violence. ‘Nuisances’ include complaints against neighbors, vandalism, and cases of drug and alcohol abuse registered by the police. ‘Major property’ crimes include burglaries and motor vehicle thefts. ‘Minor thefts’ include bike thefts, shoplifting, pickpocketing and other property crimes. Standard errors are clustered by neighborhood and the t-statistics are in parentheses.

Table 5: Difference in Price Discontinuity in Amsterdam's RLDs, Controlling for Safety and Nuisances

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Average DiD	-0.092 (-2.00)	-0.090 (-2.04)	-0.082	-0.075 (-1.84)	-0.075 (-1.72)	-0.072 (-1.66)	-0.067 (-1.54)	-0.098 (-2.19)	-0.067 (-1.54)
MWTA	0.216 (2.33)	0.199 (2.26)	0.198 (2.17)	0.201 (2.36)	0.207 (2.41)	0.201 (2.37)	0.199 (2.34)	0.227 (2.51)	0.187 (2.19)
Control variables									
Violence		Yes					Yes		Yes
Risk perception			Yes				Yes		Yes
Nuisances				Yes		Yes	Yes		Yes
Drug related					Yes	Yes	Yes		Yes
Major property								Yes	Yes
Minor thefts								Yes	Yes

This table presents the difference-in-discontinuity (Average DiD) estimates of house prices and its relationship with the difference in the distance to a red window (MWTA). Control variables are gradually added to the benchmark model in column (1) and are measured the year before. Cases of 'violence' include declarations of abuses, threats, sexual offenses, fights, assaults, and street robbery, but they exclude cases of domestic violence. 'Nuisances' include complaints against neighbors and cases of drug and alcohol abuse registered by the police. 'Major property' crimes include burglaries and motor vehicle thefts. 'Minor thefts' include bike thefts, shoplifting, pickpocketing and other property crimes. The sample includes properties located up to 2km from the closest Red Light District (RLD) from 2004 to 2014. Robust z-statistics are in parentheses. Main and pilot bandwidths are selected using the procedures proposed by [Calonico et al. \(2014\)](#).

Online Appendix to “Unveiling the Price of Obscenity: Evidence
from Closing Prostitution Windows in the Netherlands”

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S1 A Brief History of Prostitution in the Netherlands	2
S1.1 More Details on Project 1012	5
S2 Theoretical Framework	6
S2.1 Setup	7
S2.2 Setting 1 - Canal as a Border	8
S2.3 Setting 2 - Sex Industry Shutdown	11
S3 Estimators	11
S3.1 Multidimensional Difference-in-Discontinuity	11
S3.2 Conditional Difference-in-Discontinuity	14
S3.3 Multidimensional Difference-in-Slopes	15
S4 Business and Employment Data	16
S5 More Findings	17
S5.1 Housing Supply at the Canals in Amsterdam	17
S5.2 Distribution of Other Businesses in Amsterdam	17
S5.3 Changes in Employment in Utrecht	18
References	19
Figures and Tables	22

S1 A Brief History of Prostitution in the Netherlands

Prostitution has been recorded in Amsterdam since the city was a fishing village in the 13th century. Two centuries later, when licensed brothels first appeared, one of its first by-laws had already recognized the importance of sex workers for a city of commerce. However, the city council legislated that only the city bailiff and his servants could operate a brothel within a restricted area close to the harbor, called *De Wallen* — Amsterdam’s most famous Red Light District (RLD). Anyone pandering a sex worker outside this area would be subject to fines and imprisonment (Brants, 1998). Since the Middle Ages, local governments have tolerated prostitution in Dutch cities, as long as it was restricted to a designated area and did not become a public nuisance (Pol, 2011; Koski, 2007). Table S2 presents a timeline regarding prostitution policy in the Netherlands.

There are only two periods in Dutch history in which either prostitution or brothels were criminalized. First, in the 16th century with the rise of Calvinism in the Netherlands. Rather than tolerated sinners, prostitutes were viewed as wretches who needed to be punished (Pol, 2011). Second, in the early 20th century, when religious parties obtained a parliamentary majority. In practice, however, since the Dutch Golden Age in the 17th century, any effort to judicially suppress the operation of brothels was ineffective (Goodyear, 2009). Despite the ban on brothels of 1911, throughout the 20th century Dutch cities adopted unofficial tolerance policies, which confined prostitution to RLDs and *tippelzones* — nonresidential areas where street prostitution was allowed. These policies were in line with the Dutch pragmatic tolerance (*gedoogbeleid*) towards morally controversial issues. As long as public order was not threatened, authorities turned a blind eye to what was happening in the RLDs (Outshoorn, 2012).

The 1930s mark the beginning of the *raamprostitutie* (window prostitution) as an attempt to bypass the ban on brothels in 1911 (Goodyear, 2009). Uninhibited by the authorities, window prostitution gradually began attracting tourists to the Dutch RLDs. Until the end of the 1960s, in spite of the high concentration of sex workers, *De Wallen* was still one of the

safest parts of Amsterdam, with many cafes and restaurants (Sabat, 2012). In the 1970s, the RLDs grew into free zones for sex-related businesses. Relaxation of the laws on pornography led to the proliferation of live porn theaters, sex shops, and adult cinemas. Those who could afford it, including Dutch prostitutes catering for an elite clientele in sex clubs and through escort services, moved out of the RLDs. These sex workers were gradually replaced by immigrants from developing countries and former Dutch colonies (Brants, 1998).

With a large turnover, prostitution became intrinsically connected to a complex criminal network involving drug trafficking, protection rackets, human trafficking, and tax frauds (Outshoorn, 2012; Huisman and Nelen, 2014). The RLDs, including *De Wallen*, became a no-go area for the police. With citizens complaining about drunkenness, rowdiness, and violence against sex workers, public opinion swung towards repealing the ban on brothels and regulating the sex industry (Koski, 2007). As brothels were prohibited by law, local efforts to regulate them were often rejected in court. The urge to empowering local authorities and clean up the sex industry entered the political agenda in the 1990s (Visser, Oomens and Boerman, 2000).

After an unsuccessful attempt from the Second Chamber in 1992, a bill decriminalizing voluntary exploitation was passed in 1999 and implemented in October 2000. This bill gave municipalities the authority to regulate prostitution branches, but also granted several rights to sex workers (including access to social security) along with the obligation to pay taxes (Outshoorn, 2012). The early 2000s were marked by an increase in red windows in Amsterdam, from around 200 to more than 400 (Amsterdam, 2008). There was also a large inflow of prostitutes from Eastern Europe, as well as from non-EU countries (Wijk et al., 2010). The signs that many prostitutes were undocumented and sometimes victims of trafficking, along with drug use and dealing, made Amsterdam, Rotterdam, and The Hague close their *tippelzones* in December 2003, September 2005, and March 2006, respectively (Outshoorn, 2012). This repressive policy against soliciting caused the migration of many prostitutes and clients to Utrecht, increasing the popularity of its biggest RLD on *Zandpad*.

To further empower local authorities in their fight against human trafficking and other crimes, the Public Administration Probity in Decision-Making (*Bevordering Integriteitsbeoordelingen door het Openbaar Bestuur*, BIBOB) Act went into effect on June 1, 2003. The municipality of Amsterdam first invoked the BIBOB law at the end of 2006. In that year, 108 sex businesses were investigated and 58 were closed ([Amsterdam, 2010](#)). At the same time, the city decided to buy 26 prostitution-related properties, where more than 10% of the red windows. This buyout is part of Project 1012, launched at the end of 2007 and intended to reduce the presence of businesses with little economic value in the central area — details about this project are presented below. By the end of 2014, 27% of the red windows were closed either by applying the BIBOB law or by buying out properties. Some of them have been converted into homes and others occupied by retailers.

Amsterdam is not the only city that has reduced the number of sex establishments. For instance, Alkmaar and Groningen have also used the BIBOB law to downsize their sex industry. In Utrecht, signs of human trafficking led the municipality to start an investigation in 2008, which culminated in the shutdown of all brothels in May-July 2013. The construction of a new RLD, far from the city center, was approved at the end of 2016, but the project has been delayed at least until 2018.

In the whole Netherlands, the number of red windows declined from 2,096 in 1999 to 1,466 in 2009, while the number of sex clubs went from around 800 in 2000 to 370 in 2010 ([Wagenaar, Altink and Amesberger, 2013](#)).¹ With less work spaces available, sex workers are reported to be looking for other jobs or to be working from home using other forms of solicitation, such as online.

Despite the contraction of the paid-sex industry, [Wijk et al. \(2010\)](#) estimate that between 5,000 and 8,000 prostitutes were working in Amsterdam in 2009.² About 21-44% were working in red windows, 11-16% in sex clubs, 9-12% in licensed escort services, and 26-39%

¹According to the blog [Behind the Red Light District](#), there were 1,272 red windows in the country in 2016.

²These are annual numbers. [Wagenaar, Altink and Amesberger \(2013\)](#) estimate that in the four largest Dutch cities at least 2,200 sex workers are active on an average day, 35% of them in Amsterdam.

in private homes. No license is required for working as a prostitute at home; it is considered legal as long as the prostitute works alone and is self-employed. Finally, at least 12% of sex workers in Amsterdam are working illegally, mostly in unlicensed escorting and massage parlors.

S1.1 More Details on Project 1012³

Project 1012 was a public-private partnership, run from 2007 to 2018. It was named after the postcode area, 1012, in the center of the city. The main goal was to reduce crime in this area and start an economic revival. The planned interventions were deployed from a spatial perspective, with three components: 1) the street-oriented approach; 2) the redevelopment of public space; and 3) the facilitation of ten key projects. The location of these developments is presented in Figure S2.

The street-oriented approach was focused on reducing the number of brothels and coffeshops, providing space for a range of new shops and restaurants. According to van Liempt and Chimienti (2017), the municipality encouraged some artists and designers to occupy the area by offering rent subsidies, especially in the start-up phase. The goal was to close 40% of the 476 prostitution windows and concentrate them in two areas: *Oude Nieuwstraat* in *Singelgebied* and *Oudezijds Achterburgwal* (and side streets) in *De Wallen*. However, buying properties and converting the small, dark workspaces into high-end businesses are not cheap (van Liempt and Chimienti, 2017). Then partly due to the financial crisis and partly due to imprecise financial planning, the closing of brothels costed more than the city could afford (Huisman and Nelen, 2014). As a result, only 130 windows were closed by the end of 2014. Like brothels, coffeshops were closed on the grounds of misbehavior, so the ability to close and replace these businesses were limited.

The redesign of public space was intended to enhance the streetscape, giving extra attention to waste collection, street cleaning and graffiti removal. Alleys that had been closed

³Source: www.amsterdam.nl/projecten/project-1012

for security reasons, were open during the day, improving pedestrian routes.

The key projects were intended to boost the economic development. Most of these projects were initiated by business owners and private investors, and a few others came from the municipality. Two projects in particular, *Cluster Oudekerksplein*, a plaza surrounded by prostitution windows, and *Cluster Beursplein*, were intended to remodel the area and improve mobility. The latter, however, did not take off. Another project, *Chinatown*, was also intended to improve the public space, but with the collaboration of local entrepreneurs, who are responsible for its maintenance. The seven remaining projects concerned the renovation of historic buildings that would function as high-end hotels, offices, museums and retailers.

In addition to those three components, a task force, named project Emergo, screened all the businesses in the RLD searching for criminal activities. Based on its findings, dozens of control and enforcement interventions were carried out. The project was completed in 2011 and formed the basis for the Regional Information and Expertise Centers (RIECs) in the Netherlands. In 2012, the municipality, along with other authorities, also implemented the *Programma Prostitutie* (Prostitution Program). The goal was to put an end to human trafficking and the exploitation in the sex industry, so that sex workers can work safely, independently and under proper conditions. This program lasted five years. In both cases, the municipality used the BIBOB law and other administrative instruments to enforce actions by refusing or withdrawing licenses and subsidies.

S2 Theoretical Framework

The two settings that we exploit — boundary discontinuity in Amsterdam and industry shutdown in Utrecht — have distinct interpretations. The former assesses only the environmental externality, related to the noise, crowdedness, and presence of sex workers in the RLD. The latter assesses the value of the RLD for those living out of the area. To illustrate the counterfactual differences, we outline a simple model of housing prices with a RLD.

S2.1 Setup

The economy consists of a continuum of individuals of measure one, indexed by $i \in (0, 1)$, and a continuum of houses of measure one, indexed by $h \in (0, 1)$. Suppose that a brothel is located at 1, so that h_i represents the distance of individual i to the brothel. Based on their tastes, some individuals choose to live near the brothel ($h_i \rightarrow 1$) and others choose to live further away ($h_i \rightarrow 0$). The location choice also depends on the house quality, represented by a vector of characteristics $\mathbf{x}_{ht}$. The equilibrium price at time t , $p_t(h, \mathbf{x}_{ht})$ for all h , is such that no one is better off moving to a different house.

Wage income, w_t is assumed to be constant among individuals and exogenous, but it may change over time. Individuals, however, differ in where they work and where they spend their income. Thus their disposable income is

$$w_{it}(h_i) = w_t - k_{it}(h_i),$$

where $k_{it}(\cdot)$ is the cost individual i pays to commute to the brothel area. Intuitively, if the sex industry creates jobs and/or attracts customers, then $k'_{it}(h_i) < 0$ and individual i will prefer to live close to it to increase the disposable income. Individuals differ in $k'_{it}(\cdot)$ depending on how often they go to the brothel area and how close to this area they have to go.

Furthermore, on-site prostitution creates “noise.” Some individuals may like it, but others may not. This noise depends on the distance to prostitution, h , and is measured by function $r_t(h)$ at time t . To simplify the following expressions, let $r'_t = 1$. Each location h also provides other amenities, such as bars, restaurants, schools, parks and theaters. Their level is measured by a continuous function, $g_t(h)$.

So far, we implicitly assume that there is no migration and housing supply is inelastic. Although the labor force is fixed, shifts in housing demand are captured by changes in the aggregate income, w_t — or time effects. Second, assuming inelastic supply is reasonable for inner cities in the Netherlands. Nonetheless, housing suppliers compete on quality and

profits from adjusting $\mathbf{x}_{ht}$ are assumed to be zero. The zero-profit condition implies that landlords only profit from the rent of land (inelastic) because gains from quality are offset by the cost of investment (perfectly elastic).

On the demand side, individual's indirect utility function is given by:

$$V_{it} = v_i [r_t(h_i), g_t(h_i), \mathbf{x}_{hit}] + w_{it}(h_i) - p_t(h_i, \mathbf{x}_{hit});$$

and the first order condition implies that the bid function for location h_i is equal to marginal utility of h — or the marginal rate of substitution between h and a bundle of other private goods — plus the marginal income yielded by living at h_i :

$$\begin{aligned} \frac{\partial p_t}{\partial h}(h_i, \mathbf{x}_{hit}) &= \frac{\partial v_i}{\partial h}(h_i, \mathbf{x}_{hit}) + \frac{\partial w_{it}}{\partial h}(h_i) \\ &= \frac{\partial v_i}{\partial r_t}(h_i, \mathbf{x}_{hit}) + \frac{\partial v_i}{\partial g_t} \frac{\partial g_t}{\partial h}(h_i, \mathbf{x}_{hit}) - \frac{\partial k_{it}}{\partial h}(h_i). \end{aligned} \quad (\text{S.1})$$

The first term represents the marginal willingness to accept (MWTa) the noise caused by prostitution, r , the second term is marginal willingness to pay (MWTP) for other amenities at h_i , and the third term is the marginal income at h_i . Given the confoundedness among those terms, neither can simply be recovered from a hedonic regression, also known as **Rosen's (1974)** first stage.

S2.2 Setting 1 - Canal as a Border

S2.2.1 Cross-sectional discontinuity

Suppose that a canal, or a wall, is placed at location $c < 1$, between part of the houses and the brothels. This area, denoted by $\bar{h} \in (c, 1]$, is named RLD. Although the commuting cost to brothels is not affected, two environments are created: one where the noise is felt, and another that is isolated by the canal.

The bid price for a house in the RLD is the same as in (S.1). However, individual j living

out of the RLD, $\underline{h}_j \in [0, c)$, is not affected by r and the marginal bid function is simply:

$$\frac{\partial p_t}{\partial \underline{h}}(\underline{h}_j, \mathbf{x}_{\underline{h}_j t}) = \frac{\partial v_i}{\partial g_t} \frac{\partial g_t}{\partial \underline{h}}(\underline{h}_j, \mathbf{x}_{\underline{h}_j t}) - \frac{\partial k_{it}}{\partial \underline{h}}(\underline{h}_j). \quad (\text{S.2})$$

If we hold $\mathbf{x}_{\bar{h}_j t} = \mathbf{x}_{\underline{h}_j t} = \mathbf{x}$, then as $\bar{h}_i$ and $\underline{h}_j$ approach c , individuals i and j tend to be more similar in their taste for g and commuting cost k . Then the price discontinuity at c is:

$$\begin{aligned} \tau_t(c; \mathbf{x}) &\equiv \lim_{\bar{h}_i \rightarrow c} p_t(\bar{h}_i, \mathbf{x}) - \lim_{\underline{h}_j \rightarrow c} p_t(\underline{h}_j, \mathbf{x}) \\ &= v_i[r_t(c), g_t(c), \mathbf{x}] - v_i[0, g_t(c), \mathbf{x}] \\ &\approx \frac{\partial v_i}{\partial r_t}(c, \mathbf{x}) \cdot r_t(c), \end{aligned} \quad (\text{S.3})$$

which is equal to individual i 's (discrete) willingness to accept (WTA) the noise at c .⁴

By placing c at different locations, we can fully recover the hedonic function of externalities from $c = 1$, where r_t is the maximum, to $c = 0$, where r_t is the minimum. This is why we adopt a two-dimensional regression discontinuity design, described in section 3.1. This hedonic function, however, is not equivalent to the average bid function because individuals are heterogeneous and sort themselves on the basis of their tastes. While the most receptive to prostitution will live close to brothels, the most averse will live as far away as possible.

Most important is that for $c \rightarrow 1$, the price discontinuity, $\tau_t(c)$, is the lower bound of the discount required by the average individual to live next door to a brothel. In the spirit of Chetty (2009), as long as the hedonic function is identified, it is sufficient to assess the welfare effect of on-site prostitution. If all brothels were closed, the *ex-ante* non-marginal welfare effect would be:

$$\begin{aligned} \Delta W &= \int_i \left\{ v_i[r_t(h_i), g_t(h_i), \mathbf{x}] - v_i[0, g_t(h_i), \mathbf{x}] \right\} \cdot I(h_i > c) \, di \\ &\approx \int_c^1 \tau_t(h; \mathbf{x}) \, dh \end{aligned} \quad (\text{S.4})$$

⁴The price discontinuity, $\tau_t(c)$, actually lies between the individual i 's WTA and individual j 's WTP for $r_t(c)$. By the continuity of individual types and inelasticity of the housing supply, their WTP and WTA must converge to the same value. That is to say, there is some individual out of the RLD, who is very similar to i and whose WTP will drive up the price inside. Yet the empirical evidence suggests that for the same individual, WTA is often greater than WTP (Brown and Gregory, 1999; Horowitz and McConnell, 2002).

This policy shock would primarily affect the welfare of the most receptive to prostitution. In the case of an increase in on-site prostitution, this is not true because it would also affect the welfare of less receptive citizens, whose WTA is unknown.

S2.2.2 *Difference in discontinuity*

The hedonic price of prostitution externality, r_t , is identified by the price discontinuity in (S.3) only if all characteristics in $\mathbf{x}$ are observed. Otherwise, $\tau_t(c; \mathbf{x})$ would also comprise differences in housing investments on the supply side:

$$\tau_t(c; \mathbf{x}) \approx \frac{\partial v_i}{\partial r_t}(c, \mathbf{x}) \cdot r_t(c) + \left[\xi_{\bar{h}_i t} - \xi_{\underline{h}_j t} \right], \quad (\text{S.5})$$

where $\xi_{\bar{h}_i t}$ is value of unobserved features of house $\bar{h}_i$ and $\xi_{\underline{h}_j t}$ is the value of unobserved features in house $\underline{h}_j$. The second term in (S.5) is different from zero only if the hedonic price of unobservables is sensitive to r_t — for instance, if the marginal utility of unobservables depends on r_t .

To identify the WTA, suppose that the sex industry shrinks from time 0 to time 1, so that $r_0(\bar{h}) - r_1(\bar{h}) = \Delta r > 0$. Holding everything else constant, the bid function for r at c is identified by the difference in discontinuity:

$$\begin{aligned} \Delta \tau(c; \mathbf{x}) &\equiv \tau_0(c; \mathbf{x}) - \tau_1(c; \mathbf{x}) \\ &\approx \frac{\partial v_i}{\partial r}(c, \mathbf{x}) \cdot \Delta r. \end{aligned} \quad (\text{S.6})$$

That is, the ratio between $\Delta \tau(c; \mathbf{x})$ and Δr identifies the MWTA for r at c . With the zero-profit condition, the welfare effect of shrinking the sex industry is:

$$\Delta W \approx \int_c^1 \Delta \tau(h; \mathbf{x}) dh. \quad (\text{S.7})$$

A reduction in the sex industry would also provoke changes in the disposable income, w_{it} . Yet this change would equally affect individuals on both sides of the canal. Furthermore, a single-crossing condition is necessary for the identification in (S.6), so that individuals are ordered by the value that they give to the externality and the ordering is the same for any

industry size.⁵

S2.3 Setting 2 - Sex Industry Shutdown

In the second setting, we consider the case in which no one lives in the RLD and all brothels are closed from time 0 to time 1. At time 0, the hedonic function for location h looks like (S.2). At time 1, this hedonic function depends only on the MWTP for other amenities:

$$\frac{\partial p_1}{\partial h}(h_i, \mathbf{x}_{h_{i1}}) = \frac{\partial v_i}{\partial g_1} \frac{\partial g_1}{\partial h}(h_i, \mathbf{x}_{h_{i1}}). \quad (\text{S.8})$$

That is, with no prostitution, the disposable income becomes flat.

As before, the single-crossing condition is required so that the ordering of individuals does not change. As long as prostitution does not emerge somewhere else, the difference in hedonic prices will not be driven by the relocation of households. Another condition is that the relative distribution of other amenities does not change, so that $g'_1(h) = g'_0(h) = g'(h)$ for all h . Then the difference in hedonic prices at h_i is only a function of the marginal income created by the sex industry:

$$\begin{aligned} \Delta p^h(h_i; \mathbf{x}) &\equiv \frac{\partial p_0}{\partial h}(h_i, \mathbf{x}) - \frac{\partial p_1}{\partial h}(h_i, \mathbf{x}) \\ &= -\frac{\partial k_{i0}}{\partial h}(h_i), \end{aligned} \quad (\text{S.9})$$

and the non-marginal welfare effect of the shutdown policy is:

$$\Delta W \approx \int_0^1 \int_0^z \Delta p^h(h; \mathbf{x}) dh dz. \quad (\text{S.10})$$

S3 Estimators

S3.1 Multidimensional Difference-in-Discontinuity

To estimate τ_{lt} in equations (2) and (3), we apply a multidimensional kernel estimator described as follows. The first step is to define a target point on the border line, say

⁵It implies that individuals are always sorted over some attribute in the same order, even if the consumption of other attributes changes (Edlin and Shannon, 1998; Banzhaf, 2015).

$\mathbf{c}_l = (c_{1l}, c_{2l})$. Then for every observation i , we calculate the distance between its location $\mathbf{s}_i$ and $\mathbf{c}_l$, $d(\mathbf{c}_l, \mathbf{s}_i)$. If $\mathbf{s}_i$ and $\mathbf{c}_l$ were single variables, then $d(\mathbf{c}_l, \mathbf{s}_i) = |s_i - c_l|/\sigma_s$. Since they comprise two variables, longitude and latitude, we calculate the distance applying the spherical law of cosines:

$$d(\mathbf{c}_l, \mathbf{s}_i) = \varrho_l \cdot \arccos[\sin(\tilde{s}_{1i}) \sin(\tilde{c}_{1l}) + \cos(\tilde{s}_{1i}) \cos(\tilde{c}_{1l}) \cos(\tilde{c}_{2l} - \tilde{s}_{2i})], \quad (\text{S.11})$$

where $\tilde{s} = \pi \cdot s/180$ and ϱ_l is the Earth's radius at $\mathbf{c}_l$.^{6,7} Also let $\psi_{li} = (1 - 2z_i) \cdot d(\mathbf{c}_l, \mathbf{s}_i)$, which is negative if coordinate $\mathbf{s}_i$ is in the RLD ($z_i = 1$) and positive otherwise ($z_i = 0$).

By reducing the running variable to one dimension, ψ_{li} , this transformation leads to the simple kernel weighting function, $K(\psi_{li}/b)$, where b is a chosen bandwidth. Note that this transformation is not the same as treating the regression discontinuity (RD) design as unidimensional — i.e., calculating the shortest distance between $\mathbf{s}_i$ and any point on line $\mathbf{c}$. For each target point on the border line, as well as off the line, there is a local (b -ball) transformation taking place. Unlike Dell (2010), who estimates the multidimensional RD using a parametric, cubic specification, our nonparametric approach is more flexible to capture spatial patterns and less sensitive to high-order polynomials.⁸

To simplify the notation, suppose the number of units is equal to $n/2$ and the panel is balanced for periods $t \in \{0, 1\}$.⁹ Then let $j = i + t \cdot n/2 \in \{1, \dots, n\}$ be the observation index, replacing (i, t) , and $t_j \in \{0, 1\}$ be the period dummy. We set $Y = [y_1 \dots y_n]'$, $X = [x_1 \dots x_n]'$, $\Psi_l = [(1, \psi_{l1}) \dots (1, \psi_{ln})]'$, and $W_{ztl} = \text{diag}(\mathbf{1}(z_1 = z) \mathbf{1}(t_1 = t) k_{l1}, \dots, \mathbf{1}(z_n = z) \mathbf{1}(t_n = t) k_{ln})$, where $\text{diag}(\cdot)$ denotes a diagonal matrix and $k_{lj} = \max\left[0, \left(1 - |\psi_{lj}/b_l|\right)\right]$ is a triangular kernel weight.

Based on McMillen (1996) and Calonico, Cattaneo and Titiunik (2014), we apply the

⁶ $\varrho_l = \sqrt{[(6378.137)^2 \cdot \cos(c_{2l})]^2 + [(6356.7523)^2 \cdot \sin(c_{2l})]^2} / [6378.137 \cdot \cos(c_{2l})]^2 + [6356.7523 \cdot \sin(c_{2l})]^2$.

⁷ If $\mathbf{s}$ has two or more variables, then ψ can also be specified as a Mahalanobis distance.

⁸ See Gelman and Imbens (2017) on the implications of high-order polynomials in RD designs.

⁹ In practice, however, the panel is unbalanced.

following locally weighted regression (LWR) estimator for each location $\mathbf{c}_l$:

$$\hat{\mu}_{zt}(\mathbf{c}_l) = (1 \ 0) (\Psi_l' W_{ztl} \Psi_l)^{-1} \Psi_l' W_{ztl} (Y - X \hat{\beta}_t), \quad (\text{S.12})$$

with $z \in \{0, 1\}$ and $t \in \{0, 1\}$. The samples for each pair (z, t) are treated as independent. This independence makes the variance of the Difference-in-Discontinuity (DiD) estimator straightforward. In the same period, however, two different target points may have dependent samples. Accordingly, for each pair (z, t) , the covariance between $\hat{\mu}_{zt}(\mathbf{c}_l)$ and $\hat{\mu}_{zt}(\mathbf{c}_m)$ is calculated using seemingly unrelated regressions (SUR). The SUR allows us to properly calculate the standard error for the average DiD, as shown in Table 2.

As proposed by [McMillen and Redfearn \(2010\)](#), vector β_t is previously estimated by two steps. For each target point on and off the border line, we first estimate LWRs of Y on Ψ_l and each variable in X on Ψ_l . Then we regress the residual of Y on the residuals of X , omitting the intercept, to obtain $\hat{\beta}_t$. Finally, we plug $\hat{\beta}_t$ into equation (S.12). The three-step estimator is proven to be consistent by [Robinson \(1988\)](#). This approach assumes that the marginal effect of covariates is constant for all locations, so it is in line with standard hedonic models.¹⁰

From (S.12), the DiD estimator is the following:

$$\begin{aligned} \Delta \hat{\tau}_l &= \hat{\tau}_{l0} - \hat{\tau}_{l1} \\ &= \left[\hat{\mu}_{10}(\mathbf{c}_l) - \hat{\mu}_{00}(\mathbf{c}_l) - b_l^2 \hat{B}_0(\mathbf{c}_l, b_l, b_l^*) \right] \\ &\quad - \left[\hat{\mu}_{11}(\mathbf{c}_l) - \hat{\mu}_{01}(\mathbf{c}_l) - b_l^2 \hat{B}_1(\mathbf{c}_l, b_l, b_l^*) \right], \end{aligned} \quad (\text{S.13})$$

where b_l is the optimal main bandwidth and b_l^* is the optimal pilot bandwidth at $\mathbf{c}_l$. The bias estimator, $\hat{B}_t(\cdot)$, adjusts the LWR estimates for a large, MSE-optimal bandwidth. See [Calónico, Cattaneo and Titiunik \(2014\)](#) for details on the bias correction and robust variance for $\hat{\tau}_{lt}$.

¹⁰See [Frölich and Huber \(2018\)](#) for an alternative, nonparametric approach.

Bandwidths b_l and b_l^* are calculated using the following MSE-optimal estimators:¹¹

$$b_l = \left[\frac{\hat{V}_{1,l}}{4\hat{B}_{1,l}^2 + \hat{R}_{1,l}} \right]^{1/5} n^{-1/5} \quad \text{and} \quad b_l^* = \left[\frac{5\hat{V}_{2,l}}{2\hat{B}_{2,l}^2 + \hat{R}_{2,l}} \right]^{1/5} n^{-1/5}, \quad (\text{S.14})$$

where for $q = 1, 2$, $\hat{V}_{q,l} = \sum_t \sum_z \mathcal{V}_q[\hat{\mu}_{zt}(\mathbf{c}_l)]$, $\hat{B}_{q,l} = \sum_z \sum_t (2z-1)(1-2t) \mathcal{B}_q[\hat{\mu}_{zt}(\mathbf{c}_l)]$, and $\hat{R}_{q,l} = \sum_t \sum_z \mathcal{R}_q[\hat{\mu}_{zt}(\mathbf{c}_l)]$. Functions $\mathcal{V}_q(\cdot)$, $\mathcal{B}_q(\cdot)$ and $\mathcal{R}_q(\cdot)$ are specified by [Calonico, Cattaneo and Titiunik \(2014\)](#), as well as [Imbens and Kalyanaraman \(2012\)](#). See the former for details.

S3.2 Conditional Difference-in-Discontinuity

To estimate equations (7) and (8), first we calculate the shortest distance between house i and the border line: $s_i = \min_l d(\mathbf{c}_l, \mathbf{s}_i)$; where function $d(\cdot)$ is defined in (S.11). Let r_{it} be the shortest distance from house i to a brothel in time t , so that r_{i0} is its initial distance and Δr_i is the change in distance to a brothel.

With the same simplified notation as above, we set $Y = [y_1 \dots y_n]'$, $X = [x_1 \dots x_n]'$, and $W_{zt} = \text{diag}(\mathbf{1}(z_1 = z) \mathbf{1}(t_1 = t) k_1, \dots, \mathbf{1}(z_n = z) \mathbf{1}(t_n = t) k_n)$, where $k_j = \max\left[0, \left(1 - |s_j/b|\right)\right]$ is a triangular kernel weight. We also set $R = [(\Delta r_1, r_{10} \cdot \Delta r_1, 1, r_{10}, s_1) \dots (\Delta r_n, r_{n0} \cdot \Delta r_n, 1, r_{n0}, s_n)]'$. Then the LWR estimator is:

$$\begin{aligned} \hat{\boldsymbol{\lambda}}_{zt} &= \left(\hat{\lambda}_{0,zt}, \hat{\lambda}_{1,zt}, \hat{\lambda}_{2,zt}, \hat{\lambda}_{3,zt}, \hat{\lambda}_{4,zt} \right) \\ &= (R' W_{zt} R)^{-1} R' W_{zt} (Y - X \hat{\beta}_t). \end{aligned} \quad (\text{S.15})$$

As in (S.12), β_t is previously estimated. For $r_0 = 0$ and $\Delta r = 0$, the baseline RD estimator is:

$$\hat{\tau}_t(0, 0) = \hat{\lambda}_{2,1t} - \hat{\lambda}_{2,0t} - b^2 \hat{B}_t(b, b^*) \quad (\text{S.16})$$

where b is the optimal main bandwidth and b^* is the optimal pilot bandwidth. The bias estimator, $\hat{B}_t(\cdot)$, adjusts the LWR estimates for a large, MSE-optimal bandwidth ([Calonico](#),

¹¹We apply the following estimators twice. First, for regressions that do not include covariates, X , so that we can obtain $\hat{\beta}_t$. Then, for regressions that include covariates.

Cattaneo and Titiunik, 2014). Note that the bias correction is applied to the discontinuity estimator at any pair $(r_0, \Delta r)$, but we do not apply it to the marginal estimators.

Hence, the estimator for coefficients in equation (8) is:

$$\hat{\delta}^k = \begin{cases} \hat{\lambda}_{k,10} - \hat{\lambda}_{k,00} - (\hat{\lambda}_{k,11} - \hat{\lambda}_{k,01}) & \text{for } k = 0, 1, 3 \\ \hat{\tau}_0(0, 0) - \hat{\tau}_1(0, 0) & \text{for } k = 2. \end{cases} \quad (\text{S.17})$$

Optional bandwidths are calculated as in (S.14), minimizing the MSE of the baseline DiD estimator, $\Delta \hat{\tau}(0, 0) = \hat{\tau}_0(0, 0) - \hat{\tau}_1(0, 0)$.

S3.3 Multidimensional Difference-in-Slopes

To estimate equation (10), first we define a set of target points $(\mathbf{a}_0, \dots, \mathbf{a}_L)$, where $\mathbf{a}_l = (a_{1l}, a_{2l})$. One of these target points, say $\mathbf{a}_0$, is the RLD itself. The others are selected using an adaptive decision tree, as described by Loader (1999). This approach efficiently keeps the number of target points as small as possible, retaining sufficient information to interpolate estimates for the entire surface. Later, the interpolation between target points is made using the modified Shephard algorithm (Franke and Nielson, 1980).

Without loss of generality, we present the Difference-in-Slope (DiS) estimator at $\mathbf{a}_l$. Let $\psi_i = d(\mathbf{a}_l, \mathbf{s}_i)$ be the distance of house i to target l and $h_i = d(\mathbf{c}, \mathbf{s}_i)$ be the distance of house i to the RLD, where $d(\cdot)$ is defined in (S.11). Also let $\tilde{h}_i = h_i - d(\mathbf{c}, \mathbf{a}_l)$, so that $\tilde{h}_i = 0$ if $\psi_i = 0$.

We simplify the panel notation as above and set $Y = [y_1 \dots y_n]'$, $X = [x_1 \dots x_n]'$, and $W_t = \text{diag}(\mathbf{1}(t_1 = t) k_1, \dots, \mathbf{1}(t_n = t) k_n)$, where $k_j = \max \left[0, \left(1 - |\psi_j/b| \right) \right]$ is a triangular kernel weight. We also set $R = \left[(1, \tilde{h}_1, \tilde{h}_1^2/2) \dots (1, \tilde{h}_n, \tilde{h}_n^2/2) \right]'$. As proposed by McMillen and Redfearn (2010), the LWR estimator is:

$$(\hat{\mu}_t, \hat{\gamma}_t, \hat{\gamma}'_t) = (R'W_t R)^{-1} R'W_t (Y - X\hat{\beta}_t). \quad (\text{S.18})$$

As in (S.12), β_t is previously estimated.

Then the DiS estimator is:

$$\Delta\hat{\gamma} = \hat{\gamma}_0 - \hat{\gamma}_1 - b^2\hat{B}(b, b^*) \quad (\text{S.19})$$

where b is the optimal main bandwidth, b^* is the optimal pilot bandwidth, and $\hat{B}(\cdot)$ is the bias estimator. Both the optimal bandwidths and the bias estimator, as well as the robust variance of $\Delta\hat{\gamma}$, are the same as proposed by [Calonico, Cattaneo and Titiunik \(2014\)](#) for regression kink designs.

S4 Business and Employment Data

Information on local businesses is obtained on Orbis from Bureau van Dijk. From this platform, we collected the street address, legal status, industry code and trade description for every establishment, including branches, that was active at any time between 2001 and 2015. The cities of Amsterdam and Utrecht also provided a list with all the businesses registered under their jurisdiction. By checking this list, we confirm that Orbis has the correct location of almost every establishment. These locations were then geocoded using Google Maps API. Another variable from Orbis is the number of employees, which is available only for 2007-2015.

The industry codes on Orbis do not distinguish cannabis sales from other retail trades and not every coffeeshop (cannabis lounge) includes cannabis in its trade description. As a result, we also consulted a list of coffeeshops from www.coffeeshopdirect.com, which has the most complete directory of coffeeshops in the Netherlands since 1998. From this list, we find almost 100% of the active coffeeshops and more than 90% of the inactive ones on Orbis, based on company name, trade description, address, and status.

S5 More Findings

S5.1 Housing Supply at the Canals in Amsterdam

Figure S6 presents McCrary's (2008) density test, where θ is the log difference between the limits of the density function approaching the border from both sides. This test reveals that the density of houses on the market is fairly continuous in both periods. Since the density test can be sensitive to the choice of bin width, we also present test results under several bin widths in Table S4. In any case, the continuity hypothesis is never rejected.

Table S5 presents the estimated average discontinuity in house characteristics. In fact, there are some significant differences in housing features at the RLD border. In 1991-2006, for instance, the interior and exterior maintenance condition was slightly worse on the RLD side. However, by combining those estimates with hedonic coefficients, we find that they account for a price difference of less than 1%. More characteristics are found to be significantly different in 2007-2014. In particular, the dwellings sold on the RLD side were on average smaller. This difference may have been a response to the increase in the value of the square meter, but the price effect remains small, around 2%.

S5.2 Distribution of Other Businesses in Amsterdam

To analyze the distribution of other businesses, we divide them into four categories:

1. *coffeeshops* – Establishments that sell cannabis for individual consumption.
2. *cafes* – Establishments that serve alcoholic beverages, such as bars and nightclubs.
3. *restaurants* – Establishments classified as either 'restaurant' or 'hotel-restaurant,' excluding diners and lunchrooms.
4. *retailers* – Specialized retailers, excluding grocery stores, gift shops, and sex shops.

The maps in Figure S7 show the location of the first three types in 2001, 2007, and 2014. First, they confirm that coffeeshops are neither restricted to the RLD nor to the central

“island” in Amsterdam. Second, along with coffeeshops, cafes and restaurants are indeed more concentrated in the RLD. However, these establishments also appear on the other side of the RLD border. McCrary’s test, shown in Table S6, confirms that the density of coffeeshops, cafes, and restaurants is higher on the RLD side of the border in any year. But this difference has not significantly changed over time.

For each house sold on the market, we also calculate the shortest distance to these establishments on their side of the RLD border. Then we estimate the average difference in distance at the border using the RD design. Our findings in Table S7 reveal that in 2001-2006 a house on the RLD side was 219 meters closer to a coffeeshop, but 38 meters farther from a cafe, than a house on the other side. The distance to a retail store was also significantly shorter in the RLD. After 2006, however, the distance to a coffeeshop, as well as the distances to a retailer and to a restaurant, has not significantly changed.

Our cross-sectional estimates for house discontinuity may be driven by the difference in the initial distance to other businesses. Accordingly, we deal with this confoundedness by applying the DiD design, which is consistent as long as the other amenities remain constant. Since the discontinuity in the distance to coffeeshops, restaurants, and retailers has not changed, their location is unlikely to drive the DiD in house prices. The only businesses that could explain our results are the cafes. Table S7 shows that the average distance to a cafe on the RLD side has decreased. However, by controlling for the varying change in distance to any type of establishment (Table S8), we find that neither the DiD in house prices nor the MWTAs is explained by it.

S5.3 Changes in Employment in Utrecht

To verify how employment has changed after the RLDs were closed in Utrecht, Figure S12 presents the density of jobs per distance to these areas. In *Zandpad*, the density is very low in all periods, so we do not observe a clear change. In *Hardebollenstraat*, however, there seems to be a reduction in the employment level within 500 meters.

The reduction in the employment level around *Hardebollenstraat* could be either statistically insignificant or caused by drastic changes in other areas. To test for the effect of the RLDs, we first rasterize the number of jobs and then estimate the DiS, $\Delta\gamma$, from the following equation:

$$\Delta \ln(jobs_i) = \Delta\mu(\mathbf{s}_i) + \Delta\gamma(\mathbf{s}_i) h_i(\mathbf{s}_i) + \Delta\varepsilon_i,$$

where $\Delta \ln(jobs_i) = \ln(jobs_{i0}) - \ln(jobs_{i1})$ and $jobs_{it}$ is the total number of employees at cell i and time t . As in equation (10), $\mathbf{s}_i$ is the vector of longitude and latitude and h_i is the minimum distance to an RLD.

Figure S13 presents these estimates under three raster resolutions. With smaller cells, we verify that the relationship between employment level and distance to RLD is either insignificant or negative, particularly around *Hardebollenstraat*. This finding suggests that the RLD, if located in a dense area, raises the employment level nearby.

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Figure S1: Examples of Prostitution Windows in Amsterdam

Source: www.amsterdamredlightdistricttour.com.

Figure S2: Map of Investments from Project 1012 in Amsterdam

This map, copied from the Municipality of Amsterdam website, shows the location of all projects, investments and interventions made by Project 1012 since 2007, excluding those related exclusively to prostitution windows. Source: www.amsterdam.nl/projecten/project-1012.

Figure S3: Pictures of Bordering Canals in Amsterdam

(a) *Geldersekade*

(b) *Herengracht*

Source: Google Street View.

Figure S4: Discontinuity of House Prices at the Entire RLD Border in Amsterdam

This figure shows the log price per square meter as a function of the minimum distance in km to the closest border of a Red Light District (RLD) in Amsterdam. Unlike in Figure 2, the border is not only defined by canals but also by streets (land borders). The sample includes all the properties located up to 2km from the closest border. Dwelling characteristics are controlled for as shown in equation (1). Distance functions are estimated using triangular kernel with the bandwidth selection procedure proposed by Calomico, Cattaneo and Titiunik (2014). τ is the regression discontinuity estimate, with robust standard errors in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Figure S5: Two-Dimensional Regression Discontinuity Estimates in Amsterdam's RLDs**(a)** 1991-2006

(continuing)

(b) 2007-2014

This figure shows on the left the heat maps of house prices in the Red Light Districts (RLDs) of Amsterdam. The graphs on the right show the regression discontinuity (RD) estimates along the RLD natural borders, as shown in equation (2). Minimum and maximum values are highlighted with robust standard errors in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively. The sample includes properties located up to 2km from the closest border. Dwelling characteristics are controlled for as shown in equation (1). Log prices are estimated using triangular kernel with the bandwidth selection procedure proposed by [Calonico, Cattaneo and Titiunik \(2014\)](#). The figure also shows the location of operating and closed red windows.

Figure S6: Density of Houses for Sale per Distance to RLD's Border in Amsterdam and Discontinuity Test

This figure shows the density of dwellings for sale as a function of the distance in km to the closest Red Light District (RLD) natural border in Amsterdam. The sample includes properties located up to 2km from the closest border and it excludes properties outside an RLD that are not separated by a natural border. θ is the McCrary's (2008) estimator for log density discontinuity, with standard error in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively. Black dots are bins with size around 0.006km.

Figure S7: Location of Other Businesses in the Center of Amsterdam

This figure shows the maps locating the Red Light Districts (RLDs) in the center of Amsterdam, their natural borders, and three types of establishments: restaurants, cafes, and coffeeshops. 'Restaurants' are establishments serving food, which also include hotel-restaurants, but exclude diners and lunchrooms. 'Cafes' are establishments whose main activity is to serve alcoholic beverages. 'Coffeeshops' are establishments that sell cannabis.

Figure S8: Pictures of Red Light Districts in Utrecht

(a) *Hardebollenstraat*

(b) *Zandpad*

Source: Google Images.

Figure S9: Quantiles of Marginal Effects of RLDs on House Prices in Utrecht

This figure shows the distribution (quantiles) of marginal effects in log price (on the left) and in euros (on the right) as a function of the radius to the center of the Red Light Districts (RLDs) in Utrecht. The 'marginal effect', or Difference-in-Slope (DiS), is the difference in the first derivative of the distance functions in January 2011-December 2012 and August 2013-December 2014. The distribution of DiS is weighted by the density of houses for sale in 2011-2012. For better illustration, we apply an empirical Bayes shrinkage to estimates that are not significant at 10%. The bandwidth is selected using the procedure adapted from [Calonico, Cattaneo and Titiunik \(2014\)](#). See Table S9 in the Appendix (scale 1). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs.

Figure S10: Marginal Changes in House Prices Before Closing of RLDs in Utrecht

This figure shows the location of changes in the relationship between log price per square meter and distance to a Red Light District (RLD) in Utrecht. See equation (10). The Difference-in-Slope (DiS) is the difference in the first derivative of the distance functions in 2007-2008 and 2009-2010 (on the left) and in 2009-2010 and 2011-2012 (on the right). For better illustration, we apply an empirical Bayes shrinkage to estimates that are not significant at 10%. The bandwidth is selected using the procedure adapted from Calónico, Cattaneo and Titiunik (2014). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs.

Figure S11: Quantiles of Marginal Effects of Random Locations on House Prices in Utrecht

This figure shows the distribution of estimated Difference-in-Slope (DiS) quantiles for random locations in Utrecht. The DiS is the difference in the first derivative of log price with respect to distance in January 2011–December 2012 and August 2013–December 2014. The distance is calculated 1,000 times from different pairs of random locations within the city limits. The blue vertical line represents the quantile DiS for the actual Red Light Districts (RLD). The bandwidth is selected using the procedure adapted from [Calonico, Cattaneo and Titiunik \(2014\)](#). See Table S9 (scale 1). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs and quantiles are calculated for properties up to 2km from the RLDs.

Figure S12: Density of Employment per Distance to RLDs in Utrecht

This figure shows the density of employment as a function of the distance in km to the Red Light Districts (RLD) in Utrecht. Employment level is measured by the total number of employees per six-digit postal code.

Figure S13: Spatial Marginal Effect of RLDs on Employment in Utrecht, 2012-2014

This figure shows the location of changes in the relationship between the log of total number of employees and distance to a Red Light District (RLD) in Utrecht. See equation (11). The 'marginal effect', or Difference-in-Slope (DiS), is the difference in the first derivative of the distance functions in 2012 and 2014. The total number of employees is calculated per pixel in three raster resolutions: 0.03 km^2 on the left, 0.02 km^2 in the center, and 0.01 km^2 on the right. The bandwidth is selected using the procedure adapted from [Calonico, Cattaneo and Titiunik \(2014\)](#).

Figure S14: Quantiles of Price Effects of RLDs in Utrecht, Controlling for Safety and Nuisances

This figure shows the distribution (quantiles) of non-marginal effects in log price as a function of the radius to the center of the Red Light Districts (RLDs) in Utrecht. Control variables are gradually added to the benchmark model and are measured the year before. Cases of ‘violence’ include declarations of abuses, threats, sexual offenses, fights, assaults, and street robbery, but they exclude cases of domestic violence. ‘Nuisances’ include complaints against neighbors and cases of drug and alcohol abuse registered by the police. ‘Major property’ crimes include burglaries and motor vehicle thefts. ‘Minor thefts’ include bike thefts, shoplifting, pickpocketing and other property crimes. The effects are calculated through a second-order approximation, equation (12), using the estimated Difference-in-Slope (DiS). The DiS is the difference in the first derivative of the distance functions in January 2011–December 2012 and August 2013–December 2014. The distribution of effects is weighted by the density of houses for sale in 2011–2012. For better illustration, we apply an empirical Bayes shrinkage to estimates that are not significant at 10%. The bandwidth is selected using the procedure adapted from [Calonico, Cattaneo and Titiunik \(2014\)](#). Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs.

Table S1: Descriptive Statistics of Other House Characteristics

	Amsterdam				Utrecht area			
	in sample		out of sample		in sample		out of sample	
	mean	std.dev.	mean	std.dev.	mean	std.dev.	mean	std.dev.
Apartment with open porch	0.019	0.137	0.021	0.142	2.066	0.846	2.407	0.800
Number of floors	1.449	0.674	1.504	0.717	0.811	0.525	0.891	0.546
Number of kitchens	0.814	0.499	0.810	0.484	1.094	0.625	1.357	0.671
Number of WCs	0.961	0.604	1.015	0.594	0.904	0.387	0.977	0.347
Number of bathrooms	0.914	0.452	0.928	0.378	0.012	0.110	0.011	0.103
Central heating	0.831	0.374	0.869	0.337	0.103	0.305	0.140	0.347
L-shape living room	0.070	0.255	0.084	0.278	0.148	0.356	0.151	0.358
Sun-through living room	0.061	0.240	0.074	0.262	0.083	0.276	0.029	0.167
Room and suite	0.043	0.203	0.080	0.271	0.151	0.358	0.232	0.422
Dormer window	0.016	0.125	0.022	0.147	0.385	0.487	0.329	0.470
Balcony	0.400	0.490	0.561	0.496	0.787	0.410	0.937	0.244
No isolation	0.414	0.493	0.335	0.472	0.340	0.474	0.188	0.391
Some isolation	0.447	0.497	0.502	0.500	0.581	0.493	0.577	0.494
Full isolation	0.139	0.346	0.163	0.370	0.079	0.269	0.235	0.424
Attic	0.042	0.201	0.057	0.233	0.184	0.388	0.278	0.448
Terrace	0.130	0.337	0.091	0.287	0.111	0.314	0.064	0.245
Carport	0.026	0.160	0.044	0.204	0.022	0.147	0.080	0.272
Garage	0.020	0.140	0.046	0.210	0.045	0.208	0.240	0.427
Garden	0.194	0.396	0.278	0.448	0.555	0.497	0.689	0.463
South-facing garden	0.106	0.308	0.148	0.355	0.260	0.439	0.357	0.479
Sold in 1991-2000	0.238	0.426	0.218	0.413	0.293	0.455	0.292	0.455
Sold in 2001-2004	0.170	0.375	0.179	0.384	0.223	0.417	0.204	0.403
Sold in 2005-2008	0.250	0.433	0.262	0.440	0.234	0.423	0.242	0.429
Sold in 2009-2012	0.218	0.413	0.211	0.408	0.162	0.369	0.167	0.373
Sold in 2013-2014	0.124	0.330	0.129	0.335	0.088	0.283	0.095	0.294
Number of observations	37,355		85,672		54,148		27,466	

This table presents the descriptive statistics of the remaining variables, not included in Table 1. The category ‘in sample’ comprises dwellings within 2km from the Red Light Districts (RLDs) in the center of Amsterdam and within 3km from the RLDs in Utrecht. In Amsterdam, the ‘in sample’ excludes Amsterdam Noord. The Utrecht area includes dwellings from Utrecht, De Bilt, Bunnik and Zeist.

Table S2: History of the Dutch Policy on Prostitution

Date	Event
1275	Amsterdam was founded and the first RLD, named <i>De Wallen</i> , expanded around the harbor.
15th century	City governments shifted from keeping prostitution outside the city walls to designating soliciting zones in the city.
1413	A by-law of Amsterdam officially claimed that prostitution was necessary for the city, but allowed only in <i>De Wallen</i> .
16th century	Rise of Calvinism. Prostitution was viewed as a sin by the church and therefore prohibited.
1578	Calvinists took over the city government in Amsterdam and closed all brothels.
17th century	In the Golden Age, brothels appeared inevitable, but they had to remain unnoticeable.
1810-1813	French occupation. Prostitution was decriminalized and regulated. Prostitutes were required to register and undergo medical examinations.
1851	Local Government Act was passed to permit the sanitary control of prostitution.
Late 19th century	The abolitionist movement. Public opinion became strongly hostile to the practice of trafficking in and enslaving women. City governments started to abolish regulated prostitution, ending mandatory health checks and criminalizing brothel-keeping.
1911	The Morality Laws criminalized brothel keeping, but prostitution itself was not prohibited.
20th century	Dutch cities adopted tolerance policies and prostitution was allowed but only in designated areas (RLDs).
1930s	<i>Raamprostitutie</i> (window prostitution) was introduced in the RLDs.
1950s and 1960s	Post-war recovery. <i>De Wallen</i> reestablished itself as the main RLD in Amsterdam.
1970s	Relaxation of pornography laws led to the growth of live porn theaters, sex shops and adult cinemas in the RLDs. Procurers started trafficking in women from Southeast Asia.
1980s	Prostitutes started to migrate from Latin America and Africa. The Hague and Utrecht created official soliciting zones (<i>tippelzones</i>).
1990s	Fall of the Berlin Wall. Prostitutes started to migrate from Eastern Europe.
1996	Amsterdam created a <i>tippelzone</i> , moving street prostitution out of the city, along with a strict zoning plan that limited the expansion of RLDs.
October 1st, 2000	Brothels became licensed and fully legal. Prostitutes could work either as regular employees or as independent contractors. Labor unions started to accept prostitutes as members.
December 2003	Amsterdam closed its <i>tippelzone</i> following evidence of criminal activities.
June 1st, 2003	BIBOB Act came into effect, allowing city governments to refuse and withdraw permits from suspicious business owners.
2007	With the BIBOB Act, Amsterdam closed 58 sex businesses out of 108 that were investigated.
September 2007	The city of Amsterdam announced the intention to purchase several buildings in the RLD.
December 2007	Project 1012, which restricts window brothels to a few streets, was approved by the municipal council.
End of 2008	The mayor of Amsterdam announced plans to close half of the red windows, but no property was bought until 2011.
2009	The 'Law Regulating Prostitution' (WRP, <i>Wet Reguleren Prostitutie</i>) was introduced in parliament. Sex workers would be required to register and receive a registration pass. The minimum age to work would rise from 18 to 21 years. A vote on the law has been deferred so far.
2011-2014	The city of Amsterdam purchased more properties in 2011 and 2014.
May-July 2013	Evidence of human trafficking in Utrecht led to the shutdown of all red windows in the city.

Sources: de Vries (1997), Bossenbroek and Kompagnie (1998), Brants (1998), Pol (2011), Koski (2007), Goodyear (2009), Wijk et al. (2010), Outshoorn (2012), Aalbers and Deinema (2012), McCoy (2013), Huisman and Nelen (2014), and Bisschop, Kastoryano and van der Klaauw (2017).

Table S3: Hedonic Coefficients of Dwelling Characteristics

	Amsterdam			Utrecht		
	1991-2006	2007-2014	1991-2010	2011-2014		
Log size	-0.269*** (0.005)	-0.222*** (0.005)	-0.520*** (0.006)	-0.362*** (0.005)		
Number of rooms	0.022*** (0.001)	0.020*** (0.002)	0.035*** (0.001)	0.017*** (0.001)		
Ground-level apartment	0.002 (0.004)	0.022*** (0.004)	0.039*** (0.006)	0.043*** (0.004)		
Staircase-access flat	-0.019*** (0.005)	-0.002 (0.006)	0.026*** (0.008)	0.021*** (0.005)		
Maisonette	-0.002 (0.007)	-0.033*** (0.008)	0.049*** (0.010)	0.043*** (0.007)		
Gallery	-0.002 (0.006)	-0.004 (0.011)	0.028*** (0.008)	0.009 (0.006)		
Townhouse	0.042*** (0.007)	0.086*** (0.010)	0.060*** (0.005)	0.066*** (0.004)		
Semi-detached house	0.118*** (0.018)	0.120*** (0.020)	0.089*** (0.007)	0.102*** (0.005)		
Detached house	-0.046** (0.020)	0.090*** (0.021)	0.415*** (0.023)	0.440*** (0.020)		
Attached mansion	-0.015* (0.008)	-0.015 (0.010)	0.176*** (0.007)	0.187*** (0.006)		
Detached mansion	0.012 (0.023)	0.069*** (0.025)	0.199*** (0.011)	0.194*** (0.009)		
Built 1906-1930	-2.448*** (0.775)	-0.518 (0.744)	-2.159*** (0.575)	0.063 (0.407)		
Built 1931-1944	1.388 (4.260)	1.195 (4.583)	5.284* (2.852)	13.841*** (2.473)		
Built 1945-1970	3.410 (2.856)	0.939 (3.726)	11.278*** (1.500)	13.384*** (1.005)		
Built 1971-1990	0.400 (1.777)	-2.654 (1.822)	-22.910*** (2.112)	-21.009*** (1.508)		
Built after 1990	4.902** (1.985)	-4.280*** (1.306)	-0.471 (3.705)	-2.788*** (1.020)		
Year built	0.000*** (0.000)	0.000*** (0.000)	0.000** (0.000)	0.000*** (0.000)		
Built 1906-1930 × year built	0.001*** (0.000)	0.000 (0.000)	0.001*** (0.000)	0.000 (0.000)		
Built 1931-1944 × year built	-0.001 (0.002)	-0.001 (0.002)	-0.003* (0.001)	-0.007*** (0.001)		
Built 1945-1970 × year built	-0.002 (0.001)	0.000 (0.002)	-0.006*** (0.001)	-0.007*** (0.001)		
Built 1971-1990 × year built	0.000 (0.001)	0.001 (0.001)	0.012*** (0.001)	0.011*** (0.001)		
Built after 1990 × year built	-0.002** (0.001)	0.002*** (0.001)	0.000 (0.002)	0.001*** (0.001)		
Heritage listed	0.038*** (0.005)	0.043*** (0.005)	0.105*** (0.011)	0.049*** (0.007)		
Interior maintenance	-0.026*** (0.002)	-0.019*** (0.002)	-0.014*** (0.002)	-0.033*** (0.002)		
Exterior maintenance	-0.014*** (0.002)	-0.004* (0.002)	-0.011*** (0.002)	0.000 (0.002)		
Int. maint. × ext. maint.	-0.003*** (0.001)	-0.004*** (0.001)	-0.005*** (0.000)	-0.002*** (0.000)		
Luxury	0.029*** (0.004)	0.037*** (0.004)	0.067*** (0.007)	0.044*** (0.004)		
Apartment with open porch	0.007 (0.011)	0.001 (0.008)	0.017 (0.012)	-0.002 (0.009)		
Has 2 floors	0.006* (0.003)	0.019*** (0.004)	0.007 (0.005)	-0.011*** (0.004)		
Has 3+ floors	-0.012** (0.006)	-0.001 (0.007)	0.022*** (0.006)	-0.013*** (0.004)		
Has 1 kitchen	-0.004 (0.004)	-0.002 (0.003)	-0.016* (0.009)	-0.010*** (0.002)		
Has 2+ kitchens	-0.019*** (0.007)	-0.036*** (0.007)	-0.018* (0.010)	-0.051*** (0.005)		
Has 1 WC	-0.008** (0.004)	-0.024*** (0.006)	-0.003 (0.004)	-0.022*** (0.004)		
Has 2+ WCs	0.024*** (0.005)	0.014** (0.007)	0.027*** (0.005)	0.026*** (0.005)		
Has 1 bathroom	0.030*** (0.004)	0.004 (0.006)	0.027*** (0.003)	-0.001 (0.004)		
Has 2+ bathrooms	0.059*** (0.007)	0.022*** (0.008)	0.066*** (0.008)	0.049*** (0.006)		

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Table S3 – continued from the previous page

	Amsterdam			Utrecht		
	1991-2006	2007-2014	1991-2010	2011-2014		
L-shape living room	-0.002 (0.005)	-0.009 (0.006)	0.004 (0.004)	-0.015*** (0.004)		
Sun-through living room	0.003 (0.006)	-0.007 (0.005)	0.008** (0.003)	-0.002 (0.004)		
Room and suite	0.030*** (0.007)	0.010 (0.007)	0.057*** (0.004)	0.041*** (0.004)		
Dormer window	-0.004 (0.011)	-0.026*** (0.008)	0.014*** (0.004)	0.011*** (0.003)		
Balcony	0.015*** (0.003)	0.024*** (0.003)	0.026*** (0.003)	0.023*** (0.003)		
Central heating	0.066*** (0.004)	0.039*** (0.004)	0.043*** (0.003)	0.036*** (0.003)		
Some isolation	0.011*** (0.003)	0.003 (0.003)	0.020*** (0.003)	0.003 (0.002)		
Full isolation	0.006 (0.005)	0.007 (0.004)	0.009 (0.009)	0.015*** (0.004)		
Attic	-0.011* (0.006)	-0.014* (0.007)	-0.012*** (0.003)	-0.015*** (0.003)		
Terrace	0.034*** (0.004)	0.060*** (0.004)	0.019*** (0.005)	0.014*** (0.003)		
Lift	0.052*** (0.004)	0.064*** (0.005)	0.027*** (0.007)	0.016*** (0.004)		
Parking available	0.094*** (0.011)	0.102*** (0.010)	0.085*** (0.011)	0.061*** (0.006)		
Carport	-0.011 (0.012)	-0.001 (0.011)	0.032*** (0.013)	0.036*** (0.007)		
Garage	0.025** (0.012)	0.024** (0.011)	-0.018 (0.012)	0.007 (0.008)		
Garden	0.030*** (0.005)	0.041*** (0.005)	0.038*** (0.004)	0.039*** (0.003)		
South-facing garden	0.019*** (0.005)	0.013** (0.006)	0.010*** (0.003)	0.007*** (0.002)		
Year dummies	Yes	Yes	Yes	Yes		
Number of observations	19,118	16,606	45,394	8,754		

This table presents the value (coefficients) of dwelling characteristics in the hedonic models, described by equation (1) for Amsterdam and equation (10) for Utrecht. The samples include properties within 2km from the Red Light Districts (RLDs) in the center of Amsterdam and within 3km from the RLDs in Utrecht. The nonparametric term in these models are estimated using triangular kernel with the bandwidth selection procedure proposed by [Calónico, Cattaneo and Titiunik \(2014\)](#). Robust standard errors are in parentheses. ***, **, * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Table S4: Density Discontinuity Test under Multiple Bin Widths for Housing Supply in Amsterdam

	Bin width (in km)											
	0.001		0.003		0.006		0.009		0.012		0.020	
	θ	p-value	θ	p-value	θ	p-value	θ	p-value	θ	p-value	θ	p-value
1991-2006	-0.065 (0.073)	0.370	-0.062 (0.073)	0.391	-0.055 (0.071)	0.435	-0.056 (0.071)	0.432	-0.028 (0.067)	0.676	-0.055 (0.070)	0.437
2007-2014	-0.103 (0.094)	0.274	-0.100 (0.094)	0.286	-0.097 (0.095)	0.305	-0.102 (0.094)	0.279	-0.087 (0.100)	0.385	-0.090 (0.096)	0.349

This table shows the density discontinuity test for dwellings for sale at the natural borders of the Red Light Districts (RLDs) in Amsterdam. The sample includes properties located up to 2km from the closest RLD and it excludes properties outside the RLDs that are not separated by a natural border. θ is the McCrary's (2008) estimator for log density discontinuity, with standard errors in parentheses.

Table S5: Average Discontinuity in Dwelling Characteristics at the RLD Border in Amsterdam

	1991-2006			2007-2014		
	discontinuity	mean	price eff.	discontinuity	mean	price eff.
Number of rooms	0.497 (2.17)	2.919	-0.002	-0.728 (-2.63)	3.016	0.003
Top-level apartment	-0.137 (-2.28)	0.495	-0.007	0.060 (0.80)	0.706	-0.002
Ground-level apartment	0.017 (0.45)	0.137	0.001	-0.026 (-0.41)	0.157	0.001
Staircase-access flat	0.071 (1.60)	0.123	0.003	-0.105 (-1.46)	0.051	0.004
Maisonnette	0.038 (2.06)	0.039	0.002	0.001 (0.02)	0.028	0.000
Gallery	-0.079 (-1.93)	0.124	-0.004	0.000 (0.00)	0.011	0.000
Townhome	0.052 (1.26)	0.039	0.002	-0.126 (-2.81)	0.019	0.002
Semi-detached house	0.004 (0.58)	0.004	0.000	-0.021 (-0.38)	0.003	0.001
Detached house	0.003 (0.48)	0.004	0.000	-0.004 (-0.02)	0.003	0.000
Attached mansion	0.209 (0.95)	0.033	0.008	0.047 (1.42)	0.021	-0.002
Detached mansion	0.319 (1.00)	0.003	0.000	0.029 (0.95)	0.002	0.000
Built after 1906	-0.036 (-0.78)	0.556	0.001	0.297 (4.40)	0.596	-0.006
Built after 1931	-0.008 (-0.20)	0.331	0.000	0.177 (3.01)	0.328	0.001
Built after 1945	-0.017 (-0.46)	0.271	0.000	0.176 (3.26)	0.259	0.002
Built after 1971	-0.021 (-0.62)	0.244	0.001	0.082 (1.70)	0.245	-0.003
Built after 1990	-0.027 (-1.14)	0.140	0.000	0.045 (0.89)	0.143	0.001
Heritage listed	0.018 (0.29)	0.113	0.001	-0.143 (-2.02)	0.067	-0.004
Interior maintenance	0.212 (1.23)	2.673	0.000	0.231 (1.18)	2.644	0.000
Exterior maintenance	0.044 (0.30)	2.584	0.000	-0.004 (-0.03)	2.635	0.000
Luxury	-0.116 (-2.06)	0.239	-0.001	-0.181 (-2.80)	0.222	-0.001
Apartment with open porch	0.000 (0.00)	0.013	0.000	0.011 (0.45)	0.027	0.000
Has 2+ floors	0.296 (4.75)	0.392	0.000	0.098 (1.24)	0.285	0.000
Has 3+ floors	0.105 (2.14)	0.122	0.000	-0.007 (-0.11)	0.076	0.000
Has a kitchen	0.110 (2.61)	0.841	0.000	-0.144 (-1.79)	0.678	0.000
Has 2+ kitchens	0.021 (0.71)	0.059	0.000	-0.148 (-1.28)	0.036	0.000
Has a WC	0.099 (1.75)	0.713	0.000	0.031 (0.49)	0.897	0.000
Has 2+ WCs	0.015 (0.33)	0.139	0.000	0.011 (0.16)	0.189	0.000
Has a bathroom	0.052 (1.17)	0.811	0.000	0.049 (0.80)	0.894	0.000
Has 2+ bathrooms	0.081 (2.23)	0.056	0.000	-0.128 (-2.75)	0.066	-0.001
L-shape living room	0.008 (0.25)	0.091	0.000	-0.166 (-1.67)	0.047	0.001
Sun-through living room	0.076 (2.87)	0.059	-0.001	-0.080 (-0.87)	0.066	0.001
Room and suite	0.079 (0.57)	0.049	0.000	0.039 (1.00)	0.039	0.000
Dormer window	0.028 (0.17)	0.013	0.000	0.353 (0.75)	0.020	0.000
Balcony	-0.036 (-0.97)	0.353	0.000	-0.005 (-0.09)	0.468	0.000
Central heating	-0.025 (-0.63)	0.775	0.000	0.100 (1.54)	0.889	0.001
Some isolation	-0.024 (-0.41)	0.465	0.000	0.002 (0.03)	0.731	0.000
Full isolation	0.156 (1.19)	0.098	-0.001	0.020 (0.37)	0.189	0.000
Attic	0.040 (1.34)	0.053	0.000	-0.110 (-1.50)	0.030	0.001
Terrace	0.000 (-0.01)	0.105	0.000	-0.108 (-1.56)	0.155	0.000
Lift	1.155 (1.72)	0.155	0.015	0.308 (0.48)	0.123	0.002

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Table S5 – continued from the previous page

	1991-2006				2007-2014			
	discontinuity	mean	price eff.		discontinuity	mean	price eff.	
Parking available	0.031 (0.32)	0.049	0.000		0.023 (0.16)	0.053	0.000	
Carport	0.049 (0.50)	0.021	0.000		0.034 (0.23)	0.031	0.000	
Garage	0.031 (0.32)	0.019	0.000		0.023 (0.16)	0.019	0.000	
Garden	-0.098 (-1.87)	0.223	0.000		0.033 (0.75)	0.166	0.000	
South-facing garden	-0.059 (-1.47)	0.124	0.000		-0.501 (-3.61)	0.087	0.002	
Total effect on log price			0.020				-0.004	

This table presents the average regression discontinuity (RD) estimates for dwelling characteristics, their mean value in the sample, and their effect on log price. The sample includes properties located up to 2km from the closest Red Light District (RLD). Robust z-statistics are in parentheses. Bandwidths are the same as those applied in Table 2. Effect on log price is calculated by plugging the estimated discontinuities into a hedonic regression, controlling for year and location.

Table S6: Density Discontinuity Test for Other Businesses at the RLD Border in Amsterdam

		Bin width (in km)							
		0.02		0.03		0.04		0.05	
		θ	p-value	θ	p-value	θ	p-value	θ	p-value

Table S6 – continued from previous page

		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
Restaurants											
2001		0.719	0.005	0.769	0.002	0.842	0.001	0.849	0.001	0.951	0.000
		(0.257)		(0.253)		(0.244)		(0.245)		(0.243)	
2007		1.004	0.000	1.020	0.000	1.096	0.000	1.039	0.000	1.172	0.000
		(0.245)		(0.245)		(0.237)		(0.240)		(0.240)	
2014		0.836	0.000	0.878	0.000	0.823	0.000	0.804	0.000	0.918	0.000
		(0.220)		(0.215)		(0.214)		(0.221)		(0.217)	
2007-2001		0.284	0.423	0.251	0.475	0.253	0.457	0.190	0.580	0.221	0.518
		(0.355)		(0.352)		(0.340)		(0.343)		(0.341)	
2014-2007		-0.167	0.612	-0.142	0.663	-0.273	0.393	-0.236	0.471	-0.254	0.432
		(0.330)		(0.326)		(0.319)		(0.327)		(0.323)	
2014-2001		0.117	0.730	0.109	0.742	-0.019	0.953	-0.045	0.891	-0.033	0.919
		(0.338)		(0.332)		(0.325)		(0.330)		(0.326)	
Retailers											
2001		-0.027	0.899	-0.120	0.614	-0.026	0.899	-0.078	0.739	-0.175	0.482
		(0.209)		(0.238)		(0.201)		(0.234)		(0.248)	
2007		0.206	0.269	0.175	0.383	0.190	0.282	0.178	0.393	0.134	0.534
		(0.187)		(0.200)		(0.176)		(0.208)		(0.216)	
2014		0.298	0.128	0.278	0.169	0.283	0.099	0.337	0.086	0.251	0.211
		(0.196)		(0.202)		(0.172)		(0.196)		(0.201)	
2007-2001		0.233	0.406	0.295	0.343	0.215	0.421	0.256	0.414	0.309	0.348
		(0.280)		(0.311)		(0.268)		(0.313)		(0.329)	
2014-2007		0.092	0.734	0.103	0.718	0.094	0.704	0.160	0.576	0.117	0.693
		(0.271)		(0.285)		(0.246)		(0.286)		(0.295)	
2014-2001		0.325	0.257	0.398	0.202	0.309	0.243	0.415	0.174	0.425	0.182
		(0.286)		(0.312)		(0.265)		(0.305)		(0.319)	

Table S7: Discontinuity in Distance to Other Businesses at the RLD Border in Amsterdam

	discontinuity in distance (100m)		mean distance (100m)
2001/2006			
coffeshop	-2.186	(-22.5)	1.755
cafe	0.381	(6.84)	0.908
restaurant	0.264	(4.26)	0.886
retailer	-0.075	(-2.64)	0.389
2007/2014			
coffeshop	-2.134	(-25.7)	1.838
cafe	0.190	(3.55)	0.938
restaurant	0.359	(6.62)	0.846
retailer	-0.044	(-1.49)	0.385
2014/2007-2006/2001			
coffeshop	0.052	(0.40)	0.083
cafe	-0.190	(-2.46)	0.030
restaurant	0.095	(1.16)	-0.039
retailer	0.032	(0.78)	-0.003

This table presents the average regression discontinuity (RD) estimates for the distance from sold houses to business establishments on the same side of the border. The sample includes properties located up to 2km from the closest Red Light District (RLD). Robust z-statistics are in parentheses. Bandwidths are the same as those applied in Table 2. Types of business are described as: ‘coffeeshop,’ which sells cannabis; ‘cafe,’ whose main activity is to serve alcoholic beverages; ‘restaurant,’ which serves food and includes hotel-restaurants, but excludes diners and lunchrooms; and ‘retailer,’ which denotes a specialized retailer, except for grocery stores, gift shops, and sex shops.

Table S8: Difference in Price Discontinuity in Amsterdam's RLDs,
Controlling for Distance to Other Businesses

	(1)	(2)	(3)	(4)	(5)	(6)
Average DiD	-0.118 (-2.91)	-0.121 (-2.99)	-0.119 (-3.01)	-0.124 (-3.12)	-0.118 (-2.91)	-0.121 (-3.07)
MWTA	0.230 (2.86)	0.210 (2.68)	0.244 (3.17)	0.236 (2.97)	0.230 (2.86)	0.224 (2.93)
Control variables						
Shortest distance to						
coffeeshop		X				X
cafe			X			X
restaurant				X		X
retailer					X	X

This table presents the difference-in-discontinuity (Average DiD) estimates of house prices and its relationship with the difference in the distance to a red window (MWTA). Control variables are gradually added to the benchmark model in column (1). The distance from houses to business establishments is calculated for each year from 2001 to 2014. Types of business are described as: 'coffeeshop,' which sells cannabis; 'cafe,' whose main activity is to serve alcoholic beverages; 'restaurant,' which serves food and includes hotel-restaurants, but excludes diners and lunchrooms; and 'retailer,' which denotes a specialized retailer, except for grocery stores, gift shops, and sex shops. The sample includes properties located up to 2km from the closest Red Light District (RLD). Robust z-statistics are in parentheses. Main and pilot bandwidths are selected using the procedures proposed by [Calonico, Cattaneo and Titiunik \(2014\)](#).

Table S9: Marginal Effects of RLDs on House Prices in Utrecht

Bandwidth scale	Log price per 100m					Euros per 100m				
	0.80	0.90	1.00	1.10	1.20	0.80	0.90	1.00	1.10	1.20
radius	0.99 quantile					0.99 quantile				
0.2 km	0.005 (1.05)	0.012 (1.90)	0.012 (2.22)	0.012 (2.49)	0.010 (2.53)	3,307 (0.95)	8,439 (1.91)	8,284 (2.20)	8,058 (2.53)	7,532 (2.71)
0.5 km	0.013 (2.19)	0.012 (2.36)	0.012 (2.58)	0.011 (2.94)	0.011 (3.24)	5,878 (1.65)	7,617 (1.88)	7,517 (2.17)	7,155 (2.45)	6,354 (2.51)
1.0 km	0.018 (3.32)	0.014 (2.69)	0.014 (2.96)	0.012 (2.78)	0.011 (3.19)	5,173 (2.03)	5,127 (2.08)	4,977 (2.44)	5,000 (2.76)	4,913 (3.07)
1.5 km	0.016 (2.88)	0.014 (2.58)	0.013 (2.07)	0.012 (2.94)	0.011 (1.93)	4,617 (1.82)	4,494 (2.11)	4,098 (2.51)	4,179 (2.87)	4,189 (2.60)
radius	0.75 quantile					0.75 quantile				
0.2 km	0.004 (0.88)	0.011 (1.94)	0.011 (2.27)	0.011 (2.59)	0.010 (2.56)	1,181 (0.87)	2,844 (1.94)	2,778 (2.22)	2,673 (2.52)	2,456 (2.66)
0.5 km	0.011 (1.74)	0.011 (2.09)	0.010 (2.43)	0.010 (2.76)	0.010 (2.97)	2,092 (1.70)	2,700 (2.04)	2,598 (1.66)	2,636 (2.36)	2,570 (3.18)
1.0 km	0.005 (1.14)	0.010 (2.00)	0.010 (2.12)	0.009 (2.42)	0.009 (2.58)	1,766 (1.79)	1,971 (1.97)	1,935 (2.86)	1,878 (1.74)	1,865 (2.60)
1.5 km	0.003 (0.75)	0.003 (0.91)	0.003 (0.92)	0.003 (1.14)	0.005 (1.79)	933 (0.79)	1,012 (0.72)	965 (0.51)	1,029 (1.68)	1,024 (0.85)
radius	median					median				
0.2 km	0.004 (0.83)	0.011 (1.81)	0.011 (2.13)	0.010 (2.31)	0.009 (2.41)	841 (0.77)	1,775 (1.77)	2,235 (1.76)	2,131 (1.99)	1,942 (2.09)
0.5 km	0.004 (0.85)	0.009 (1.72)	0.009 (2.00)	0.008 (2.12)	0.008 (2.68)	1,028 (1.85)	1,346 (1.83)	1,566 (2.12)	1,698 (2.84)	1,585 (3.38)
1.0 km	0.003 (0.58)	0.003 (0.78)	0.003 (0.91)	0.003 (1.04)	0.002 (1.04)	549 (0.66)	628 (0.58)	681 (1.09)	765 (0.87)	696 (0.59)
1.5 km	0.002 (0.38)	0.002 (0.54)	0.002 (0.56)	0.002 (0.57)	0.001 (0.67)	392 (0.75)	435 (0.41)	414 (0.63)	407 (0.42)	321 (1.10)
radius	0.01 quantile					0.01 quantile				
0.2 km	0.002 (0.36)	0.003 (0.63)	0.003 (0.82)	0.002 (0.78)	0.002 (0.66)	346 (0.36)	602 (0.63)	568 (0.82)	449 (0.78)	298 (0.66)
0.5 km	0.001 (0.19)	0.001 (0.39)	0.001 (0.43)	0.001 (0.40)	0.001 (0.39)	128 (0.20)	208 (0.38)	176 (0.39)	135 (0.35)	110 (0.36)
1.0 km	-0.002 (-0.32)	-0.001 (-0.18)	0.000 (-0.06)	0.000 (-0.03)	0.000 (0.04)	327 (-0.31)	107 (-0.18)	40 (-0.05)	12 (-0.03)	21 (0.04)
1.5 km	-0.002 (-0.45)	-0.002 (-0.49)	-0.001 (-0.17)	0.000 (-0.07)	0.000 (-0.07)	624 (-0.36)	373 (-0.23)	134 (-0.16)	41 (-0.08)	29 (-0.04)
main bandwidth	0.661	0.744	0.826	0.909	0.992	0.661	0.744	0.826	0.909	0.992
pilot bandwidth	1.161	1.306	1.451	1.596	1.741	1.161	1.306	1.451	1.596	1.741

This table presents the quantiles of marginal effects in log price (on the left) and in euros (on the right) as a function of the radius to the center of the Red Light Districts (RLDs) in Utrecht. The ‘marginal effect’, or Difference-in-Slope (DiS), is the difference in the first derivative of the distance functions in January 2011–December 2012 and August 2013–December 2014. Estimates are obtained using several different bandwidths around the optimal, given by [Calonico, Cattaneo and Titiunik’s \(2014\)](#) procedure. Robust z-statistics are in parentheses. The distribution of DiS is weighted by the density of houses for sale in 2011–2012. For better illustration, we apply an empirical Bayes shrinkage to estimates that are not significant at 10%. Dwelling characteristics are controlled for using a hedonic model, equation (10), and prices are deflated to values of 2014. The sample includes properties located up to 3km from the RLDs.

Table S10: Difference-in-Differences in Crime Rates and Risk Perception in each RLD of Utrecht

	Crime rate					% who feel unsafe in the neighborhood
	total	violence	nuisances	major property	minor thefts	illegal drug dealing
Hardbollestraat						
(year $\geq$ 2013) $\cdot$ (distance $\leq$ 50m)	-0.271 (-3.32)	-0.210 (-1.74)	-0.281 (-2.86)	-0.120 (-0.91)	-0.678 (-3.71)	-0.582 (-1.56)
(year $\geq$ 2013) $\cdot$ (50m < distance $\leq$ 200m)	-0.226 (-2.60)	-0.029 (-0.18)	-0.085 (-0.72)	-0.463 (-3.43)	-0.333 (-1.90)	0.289 (0.89)
Zandpad						
(year $\geq$ 2013) $\cdot$ (distance $\leq$ 50m)	0.068 (0.85)	-0.357 (-2.33)	0.022 (0.20)	0.247 (2.14)	-0.111 (-0.63)	-0.510 (-1.06)
(year $\geq$ 2013) $\cdot$ (50m < distance $\leq$ 200m)	0.029 (0.35)	-0.122 (-0.77)	0.153 (1.33)	-0.005 (-0.04)	0.256 (1.34)	-0.088 (-0.21)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Neighborhood fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	268	268	268	268	268	260
Number of neighborhoods	67	67	67	67	67	65
						22

This table presents Difference-in-Difference estimates for crime rates, estimated using a negative binomial regression, and risk perception, estimated using a linear regression. The level of observation is the neighborhood (*buurt*), except for the ‘% who feel unsafe’, where it is the sub-district (*subwijk*). ‘Distance’ means the shortest distance between the area and a Red Light District (RLD) and the sample includes only areas within 2km. The sample period is between 2010 and 2015, excluding 2013. The ‘total’ crime rate does not include minor felonies, such as shoplifting, pickpocketing, and bike theft, and reported nuisances, such as complaints about neighbors and alcohol abuse. Cases of ‘violence’ include declarations of abuses, threats, sexual offenses, fights, assaults, and street robbery, but they exclude cases of domestic violence. ‘Nuisances’ include complaints against neighbors, vandalism, and cases of drug and alcohol abuse registered by the police. ‘Major property’ crimes include burglaries and motor vehicle thefts. ‘Minor thefts’ include bike thefts, shoplifting, pickpocketing and other property crimes. Standard errors are clustered by neighborhood and the t-statistics are in parentheses.