

THE EFFECTS OF DISCLOSURE REGULATION: EVIDENCE FROM RESTAURANTS[†]

Ginger Jin

Dept of Economics

University of Maryland

jin@econ.umd.edu

Phillip Leslie

Dept of Economics

UCLA

pleslie@econ.ucla.edu

Abstract

This study examines the effect of increased product information to consumers on firm behavior. In 1998, Los Angeles County introduced hygiene quality grade cards to be displayed in restaurant windows. This regulatory change provides exogenous variation in whether firms are subject to voluntary disclosure (of hygiene quality) without a standard-format, voluntary disclosure with a standard-format or mandatory disclosure. We analyze the effect of these three regimes on firms' actual quality choices. The results show that mandatory disclosure of hygiene grades causes restaurants to increase hygiene quality by an amount that is statistically significant and large in magnitude. We are also able to test whether the effects of mandatory disclosure are different from the effects of voluntary disclosure with a standard format—a test of the unraveling hypothesis. The results reveal statistically but not economically significant differences. To verify that it is economic incentives driving firms to improve their quality and/or voluntarily disclose information about product quality, we also provide evidence that average restaurant revenue is higher due to the introduction of grade cards, and that the increase in revenue is higher for restaurants with better hygiene quality grades.

This version: July, 2001

[†]We thank Dan Akerberg, Rudolfo Bagnera, Paul Devereux, Ron Goettler, Joe Hotz, Tom Hubbard, Guido Imbens, Dan Kessler, Rachel Kranton, Seth Sanders and Joel Waldfogel for valuable advice. We are also grateful to the Los Angeles County Department of Health Services and the California State Board of Equalization for allowing us to access the data.

1 Introduction

A theoretical literature identifies several ways through which information to consumers may impact the behavior of firms and the efficiency of markets.¹ With rare exception, the insight is typically that more information is better, which has led economists to support policies that seek to increase the amount of information available to consumers.² Meanwhile existing empirical studies into the effects of information on firm behavior find small or negligible effects from increased information, casting doubt on the importance of such policies. We contend the failure is on the part of the empirical research, and is mainly due to the difficulty of observing exogenous variation in the amount of information available to consumers. In this study, we analyze a regulatory change that provides a context for evaluating the effects of increased product information on firms' product quality choices and disclosure decisions. In contrast to prior empirical studies into these issues, we find both statistically and economically significant increases in product quality due to an increase in information to consumers.

In December 1997 the Los Angeles County government passed an ordinance requiring restaurants to publicly display grade cards resulting from Department of Health Services (DHS) hygiene inspections. Restaurants had been subject to hygiene inspections for many years prior to the change, but the new regulation requires that the results of the inspections be revealed to consumers via a standard-format grade card to be prominently displayed in the window of each restaurant. However for the ordinance to apply to a restaurant, the city in which the restaurant is located must also vote to adopt the county ordinance. If a city does not adopt the ordinance, DHS inspectors nonetheless issue an official grade card, but it is at the discretion of the restaurant whether the grade card is displayed. We have obtained a new panel dataset that includes complete details of all health inspections in restaurants in Los Angeles county from January 1, 1996 to December 31, 1998. In addition, the California State Board of Equalization (SBE) granted us access to confidential quarterly sales tax data for these restaurants over the same period of time, from which we observe quarterly restaurant revenue.

The goals of this study are three-fold. First, we analyze the effect of a policy generating increased information provision on firms' hygiene quality choices. Second, we examine the effect of the policy on restaurant revenue. This is important because it verifies that observed changes in quality are driven by economic incentives, and are not merely a spurious correlation

¹The prior literature is discussed in Section 2.

²Examples of mandatory disclosure policies in the U.S. include food labeling, energy efficiency of new home appliances, gas mileage of new cars and accounting disclosures for publicly traded firms.

or artifact of the regulation. Third, we examine whether mandatory disclosure yields different equilibrium outcomes than voluntary disclosure. We are able to shed light on these issues since our dataset includes exogenous variation in whether firms are subject to one of three regimes: (i) voluntary disclosure without a standard-format, (ii) voluntary disclosure with a standard-format, or (iii) mandatory disclosure with a standard-format.

Mandatory and voluntary disclosures are relevant for many consumer markets in which little information appears available to consumers. The likely failure of a market for information in such cases raises the possibility of benefits from government intervention. At the extreme, the government might require firms to disclose certain kinds of product information. However, such mandatory disclosure requirements may be difficult to implement (industries may lobby against such requirements), and may not be necessary to achieve the desired outcome. An alternative is for the government to facilitate voluntary information disclosure, by verifying information or providing a standard-format for disclosure, for example. Whether voluntary disclosure can perform as well as mandatory disclosure in obtaining favorable market outcomes is an important question for policy-makers.

The theoretical literature on disclosure of firms' private information highlights the possibility of "unraveling" equilibria, in which voluntary and mandatory disclosure yield the same outcome, as long as the information is verifiable with zero cost. Applied to our case, the logic is as follows. Since consumers believe the highest quality non-disclosing restaurants to be no different than the lowest quality non-disclosing restaurants, there are incentives for the highest quality restaurants to reveal their quality. The next highest quality restaurants are then the highest quality non-disclosing restaurants, so these firms then have an incentive to disclose their quality. This unraveling continues as long as the benefit of disclosure outweighs the cost. In our particular situation the cost for a restaurant to display their hygiene grade card is zero, regardless of whether it is mandatory or voluntary. The reason is that in either case the DHS performs inspections and provides the grade card immediately after. Following the logic of unraveling, the effects of the grade cards should be the same in cities with voluntary posting as in cities where posting is mandatory. We are able to test this hypothesis.

The unraveling argument in its simplest form takes hygiene quality as exogenous. However the stated purpose of the grade card ordinance is to increase hygiene quality at Los Angeles restaurants. Prior to the ordinance, no restaurants in the county exhibited or advertised any information concerning their hygiene inspection score.³ This may have been due to the difficulty

³Based on conversations with DHS employees and press coverage surrounding the grade cards.

for consumers to verify and/or evaluate the relative merits of any such claim made by a restaurant. The grade cards, on the other hand, provide credible and comparable information about hygiene quality. Hence, we are able to analyze the effect of increased information provision on firms' choices of quality.

We find that hygiene quality has significantly increased due to the introduction of hygiene grade cards, regardless of whether disclosure is mandatory or voluntary. There are statistically significant differences in the effect on hygiene quality between mandatory and voluntary disclosure. We therefore reject the unraveling hypothesis in its pure form. However, these differences are small in magnitude which lends support to the unraveling story. When restaurants are not issued hygiene quality grade cards we find that hygiene quality has no effect on restaurant revenue. In contrast, hygiene grade cards give rise to economically and statistically significant effects of hygiene quality on revenue, confirming the role of economic incentives in firms' quality improvements due to the grade cards. We also present evidence from price indices and industry employment data indicating that prices may have decreased and output may have increased for restaurants in Los Angeles because of the grade cards. The results of our study verify the effectiveness of increasing information to consumers for motivating firms to improve product quality. Our findings also support the argument that mandatory disclosure is less important than firms having access to a low cost method of voluntarily disclosing credible information using a standard-format.

In Section 2 we survey the relevant prior literature. Los Angeles restaurant hygiene regulations are summarized in Section 3, where we also explain why it is reasonable to consider the alternative regulatory regimes as exogenous. The effects of mandatory and voluntary disclosure on hygiene quality are analyzed in Section 4 and the effects on revenue are analyzed in Section 5. Section 6 concludes the paper.

2 Prior Literature

Our study draws on previous developments in two branches of the literature concerning product information in consumer markets. On the one hand, there have been numerous studies into the relationship between changes in the provision of information to consumers, usually in the form of advertising, and firms' responses to this, usually in the form of altering prices. On the other hand, there have been a series of papers that analyze the incentives for firms to reveal their

private information, in which the unraveling equilibria described above, is explored in greater depth. It is convenient for our purpose to briefly review each branch separately.

2.1 The Effect of Information on Firm Behavior

In the seminal contribution by Stigler (1961) a connection between information and market outcomes is proposed and a formal model is presented in which price advertising reduces search costs and thereby lowers the mean and variance of the price distribution. Subsequent researchers have refined the idea that search costs play an important role in determining market outcomes, including Nelson (1970) who considers the effect of consumers being uninformed about product quality instead of price, which is more in line with our study.⁴ Beginning with Nelson (1974), a quite different role of product information has been put forward in which advertising is a signal of quality.⁵

Existing empirical studies into the effect of information on firm behavior can be divided into three categories: (i) studies that examine the effect of advertising on prices based upon cross-sectional data, (ii) studies that examine the effect of advertising on prices based upon panel data, and (iii) studies that examine the effects of information on outcomes other than prices.⁶ In the first of these groups is the classic study by Benham (1972) which examines the prices of eyeglasses in states that did and did not allow advertising. Prices are found to be lower and exhibit less dispersion in markets where advertising is allowed.⁷ Two prior studies examine panel data to identify the effect of advertising on prices. Devine and Marion (1979) performed an experiment in which they published comparative price information in local newspapers concerning supermarkets and found a small decrease in the mean and variance of prices. Milyo and Waldfogel (1999) analyze the effect of advertising on prices in liquor sales using a panel dataset with an exogenous change in advertising. Their main finding is that there are insignificant decreases in prices due to advertising.

⁴Other examples include Butters (1977) and Salop and Stiglitz (1977) who show that the presence of consumers facing different search costs may not lead to a lower mean and variance in the price distribution due to price advertising.

⁵See also Milgrom and Roberts (1986).

⁶There is also a literature that examines whether, and to what extent, consumers' are responsive to the increased provision of product information. For example, a number of studies examine the effects of product labeling regulations on consumer demand. Teisl and Roe (1998) survey the studies of labeling issues. The focus of our study is firm decision-making in the face of increased provision of information to consumers.

⁷There are numerous reasons, several of which are noted by Benham, why the analysis of cross-sectional data in this context may not identify a causal effect.

A couple of prior studies investigate the effects of information on outcomes other than prices. Kwoka (1984) undertakes a study of the effects of advertising on quality (and prices) of optometric services in a cross-section of geographic markets.⁸ It is found that quality is lower in advertising markets than in non-advertising markets (prices are also lower). In a study of child-care markets, Chipty and Witte (1998) analyze the effects of price and quality information provided by Resource and Referral agencies (R&Rs) on the distribution of prices and quality. Their analysis is based on cross-sectional data for geographic markets. In estimation, an observation is a market since the measure of information is a binary variable for whether there is an R&R in the market. Chipty and Witte find that (i) price dispersion for toddler care is lower in markets with R&Rs than without; (ii) there is no significant difference in price dispersion for pre-school and school-age children care in markets with R&Rs than without; and (iii) distributions of service quality (measured by staff/child ratios) are insignificantly different in areas with and without R&Rs.⁹

Let us summarize the existing empirical results regarding the effects of the increased provision of information on firm behavior. There remains uncertainty about the effect of advertising on the distribution of prices, but this could be due to the competing roles of advertising (reducing search costs versus signalling) and is clouded by the complication that advertising is a choice for firms. When information about product quality is provided by an independent institution there is no strong evidence that this has any effect on quality.

2.2 Information Disclosure Incentives

Beginning with the pioneering study of Akerlof (1970) economists have theorized about the incentives and problems for vertically (or quality) differentiated firms to reveal their private information to consumers. The notion of unraveling equilibria in settings with voluntary disclosure was initially put forward by Grossman (1981) and Milgrom (1981). Subsequent extensions to the theory include the effect of disclosure costs (Jovanovic, 1982), the effect of information acquisition costs (Farrell, 1986), the effect of some consumers being uninformed (Fishman and Hagerty, 1999) and the effect of competition (Jin, 2000b).¹⁰

⁸Quality is measured by time spent in the examination.

⁹In another related study, but with a different focus, Dranove *et al* (2000) examine the effects of mandatory medical surgery report cards in certain states of the U.S. It is found that the report cards are welfare reducing due to the strong incentives for doctors to increase treatment of the relatively healthy and to not treat the very unhealthy in order to improve their report card.

¹⁰For a more detailed review of disclosure incentives and unraveling see Fishman and Hagerty (1998).

We are aware of two prior empirical studies focusing on the specific issue of firms' disclosure incentives. The first is Mathios (2000) who studies fat content labeling of salad dressing. Prior to May, 1994, disclosure of fat content was voluntary and Mathios documents that about half the products displayed the fat content on the container, and that these were almost all the products with low fat content. However, there is significant variation in fat content for the non-disclosing firms, and on this basis it is concluded that unraveling is incomplete. In May, 1994, the Nutrition Labeling and Education Act came into force, which requires firms to include fat content on the label. This allows Mathios to compare product-level demand under voluntary disclosure (before May, 1994) with mandatory disclosure (after May, 1994). It is shown that previously unlabeled products generally suffer a decline in demand under mandatory disclosure. The second empirical study is by Jin (2000a) who examines the voluntary disclosure decisions of Health Maintenance Organizations (HMOs). Jin finds that competitive factors play a prominent role in explaining the variation in disclosure decisions by HMOs, while cost and demand variation is less important.

3 Summary of the Data

According to the Census Bureau's 1997 Economic Census, full-service restaurants and limited-service eating places employed almost 7 million people in the U.S., or roughly 5% of total employment. Total annual revenue for these firms was \$220 billion. In Los Angeles County the industry employed 207,000 people, with annual revenues of \$7.9 billion. The DHS randomly inspects all restaurants in Los Angeles county and our data contains every inspection from January 1, 1996, to December 31, 1998.¹¹ The first column of Table 1 shows the number of restaurants that are subject to DHS inspections in each quarterly period (which is different from the number of inspections). During the period of our data the number of restaurants rises from 19,590 to 22,652. The second column provides the average hygiene score for all inspections conducted in each quarter. A point to note is the stability of the average score around 75% for the first half of the period, followed by a dramatic rise to 90% in the second half.

The inspection data from the DHS is matched to sales tax data from the SBE. The matching process is imperfect which reduces the number of observations.¹² Columns 3 and 4 of Table 1 show the number of restaurants the SBE successfully matches with the DHS data. After matching the total number of restaurants in our sample is reduced by approximately 28%. From the

¹¹Random timing of restaurant inspections is an important source of exogenous variation for our analysis.

¹²As there is no common numerical identifier that DHS and SBE have in their data, matching is done on the basis of establishment name and address. Matching fails in cases where no common address or name is found.

matched data, we then eliminate restaurants for which the tax data are missing, further reducing the sample to 57% of all restaurants in Los Angeles county. Hence all results reported in this paper are based on the sample of 13,544 restaurants. There are only minor differences in the average hygiene scores between the full sample and the reduced sample, as shown in Table 1, suggesting that the selection is unbiased for our purposes. Moreover, in our analysis of the effects on hygiene quality, below, we obtain very similar estimates whether we use the the full 23,921 restaurants or the sample of 13,544 restaurants, providing even stronger evidence of an unbiased sample.

The key feature of our data is the introduction of hygiene grade cards. We consider this to be an exogenous change in particular because the change in regulation was rapid and unanticipated. The timing of events is as follows:

- November 16–18, 1997 — over three consecutive evenings CBS 2 News on the Los Angeles based Channel 2000 aired a three-part report titled “Behind the Kitchen Door”. The report used hidden cameras to show viewers unsanitary restaurant kitchens.
- December 16, 1997 — in response, the Los Angeles County Board of Supervisors unanimously voted in favor of the grade card ordinance.
- January 16, 1998 — the ordinance came into effect at the county-level.

Incorporated cities within the county, however, are free to adopt the ordinance or not.¹³ Unincorporated cities, and some incorporated cities, adopted the ordinance immediately, while others took longer, and a small number of cities have still not adopted as of June, 2000. Importantly, whether a restaurant is located in a city that adopts the ordinance or not, all restaurants are issued with a grade card at any inspection after January 16, 1998. For restaurants located in cities that have not adopted the ordinance the restaurant has complete discretion whether the card is displayed or not.

Table 2 shows the extent of adoption on a quarterly basis during 1998 for the restaurants in our sample. Since it may take several months for a restaurant to receive its first inspection after January 16, 1998, Panels A and B distinguish between the number of restaurants in cities that have adopted the regulation, and the number of restaurants subject to each of the three mutually exclusive and exhaustive regimes. “Voluntary disclosure without standard-format” refers to restaurants who have not yet received an inspection after the grade cards are introduced. These restaurants have no grade card, so it is irrelevant whether their city has adopted the ordinance

¹³There are 88 incorporated cities in Los Angeles county.

or not. “Voluntary disclosure with standard-format” applies to restaurants that have received a grade card (or equivalently, have been inspected at least once after January 16, 1998), but are located in a city that has not adopted the ordinance at that point in time. Finally, “mandatory disclosure” applies to restaurants that have been issued a grade card and are required to display it. We observe inspection dates and city adoption dates, hence the table is constructed by aggregating daily observations to the quarterly level.

As shown in Panel A of Table 2, for the first quarter of 1998, less than 5% of restaurants are located in cities that have adopted mandatory disclosure of grade cards. This number rises to 80% by the end of 1998. Panel B displays a more relevant summary of the frequency of the three policy regimes. In the first quarter of 1998, roughly 85% of restaurant-days have no disclosure possibility. This number rapidly falls to 4% in the fourth quarter. Also in the fourth quarter of 1998, notice that 34% of restaurant-days fall under voluntary standard-format disclosure, with the majority (62%) falling under mandatory disclosure.

The different dates at which cities adopt the mandatory disclosure ordinance, as depicted in Table 2, is another source of variation we exploit in our analysis. We believe this variation in the timing of city adoption to be exogenous for the following reasons. The fact that most cities which did not initially adopt, eventually do adopt within 12 months, suggests it is more likely due to bureaucratic delays rather than the influence of restaurants. To verify this intuition we examine whether the timing of ordinance adoption by each city is correlated with characteristics of restaurants in the city. To do so, we estimate a duration model in which the dependent variable is the probability of a city adopting the ordinance at a point in time conditional on having not adopted so far. The explanatory variables include characteristics related to restaurants in the city (restaurant revenue per person, median restaurant revenue, dispersion of restaurant revenue and proportion of restaurants with hygiene scores above 90), and city demographics (number of households in the city, median household income, children per household, proportions of females, blacks, Asians, and Hispanics).¹⁴ While not reported in a table, the results support our intuition in favor of exogenous city adoption dates—estimated coefficients on the restaurant characteristics are insignificantly different from zero.¹⁵

During the three years covered in our data the average number of inspections per restaurant

¹⁴Demographic variables are obtained from the 1990 population census. Restaurant characteristics are for the period before the CBS news story that provoked the grade card policy. There are 83 observations (cities) in the estimation.

¹⁵For the coefficients on restaurant revenue per person, median restaurant revenue and proportion of restaurants with hygiene scores above 90 the p-values are greater than 0.3, while for revenue dispersion the p-value is slightly above 0.1.

per calendar year has changed from around 1.9 to over 2.1, with some restaurants inspected more than four times per year. Over 85% of inspections are regular random inspections. However there are also complaint-initiated inspections and owner-initiated inspections, both of which are identified in the data.¹⁶ Beginning on January 16, 1998, at the end of an inspection each restaurant is issued a grade card: “A” (90–100%), “B” (80–89%), “C” (70–79%), or if the score is less than 70% the restaurant is issued a card that reports the actual score.¹⁷ In cities that have adopted mandatory disclosure, the signs are required to be in clear view for customers. A restaurant is closed by the DHS if (i) two consecutive inspections result in a score below 60%, or (ii) if there is a severe hygiene problem (such as an infestation).

There have been a few changes in the inspection scoring criteria during our sample which we incorporate in the analysis below. Until July 1, 1997, the inspections included both an objective and a subjective element. The subjective aspect was the inclusion of an “establishment status score” which was one of excellent (zero points deducted), good (5 points), average (20 points), fair (30 points) or poor (40 points), and was intended to be the inspector’s overall evaluation of the hygiene status of the restaurant. Since July 1, 1997, the subjective component of the assessment has been removed and inspections are now objective in nature. Beginning with a score of 100, pre-specified points are deducted for each violation. For example, a food temperature violation results in a 5 point deduction, evidence of cockroaches results in a 3 point deduction, a functioning but unclean toilet results in a 2 point deduction, and improperly washed/sanitized eating utensils results in a 5 point deduction. A minor change in the inspection scoring was again made on March 18, 1998, to add in a small number of additional potential violations. Because this change is only two months after grade cards have begun to be issued, observed changes in hygiene scores in 1998 may be partly due to the introduction of grade cards, and partly due to the change in assessment criteria. In the analysis below, we attempt to distinguish the two effects by exploiting the two month time difference between the changes.

In this section we have described some important aspects of the regulatory change with particular emphasis on the variation in the data that facilitates our analysis that follows. To summarize, there are three main sources of exogenous variation: (i) the unanticipated introduction of grade cards to be issued to every restaurant in Los Angeles county following their

¹⁶The DHS will inspect a restaurant in response to a single customer complaint. The DHS introduced owner-initiated inspections in the last half of 1998 out of concern for the fact that a restaurant may be branded with a low grade for several months for violations that can be corrected in a short space of time. The DHS allows each restaurant to request an inspection up to a maximum of once per year, for which they must pay the stated marginal cost of the inspection of \$161.

¹⁷We have placed a selection of photos of the grade cards in restaurant windows on the web to give an idea of what the consumer sees: www.econ.ucla.edu/pleslie/restaurants

next inspection regardless of whether disclosure is mandatory or voluntary; (ii) different cities within the county adopt the ordinance for mandatory disclosure at different points in time; and (iii) individual restaurants are randomly inspected at different points in time.¹⁸ In the next section we analyze the effects of the grade cards on restaurant hygiene quality.

4 The Effect of Hygiene Grade Cards on Hygiene Quality

Restaurants offer products whose characteristics include quality, food type and geographic location. Quality itself involves many dimensions: food quality, service quality, and hygiene quality. In this study, we examine restaurants' hygiene quality. The stated goal of the grade cards was to increase hygiene quality levels in Los Angeles restaurants. In this section of the paper we examine to what extent this goal has been achieved. In so doing we answer the questions: (i) does the increased provision of information about quality cause an increase in product quality, and (ii) does the effect on quality differ according to whether the increased provision of information is mandatory or voluntary?

Our measure of hygiene quality is the score that results from an inspection by the DHS. The hygiene assessment is very quantitative in nature so we consider this to be a reasonable measure of quality. However, this is only one measure of hygiene quality and, in particular, ignores any count of incidents of unhealthiness for restaurant patrons. Nevertheless, there is evidence that restaurants with higher hygiene scores receive fewer hygiene related complaints, even before the introduction of grade cards. Table 3 shows the percent of restaurants for which there is at least one complaint to the DHS about hygiene quality, conditional on a particular year and hygiene score.¹⁹ The table reveals that A-grade restaurants (scores above 90) generally receive the fewest complaints. For these reasons, we are confident that hygiene scores serve as a good measure of true hygiene quality.

Figure 1 shows the changing distribution of hygiene quality over time, also indicating the timing of the two assessment changes and the introduction of grade cards. Prior to July 1997 the distribution is stable with a median around 75. The assessment change in July 1997 results in an increase of about 10 points in the median and reduced dispersion. In November 1997 the distribution shifts down, presumably a response by inspectors to the television news story. The introduction of the grade cards are followed by two months of increasing hygiene before

¹⁸Which particular source of variation identifies the effect of interest is different in different regressions.

¹⁹If we weight each restaurant by capacity or revenue the results in this table are not substantively different.

the second assessment change which is also followed by continued increases. By the end of 1998 the figure shows dramatically reduced dispersion relative to 1996, with approximately 70% of restaurants obtaining a score above 90%. The lower scores in November and December of 1997 perhaps give rise to a misleading impression that the grade cards caused larger improvements in hygiene than is right. Nevertheless, the figure also shows every quartile is higher in January 1998 (and beyond) than in July 1997 which is the month with the highest scores before the news story, suggesting a degree of improvement in true hygiene quality due to the grade cards. The assessment change in March 1998 is a relatively minor one, but we can not be certain the observed increases in hygiene scores in 1998 are not at least partially due to this. In the regression analysis we include dummy variables for each of the assessment changes. Finally, we note that in Figure 1 there is no apparent time trend or seasonality in hygiene quality.

The estimating equation of primary interest is

$$H_{it} = \alpha_i + \beta_1 N_{it} + \beta_2 M_{it} + \beta_3 V_{it} + \gamma_1 C_{1t} + \gamma_2 C_{2t} + \gamma_3 C_{3t} + \epsilon_{it}, \quad (1)$$

where H_{it} denotes the hygiene inspection score obtained by restaurant i at time t , N equals one if no grade card is issued for the inspection (this dummy is excluded in estimation), M equals one if it is mandatory to post a grade card for the inspection, V equals one if it is voluntary to post a grade card for the inspection, C_1 , C_2 and C_3 are dummies for the different inspection score criteria discussed above (C_1 is also excluded in estimation), the α , β and γ terms are coefficients to be estimated and ϵ is a residual.²⁰ In addition to estimating equation (1), we estimate an equation in which the restaurant fixed-effects (α_i) are replaced by observable restaurant characteristics ($X_i\alpha$).

In this regression an observation is a restaurant inspection.²¹ After the county passed the grade card ordinance all restaurants are issued a grade card following an inspection, so there is no control group of restaurants undergoing inspections by the DHS at the same time which are not issued with grade cards. Identification of the effects from grade cards is therefore primarily due to time series variation in whether grade cards are issued. However, at the same point in time in some cities the posting of grade cards is voluntary while in other cities the posting is mandatory, providing cross-sectional variation which helps to separately identify the effects of mandatory and voluntary disclosure. In the previous section we explained why it is reasonable to consider both kinds of variation as exogenous. To the extent that one may still be concerned about possible bias in this regression due to endogeneity of the timing when cities switch from

²⁰We also include city-year-quarter random effects in the specification to allow for clustering in the data (which increases the standard errors by a small amount).

²¹In the revenue regressions of the next section an observation is a restaurant in a quarter.

voluntary to mandatory disclosure, note that we include restaurant fixed effects to control for time-invariant restaurant (and hence also city) characteristics which preclude some sources of bias. If there is a bias due to endogenous city ordinance adoption it must be because time-varying city characteristics contained in the residual are correlated with the timing of ordinance adoption. Two pieces of evidence argue against this possibility. First, the finding in the previous section that time-invariant characteristics of restaurants in each city are uncorrelated with the timing of city adoption suggests any time-varying characteristics of restaurants may also be uncorrelated. Second, a leading example of the sort of correlation that could induce a bias would be if the rate of change of hygiene quality in each city is correlated with the timing of city ordinance adoption, which we find not to be the case.²²

Table 4 reports the results from OLS estimation of equation (1). All coefficients are highly significant and there is no substantial difference when observable restaurant characteristics or restaurant fixed effects are included, so we focus on the fixed effects results here. The coefficient on the Inspection Criteria II dummy reveals the change in assessment criteria in July of 1997, prior to the introduction of grade cards, caused hygiene scores to increase by an average of 8.09 points. Since the change in assessment was not trivial in this case, we presume this coefficient identifies a purely nominal change in scoring, with no change in the actual hygiene quality of restaurants.

The estimated effect from mandatory disclosure of hygiene grade cards is an average increase in hygiene quality of 4.40 points, or 5.3%. To emphasize the magnitude of the effect, this is equal to 0.4 of a standard deviation of the hygiene distribution.²³ Therefore the increased provision of information about firm quality does indeed cause firms to increase quality levels. The estimated effect from voluntary disclosure of hygiene grade cards is an average increase in hygiene quality of 3.25 points, or 3.9%. The significance of the coefficient on the voluntary disclosure dummy provides empirical support for the claim that there is an incentive for firms' to voluntarily disclose their private information, and that firms are responsive to this. The estimate for the nominal effect on hygiene scores from changing to Inspection Criteria III in March of 1998, after the introduction of grade cards, is an average increase of 2.33 points.²⁴

²²Specifically, we regress the timing of city adoption on the average rate of change of hygiene scores in each city prior to the CBS news story and find the estimated coefficient is insignificant (p-value greater than 0.3).

²³The standard deviation for the distribution of hygiene scores from inspections conducted between July 1, 1997, and January 15, 1998, was 11.29. As verification of the statistical significance, a simple test of the difference in means between the distribution of scores under Inspection Criteria II without grade cards, and Inspection Criteria II with mandatory grade cards, rejects equality with 99.99% confidence.

²⁴To compute the net effect from changing to Inspection Criteria III, subtract the coefficient on Inspection Criteria II from the coefficient on Inspection Criteria III.

An important question is whether the coefficients on the mandatory and voluntary disclosure dummies are significantly different from each other? This is a test of the unraveling hypothesis. With 90 percent confidence we reject the hypothesis of equal coefficients on the two disclosure dummies.²⁵ We therefore reject the unraveling hypothesis, at least in its strongest form. But, while the coefficients are statistically different, the magnitude of the difference is only 1.15 points, which is small in comparison to the levels of these effects.²⁶ The high degree of unraveling is also evident from Figure 2 which shows the distributions of hygiene quality under the three regimes of no grade cards, mandatory disclosure of grade cards and voluntary disclosure of grade cards. The hygiene distributions for mandatory disclosure and voluntary disclosure are remarkably similar to each other, and both are very different to the distribution when there are no grade cards. The evidence, therefore, supports a significant degree of unraveling taking place. The policy of mandatory posting of grade cards seems to make little difference to a policy of issuing grade cards and allowing firms the discretion of whether their grade card is displayed.

Figure 2 also reveals a spike in the hygiene distributions for both mandatory and voluntary disclosure at the score of 90.²⁷ The distribution of hygiene under the no grade cards regime exhibits no such spike. There are two likely explanations for the spike. On the one hand, since grade cards do not distinguish between a low-A and a high-A score, there is no benefit for restaurants to improve hygiene beyond obtaining a score of 90. Consequently if restaurants face little uncertainty over the score they will obtain from an inspection and it is costly to improve hygiene, then we would expect to observe a spike in the hygiene distribution at 90. On the other hand, if restaurants' profits are harmed by obtaining a B-grade, inspectors may ignore a violation in order to help restaurants that are only a point or two below obtaining an A-grade.²⁸ The former explanation is consistent with the grade cards having a positive effect on hygiene quality. The latter explanation would lead to an over-estimate of the effect from grade cards. If the spiking is due to differences in behavior only when hygiene scores are within a few points of the grade cut-offs, then an alternative specification that would be consistent is an ordered

²⁵There is a positive covariance of 3.18 between the coefficients on the mandatory and voluntary disclosure dummies, which is why we find the difference to be significant even though they are fairly close to each other given the standard errors.

²⁶The effect of mandatory disclosure is larger than the effect of voluntary disclosure. Given there is a difference, this is the direction we would expect.

²⁷There is also a spike at 80 that is much smaller than the spike at 90.

²⁸The DHS conducts random follow-up inspections as a check on the possibility of inspectors being bribed or manipulating scores, which would mitigate this behavior to some extent.

probit with the dependent variable

$$S_{it} = \begin{cases} 0 & : H_{it} < 65 \\ 1 & : 65 \leq H_{it} < 75 \\ 2 & : 75 \leq H_{it} < 85 \\ 3 & : 85 \leq H_{it} < 95 \\ 4 & : H_{it} \geq 95. \end{cases}$$

The explanatory variables are the same as equation (1) with restaurant random effects instead of restaurant fixed effects. While not reported in a table, the estimates for this specification confirm the results in Table 4—all coefficients are positive and highly significant. The result is not surprising given that Figure 2 clearly shows the distribution of scores under grade cards (mandatory or voluntary) to have lower mass for all scores below 89 than when there are no grade cards.

To further check the robustness of the estimates reported in Table 4 we considered a few variations on the reported regression. First, we transformed the dependent variable using a logit function which bounds the predicted scores to lie between zero and 100.²⁹ There were no significant changes in the estimated effects. However the logit transformation did reveal statistically insignificant differences between the effects of mandatory and voluntary disclosure, providing further evidence of the high degree of unraveling. Second, we separately re-estimate after excluding (i) restaurants that appear to have exited at some time during 1998—this can shed light on the extent to which hygiene improvements are obtained by improving incumbents or by a process of entry and exit); (ii) owner-initiated inspections; and (iii) complaint-initiated inspections. In each case the number of excluded observations is few and in each case the estimated coefficients did not change in any significant way. Third, to investigate the possibility that the effects on hygiene quality from grade cards are gradual, perhaps even to such an extent that the full effects are not apparent by the end 1998, we also estimate the average effects of grade cards separately for each quarter period in 1998. While not shown in a table, we find that average effects, from both mandatory and voluntary disclosure, in the second quarter of 1998 are significantly higher than in the first quarter, and the effects in the third and fourth quarter are not significantly different from the second quarter.³⁰ These results suggest the effects on hygiene from the grade cards are realized fairly rapidly.

The dataset includes information on the occurrence of specific hygiene violations at each inspection, which allows us to examine the effect of grade cards on the frequency of particular

²⁹Specifically, we transform the score H using $\ln(H/(100 - H))$.

³⁰This is also graphically evident to a degree in Figure (1).

violations. Some aspects of hygiene quality, such as employee hand-washing, are based on human behavior and it is conceivable that employees may only act on their best behavior during an inspection.³¹ Grade cards could then be misleading to consumers and the effect of the increased provision of information on true hygiene quality would be less than we have estimated above. But some hygiene violations require changes to the building structure, such as adequate and approved ventilation in the cooking area. If we observe significant decreases in the incidence of violations related to the building structure as a result of the introduction of grade cards, then this would be evidence that the increased provision of information in this case does not merely cause transient improvements in hygiene quality.

Table 5 reports the results from OLS regressions in which the dependent variable is the number of points deducted for violations of a particular type in each inspection.³² In Panel A of Table 5, we look at building structure violations, specifically the requirements of (i) lavatories in good repair, with hot and cold water available, adequate soap and towel dispenser, and a sufficient number of lavatories; (ii) adequate and approved ventilation in the cooking area and restrooms; (iii) clean walls and ceilings in good repair, easily cleanable and impervious to grease and moisture; and (iv) adequate lighting with shatterproof lights or light shields. As the table shows, we find there are significant reductions in the average number of points deducted for building structure violations because of the introduction of both mandatory and voluntary grade cards.³³ This seems to be strong evidence that grade cards cause restaurants to make relatively long-lasting improvements in hygiene quality.

In Panel B of Table 5 we examine the number of points deducted for particular hygiene violations that we think are unobservable to a typical restaurant customer. Specifically, unobservable violations are all violations excluding those relating to insects, animal/fowl, utensils, premises, toilets, lighting, signs and permits, ventilation, floors, walls and ceilings. The results show significant decreases in the average number of points deducted for these violations due to the introduction of mandatory and voluntary grade cards. The finding of a significant decrease in unobservable (to the consumer) hygiene violations because of voluntary grade cards is compelling evidence of the high degree of unraveling taking place, since it concerns hygiene improvements which patrons are unlikely to notice.³⁴ The main reason for incurring the cost of

³¹Prior to grade cards, incentives were effectively zero, so that even temporary best behavior of employees did not occur.

³²A negative coefficient is interpreted as a decrease in the number of points deducted, or equivalently a decrease in the incidence of violations of that kind.

³³To help gauge the magnitude of the effects, the mean number of structural violations is 1.96 and the estimated coefficient on mandatory grade cards is -0.38 (19% reduction).

³⁴Again, to help gauge the magnitude of the effects, the mean number of unobservable violations is 11.12 and

these changes is to voluntarily post an A-grade card in the window.

To summarize the main results of this section: we find (i) the policy of mandatory posting of hygiene grade cards causes an increase in average hygiene quality equal to nearly half a standard deviation of the hygiene distribution prior to grade cards; (ii) the effect on hygiene quality from a policy of voluntary posting of hygiene grade cards is statistically but not economically different from the effect of mandatory posting; and (iii) the introduction of grade cards caused restaurants to improve the physical structure of buildings, indicating hygiene quality improvements of a relatively long-lasting nature.

5 The Effect of Hygiene Grade Cards on Revenue

In the preceding section we showed that the increased provision of hygiene quality information causes an increase in the average hygiene quality of restaurants, and that this is true whether disclosure of the information by restaurants is voluntary or mandatory. A concern might be that the increased hygiene scores are the result of some unobserved change in hygiene inspections, or perhaps driven by restaurant owners/managers pride, rather than economic incentives. By examining the effect of grade cards on revenue, we can verify that demand is responsive to hygiene quality and the increased provision of information.³⁵ This is a necessary condition if observed increases in quality are motivated by profit maximization. A finding of significant revenue effects would also strengthen our belief that the true data generating process resembles the theories which emphasize firms' incentive to reveal quality information. From revenue data alone we are unable to infer changes in price and quantity separately. However, at the end of this section we discuss changes in price indices and industry employment which are suggestive of the separate effects on price and quantity from the grade cards.

The finding in the previous section that grade cards cause a decrease in the likelihood of building structure violations already suggests the presence of economic incentives, since these are likely to be relatively costly improvements for restaurants to make. Some additional evidence of economic incentives comes from the extent of owner-initiated inspections. Of the 446 owner-initiated inspections, 70 were for restaurants in cities with voluntary disclosure. For owner-initiated inspections, hygiene scores increase by an average of 12.02 points above the score from the estimated coefficient on mandatory grade cards is -1.98 (18% reduction).

³⁵While it is costly to increase hygiene quality, and while changes in costs may lead to revenue changes in equilibrium, if consumers are unresponsive then firm's would not choose to incur these costs.

the previous inspection. One interpretation is that restaurants expect an improvement in their score upon re-inspection, allowing them to post a high grade, which causes their profit to be higher by an amount exceeding the cost of the inspection (\$161).

A problem arises when analyzing the effects on revenue because the revenue data is quarterly, while inspections occur on a specific date within a quarter. Hence, in any given quarter in 1998, a restaurant may fall under multiple policy regimes. For example, on April 15 a restaurant may receive its first inspection since the grade cards were first introduced in January, and suppose on May 1 the city in which the restaurant is located decides to adopt the county ordinance, following which the restaurant happens to be inspected again on June 1 for which disclosure is then mandatory. In this case, the disclosure dummies take on values between zero and one, reflecting the proportion of time during that quarter that each regime applied. A similar problem arises when a restaurant starts a quarter with a score of 75%, say, is then inspected during the quarter and receives a score of 95%, say. In such cases we assign the days-weighted average score to the restaurant for that quarter and determine a grade for that quarter based on the weighted average score. In each of these examples we effectively assume that revenue is uniformly distributed over each quarter.

To analyze the effect of the increased information on restaurant's revenue we are primarily interested in estimating the following equation for the log of revenue obtained by restaurant i in quarter t :

$$\ln(R_{it}) = \alpha_i + \tau_t + \sum_j \beta_j H_{ijt} + \sum_k \gamma_k G_{ikt} + \sum_j \sum_k \delta_{jk} H_{ijt} G_{ikt} + \epsilon_{it}, \quad (2)$$

where

$$\begin{aligned} H_{it} &= \{H_{i1t}, \dots, H_{i4t}\} \equiv \{A_{it}, B_{it}, C_{it}, D_{it}\}, \quad \text{and} \\ G_{it} &= \{G_{i1t}, \dots, G_{i3t}\} \equiv \{N_{it}, M_{it}, V_{it}\}. \end{aligned}$$

The variables for the disclosure regimes of no grade cards (N), mandatory disclosure (M) and voluntary disclosure (V) are no longer dummy variables equal to either zero or one. Instead, because we aggregate to the quarterly level, these variables take on continuous values between zero and one. The variables in H are for hygiene grades (eg. A for A-grade), where D corresponds to all scores below 70, and also take on continuous values between zero and one. In the estimation we exclude the variables A and N . As shown in equation (2) we include restaurant fixed-effects (α_i) and a full set of quarterly dummies (τ_t).³⁶ We also estimate a simpler version of equation (2)

³⁶As in the hygiene regressions, we also include city-quarter random effects to allow for clustering in the data. In addition, we estimated the revenue regressions using observable restaurant characteristics instead of restaurant fixed effects and found no interesting differences so these results are not reported.

by excluding the grade card variables and interaction terms.

In the revenue regressions an observation is a restaurant in a quarter. Since we observe restaurant revenue regardless of whether the restaurant was inspected in that quarter or whether the restaurant has been issued a grade card, we observe restaurants at the same point in time that can be regarded as a control-group. The variation in grade cards in the cross-section is exogenous because the DHS ensures the timing of individual restaurant inspections is random. The effects on revenue from the grade cards are therefore identified from a combination of time series and cross-sectional variation.

If a restaurant owner has multiple restaurants in a single city, the tax payments for these restaurants are made to a single account with the government.³⁷ In these cases we have no way of knowing how to assign revenue to the different restaurants owned by the person in a given city, though we do observe a binary variable identifying when these instances occur. We perform the revenue regression on the sample including these joint-account restaurants and on a sample in which they are excluded. The results differed only slightly between the two samples suggesting the smaller sample is not biased. We therefore report results for the smaller sample where we always observe individual restaurant revenues.

Table 6 reports OLS estimates for revenue regressions using three different specifications. We now discuss each in turn. The first specification examines the effects on average restaurant revenue from the introduction of grade cards, without conditioning on particular grades. The estimates reveal statistically significant increases in average restaurant revenue due to the introduction of grade cards. For the policy of mandatory disclosure of hygiene grade cards we estimate that average restaurant revenue increases by a strikingly large 3.3%, relative to average revenue in the absence of grade cards.³⁸ The effect from voluntary disclosure is smaller at 2.6%. One possible explanation for increased revenue is that grade cards cause an increase in aggregate demand for restaurants (maybe due to people eating at home less often). Another possible explanation is that grade cards cause some restaurants to shut down, leading to less intense price competition and higher revenue for the remaining firms. Since the effects of the grade cards appear to have been fairly rapid we are skeptical that firms would have shutdown so quickly due to the grade cards, while it seems plausible that consumer demand could be very

³⁷If the restaurants owned by the same person are in different cities then tax payments are made to different accounts, allowing us to observe individual restaurant revenue.

³⁸With total restaurant revenue in Los Angeles county in 1997 equal to \$7.9 billion, the estimate suggests grade cards may increase total annual revenue by over \$250 million.

responsive in the short run.³⁹ But this is speculation and one should also remember that higher revenue does not imply higher profit—there are costs to increasing hygiene quality and so the effect on average restaurant profit remains uncertain.

The estimates for the first specification shown in Table 6 may be biased upwards if there are substitution effects of consumers switching demand away from restaurants without grade cards toward restaurants with grade cards.⁴⁰ This would imply that restaurants without grade cards are not a control-group as they are also affected by the provision of grade cards to other restaurants. To examine this possibility we distinguish between restaurants without grade cards prior to the introduction of grade cards, and restaurants without grade cards after the introduction of grade cards. We further distinguish restaurants without grade cards located in cities where posting is mandatory for those restaurants with grade cards, and restaurants without grade cards located in cities where posting is voluntary for those restaurants with grade cards. Hence there is no longer a control-group for the estimation and the coefficients are primarily identified by time series variation. Reliance upon time series variation to identify the effects of interest is also why we employ a flexible time trend rather than a full set quarterly dummies. The results for this second specification are also shown in Table 6 (in the middle columns). We find the average effect on revenue, relative to before grade cards were ever issued, for restaurants yet to receive grade cards is insignificantly different from zero. This also holds whether disclosure is mandatory or voluntary for restaurants receiving grade cards in the same city. Furthermore, the estimated effects from grade cards are close to the estimates under the first specification (indeed even larger in magnitude). On this basis we conclude there are no significant substitution effects.

Another possible source of bias influencing the large magnitude of the revenue effects may be variation in revenue growth rates which are not controlled for with restaurant fixed effects. If restaurants with high revenue growth rates tend to receive inspections with mandatory disclosure sooner than restaurants with low revenue growth rates, then we may over-estimate the true effect of mandatory grade cards on revenue. To address this possibility we compute the correlation between restaurants' annual revenue growth rates prior to grade cards and the timing of when they are first subject to mandatory disclosure of a grade card. The correlation coefficient is 0.009.⁴¹ Again, we conclude this is unlikely to be a source of bias in our estimates. Our finding

³⁹In future research we intend analyzing the effect of grade cards on entry/exit of restaurants in the short and long run to more closely examine these issues.

⁴⁰If the grade cards have no effect on aggregate revenue but cause substitution away from restaurants without grade cards, the first specification would yield positive coefficients on the grade card dummies that may be mistaken for identifying an aggregate effect.

⁴¹The correlation between revenue growth and the timing of the first inspection resulting in voluntary disclosure is -0.0035. We tried various measures of revenue growth (eg. annual or quarterly) and the correlations were not

that mandatory disclosure of hygiene grade cards causes average restaurant revenue to increase by 3.3%, while surprisingly large, appears to be well identified in our analysis.

The third specification shown in Table 6 is for the full equation (2) in which we examine the effects on revenue for restaurants with different hygiene grades.⁴² The first point to note from these estimates is that when there are no grade cards, restaurant revenue is unaffected by changes in hygiene quality.⁴³ This is evident from the coefficients on B-grade, C-grade and <C-grade which are insignificantly different from zero (even with rather small standard errors). The estimated coefficient on the mandatory disclosure dummy implies the effect from mandatory posting of grade cards for an A-grade restaurant is a 5.7% increase in revenue compared to before the introduction of grade cards. Since average annual revenue for restaurants in our sample in 1997 is roughly \$260,000, the absolute magnitude of the effect is nearly \$15,000. Revenue for B-grade restaurants increases by about 0.7% due to the introduction of mandatory grade cards, or 4.97% less than the effect for A-grade restaurants. For C-grade restaurants under mandatory disclosure the net effect is a 1% decrease in revenue. These results confirm the presence of economic incentives underlying the observed increases in hygiene quality.

The effect of voluntary disclosure for A-grade restaurants is estimated to be an increase in revenue of 3.3%. This is 2% less than the effect under mandatory disclosure, but it does reveal an economic gain from disclosure for restaurants with high quality hygiene. The net effects of voluntary disclosure for B-grade and C-grade restaurants are insignificantly different from the effect from an A-grade with voluntary disclosure, though the point estimates indicate less of an increase than for an A-grade. Why are the effects on revenue from voluntary disclosure so much smaller in magnitude than the effects from mandatory disclosure? The reason may be that the details of the regulatory change were not well explained to the residents of Los Angeles county. Media coverage at the time the grade cards were introduced emphasized the mandatory disclosure requirement, without explaining that for many cities disclosure was in fact voluntary. Restaurants located in cities with voluntary posting were able to take advantage of the misconception that the absence of a posted grade card must be because the restaurant has not yet been inspected since the grade cards were introduced. Hence, restaurants obtaining a B-grade

⁴²Note, even though hygiene scores (and hence grades) endogenously increased, this does not give rise to an endogeneity problem in the sense of biasing the estimated coefficients, because we also include as regressors the policy-regime dummies which cause the hygiene changes. In other words, the assumption that hygiene grades are uncorrelated with the residual is valid.

⁴³Since the regression includes restaurant fixed effects, it may be that restaurants with consistently high hygiene quality earn high revenue, for example. However the estimates reveal that increasing hygiene quality at a particular restaurant has no impact on revenue at that restaurant (before the introduction of grade cards).

may choose not to post the grade and consumers incorrectly believe the restaurant is likely to be of A-grade standard. This argument is also consistent with the estimates showing the effects of A-grade, B-grade, C-grade and missing-grade under voluntary disclosure are insignificantly different from each other.

Some Evidence Concerning the Effects of Grade Cards on Price and Quantity

The above analysis shows that restaurant hygiene grade cards cause an increase in average restaurant revenue. This implies that consumers are responsive to the increased provision of information about hygiene quality. As revenue equals price times quantity, we are unable to infer the separate effects on price and quantity—for increased revenue the only possibility we are sure of is that price and quantity have not both decreased. It is interesting to disentangle price and quantity because it may indicate the effect on consumer welfare from the grade cards.

The Bureau of Labor Statistics (BLS) provides a monthly price index for “food away from home” in Los Angeles, Riverside and Orange counties (LAROC) combined.⁴⁴ Unfortunately a price index is not available for Los Angeles county alone, however Los Angeles has more than twice the combined population of Riverside and Orange counties. We compare this price index with the price indices for the same category in other regions or with other classes of goods in the same region, over the period January 1991 to February 2001.⁴⁵ In separate regressions we examine the dependent variables: (i) prices over time for food away from home in various regions, and (ii) prices over time for various goods categories in LAROC.⁴⁶ Explanatory variables are a grade card dummy (equals one for food away from home in LAROC in all months after January 1998), year dummies, month dummies and region fixed effects or goods category fixed effects. The level of the price index for food away from home in LAROC in December 1997 is 171.1. In the cross-region regression the coefficient on grade cards is estimated to be -2.14 (standard error of 0.22). In the cross-categories regression the coefficient on grade cards is estimated to be -5.78 (standard error of 0.68).

Aggregate data for restaurants’ output quantity is unavailable. However data is available for industry employment which should be correlated with output. The BLS provides the total number of people employed in each industry in each county by month.⁴⁷ In particular we observe

⁴⁴The data and supporting documentation is available from <http://stats.bls.gov/cpihome.htm>.

⁴⁵Comparison regions are: San Francisco-Oakland-San Jose counties, Chicago-Gary-Kenosha counties, and N.Y.-Northern N.J.-Long Island counties. Comparison goods categories are: food at home, alcoholic beverages and all items.

⁴⁶There is no substantive difference to the estimates if we take logs of the price indices.

⁴⁷See <http://stats.bls.gov/cewhome.htm> for a detailed description of the data.

the number of people employed in restaurants and food stores in Los Angeles county each month, which we can compare to employment in other retail industries in Los Angeles county as well as employment in the same industry in other counties, over the period January 1991 to December 1999.⁴⁸ We construct the variable $\ln(\text{employ-ratio}) = \ln(\text{food-retail employment}) - \ln(\text{non-food-retail employment})$ for each county in each month. We regress $\ln(\text{employ-ratio})$ on a grade card dummy (equals one for Los Angeles county after January 1998), year dummies, month dummies and county fixed effects.⁴⁹ The estimate for the coefficient on grade cards is 0.050 (standard error of 0.015), indicating that employment in food retail industries relative to non-food-retail industries increased by 5 percent more in Los Angeles county than in the other counties.

The analysis of aggregate data from the BLS suggests that price may have decreased and output may have increased for restaurants in Los Angeles county due to the introduction of hygiene grade cards. What change in behavior of firms and/or consumers could be consistent with these outcomes? An outward shift of demand would yield higher price and higher quantity which is inconsistent. Increased variable costs due to hygiene quality improvements should raise prices which is also inconsistent. One possible consistent explanation is that the grade cards reduced search costs for consumers, leading to intensified competition among restaurants and movement down the demand curve. There are surely other stories one can tell and the truth may involve some degree of many of these factors. Nevertheless, the effects of the grade cards on revenue and the effects on price and quantity suggested by the aggregate data, more likely indicate an increase in consumer welfare rather than a decrease.

6 Conclusion

In this study we analyze the effects of a policy that increases the provision of information to consumers. Using panel data, with a large number of observations by the standards of other empirical studies into these issues, we estimate the causal effects of a mandatory increase in the provision of information about restaurant hygiene quality to consumers, on restaurants' choices of hygiene quality and their revenue. A unique aspect of the policy change arises by virtue of the fact that some cities within Los Angeles county do not immediately adopt the county ordinance

⁴⁸Comparison regions are all counties in Arizona, California, Oregon and Washington with populations of at least 800,000 (there are eleven such counties). Comparison retail industries (2-digit SICs) are building materials, hardware, garden supply and mobile; general merchandise stores; apparel and accessory stores; furniture, home furnishings and equipment stores; and miscellaneous retail.

⁴⁹The results were not substantively different for several variations on this dependent variable.

of mandatory disclosure. In these cities, restaurants undergo the exact same inspections and are issued the exact same grade cards, but the restaurants decide whether to display the resulting grade in their window.

The central finding of the paper is that introducing restaurant hygiene grade cards causes restaurants to increase hygiene quality by an amount that is statistically significant and large in magnitude. By showing that restaurant revenue has also been affected by the grade cards we verify that consumer responsiveness, and hence economic incentives, are a motivating factor for hygiene improvements. The question remains as to whether actual health outcomes for consumers have been reduced. Nevertheless there is some evidence from aggregate BLS data that price decreased and quantity increased at restaurants in Los Angeles county due to the grade cards, indicating that consumer welfare may be higher. We have no information on the costs to restaurants of the hygiene improvements which prevents us from making conclusions about the effect of the grade cards on firm profits. The large positive effects of grade cards on revenue may be partly due to an increase in aggregate demand for restaurants which is certainly consistent with higher firm profit, but not conclusive.

The dataset also provides an opportunity to examine the empirical validity of the unraveling hypothesis. In this respect we find statistically significant differences between mandatory and voluntary disclosure with respect to the effects on hygiene quality and also revenue. We therefore reject the unraveling hypothesis, at least in its strong form. However we do find strong evidence in support of partial unraveling. Voluntary disclosure of grade cards does cause an increase in hygiene quality and causes revenue to increase. It is possible the effects from voluntary disclosure would be greater if consumers were better informed about the voluntary nature of disclosure in those cities. Overall, these findings should encourage policy-makers or private institutions to facilitate voluntary disclosure of verifiable product information in consumer-product markets.

One may wonder why restaurants did not disclose the results of their hygiene inspections prior to the grade cards. Why would a restaurant manager not create their own poster clearly showing their latest hygiene score, say, and display it in the window?⁵⁰ Perhaps this indicates it is unprofitable for restaurants to increase the provision of hygiene quality information to consumers. An alternative interpretation is that such information does enhance profitability but it is important there exists a standard-format available for all restaurants to display. We find evidence of voluntary disclosure with the standard-format in support of this explanation.

⁵⁰We presume restaurants would be honest about their score since customers may ask to see the formal inspection results.

It seems striking that simply providing a standard-format for disclosure, with no change in inspections or closure criteria, would be sufficient to change the equilibrium from zero disclosure and low hygiene quality, to high hygiene quality with potentially full disclosure.⁵¹

The insights of this study lend strong support to the case for introducing restaurant grade cards in other regions. Furthermore, at least qualitatively, our results may also be extrapolated to other industries where quality inspections of one kind or another already take place, and the results of these inspections are not readily available to the public. For firms more generally, our results indicate there may be significant benefits from being able to provide credible information about product quality. While the costs of obtaining and conveying this information are likely to vary substantially across industries, there is reason to believe the benefits greatly outweigh the costs at least in the case of restaurants. The DHS states the marginal cost of a hygiene inspection to be \$161, and we estimate the average increase in annual revenue due to posting an A-grade (which most restaurants obtain) to be around \$15,000. We expect the costs of obtaining and maintaining A-grade hygiene quality in a typical restaurant are substantially less than the increase in revenue.

⁵¹See Easterbrook and Fischel (1984) for a discussion of these issues. A remaining puzzle is why a private third party did not create a standard-format for all restaurants before grade cards were introduced.

Bibliography

- Akerlof, G.A. (1970): "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics*, 84(3), 488–500.
- Benham, L. (1972): "The Effect of Advertising on Prices of Eyeglasses," *Journal of Law and Economics*, 15(2), 337–52.
- Butters, G.R. (1977): "Equilibrium Distributions of Sales and Advertising Prices," *Review of Economic Studies*, 44(3), 465–91.
- Chipty, T. and A.D. Witte (1998): "Effects of Information Provision in a Vertically Differentiated Market," *NBER Working Paper*, #6493.
- Devine, D.G. and B.W. Marion (1979): "The Influence of Consumer Price Information on Retail Pricing and Consumer Behavior," *American Journal of Agricultural Economics*, 61(2), 228–37.
- Dranove, D., D. Kessler, M. McClellan and M. Satterthwaite (2000): "Is More Information Better? The Effects of 'Report Cards' on Health Care Providers," *Mimeo*.
- Easterbrook, F.H. and D.R. Fischel (1984): "Mandatory Disclosure and the Protection of Investors," *Virginia Law Review*, 70, 669–715.
- Farrell, J. (1986): "Voluntary Disclosure: Robustness of the Unraveling Results and Comments on Its Importance," in R. Greison (ed.) *Antitrust and Regulation*, Lexington Books.
- Fishman, M.J. and K.M. Hagerty (1998): "Mandatory Disclosure," in P. Newman (ed.), *The New Palgrave Dictionary of Economics and the Law*, Macmillan Press, London.
- Fishman, M.J. and K.M. Hagerty (1999): "Mandatory vs. Voluntary Disclosure in Markets with Informed and Uninformed Customers," *Mimeo*, Northwestern University.
- Grossman, S.J. (1981): "The Informational Role of Warranties and Private Disclosure about Product Quality," *Journal of Law and Economics*, 24, 461–489.
- Jin, G. (2000a): "Competition and Disclosure Incentives: An Empirical Study of HMOs," *Mimeo*.
- Jin, G. (2000b): "Detecting the Impact of Competition on Disclosure Incentives," *Mimeo*.
- Jovanovic, B. (1982): "Truthful Disclosure of Information," *Bell Journal of Economics*, 13, 36–44.
- Kwoka, J.E. (1984): "Advertising and the Price and Quality of Optometric Services," *American Economic Review*, 74(1), 211–16.

- Mathios, A.D. (2000): "The Impact of Mandatory Disclosure Laws on Product Choices: An Analysis of the Salad Dressing Market," *Journal of Law and Economics*, 43(2), 651–78.
- Milgrom, P. (1981): "Good News and Bad News: Representation Theorems and Applications," *Bell Journal of Economics*, 12, 380–91.
- Milgrom, P. and J. Roberts (1986): "Price and Advertising Signals of Product Quality," *Journal of Political Economy*, 94(4), 796–821.
- Milyo, J. and J. Waldfogel (1999): "The Effect of Price Advertising on Prices: Evidence in the Wake of 44 Liquormart," *American Economic Review*, 89(5), 1081–1096.
- Nelson, P. (1970): "Information and Consumer Behavior," *Journal of Political Economy*, 78(2), 311–329.
- Salop, S.C. and J.E. Stiglitz (1977): "Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion," *Review of Economic Studies*, 44(3), 493–510.
- Stigler, G.J. (1961): "The Economics of Information," *Journal of Political Economy*, 69(3), 213–25.
- Teisl, M.F. and B. Roe (1998): "The Economics of Labeling: An Overview of Issues for Health and Environmental Disclosure," *Agricultural and Resource Economics Review*, 27(2), 140–50.

Table 1: Sample of Restaurants

Quarter	DHS Sample			Matched (SBE) Sample			Our Sample		
	No. Restaurants	Ave. Hygiene Score	No. Restaurants	Ave. Hygiene Score	No. Restaurants	Ave. Hygiene Score	No. Restaurants	Ave. Hygiene Score	No. Restaurants
1996 Q1	19590	75.62	11917	75.02	9647	75.40			
Q2	19774	75.37	12821	74.67	9962	74.97			
Q3	20155	75.03	13079	74.45	10054	74.84			
Q4	20389	75.27	13445	74.73	10159	74.95			
1997 Q1	20665	75.81	13521	75.35	10198	75.75			
Q2	20898	75.31	13555	74.56	10181	74.96			
Q3	21358	83.99	13492	83.34	10128	83.63			
Q4	21647	81.82	13364	81.04	10052	81.27			
1998 Q1	21951	86.69	13328	86.10	10126	86.44			
Q2	22147	90.26	13316	89.65	10238	89.93			
Q3	22514	89.85	12867	89.27	10222	89.56			
Q4	22652	90.30	12061	89.83	9883	90.01			
Total	23921	81.22	17284	80.50	13544	80.86			

In the DHS sample, a restaurant is defined as a physical location serving food other than pre-packaged items. A restaurant is counted in a particular quarter if it is inspected during that quarter, or if it was inspected both before and after the quarter.

The matched (SBE) sample is derived from successful matches of the DHS inspection data with the SBE tax data.

Our sample includes all restaurants for which the DHS data is matched with the SBE data, and for which we observe continuously reported tax payments between the first and last payments of each restaurant.

Quarterly average hygiene scores are calculated using all inspections conducted on restaurants in the relevant sample during that quarter. Not all restaurants are inspected every quarter.

Table 2: Timing of Mandatory Grade Card Ordinance

Panel A: Number of restaurants located in cities with or without the ordinance					
Quarter	Total Restaurants	Ordinance Not Adopted		Ordinance Adopted	
		No. Restaurants	% of Restaurants	No. Restaurants	% of Restaurants
1998 Q1	10126	9626	95.06	500	4.94
Q2	10238	3806	37.18	6432	62.82
Q3	10222	2972	29.07	7250	71.93
Q4	9883	2009	20.33	7874	79.67

Panel B: Disclosure status of restaurants				
Quarter	% of Restaurant Days under Regime I:		% of Restaurant Days under Regime III:	
	<i>Without Standard-Format</i>	<i>Voluntary Disclosure</i>	<i>Voluntary Disclosure With Standard-Format</i>	<i>Mandatory Disclosure</i>
1998 Q1	84.64		15.04	0.32
Q2	40.78		43.20	16.02
Q3	15.59		41.28	43.13
Q4	4.04		34.27	61.69

Every restaurant receives an official grade card following inspections conducted after Jan. 16, 1998. However the restaurant is only required to post the grade card if it is located in a city which has adopted the ordinance. Restaurants not yet inspected after Jan. 16, 1998, fall under Regime I.

Table 3: Hygiene Scores and Percent With Complaints

Year	< 70	70–74	75–79	80–84	85–89	90–94	95–100
1996	4.96	3.79	3.25	4.81	4.31	2.55	2.68
1997	3.59	3.60	2.37	5.43	3.85	2.63	1.61
1998	4.10	5.52	4.73	5.59	5.04	3.57	2.45

Notes:

An entry in the table is the average (over quarters in that year) number of restaurants with hygiene scores in the indicated range that were inspected at least once due to a customer complaint, divided by the number of restaurants with a score in that range in the quarter, times 100.

Each restaurants' quarterly score is based on a weighted average of hygiene scores applicable to each restaurant for that quarter.

Table 4: The Effects of Grade Cards and Disclosure Regulation on Hygiene Scores

	Without Fixed Effects		With Fixed Effects	
	Coefficient	Std. Error	Coefficient	Std. Error
Mandatory Disclosure	4.9461	0.7620***	4.3987	0.8219***
Voluntary Disclosure	4.0587	0.5233***	3.2527	0.5677***
Inspection Criteria II	7.7210	0.4359***	8.0897	0.4311***
Inspection Criteria III	9.9845	0.6926***	10.4166	0.7615***
Observations	69,991			
No. Restaurants	13,544			
R^2	0.3573		0.5873	

Regressions include city-year-quarter random effects.

In the regression without fixed effects, while not reported, we also include the following restaurant characteristics: food type, food style, seating capacity, liquor license dummy, DHS risk assessment, and city dummies. Stars denote significance levels: 99 percent confidence level (***), 95 percent confidence level (**), and 90 percent confidence level (*).

The voluntary disclosure dummy is for voluntary verifiable disclosure (ie. grade cards are issued but posting is discretionary). The excluded dummy is for voluntary non-verifiable disclosure (ie. prior to the introduction of grade cards).

Inspection Criteria II Dummy is for inspections carried out between 7/1/1997 and 3/18/1998. See text for further details.

Inspection Criteria III Dummy is for inspections carried after 3/18/1998. See text for further details.

Table 5: Incidence of Groups of Violations

Panel A: Building Structure Violations				
	Without Fixed Effects		With Fixed Effects	
	Coefficient	Std. Error	Coefficient	Std. Error
Mandatory Disclosure	-0.5252	0.0576***	-0.3812	0.0586***
Voluntary Disclosure	-0.5424	0.0447***	-0.3873	0.0453***
Inspection Criteria II	0.2355	0.0268***	0.1928	0.0266***
Inspection Criteria III	0.0260	0.0547	-0.0734	0.0556***
Observations	69,991			
No. Restaurants	13,544			

Panel B: Violations Unobservable to Consumers				
	Without Fixed Effects		With Fixed Effects	
	Coefficient	Std. Error	Coefficient	Std. Error
Mandatory Disclosure	-2.4458	0.2298***	-1.9798	0.2297***
Voluntary Disclosure	-2.9392	0.1781***	-2.4122	0.1777***
Inspection Criteria II	-0.0285	0.1068	-0.3290	0.1044***
Inspection Criteria III	-2.7678	0.2180***	-3.1736	0.2181***
Observations	69,991			
No. Restaurants	13,544			

The dependent variable in Panel A is the number of points deducted because of building structure violations in an inspection. Building structure violations concern lavatories, ventilation, walls/ceiling, or lighting.

The dependent variable in Panel B is the number of points deducted because of violations that are unobservable to consumers. Unobservable violations are all violations excluding those relating to insects, animal/fowl, utensils, premises, toilets, lighting, signs and permits, ventilation, floors, walls and ceilings.

Voluntary Disclosure is a dummy variable for voluntary verifiable disclosure (grade cards are issued but posting is discretionary). The excluded dummy is for voluntary non-verifiable disclosure (ie. prior to the introduction of grade cards).

Inspection Criteria II is a dummy variable for inspections carried out between 7/1/1997 and 3/18/1998. See text for further details.

Inspection Criteria III is a dummy variable for inspections carried after 3/18/1998. See text for further details.

In the regression without fixed effects, while not reported, we also include the following restaurant characteristics: food type, food style, seating capacity, liquor license dummy, DHS risk assessment, and city dummies. Stars denote significance levels: 99 percent confidence level (***), 95 percent confidence level (**) and 90 percent confidence level (*).

Table 6: Effects of Grade Cards and Disclosure Regulation on ln(Quarterly Restaurant Revenue)

	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Mandatory Disclosure	0.0327	0.0115***	0.0424	0.0134***	0.0569	0.0136***
Voluntary Disclosure	0.0257	0.0098***	0.0301	0.0096***	0.0326	0.0132**
No Card in Mandatory City			0.0035	0.0133		
No Card in Voluntary City			0.0013	0.0011		
B Grade					-0.0074	0.0074
C Grade					0.0039	0.0073
<C Grade					-0.0023	0.0061
Mandatory × B Grade					-0.0497	0.0132***
Mandatory × C Grade					-0.0670	0.0225***
Mandatory × <C Grade					-0.0565	0.0321*
Voluntary × B Grade					-0.0023	0.0139
Voluntary × C Grade					-0.0238	0.0234
Voluntary × <C Grade					-0.0758	0.0234**
Missing Grade					-0.0001	0.0084
Observations	74,321					
R^2	0.9563		0.9563		0.9564	

All regressions include restaurant fixed effects and city-quarter random effects.

The first and third specifications include a full set of quarterly dummies. The second specification includes time, time², ..., time⁶.

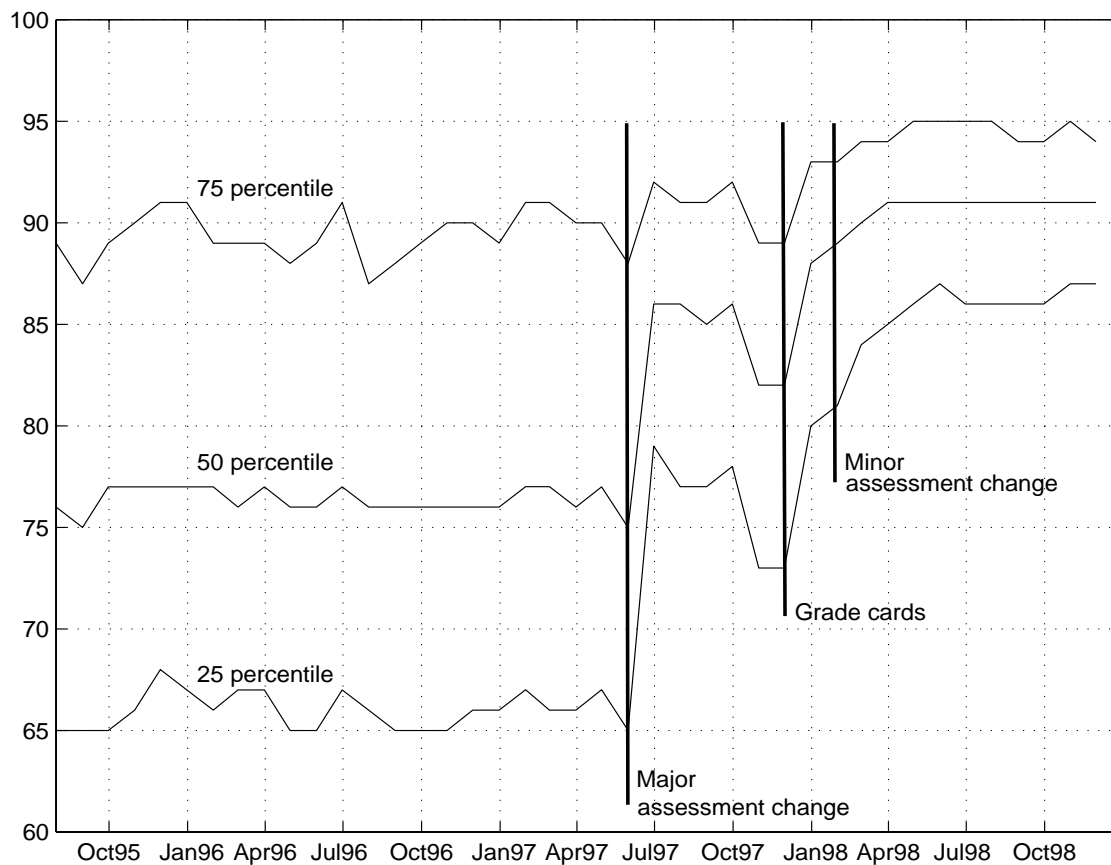
The variable Missing Grade is for restaurants that have opened but not yet been inspected.

Excluded dummy is for voluntary disclosure without a standard-format. Interactions with A grade are also excluded in the third regression.

The sample size is slightly reduced because we discard (i) observations for the first and last quarter when a restaurant is a new entrant or exits, since we do not know the date of entry or exit; (ii) observations with negative tax, and hence negative revenue (due to overpayment of tax in a prior quarter); and (iii) restaurants with merged tax accounts (see text for a detailed explanation).

Stars denote significance levels: 99 percent confidence level (***), 95 percent confidence level (**), and 90 percent confidence level (*).

Figure 1: Quartiles of hygiene quality distribution over time.



Notes:

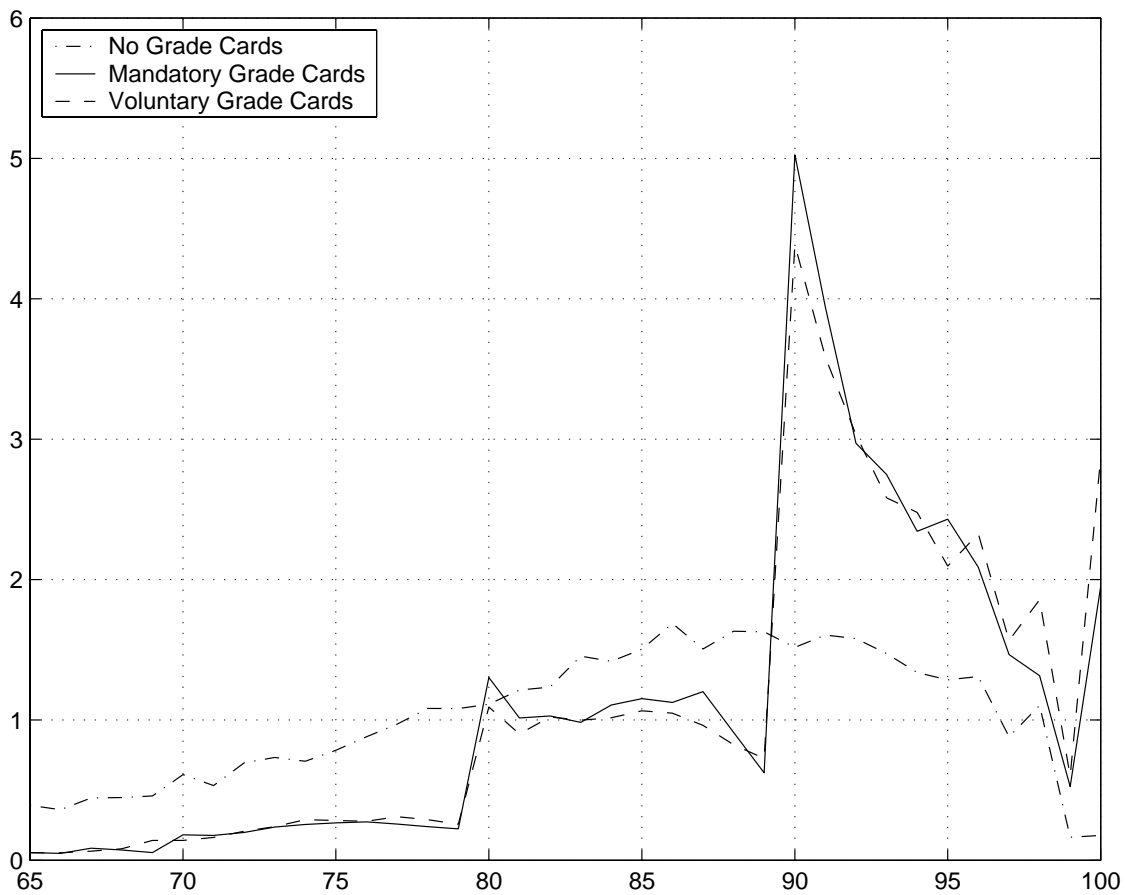
Quartiles are computed based on all inspections in a given month.

The assessment changes took place on 7/1/1997 and 3/18/1998.

The grade cards began introduction on 1/16/1998.

Vertical lines for regime changes are located immediately prior to a change in order to emphasize subsequent impacts on the hygiene distribution.

Figure 2: Distributions of hygiene scores under different disclosure regimes.



Notes:

The figure is no different to a histogram (or an unsmoothed non-parametric density).

Units on the vertical axis are meaningless.