

The Impact of the Americans with Disabilities Act on the Entry and Exit of Retail Firms¹

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Abstract

Congress enacted The Americans with Disabilities Act of 1990 over the protests of small business advocates who claimed that the ADA would trigger a wave of bankruptcies. Although the profitability of firms may suffer from the costs of ADA compliance, there has been no systematic review of the evidence. I seek to determine if the ADA had a measurable impact on the number of firms, the entry of new firms, and the failure rates of existing firms in the retail sector.

The empirical results suggest that the ADA negatively impacted the food store industry. There were fewer food stores after the ADA was passed, and the drop was larger in states in which the ADA was more of a legal innovation, and in states that had more disabled people, more ADA-related lawsuits, and more ADA-related labor complaints. There is also evidence that employment and access discrimination suits imposed real costs on stores, encouraging exit. However, the exit of incumbents was partially offset by new entry. Overall, the number of retail stores decreased an average of 4–9% after the ADA came into effect. At least a 1.5–2.3% decrease in the number of smaller food stores may be attributed directly to the ADA, net of trends affecting larger stores.

A subsidiary contribution of the paper is an econometric model to back out entry and exit rates from establishment count data. The model enables maximum likelihood estimation of unobserved entry and exit processes based on the observed establishment count data. The model shows promise for application to other questions in economics.

1 Introduction

The Americans with Disabilities Act (ADA) of 1990 is one of the most recent major federal antidiscrimination laws. The ADA seeks to prevent employment and wage discrimination against disabled workers, and to ensure the physical accessibility of businesses to disabled customers. Congress enacted the ADA over the protests of small business advocates who claimed that the ADA would trigger a wave of bankruptcies. Despite allegations, no systematic review of the evidence has been presented to evaluate this claim. The profitability of smaller firms may be vulnerable to the cost of complying with the ADA. Compliance costs stem from provisions mandating accommodation of disabled workers and customers, and from the civil lawsuits and penalties to which the ADA exposes firms.

In this paper I seek to determine if the ADA had a measurable impact on the number of firms, the entry of new firms, and the failure rates of existing firms in the retail sector. I focus on retailers because they are subject to both the employment and customer accessibility provisions of the ADA. In this paper I investigate the food store subsector of retail for the sake of brevity, although in a previous version of the paper I look at evidence from other parts of the retail sector. The empirical results are consistent with the hypothesis that the ADA indeed decreased the number of food stores. There were fewer stores after the ADA was passed, and the drop was larger in states in which the ADA was more of a legal innovation, and in states that had more disabled people, more ADA-related lawsuits, and more ADA-related labor complaints. The same conclusions hold when baseline trends for larger establishments, which are least vulnerable to the costs imposed by the ADA, are differenced out. There is also evidence that employment and access discrimination suits imposed real costs on food stores, encouraging exit. However, the exit of incumbents was partially offset by new entrants, which may imply that stores less able to adapt to the new requirements made room for the entry of stores better able to adapt. So, while the prediction by the pessimists that the ADA would cause firms to fail may be correct, the decline in the number of stores was

partially offset by new entry. Overall, the ADA is associated with 1.5 to 2.3% fewer small and medium food stores, net of trends affecting large stores.

A subsidiary contribution of the investigation is an econometric model that allows entry and exit rates to be estimated from counts of currently operating firms. Given that the impacts of the ADA on firms may be subtle, a large data set is required to assess the evidence with any degree of precision. The data used in the study are the comprehensive Census Bureau counts of business establishments by county and type of business. Thus, the data are counts of the number of businesses currently operating in a year, and do not directly give entry and exit rates. There is no publicly available data set as disaggregated and as large that gives direct information on entry and exit.¹ While standard models for count data can be used to investigate changes in the number of firms in the market, backing out the entry and exit rates from the establishment count data is the major econometric contribution of the paper. Borrowing techniques from queuing theory, I develop the maximum likelihood estimator for a latent entry and exit model based on the available count data. The model incorporates unobserved heterogeneity in and correlation between the entry and exit rates. Identification of the entry and exit rates is secured through parametric assumptions on the entry and exit processes. Entry and exit are described by Poisson stochastic processes, conditional on time-varying covariates and correlated, gamma-distributed random effects that relax the Markovian assumptions in the model. The likelihood for the count data is non-trivial to derive and I have not seen the likelihood for this model presented elsewhere. I develop the model, denoted the $CM_t/CM_t/\infty$ queuing system, out of necessity, due to the particular limitations of the available data. However, there are many other potential applications for the econometric model, and I return to these possibilities in the final section of the paper.

Estimating the entry and exit rates allows us to infer the nature of the cost increases caused by

¹Other researchers have exploited the *Longitudinal Research Database* (LRD) from the U.S. Census Bureau to study entry and exit. The LRD, however, covers only the manufacturing sector, which is not likely to be affected by Title III of the ADA, as explained below. The new *Longitudinal Business Database*, also from Census, covers the retail sector and is a promising resource; it was not yet available when the present study was begun and is still not publicly available.

the various components of the ADA. In a companion paper (Prieger, 2005*b*), I show that increases in marginal and fixed costs may have interesting and non-obvious effects on entry and exit. When costs rise, entry and exit of firms may each increase or decrease. The potential outcomes from a cost increase are the *competitor neutral* case, in which entry decreases and exit increases, the *entrant favoring* case, in which entry and exit both increase, and the *incumbent favoring* case, in which entry and exit both decrease. The entrant favoring case can arise only from an increase in marginal cost (when demand is inelastic), which favors small entering firms relative to larger incumbents. The incumbent favoring case can come about only from an increase in fixed cost, which favors incumbents with their larger market share relative to small entrants. These restrictions provided by the model allow us to infer the nature of the cost increases caused by the various components of the ADA.

The plan of the paper is as follows. The next section discusses the costs that the ADA creates for firms. Section 3 reviews the relevant literature. Section 4 summarizes the theoretical model of firm dynamics and response to the ADA. In Section 5, the $CM_t/CM_t/\infty$ econometric model is formalized. Section 6 discusses empirical strategies to identify impacts of the ADA on the number, entry, and exit of retail firms, and includes the results of the estimations. A final section concludes and discusses the broader applicability of the theoretical and econometric models in the paper. Proofs and the detailed derivation of the $CM_t/CM_t/\infty$ likelihood are in an appendix.

2 The Costs of the ADA for Firms

The ADA was passed in July 1990. Most likely to affect private firms are Title I, which prohibits discrimination by employers against disabled individuals, and Title III, which (among other things) bans discrimination in access to private commercial facilities. Title I protects disabled individuals who can perform the “essential functions” of a position, both in applying for a job and once on payroll. The employer is not allowed to discriminate against disabled workers in hiring, firing, or

wages. The employer is required to make “reasonable accommodations” for disabled workers, as long as accommodation does not create “undue hardship” (which is not defined) for the employer. The employment provisions took effect July 1992 for employers with 25 or more employees, and two years later for businesses with 15-24 employees. Smaller firms remain exempt.

Title III of the ADA requires businesses to make accessible all areas of stores where customers might go. Although the ADA instituted a national building code for accessibility for new construction, the general accessibility requirement applies to all buildings. Title III took effect January 26, 1992 for businesses with more than 25 employees, six months later for firms with 11-25 employees, and one year later for smaller firms.²

What then are the costs of the ADA to firms?³ The non-discrimination clause means that employers cannot base hiring, firing, and wage decision solely on the marginal product of the individual worker, which may lead to higher operating costs. Other costs stem from real or perceived violation of the law. Enforcement of Title I is delegated to the Equal Employment Opportunity Commission (EEOC). From July 1992 to September 2001, 158,280 discrimination charges were filed with the EEOC.⁴ When a worker files a charge, the EEOC investigates, attempts to settle, and in some cases sues the firm (or gives permission to the worker to privately sue the firm). Of the 11% of charges leading to non-litigated compensation, the average benefit paid to the worker was \$19,226.⁵ If the case is litigated and the plaintiff prevails, the ADA requires firms to pay remedies, such as back pay and all court costs.⁶ A related law, the Civil Rights Act of 1991, also makes the firm liable for damages ranging from \$50,000 to \$300,000.⁷ Thus costs come from three sources.

²In addition to the employee count, the businesses with 11-25 employees also had to have gross receipts of less than \$1,000,000, and the businesses with 0-10 employees had to have gross receipts of less than \$500,000.

³This section draws on the similar discussion in Acemoglu and Angrist (2001).

⁴These data are from the EEOC, available from <<http://www.eeoc.gov/stats/ada-charges.html>>.

⁵*Ibid.*

⁶Court costs in employment practices suits average \$50,000 to \$100,000 per claimant (Dertouzos, 1988; Chanzit, 2001).

⁷Compensatory damages averaged \$395,197 in the 101 successful suits for wrongful termination due to discrimination (of which ADA suits are a subset) in California during 1992-1996.(Jung, 1997) Plaintiffs prevailed (through verdict or settlement) in about 38.1% of such cases. Punitive damages averaged another \$895,863 in the 25 cases with punitive damage awards. These figures do not include out-of-court settlements.

The first two are the direct accommodation costs for disabled workers⁸ and the litigation, remedy, penalty, and settlement costs. The third is the cost of a new kind of insurance that has arisen in response to such lawsuits. In the past decade, more firms have begun to purchase Employment Practice Liability Insurance (EPLI), which covers litigation, remedy, and some penalty costs for most discrimination claims. Basic EPLI premiums start at \$5,000 to \$20,000 per year.

The costs of Title III stem from similar sources, although damages are not available in suits filed by private individuals, who may only obtain injunctive relief and attorneys' fees. One estimate places access accommodation costs at \$500-\$3000 on average (Chebium, 2000).⁹ Enforcement of Title III is up to the Justice Department; civil penalties in suits brought by the Attorney General can be as high as \$100,000 per violation, and remedies such as repayment of court costs and construction costs can make losing a Title III case even more expensive for a firm. It is difficult to estimate the number of lawsuits filed under Title III,¹⁰ but some evidence indicates that verdicts are scarcer than under Title I (Colker, 2005, Ch.6). However, most cases end in settlement, about which statistics are scarce. There are numerous cases reported in the press of litigants actively seeking out firms to sue under the ADA. Two individuals in California have filed 1,500 ADA suits between them (Krasnowski, 2004). The promise of recouping legal fees from plaintiffs has also led to the rise of "filing mills"—law offices that work closely with complainants to file large volumes of complaints. One such Florida lawyer has sued over 740 businesses (Voris, 2001).

These actual and expected costs prompted small business advocates to lobby vigorously against the ADA, claiming that it would trigger a wave of bankruptcies (Teltsch, 1993). While no such wave of bankruptcies has been reported in the press, there certainly have been thousands of lawsuits, and the law may have had subtle effects on the decisions of firms to enter or exit markets. For

⁸There are no good estimates of the magnitude of accommodation costs. A non-random survey cited in Acemoglu and Angrist (2001) finds average costs of \$930 per accommodation through 1997, but this figure does not include involuntary accommodations, the value of time spent on compliance, or reduced efficiency of the firm due to compliance.

⁹The estimate is from the National Federation of Independent Businesses. The most common accommodation is ensuring wheelchair access.

¹⁰The DOJ files suit itself relatively rarely and only for high-profile cases; the DOJ does not track private suits. In section 6 I use a measure of Title III suits brought to judgment in the federal court system.

example, if there are differences in the organizational adaptability of firms, then the changed legal environment may have induced the exit of those firms that found it costliest to adapt, making room for the entry of new firms that find it less costly to adapt. The evidence presented in section 6 shows there was indeed increased exit and entry in response to the ADA. In this case, changes in the number of firms in a market may mask larger structural changes caused by an increased turnover rate of firms during the period of adaptation and transition. This example highlights why entry and exit rates are interesting in their own right, instead of looking only at the number of firms in the market.

3 Relevant Literature

Two strands of literature come together in this paper: empirical studies evaluating the effects of the ADA and the industrial organization literature on firm entry and industry dynamics.

Empirical studies of the ADA all focus on the employment of disabled individuals. Acemoglu and Angrist (2001) find that the ADA appears to have reduced the employment of disabled men of all ages and of women under age 40. More recently, Jolls (2004) presents evidence suggesting that disemployment of the disabled is partially explained by their increased educational participation. In this argument, the disabled believe that better employment opportunities for them under the ADA increased the returns to human capital investment, and choose further education in the short run instead of joining the labor force.¹¹ This paper extends the empirical literature on the ADA to the impacts on the firm's profitability and industry dynamics.

There are numerous empirical studies in industrial organization examining the entry or exit of firms.¹² A few empirical regularities emerge from the many studies based on reduced-form models (see Geroski (1995) for a review). First, within an industry, high entry rates are correlated with low

¹¹See also Jolls and Prescott (2004), and Jolls (2004) for citations to the other empirical papers examining the employment effects of the ADA.

¹²There is also a large related literature in the fields of corporate demography and organizational ecology. See Carroll and Hannan (2000) for an overview.

exit rates (Dunne, Roberts and Samuelson, 1988). This fits the usual intuition that when conditions are profitable in a market, not only are new entrants attracted to the market but existing firms are unlikely to exit. Second, there are large cross-sectional variations in the entry and exit rates of industries (Dunne et al., 1988; Geroski, 1995). Third, across industries in the cross section, high entry rates are correlated with high exit rates (Dunne et al., 1988; Honjo, 2000). Fourth, the hazard rates (exit rates) estimated from panel data typically decline with the age and the size of firm (Hall, 1987; Evans, 1987).¹³ In the age dimension, therefore, there is negative duration dependence.¹⁴ I view these four stylized facts as necessary possible outcomes for any econometric model; the $CM_t/CM_t/\infty$ model I develop can accommodate them all. All of these studies use longitudinal data on individual firms in the manufacturing sector. Shonkwiler and Harris (1993) and Geroski and Mazzucato (2001) are two of the few studies that model the number of firms in the industry in an explicitly dynamic setting. Unlike the present work, they do not attempt to infer the entry and exit rates from the data. There are also an increasing number of empirical studies of entry and exit using structural econometric models, mostly in static or two-period settings (Bresnahan and Reiss, 1987; Berry, 1992; Mazzeo, 2002; Seim, 2004), although Pakes, Ostrovsky and Berry (2004) present a fully dynamic model. I do not adopt a structural model based on optimizing entry and exit behavior for the empirical work, because positing simpler reduced forms for the entry and exit rates allow us to estimate these rates from panel data on the count of establishments in each market. In contrast, Pakes et al.'s (2004) model requires observations on entry and exit, and the static models focus on estimating parameters of the profit function and not entry and exit rates themselves.

The theoretical literature on industry dynamics is reviewed in the companion paper (Prieger, 2005b) presenting the model summarized in section 4. The econometric model developed in section

¹³It is well known that estimated negative duration dependence may be a spurious result of estimating a common hazard rate for firms that actually have constant but differing rates. I account for this explicitly in my econometric model.

¹⁴A notable exception is Holmes and Schmitz (1995), who find that the hazard rate may be U-shaped for small firms run by their founders.

5 is based on queuing theory. There are many applications of queuing theory in economic literature, but empirical applications (e.g., De Vany and Frey (1982); Daniel (1995); Prieger (2001; 2002a; 2002b)) are scarcer than theoretical studies. None of these empirical queuing studies attempts to infer arrivals and departures from the number of units currently in the system, as I do here.

4 The Theoretical Model

In the companion paper (Prieger, 2005b), I construct a general model to investigate the response of industry dynamics to increases in costs. For the sake of brevity, this section only describes the impacts that the ADA is assumed to have on costs and the main results from the theoretical model; additional details of the model and proofs are presented in Prieger (2005b). The model draws on elements of Klepper (1996) for industry dynamics and Acemoglu and Angrist (2001) for the ADA-specific components.

Firms are atomistic and differ in their fixed cost F . The variable inputs of a firm are capital K , with price r , and workers. Workers are either disabled (D , with wage w_D), or not (L , with wage w_L). The production technology of each firm is identical, and is described by the constant returns to scale production function $q = G(L, D, K) = \gamma(L + eD)^\alpha K^{1-\alpha}$, $\gamma > 0$, $\alpha \in (0, 1)$, where $e \in (0, 1)$ is the relative efficiency of disabled workers. Note that disabled and nondisabled workers are perfect substitutes at rate e nondisabled workers for one disabled worker.

Each unit of disabled labor requires an accommodation cost $a > 0$; assume that e would be zero in the absence of accommodation of disabled workers. It is assumed that both disabled and nondisabled workers are active in the labor force, which in a competitive labor market requires that $w_D = ew_L - a$. The substitutability of labor implies that firms are indifferent between disabled and nondisabled workers at those wages. Labor supply of both types is assumed to be completely elastic at the given wages. Under these assumptions, the marginal cost of production is constant

at βw_L^α , where β is a function of (α, γ, r) .¹⁵

After the passage of the ADA, costs change for several reasons. First, the equal-pay provision of the ADA mandates that w_D rise to w_L .¹⁶ It is assumed that to minimize the risk of lawsuits, labor employed by each firm is now composed of D and L in the same proportion as in the labor force at large. Let x be the fraction of workers that are disabled in the labor force. Second, under the ADA firms that have entered the market are exposed to potential litigation costs. Litigation is of two types: employment discrimination suits, as authorized under Title I of the ADA, and accessibility suits, as authorized under Title III.

Employment suits may stem from (perceived) hiring discrimination and wrongful termination of disabled workers. Assume that firms lay off and replace fraction θ of their work force each period,¹⁷ that the size of the pool of potential hires is H , and that each worker composing H applies for only one of the positions open in the current period at each firm, and that H is large compared to any one firm's labor demand. A disabled applicant that is not hired for a position sues with probability ℓ_H ; the firm (assumed to be risk neutral) has expected costs of A_H from each suit, inclusive of litigation, settlement, and damages awarded. Then the expected cost from hiring discrimination suits is $xH\ell_H A_H \equiv \Lambda_H$. A disabled worker that is fired sues with probability ℓ_T and expected cost A_T . The expected termination costs are therefore $\theta D\ell_T A_T \equiv \Lambda_T D$. Thus hiring suits raise fixed costs and that termination suits raise marginal costs.¹⁸

Accessibility suits may also raise both fixed and variable costs. The expected number of accessibility suits is $s_F(y) + s_V(y)q$, where y is the fraction of the population that is disabled; s_F and s_V are assumed to increase with y . Here s_F may represent the suits filed by activists or otherwise oc-

¹⁵In particular, $\beta \equiv (\delta^{1-\alpha} + \delta^{-\alpha})r^{1-\alpha}/\gamma$, where $\delta \equiv \alpha/(1-\alpha)$.

¹⁶In a general equilibrium model, w_L would fall because (as will be shown) output and labor demanded drop. In this partial equilibrium setup, the elastic supply of labor ensures that w_L does not change.

¹⁷Turnover may be prompted by workers receiving random shocks with probability θ that cause their productivity with their current employer to fall to zero, as in Acemoglu and Angrist (2001).

¹⁸That hiring suit costs are not related to output follows from each searcher applying for one job at each hiring firm, so that the number of applicants at each firm is the same. Such a sharp distinction between hiring and firing suits is unrealistic, but the only assumption needed for the empirical work is that a firm receives a certain number of job applications whatever its output level.

curing without respect to the size of the firm.¹⁹ The term $s_V q$ represents suits filed by customers, and is therefore assumed to be proportional to output. The expected cost of each Title III suit to the firm is A_{III} . Letting $\Lambda_F \equiv s_F A_{III}$ and $\Lambda_V \equiv s_V A_{III}$, the total expected cost of accessibility suits is $\Lambda_F + q\Lambda_V$.

These assumptions imply that after the ADA costs rise to

$$C(q) = \left(\beta \left[\frac{w_L + (a + \Lambda_T)x}{1 - x(1 - e)} \right]^\alpha + \Lambda_V \right) q + F + \Lambda_H + \Lambda_F \quad (1)$$

$$\equiv c(x, \Lambda_T, \Lambda_V)q + \phi(\Lambda_H + \Lambda_F) + F \quad (2)$$

where the other arguments of marginal cost c are suppressed. With this notation, pre-ADA costs are marginal cost $c(0, 0, 0)$ and fixed cost $\phi(0) + F$. Equation (1) is derived in the appendix.

In each period potential entrants and incumbents make entry, exit, and production decisions as in the model of Klepper (1996). Since firms are atomistic, there are no strategic interactions among firms and I am able to more readily characterize how entry and exit change in response to structural cost changes. I do not consider our model's price-taking assumption as significantly detrimental in our application to the retail sector, with its great preponderance of small establishments in the period I study.²⁰ However, our model would be less suited to study of industries with few firms such as telecommunications or automobile manufacturing. Our theoretical model simplifies Klepper (1996) by abstracting away from innovation (which may not be as important in our retailing context as in Klepper's (1996) manufacturing setting). The dynamics in the model are described in Prieger (2005*b*). In that companion paper, I prove the following:

Proposition 1 (Impact of Cost Increases) *In the period in which cost increases due to the ADA, the following hold, compared to the same period were cost not to increase:*

1. *Equilibrium price rises and equilibrium market quantity falls.*

¹⁹The Title III litigants mentioned in Section 2 appear to be "equal opportunity suers", filing against firms of all sizes.

²⁰There is, however, some evidence that supermarkets erect strategic barriers to entry in the grocery store subcategory of food stores, the main category explored here (Cotterill and Haller, 1992). Extending our model to incorporate strategic action awaits future research.

2. *The number of entering firms can increase or decrease.*

3. *The number of incumbent firms exiting can increase or decrease.*

The first point follows naturally from the fact that while cost rises for all firms, the demand function is unchanged. The second and third results may be shown numerically. In static entry models such as Bresnahan and Reiss (1987), entry can only decrease when costs rise.

Thus, this relatively simple model generates interesting, varied, and non-obvious responses to the cost changes. The possibilities for entry and exit are listed in Table 1. The most intuitive case is the *competitor neutral* case, in which entry decreases and exit increases in response to the cost changes. When entry declines and the resulting lessening of competitive pressure allows more incumbents to stay in the market, so that exit also declines, we have the *incumbent favoring* case. Entry can increase only at the expense of the number of incumbents or the quantity each incumbent produces. I term the case in which entry increases and the number of incumbents falls *entrant favoring*. Note that all changes in Table 1 are with reference to the same period in the baseline in which no costs changes, not with reference to changes in entry and exit over time.

Examining when the various cases occur allows us to link changes in entry and exit with the unobserved (in the data) changes in cost. Recall that the effect of the ADA is to raise marginal cost and fixed cost. The following proposition characterizes the impacts that the changes in cost have on entry and exit.

Proposition 2 (Restrictions on Observed Outcomes) *Using the definitions from Table 1, the following hold:*

1. *When marginal cost increases, the incumbent favoring case is not possible.*

2. *When fixed cost increases, if demand is inelastic at the equilibrium price the entrant favoring case is not possible.*

When marginal cost increases, the entrant favoring case is possible because an increase in marginal cost hurts the profit of incumbents more than of entrants. Existing firms sell more than entrants if they stay in the market, and the greater inframarginal loss by incumbents causes some to exit, allowing price to rise enough to allow entry by new firms. On the other hand, when fixed cost rises and demand is inelastic, the incumbent favoring case is possible because entrants are disproportionately hurt, due to their smaller scale. In Prieger (2005*b*) I explore why entrant and incumbent favoring happen in greater detail.

The implications of the model useful for empirical work are thus as follows. When demand is inelastic (as it is in the empirical application to food stores), an entrant favoring outcome from the ADA can come only from increases in disabled workers x , or through litigation costs Λ_T and Λ_V , which increase marginal cost. Furthermore, an incumbent favoring outcome can come only through litigation costs Λ_H and Λ_F , which increase fixed cost. The competitor-neutral outcome implies no restrictions on the nature of the cost increase. In section 6, I use these two implications of the model to infer which elements of the ADA raised which costs.

5 Data and Empirical Models

One would expect that if the ADA impacted any firms, it would be those in the retail sector. Retail firms are exposed to costs under both Title I through employment and Title III through access by customers to their premises. The retail sector has many small firms operating on thin margins²¹ and is also involved in many of the ADA lawsuits. The dependent variable is therefore the number of retail establishments by major SIC group within a county; the data cover the whole U.S. except Alaska.²² Summary statistics of the data are presented in Table 2.

Figure 1 shows the percentage changes in the total number of retail establishments by two-

²¹By 1980, 93.4% of the sector was effectively competitive, based on concentration ratios (Shepherd, 1982).

²²The data are from the U.S. Census Bureau, *County Business Patterns CD-ROM*, years 1987-1997. Although establishments are not the same as firms, an establishment may be judged an “employer” under the ADA even if it is not a distinct legal entity (*EEOC v. St. Francis Xavier Parochial School*, 326 U.S. App. D.C. 67).

digit SIC code. Some subsectors are growing and some are shrinking, but the percentage changes generally trend down. Except for SIC 52 (building materials and garden supplies) and 53 (general merchandise stores), every group saw decreased growth rates in 1993, the first full year the ADA was in effect, compared to the previous year. In all but one of these cases (SIC 58, eating and drinking places), growth was negative in 1993. Given that the ADA may be a relatively minor determinant of the number of firms, however, compared to changes in demand, other costs, and general industry dynamics, Figure 1 should not be read as strong evidence by itself for impacts of the ADA. Instead, it may mainly show the trends that need to be differenced out in the analysis.

Although results from all retail subsectors are summarized in a previous version of the paper (Prieger, 2004a), here I focus on SIC 54, food stores (the heavy line in Figure 1). SIC 54 includes retail stores primarily engaged in selling food for home preparation and consumption (i.e., grocery stores).²³ Food stores were chosen for several reasons. They appear to be among the most vulnerable to cost changes within the retail sector.²⁴ Food stores also have relatively small, local markets, for which counties may be an adequate approximation. Furthermore, in comparison to restaurants (SIC 58), the other natural choice by the first two criteria, the relatively smaller number of food stores per county makes the estimation of the heterogeneous models more feasible.²⁵ Finally, demand for food consumed at home is consistently estimated in the literature to be inelastic, unlike food consumed at restaurants (e.g., Barnes and Gillingham, 1984). Restricting investigation to a good with inelastic demand allows part 2 of Proposition 2 to be applied.

In the rest of this section the econometric models used in the investigation are presented. The data are a panel of establishment counts by county and year, 1988-1997. The first question to investigate is the effect of the ADA on the number of stores. To answer this question, I use

²³SIC 54 does not include restaurants or liquor stores.

²⁴Food stores have a lower gross margin (as percent of sales) than any other two-digit retail segment except automotive dealers (U.S. Census Bureau, 1999). The sector also was relatively unconcentrated during the study period; the four largest firms accounted for only 15% of sales in 1992 (U.S. Census Bureau, 1995). There is evidence, however, that the grocery store subcategory is considerably more concentrated in local markets (Cotterill, 1993).

²⁵Estimation time for the $CM_i/CM_i/\infty$ model is proportional to the sum of the dependent variable, not the number of observations.

standard count data models. The first is a Poisson regression model estimated on the pooled data, which yields consistent estimates even if there are county-specific or county-year-specific random effects leading to clustering and overdispersion (Cameron and Trivedi, 1998, sec. 3.2.3). All standard errors are robust to county-level clustering and overdispersion in the Poisson model. If the regressors are correlated with the county-specific effects, however, the Poisson model is not consistent. To address this possibility, I also estimate a fixed effects Poisson model (Hausman, Hall and Griliches, 1984), which is analogous to the familiar “within” estimator for linear panel models.

The other question of interest is the effect of the ADA on entry and exit. Pursuing structural estimation based on the theoretical model in the previous section is impractical, given that data on entry and exit are not available. Instead, I take a simpler approach and posit reduced-form entry and exit processes. Because entry and exit are not observed, I derive the likelihood for the number of currently operating firms. The parameters governing entry and exit are identifiable from the count of currently operating firms because the number of firms, in a sense, is an instrument for the exit rate. When there are n firms observed one period and $n - 1$ the next, heuristically speaking there were n “chances” that a firm exited. Variation in the number of firms thus identifies the exit rate. The entry rate is then identified as the rate necessary to support the observed number of firms. For example, if a market is in a steady state, a well-known result from queuing theory says that the expected number of firms is the product of the entry rate and the average lifetime of the firm, where the latter is determined from the exit rate. Thus if the exit rate is identified, the entry rate is identified also. The above argument is meant to be suggestive only; the econometric model does not assume that markets are in steady state and formal identification proceeds as in Rothenberg (1971) (see also the appendix).

The model adopted to recover entry and exit rates is a queuing system in which the entry and exit rates depend on covariates that evolve period to period. I also add correlated random effects in the entry and exit rates to capture the effect of unobserved factors in the market affecting entry and exit. Conditional on these random effects, entry and exit are Markovian; unconditionally,

overdispersion and duration dependence are allowed in the processes. Borrowing nomenclature from queuing theory, I denote the model a $CM_t/CM_t/\infty$ queuing system, where the CM is for “conditionally Markovian” entry and exit, t denotes rates that vary each period, and ∞ denotes that there is no congestion in the system.²⁶ Each period a pair of random effects and the observed covariates determine the entry and exit rates, which in turn determine the distribution for the number of entering firms and a firm’s lifetime distribution. The latent entry and exit processes generate the dependent variable, the observed number of firms in the market in each period.

With this overview of the model in hand, the rest of this section describes how to construct the ML estimator for the parameters of the $CM_t/CM_t/\infty$ system. The entry of firms is a nonhomogeneous Poisson process with gamma mixing. In particular, the interarrival times (the epochs between the times at which entry occurs), conditional on a gamma-distributed heterogeneity random variable u , are exponentially distributed with instantaneous rate λ_t in period t . The lifetime of each entrant, conditional on another gamma-distributed heterogeneity random variable v , is exponentially distributed with instantaneous rate μ_t . Conditional on (u, v) , the entry and exit processes are independent; dependence is introduced by means of correlation between u and v .

In our data the number of establishments is observable, but not the entry and exit times. I derive the likelihood function for the number of firms using techniques from queuing theory (Srivastava and Kashyap, 1982). To economize on notation, the model will be explicated for a single time series of firm counts and the cross-sectional dimension is introduced later.

The entry rate λ_t and the exit rate μ_t are modeled as:

$$\lambda_t = \exp(\mathbf{X}'_t \boldsymbol{\alpha}) u_t = \lambda_{0t} u_t \tag{3}$$

$$\mu_t = \exp(\mathbf{Z}'_t \boldsymbol{\beta}) v_t = \mu_{0t} v_t, \tag{4}$$

where $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are vectors of parameters, \mathbf{X}_t and \mathbf{Z}_t are vectors of observed explanatory variables,

²⁶I.e., there are an infinite number of “servers” that “process” the lifetime of the firm, implying that firms’ lifetimes are governed by the conditional exponential distribution immediately from birth, without queuing.

and u_t and v_t are unobserved i.i.d. heterogeneity terms with distribution

$$f(u, v) = \mathcal{G}(\gamma, \sigma_u^2 v^\tau; u) \mathcal{G}(\delta, \sigma_v^2; v), \quad \gamma, \delta, \sigma_u^2, \sigma_v^2 > 0 \quad (5)$$

where \mathcal{G} is the gamma pdf

$$\mathcal{G}(a, b; x) = \frac{x^{a-1} e^{-x/b}}{b^a \Gamma(a)}. \quad (6)$$

The parameters σ_u^2 and σ_v^2 govern the variance of u and v , respectively (see appendix). In addition to the restrictions on the parameters in (5), it is also necessary that $\tau > -(2\sigma_v^2)^{-1}$ for the variance of u to be finite. The shape parameters γ and δ are normalized so that $E(u) = E(v) = 1$, which is required for identification of the intercept terms in α and β . With these restrictions, $\text{Var}(v) = \sigma_v^2$, $\text{Var}(u|v)$ is linear in σ_u^2 , and $\text{Var}(u)$ is affine in σ_u^2 (see appendix). Correlation ρ between u and v is a function of τ . The correlation has the same sign as τ , can take the full range of values on $[-1, 1]$, is zero if and only if $\tau = 0$, but is not in general monotonic in τ .

From (5) it can be seen that v has a marginal Gamma distribution and u has a Gamma distribution conditional on v .²⁷ I choose a conditional Gamma distribution for u purely for convenience; it allows analytic integration of the unobserved heterogeneity in the entry process. Numerical integration is required to integrate out v .²⁸

Gamma mixing in Poisson and exponential distributions has well-known properties and is commonly used, because it leads to closed-form likelihoods. The Gamma-Poisson mixture for entry results in a negative binomial random variable that allows for overdispersion (for which the Poisson distribution alone cannot account). A Gamma-exponential mixture for the firms' lifetimes results in a Pareto distribution, and relaxes the exponential's imposition of a constant hazard rate (Johnson, Kotz and Balakrishnan, 1995, p.574). As is true with any mixture of exponentials, the hazard rate for a Gamma-exponential mixture is decreasing, which implies that there is negative

²⁷No structural interpretation is assigned to this formulation (i.e., that entry depends on exit but not vice versa). Of course v also has a distribution conditional on u .

²⁸The distribution $f(u, v)$ is from Gran (1992, sec.2.7.5). There is no bivariate distribution with correlation for which both the marginal and conditional distributions are Gamma (Arnold, Castillo and Sarabia, 1999, sec.4.6).

duration dependence and overdispersion.²⁹ Dubey (1966) also uses Gamma-exponential mixtures for firm lifetime data.

The heterogeneity in the model thus exhibits properties that fit the stylized facts of firm entry and exit mentioned in section 3: overdispersion to account for the large variance in entry and exit rates across industry groups, correlation between the entry and exit rates, and duration dependence in the life of the firm. The $CM_t/CM_t/\infty$ model thus combines flexibility through the random effects to account for these features, with the analytical convenience of a Markovian queuing system. The former is desirable to fit the stylized facts; the latter is necessary to find a (near) closed form for the likelihood.

From the model specified above, the likelihood of the data can be obtained (see appendix). Let n_t be the number of firms in the market at the end of period $t \in \{1, \dots, T\}$. The pdf of n_t given n_{t-1} , denoted $f(n_t|n_{t-1})$, involves a unidimensional integral that I evaluate by quadrature. To introduce the cross-sectional dimension of the panel write n_t as n_{kt} , the number of firms in county k in year t . Assuming that (u_{kt}, v_{kt}) are independent across time and county, and using the fact that n_t is generated by a Markov process, the log likelihood function for the parameter vector $\theta = (\alpha, \beta, \sigma_u^2, \sigma_v^2, \tau)$ is determined from (3), (4), and

$$l_\theta(\theta|n_{k0}, ((n_{kt}, \mathbf{X}_{kt}, \mathbf{Z}_{kt})_{t=1}^T)_{k=1}^K) = \sum_{k=1}^K \sum_{t=1}^T \log f(n_{kt}|n_{kt-1}) \quad (7)$$

where $f(n_{kt}|n_{kt-1})$ is given in (29).

Let $\hat{\theta}$ be the estimate obtained from maximizing l_θ . Prieger (2005a) demonstrates that ML works well for this model. If the heterogeneity terms (u_{kt}, v_{kt}) are independent over time then $\hat{\theta}$ is a fully-efficient ML estimate. If the heterogeneity terms are not independent over time within the same county (i.e., if there is county-level clustering), then $\hat{\theta}$ is an inefficient but consistent partial ML estimate.³⁰ Because the Hessian is complicated and expensive to calculate, maximization techniques and variance estimators that require only the gradient are an appealing choice here. I

²⁹In particular, one can show that mean time remaining to exit, conditional on survival to t , increases linearly in t .

³⁰The asymptotics require fixed T and $K \rightarrow \infty$. See Wooldridge (2001), sec. 13.8 on the partial MLE.

use the BFGS variant of the DFP algorithm in the application. All standard errors are calculated with a Huber-White sandwich estimator that is robust to county-level clustering. Prieger (2004b) contains more details on estimating the model.

6 Empirical Results

In this section I apply the econometric models from the previous section to the food store data to look for effects of the ADA on the number, entry rate, and exit rate of firms. I also apply the insight gained from the theoretical model of section 4 to discern which aspects of the ADA are most important in creating additional costs for firms. I use three empirical specifications, moving from differences in means pre- and post-ADA to differences-in-differences specifications. The specifications provide increasingly stringent tests of whether the link I find between the ADA and negative industry effects is causal.

6.1 Specification A: differences in means

The simplest specification, A, uses the number of stores of all sizes per county in a year and focuses on differences in mean establishment counts, entry, and exit before and after the ADA. In the standard count data models, the mean number of stores in county k and year t is specified as an exponential function of a linear index $\mathbf{X}'_{kt}\boldsymbol{\beta}$, with

$$\mathbf{X}'_{kt}\boldsymbol{\beta} = \beta_0 + v_s + \varphi_t + \boldsymbol{\pi}'\mathbf{W}_{kt} \quad (8)$$

where v_s is a state fixed effect and φ_t is a year fixed effect with φ_{1988} normalized to zero. Covariates \mathbf{W} include county land area, population, per capita real income, and labor cost (average real wage and salary disbursements per job), all in logs. In specification A, the only evidence for the ADA's effect comes from φ_t for the ADA years, which capture changes in the number of stores after the act was in effect. Such evidence can only be suggestive, since the year indicators may merely pick up trends unrelated to the ADA.

Results from the Poisson models for the number of establishments are in Table 3. The three estimations reported are Poisson regressions with and without state dummy variables and a fixed-effects Poisson estimation. Proposition 1 by itself does not rule out that the number of stores may rise from the ADA, given that smaller entrants can replace larger incumbents when costs rise. Thus one should have no *a priori* expectation for the signs of the ADA-related variables in these estimations, although the most natural expectation is that if the ADA increased costs then the number of stores should fall. The coefficients are elasticities when the variable is in logs (all except indicator variables). The negative and significant $\hat{\varphi}_t$ for the ADA period 1993-1997 in all models implies that the number of stores decreased in the ADA periods, even after controlling for changes in the economic variables. The decreases range from 6% to 13% in the Poisson estimations, with the larger decreases coming in the later years, for an average decrease in the ADA years of 8.7% for regression 1 and 8.9% for regression 2. For the fixed-effects estimation, the decreases range from 2% to 6%, with an average of 3.6%.³¹ The economic covariates have intuitive signs. Greater population, population density ($\pi_{pop} - \pi_{area}$), and income and lower labor costs are correlated with a higher number of stores in the county. Although the magnitudes are generally smaller in the fixed-effects estimation (the right-most set of columns in Table 3) than in the pooled Poisson estimations, the qualitative results are similar in all three estimations. Results (not reported) from alternative random-effects Poisson and negative binomial models are also similar.

The theoretical model in section 4 shows that examining entry and exit in addition to the number of stores can provide insight into how the ADA changed firms' costs. Turn now to the $CM_t/CM_t/\infty$ model for entry and exit from section 5. The mean entry and exit rates λ and μ for the $CM_t/CM_t/\infty$ model are also exponential functions of indices specified as in (8) (i.e., $\mathbf{X}'_{kt}\boldsymbol{\beta}$ also stands in for the indices $\mathbf{X}'_t\boldsymbol{\alpha}$ and $\mathbf{Z}'_t\boldsymbol{\beta}$ in the notation of section 5). A few changes are made to reduce the number of parameters to be estimated. The year indicators are grouped into three periods: the pre-ADA period 1988-1992 ($\varphi_1 = 0$, the omitted variable), the initial ADA period

³¹The percentage change in the mean dependent variable from a binary variable like φ_t is $\exp(\varphi_t) - 1$.

1993-1994 (φ_2), and the subsequent ADA period, 1995-1997 (φ_3). Period 2 spans the first full year that the ADA was fully in effect for any size firm (1993) and the end of the phase-in period (1994; refer to section 2). The state fixed effects are replaced with Census region indicators. Added to \mathbf{W} is log capital cost, proxied by the Moody's Baa bond rate (capital cost is absorbed into the year fixed effects in the Poisson estimations). The specifications of the entry and exit rates are identical (in this and all specifications). There is no exclusion restriction required for identification, and none could be defended on economic grounds, given that any variable affecting profitability affects both entry and exit decisions.

The results from specification A for the $CM_t/CM_t/\infty$ model are in Table 4, both with and without random effects. Several results stand out from these estimations. Entry rates were significantly lower and failure rates were significantly higher in the ADA periods than the pre-ADA period in both specifications. If all such changes can be ascribed to the ADA, this is the *competitor neutral* case. The economic coefficients have the expected signs in the entry rate (larger area, more population and higher per capita income all increase the arrival rate; higher labor costs decrease the entry rate) except for capital costs in the homogeneous specification.³²

In the failure rate part of the homogeneous specification, the population coefficient has an unexpected sign: more populous counties have *higher* failure rates. The heterogeneous specification reverses the sign on the population failure rate coefficient. The homogeneous specification is soundly rejected in favor of the random effects version, whether by significance tests on σ_u^2 , σ_v^2 , and τ , or by likelihood ratio tests. The evidence thus indicates that the random effects are an important addition to the model and may be required to get sensible estimates from the $CM_t/CM_t/\infty$ model. Correlation between the arrival and exit rates is estimated to be negative, possibly due to omitted variables that affect the profitability of the market.

³²The unexpected sign appears perhaps because bond rates are a poor proxy for the true opportunity cost of capital or that they act as a peculiar type of time trend (recall the capital cost variable varies only over time, not in the cross section).

6.2 Specification B: ADA-specific covariates

To investigate whether the ADA had anything to do with the decline in the number of stores and the changes in firm dynamics shown in specification A, in specification B ADA-specific covariates are added. The dependent variable remains total stores of all sizes. Using the results and notation of section 4, we know that marginal cost increases with x , Λ_T , and Λ_V , that fixed cost increases with Λ_H and Λ_F , and that Λ_F and Λ_V increase with y . Since the litigation variables Λ_T , Λ_V , Λ_H , and Λ_F are not directly observed, I proxy them with related observables. The index is specified as

$$\mathbf{X}'_{kt}\boldsymbol{\beta} = \beta_0 + v_s + \varphi_t + \eta_p e_{st-1} + \zeta_p c_{st-1} + \omega_p d_{st-1} + \xi_p f_s + \boldsymbol{\pi}'\mathbf{W}_{kt} \quad (9)$$

where \mathbf{W} includes all the variables from specification A. Parameters $(\beta_0, v_s, \varphi_t)$ are as in (8). The employment litigation costs Λ_H and Λ_T increase with the probabilities of litigation (ℓ_H and ℓ_T). I proxy these probabilities by the EEOC charge rate in state s , lagged one year. The charge rate variable e_{st-1} is the number of EEOC ADA Title I charges in the state, as a fraction of prime working age disabled population (aged 21-58), times 1,000.³³ Hiring and termination charges are not distinguished in the EEOC data; evidence on which places greater costs on firms will come from application of Proposition 2. The charge rate (and the Title III case rate described below) is lagged to avoid reverse causation between current firm dynamics and worker complaints. For example, when many firms are exiting, employees may file fewer labor complaints because they are in transition to new jobs anyway. The coefficient on e_{st-1} is η_p , where $p = 2, 3$ indexes the two ADA periods.

Similarly, the accessibility litigation costs Λ_F and Λ_V increase with the number of suits (s_F and s_V). Instead of proxying the number of suits (which is highly correlated with population), I proxy the probability of accommodation suit-filing. The case rate variable c_{st-1} (with coefficient ζ_p) is the number of Title III-related federal court cases in state s in year $t - 1$, as a fraction of disabled

³³The EEOC data were obtained as summary counts per state through a Freedom of Information Act request. The disability data are from the U.S. Census' Current Population Survey, following Acemoglu and Angrist (2001).

adult population (aged 15+ years), times 1,000.³⁴ As with the EEOC charges, Proposition 2 may be used to infer whether the Title III cases increase marginal or fixed costs more. The coefficients for the charge and case rate variables are semi-elasticities.

Finally, because of the high correlation between the fractions of the labor force (x) and population (y) that are disabled, I include a single variable d_{st-1} to proxy both. This variable (with coefficient ω_p) is the log fraction of adult population (aged 15+ years) in the state that is disabled in year t (times 100), lagged one year.

Although every state had some sort of Fair Employment Practice (FEP) law before the ADA, and all but three prohibited disability-based discrimination in hiring and firing, not all of these laws had teeth. The variable f_s is an indicator for states that had a “strong” FEP law with sanctions before the ADA ($f_s = 1$ if the state had a strong pre-ADA FEP law, 0 if not).³⁵ Sanctions include misdemeanor charges and civil penalties; these are in addition to the monetary damages available under all states’ FEP laws. Title I of the ADA was less of an innovation in states with strong FEP laws, and the ADA should have had less of an impact. If there is less entry in the weaker FEP states after the ADA, for example, then $\hat{\xi}_2$ and $\hat{\xi}_3$ will be positive in the entry index.

All the ADA-related coefficients are allowed to vary between periods; since the Title I and Title III variables are not observed in period 1, I normalize $\zeta_1 = \eta_1 = 0$. In the results, I report differenced estimates (i.e., increments over the period 1 effect) where applicable; for ω_p I report $\hat{\omega}_1$, $\hat{\omega}_2 - \hat{\omega}_1$, and $\hat{\omega}_3 - \hat{\omega}_1$, for example. The coefficients on f_s are reported as difference-in-differences (D-D) estimates: $\hat{\xi}_2 - \hat{\xi}_1$ and $\hat{\xi}_3 - \hat{\xi}_1$, the difference (between strong FEP and other states) in the difference in $\mathbf{X}'_{kt}\beta$ before and after the ADA.

Although all the variables in specification A are included in specification B, only the ADA-

³⁴The case data were obtained from a search of the Lexis database (all federal trial, appellate, and Supreme Court cases) for cases matching keywords “ADA” and “public accommodation” or “Title III”. Although this is not as accurate a means of classification as reviewing each of the numerous cases individually, a check of the cases matched showed this method to be fairly accurate.

³⁵These data are from Percy (1989). Jolls and Prescott (2004) and Jolls (2004) categorize states’ pre-ADA FEP laws differently; see section 6.5 for discussion.

specific coefficients are reported in Tables 5 and 6. Of interest here are the difference and D-D estimates. For the count models in Table 5, with the exception of the Title III case rate, all of these estimates have signs unambiguously associating the ADA with a decreased number of stores. In particular, the coefficients for the percentage of disabled adults and the EEOC charge rate are negative in the ADA periods. The coefficient for states with strong FEP laws is positive, which is also consistent with the ADA causing the number of stores to fall. These signs are robust across models, and are statistically significant in all but the first estimation. Due to the presence of nonlinearity in the effect of Title III case rates during 1993-1994 detected in preliminary estimations, a squared term is added for those years (no significant nonlinearity was found for 1995-1997). The Title III case rate coefficient for 1993-1994 displays a U-shaped effect in all specifications, with at least 99% of the observations occurring in the downward sloping (and thus negative) part of the effect in all estimations. However, the Title III coefficients are jointly significant only in first estimation, and the Title III coefficient for 1995-1997 is never significant, perhaps because there are not enough Title III cases to impact firms much. I defer interpreting the magnitudes of the estimates until section 6.6.

Table 6 has the results from specification B for the $CM_t/CM_t/\infty$ model. The versions with and without heterogeneity are generally in agreement; there are no (statistically significant) sign changes of the estimates between versions. Of the significant estimates, the EEOC charge rates and the percentage of adults disabled in both ADA periods show incumbent favoring behavior.³⁶ From Proposition 2, this implies that these variables (on net) raise fixed costs.³⁷ The result for the charge rates implies that the ADA raised hiring costs (through ℓ_H and Λ_H from section 4) more than termination costs (through ℓ_T and Λ_T). This seems unlikely; Moss *et al.* (1999) report that fewer than 10 percent of the ADA charges filed with the EEOC concern hiring discrimination. I

³⁶The estimates discussed here are those for which either the entry or failure coefficient was significant in one or both specifications. All of these are pairwise jointly significant.

³⁷The results of Proposition 2 apply to small univariate increases in marginal cost c or fixed cost ϕ . Given that both may have actually increased, “incumbent favoring” here means that the effects of the increase in ϕ outweigh the effects of any increase in c .

return to this issue in the next specification.

Recall that the disability variable d_{st} stands in for the fraction of the labor force and population that is disabled (x and y of section 4, resp.). The disability variables raise fixed costs by increasing Λ_H , the cost of hiring discrimination suits (through x) and by increasing Λ_F , a component of the cost of accessibility suits (through y). Setting aside the possibility of significant impacts through hiring-related suits, the incumbent favoring impact of the disability variable may imply that “serial suers” or other litigants have significant impacts on entry by raising the expected cost of accessibility lawsuits (or other such suits not related to the scale of the businesses), Λ_F . Another explanation for the incumbent favoring, apart from the implications of Proposition 2, may be that negative impacts from the disability variable show up on entry and not exit if potential entrants perceive the costs from ADA suits to be larger than incumbents actually find them to be.

The other significant estimates are the Title III case rates and the strong FEP law D-D estimates (first ADA period only for the latter). The Title III coefficients for the second ADA period and the strong FEP law coefficients for the first ADA period show entrant favoring behavior. Proposition 2 therefore implies that these variables raise marginal costs. For the case rate variable, this result is consistent with the ADA imposing real litigation costs Λ_V from accessibility suits from customers. However, the next section shows that this result does not persist when trends common to all sizes of stores are removed. Also, the Title III entry coefficient for the first ADA period is negative. I return to the Title III estimates in the next section. The results for the strong FEP laws imply that marginal costs increased more in states for which the ADA was more of an legal innovation (at least during the first ADA period). This latter result may indicate that overall, the ADA helped entrants at the expense of incumbents. Combining all results from this section, there is much evidence that the ADA had real impacts on the number, entry, and exit of food stores. Specification B does not, however, take advantage of the fact that small stores are likely to be more vulnerable to costs imposed by the ADA than larger stores. In the next section I use large stores as a control group to strengthen the conclusions of this section.

6.3 Are disability and labor claims exogenous?

One may suspect that some of the variables treated as exogenous in Specification B are in fact endogenous. For example, self-reported disability status may respond to economic conditions, and thus be artificially high when industry is declining. However, recent evidence in the literature suggests accepting disability status as reported in anonymous surveys as exogenous (Benitez-Silva, *et al.*, 2000).³⁸ Nonetheless, I explore its potential endogeneity here. There is stronger evidence that EEOC charge rates in general (before the ADA) may also increase when joblessness, perhaps due to turnover of firms, increases (Donohue and Siegelman, 1991). In this section I therefore explore instrumental variable regressions in which the disabled and EEOC variables are treated as endogenous.

Instrumenting for the CPS disability variable requires finding measures of disabled persons less susceptible to self-reporting bias. Here I use some variables from the U.S. Census Bureau's Survey of Income and Program Participation (SIPP) as instruments for the disability measure used above constructed from the rather general CPS question regarding ability to work.³⁹ The three SIPP variables used were chosen for their specificity: whether the respondent is blind, deaf, and needs help taking a bath. From these variables, state-level fractions of blind, deaf, and limited-ability adults were constructed. Unfortunately, the SIPP data are available only after 1990, which necessitates dropping the early years of the sample. To instrument for the EEOC case rates, I follow Acemoglu and Angrist (2001) and drop the FEP variables from the main estimation, using them as instruments instead.

To allow use of standard IV techniques with the Poisson count data, the dependent variable was transformed by square root,⁴⁰ so the coefficients (reported in Table 7) are not comparable to

³⁸In an earlier investigation, Stern (1989) found only weak evidence of endogeneity self-reported disability status in a labor force participation estimation.

³⁹The CPS question is "Does [respondent] have a health problem or disability which prevents him/her from working or which limits the kind or amount of work he/she can do"?

⁴⁰The log transformation for count data often performs poorly (Cameron and Trivedi, 1998, sec. 3.7.2). McCullagh and Nelder (1989) suggest the square-root transformation as an alternative.

those in previous tables. OLS coefficients for comparison are reported in the first column, and are qualitatively similar to the Poisson regression. In particular, the signs of the disability, EEOC, and Title III coefficients match those of the analogous Poisson Regression 2 in Table 5. When disability and EEOC cases are treated as endogenous in columns 2, the results show that the sign and significance of the coefficients persist. An overidentification test does not reject the hypothesis that the disability and EEOC variables are exogenous. Therefore in the rest of the paper I treat these as exogenous.

6.4 Specification C: difference-in-differences

In specification C, the dependent variable is split into number of stores within size groups: small (1-19 employees), medium (20-49 employees), and large (50+ employees). The independent variables are as in specification B. Estimations for the different size stores are run separately, which effectively adds a size subscript $j = S, M, L$ to all the variables in (9). This allows all the ADA-related variables to be differenced over firm sizes as well as over time, and is the most demanding test that the ADA had a causal impact on stores. In specification C, we require not only that the ADA-related variables affect the number of stores, entry, or exit, but that the impacts be greater on the small firms that are most vulnerable to the ADA. By looking for impacts on small stores, net of trends for large stores, potentially spurious trends affecting all sizes of stores are differenced out. Recall from section 2 that the smallest stores (those with fewer than 15 employees) are exempt from Title I employment discrimination obligations. Therefore for the Title I variable e_{st} differences of medium size stores from large stores are presented. The strong FEP law coefficient is triple differenced (D-D-D) in this specification, with differencing over states with strong and weak laws, over small and large stores, and over time. This allows the D-D estimate for large stores to be a baseline, against which the incremental effects for small stores can be compared.

The results are reported as D-D or D-D-D estimates. The D-D estimate labeled *% adult disabled, 1993-94* in the first row of Table 8, for example, is $(\hat{\omega}_{2S} - \hat{\omega}_{1S}) - (\hat{\omega}_{2L} - \hat{\omega}_{1L})$: the

difference (between small and large stores) in the difference in $\mathbf{X}'_{kt}\boldsymbol{\beta}$ from a unit change in d_{st} before and after the ADA. Similarly, the D-D-D strong FEP state estimate labeled *strong FEP state, 1993-94* is $(\hat{\xi}_{2S} - \hat{\xi}_{1S}) - (\hat{\xi}_{2L} - \hat{\xi}_{1L})$: the difference (between small and large stores) in the difference (between strong FEP and other states) in the difference in $\mathbf{X}'_{kt}\boldsymbol{\beta}$ before and after the ADA.

Table 8 presents the results from specification C for the standard count models. The table reports only the D-D and D-D-D calculations; each is the set of small or medium firm estimates net of the large firm estimates. The results are qualitatively similar to Specification B. Of the significant estimates for small stores, all have signs consistent with the ADA decreasing the number of stores. The Title III case rate D-D coefficients for the initial ADA display the same U-shaped effect as found in Specification B, again with virtually all observations occurring in the downward sloping, negative part of the effect. In contrast with Specification B, the Title III coefficient for 1995-1997 is now significant in the last two estimations. The D-D-D coefficients for the strong FEP state variables are positive in Table 8. These D-D-D estimates imply that not only did the number of stores fall in weaker FEP states after the ADA (from the D-D estimates in Specification B) but that the trend is more marked for the ADA-vulnerable small stores than for large stores. The lower part of Table 8 has the D-D estimates of the EEOC charge rate coefficients for medium stores. These estimates are all negative, and are significant at the 1% level except for the first ADA period in the last two estimations. Taken altogether, the evidence is consistent with the ADA reducing the number of establishments in each market. While causality can not directly proven here, in the D-D and D-D-D settings any alternative explanations become increasingly complicated.

Table 9 contains the estimates of interest from the $CM_t/CM_t/\infty$ model. With the exception of the Title III case rates, all of the incumbent favoring or entrant favoring behavior found in specification B carries through to the small firm D-D and D-D-D estimates.⁴¹ Thus not only are

⁴¹The entry and exit coefficients are jointly significant for all the variables discussed in specification B. The entry and exit coefficients for disabled population rate in ADA period 2 are individually insignificant in specification C but retain joint significance.

effects from the ADA-related variables significant, they generally show up strongest for the small stores likely to be most susceptible to the costs of the ADA. For the accessibility estimates, the first ADA period Title III estimates show strong incumbent favoring, and the entry-favoring previously found for the second period Title III estimates in specification B disappears. The Title III results are thus brought into line with the results for the disability variable d_{st} ; the evidence from both suggests that fixed costs rose, which is consistent with accessibility suits by activists raising costs through s_F and Λ_F .

The suspect finding from specification B that EEOC charge rates appear to increase fixed costs is still present for the first ADA period when looking at small stores. However, because of the Title I exemption for most small stores, medium size stores provide a better test of the effect of the EEOC charges. The bottom part of Table 9 has the results for the EEOC charge rate D-D estimates for medium stores (net of large stores). Here, the Title I variable exhibits entrant favoring effects in both ADA periods, which implies from the theoretical model that the costs of termination suits (and possibly other suits from employees regarding accommodation⁴²) have more of an impact than hiring suits. Given that over 81 percent of charges filed with the EEOC concern termination or accommodation of employees, this is a plausible finding.

A caveat applies to specification C when estimating the entry and exit model. Given the anonymous nature of individual stores in the establishment counts, true exits cannot be distinguished from size group switching. E.g., if a firm grows from 10 to 40 employees one year to the next, the econometric model treats it as an exit of a small firm and *de novo* entry of a medium firm. Thus, entry and exit may be over counted in specification C and the magnitudes of the coefficients must be interpreted with caution. By comparing entry rate $\hat{\lambda}$ from specification B with the sum of the $\hat{\lambda}_j$ for all size groups from specification C, one can estimate the extent of the overcounting. Arrival rates are over counted 22–25% in the ADA periods in specification C; similar calculation

⁴²Although not included in the model, suits from non-terminated employees would increase marginal costs similarly to termination suits.

for the failure rate shows over counting of 19–23% in the ADA periods. These figures provide rough upper bounds on the mismeasurement of the ADA-related coefficients; in a best-case scenario the category switching is not related to the variables of interest, the estimate of the constant absorbs the mismeasurement, and the other coefficients are correctly estimated.

6.5 Alternative estimations

Consider now some alternative estimations to check the robustness of the conclusions. Since identification of the entry and failure rate parameters comes from the functional forms assumed for the $CM_t/CM_t/\infty$ model, it would be reassuring if the model passed econometric specification tests. However, there is no test of parametric dynamic, discrete models of which I am aware that is consistent against non-parametric alternatives and is feasible for our case.⁴³ Instead I compare the $CM_t/CM_t/\infty$ estimates with those from simpler regressions using observed establishment births and deaths as the dependent variables. As discussed above, such data are not publicly available at the detailed SIC and county level. However, if one is willing to lump all retail subsectors together and to aggregate to the state level, then the joint Census/Small Business Administration Statistics of U.S. Businesses (SUSB) dynamic data on establishment births and deaths are available.⁴⁴ In Poisson regressions not reported here, I estimated specification A separately for overall entry and exit in the retail sector using the SUSB data.⁴⁵ Even though the level of aggregation and the businesses covered differed, the qualitative results from the SUSB data for the determinants of retail entry were close to those reported in Table 4 (heterogeneous model): the signs of each coefficient matched (or in one case differed but were both insignificant). The coefficients for the determinants of retail exit from the SUSB data were not as close to the analogous estimates in Table 4, but seven out of ten of them matched sign or were both insignificant. While the similarities between

⁴³Available tests are either not suited to discrete data, not suited to dynamic models, or require bootstrapping (e.g., Andrews (1997), Corradi and Swanson (2003)), which is far too computationally onerous to be practical here.

⁴⁴See <http://www.census.gov/csd/susb/susbdyn.htm> for a description of the data.

⁴⁵I use specification A because the signs of those coefficients from the $CM_t/CM_t/\infty$ model were more consistent across retail subsectors than were coefficients from specifications B or C.

the estimations performed on observed firm dynamics and the establishment counts do not provide a complete specification check, they do lend credence to the results from the $CM_t/CM_t/\infty$ model.

Some other studies classify states' pre-ADA laws differently than I do. Instead of categorizing state laws on the basis of sanctions (which follows Acemoglu and Angrist (2001)), Jolls (2004) and Jolls and Prescott (2004) classify states as full-protection (FP), limited protection (LP), or no-protection (NP) states. FP states had pre-ADA laws requiring employers to avoid disability-based discrimination in hiring and firing and to provide reasonable accommodations to disabled workers. LP states had laws lacking the reasonable accommodation provision, and the three NP states had no disability discrimination laws. To investigate this alternative approach, I re-estimated the Poisson regressions for specification B including as the only ADA-related variables a full set of FEP categories, interacting our "strong law" categorization with the alternative FP/LP/NP classification, leading to five groups: FP/strong, LP/strong, FP/not strong, LP/not strong, and NP. The results (not reported) show that the only category significantly different from the others is LP/strong, which has a coefficient positive and larger than those for any other group in both ADA periods. If the states in this group are different due mainly to the extent of protection afforded by the state law, then the nonintuitive interpretation is that where the ADA created new requirements, there was an increase in the number of stores. If the difference is due mainly to whether the state law had teeth, however, then the more natural interpretation follows that states in which the ADA created new penalties saw the number of stores decrease.

6.6 The overall impact of the ADA

To gauge the overall impact of the ADA on food firms, Table 10 show the magnitudes of the effects of the ADA variables. The table presents the number of small and medium size stores "lost" when the ADA is implemented, calculated by subtracting the number of establishments in a "no ADA" counterfactual from the actual figures. In the counterfactual, I assume there are no EEOC charges or Title III cases, since without the ADA neither would have been possible (medium stores only

for the former, due to the inapplicability of Title I to most of the small stores). I also assume in the counterfactual that there were no incremental effects in states with weak FEP laws compared to those with strong FEP laws in the ADA periods, on the logic that any such effects were due to the legal innovation of the ADA. To be conservative, I do not assume that the impact of disabled workers changes in the counterfactual, given that their impact on firms may have changed over time due to factors other than the ADA (for example, through changes in state law). All figures are calculated using coefficients from specification C, and thus are to be interpreted as net of trends for large stores.

The first three columns of Table 10 show the total impact of the ADA (defined as the difference between the actual number of stores and the estimated number of stores in the counterfactual) on the number of small and medium stores, with one column for each standard count data model in Table 8. The estimates range from 2,450 to 3,654 fewer small and medium stores nationally (1.5–2.2% of actual stores) during the initial ADA period and from 2,574 to 3,689 (1.6–2.3%) fewer small and medium stores during the later ADA period, depending on the estimation.⁴⁶ The large majority of these losses come from small stores. The other columns in Table 10 show the ADA impacts implied by the $CM_t/CM_t/\infty$ model estimates from Table 9. The $CM_t/CM_t/\infty$ estimations imply that overall, entry and exit increase due to the ADA, with the latter outweighing the former so that the number of stores falls.⁴⁷ The implied changes in the number of stores from the $CM_t/CM_t/\infty$ estimates are smaller than those from the standard count data models, but in all cases the number of stores is estimated to decrease due to the ADA.

These estimates are not meant to be a precise comparison to a world without the ADA. State disability law and enforcement of existing law might have changed in the absence of the ADA. The ADA might also have crowded out some legal action pursued under state disability law.

⁴⁶If the disabled variables for the ADA periods are also changed to zero in the counterfactual, the estimates increase by an order of magnitude.

⁴⁷The number of exiting firms is calculated by applying the per-firm exit rate μ to the number of firms in the county at the end of the previous period.

Furthermore, there is no way to tell how the impact of disabled workers (either to the benefit or the detriment of firms) may have changed over time without the ADA, which is why this variable was not included in the counterfactual. With these qualifications, and given the potential overcounting of entry and exit discussed at the end of section 6.4, the estimates are perhaps best viewed as merely illustrative of the magnitudes of the coefficients in Tables 8 and 9.

7 Concluding Remarks

There is convincing evidence that the ADA had real impacts on the number, entry, and exit of food stores. A previous version of the paper (Prieger, 2004a) found that the results for other retail segments generally mirror those for food stores. In the ADA period, there were an average of 4–9% fewer retail establishments than before. For food stores, the drop was larger in states in which the ADA was more of a legal innovation, and in states that had more disabled people and more ADA-related labor complaints. The same conclusions hold when baseline trends for larger establishments (those least vulnerable to the costs imposed by the ADA) are differenced out, and in addition ADA-related accessibility lawsuits are associated with declines in store counts. There is also evidence that labor complaints (and to a lesser extent, access discrimination suits) raised the marginal costs of food stores, encouraging exit. At the same time that the ADA spurred exit, however, it apparently increased entry, perhaps because stores less able to adapt to the new requirements failed and made room for new stores in the local market. So, while predictions that the ADA would cause firms to fail may have proven correct, the decline in the number of stores was partially offset by new entry. A conservative estimate, based only on factors directly related to the ADA and net of trends for large stores, is that there were 1.5–2.3% fewer small and medium food stores during the ADA periods than before. These percentages translate to 2,450–3,700 stores nationally.

To say that the ADA was bad for businesses overall is not to conclude that the ADA fails a

cost-benefits test. However, given the evidence of Acemoglu and Angrist (2001) that the ADA did not improve employment prospects for the disabled, the only remaining benefit of the law may be the greater physical accessibility requirements it mandates for businesses. Quantifying the benefits of accessibility for disabled customers would be difficult, and is beyond the scope of this work.

More generally, this paper develops an econometric model that may be useful for many economic questions. The $CM_t/CM_t/\infty$ model may apply to any example where a quantity of interest is a count of events in progress at a given time. For example, consider the number of ongoing strikes, or the number of people receiving unemployment compensation, or visiting an attraction. When only the count of pending spells is observed, the $CM_t/CM_t/\infty$ model allows estimation of the unobserved arrival and duration parameters. Such data arise whenever census methods report stock levels (e.g., population, pending stock trades, monetary aggregates, number of patients on a waiting list) and not flows.

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A Appendix

A.1 Derivation of the Cost Function

Proof of equation (1): after the ADA, marginal production cost is still constant given the assumptions, of form βw^α , where w is the price of effective labor $L + eD$, inclusive of accommodation costs. Adding in the accommodation cost of a and the termination cost of Λ_T per disabled worker leads to total labor expenses of $w_L L + (w_D + a + \Lambda_T) D$. Since disabled workers are hired in proportion x and receive wage w_L after the ADA, total labor expenses are $w_L L + (w_L + a + \Lambda_T) Lx/(1 - x) = [w_L + (a + \Lambda_T)x] L/(1 - x)$. The total amount of effective labor is $L + eD = L + eLx/(1 - x) = (1 - x(1 - e)) L/(1 - x)$, so that the factor price of effective labor is $[w_L + (a + \Lambda_T)x] / [1 - x(1 - e)]$, found as the ratio of the total labor expense to total effective labor. Adding in the hiring and accessibility litigation costs results in (1). All other proofs for the theoretical model are found in Prieger (2005*b*).

A.2 Variance and correlation of entry and exit

The variance of v is σ_v^2 and the variance of $u|v$ is $\sigma_u^2 v^\tau$. To ensure that $E(u) = E(v) = 1$, δ and γ are normalized

$$\delta = \sigma_v^{-2} \tag{10}$$

$$\gamma = \frac{\Gamma(\delta)}{\sigma_u^2 \sigma_v^{2\tau} \Gamma(\tau + \delta)} \tag{11}$$

With these restrictions, $\text{Var}(u|v) = \sigma_u^2 \sigma_v^{-2\tau} v^{2\tau} g(0)/g(1)$ is linear in σ_u^2 , and

$$\text{Var}(u) = g(2) \cdot [g(0)/g(1) + \sigma_u^2 \sigma_v^{2\tau}] / g(1) - 1$$

is affine in σ_u^2 , where $g(a) = \Gamma(a\tau + \sigma_v^{-2})$. Correlation between u and v , ρ , is:

$$\rho = \tau \sigma_v \left(\frac{g(2)}{g(1)} \left[\frac{g(0)}{g(1)} + \sigma_u^2 \sigma_v^{2\tau} \right] - 1 \right)^{-1/2}$$

The correlation has the same sign as τ and can take the full range of values on $[-1, 1]$. For example, when $\tau = 1$, $\rho \rightarrow 1$ as $\sigma_u^2 \rightarrow 0$. If $\sigma_u^2 = \tau^2 \sigma_v^2$, then $\rho \rightarrow -1$ as $\tau \rightarrow 0$ from below and $\sigma_v^2 \rightarrow 0$. Correlation is zero if and only if $\tau = 0$, but is not in general monotonic in τ .

A.3 Derivation of the likelihood of the $CM_t/CM_t/\infty$ queuing system.

From the properties of Poisson and exponential processes, when $(s, s + \Delta s)$ is strictly within a period we have the following (where $o(x)$ denotes order smaller than x):

$$\Pr\{1 \text{ entrant in interval } (s, s + \Delta s)\} = \lambda_t \Delta s + o(\Delta s) \quad (12)$$

$$\Pr\{\text{no entrants in interval } (s, s + \Delta s)\} = 1 - \lambda_t \Delta s + o(\Delta s). \quad (13)$$

where $s \in [t - 1, t)$. For any particular firm currently in the market we have:

$$\Pr\{\text{exit in interval } (s, s + \Delta s)\} = \mu_t \Delta s + o(\Delta s) \quad (14)$$

$$\Pr\{\text{not exit in interval } (s, s + \Delta s)\} = 1 - \mu_t \Delta s + o(\Delta s). \quad (15)$$

The probability of any compound event (e.g., entry and an exit) is $o(\Delta s)$. For now all expressions are treated as conditional on (u, v) .

From (12)–(15) one can derive the probability of the number of firms in the market at time t . Most queuing studies focus on the limiting behavior of the system, but here the transient behavior is of interest; in application there is no reason to assume that the system is in steady state (or even that the system is ergodic). Let $N(s)$ be the random variable generating the number of firms (i.e., firms that have entered but not exited) at time $s \in [0, T]$, $n(s)$ be a realization of $N(s)$, and n_t be the number of units in the system at the end of period $t \in \{1, \dots, T\}$. For simplicity each period is of unit length (one year, in the application), so that $n_t = n(t)$. The entry rate $\lambda(s)$ and the failure rate $\mu(s)$ are taken to be constant within a period, so that $\lambda(s) = \lambda_t$ and $\mu(s) = \mu_t$ for $s \in [t - 1, t)$. We begin by deriving the likelihood for n_{t+1} given that $N(t) = n_t$.

Restrict attention for the moment to behavior within a period t , during which λ and μ are constant, and suppress the dependence on t in the notation for λ , μ , and n . Let $P_n(s)$ be the probability that $N(s) = n$. Then from (12)–(15) one can derive a recursive equation for the probability that there are n units in the system at time s :

$$\frac{d}{dt} P_n(s) = -P_n(s)(\lambda + n\mu) + P_{n+1}(s)(n+1)\mu + P_{n-1}(s)\lambda, \quad n \geq 0; \quad (16)$$

see (Kalashnikov, 1994, p.276). Add the initial condition

$$P_n(t-1) = \delta_{n_{t-1}n} \quad (17)$$

where $\delta_{n_{t-1}n}$ is the Kronecker delta (δ_{xy} equals 1 if $x = y$ and 0 otherwise). Equations (16)–(17) form a differential difference equation known as the *forward Kolmogorov equation*, which admits a solution, after employing a generating function that reduces the problem to a linear partial differential equation.

Define the generating function of the sequence $\{P_n(s)\}_{n=0}^{\infty}$ as⁴⁸

$$P(z, s) \equiv \sum_{n=0}^{\infty} P_n(s) z^n, \quad (18)$$

where $z \in \mathbb{C}$, $\|z\| < 1$. $P(z, s)$ allows us to restate (16)–(17) as an initial value partial differential equation:

$$P(z, 0) = z^{n_{t-1}} \quad (19)$$

$$\frac{\partial P}{\partial s} = (1-z) \left[\mu \frac{\partial P}{\partial z} - \lambda P(z, s) \right]. \quad (20)$$

The solution to this partial differential equation is

$$P(z, s) = c \exp[-\kappa(1-z)] \quad (21)$$

where c is an arbitrary function ϕ of $(z-1)e^{-\mu s}$ and $\kappa \equiv \lambda/\mu$ is the *traffic intensity*. To determine c , use (19) to find that

$$\phi(z-1) \exp[-\kappa(1-z)] = z^{n_{t-1}} \Rightarrow \quad (22)$$

$$\phi(w) e^{\kappa w} = (w+1)^{n_{t-1}} \Rightarrow \quad (23)$$

$$\phi((z-1)e^{-\mu s}) = \exp[\kappa(1-z)e^{-\mu s}] [1 - (1-z)e^{-\mu s}]^{n_{t-1}} = c \quad (24)$$

Thus the particular solution of (21) that matches the boundary condition (24) is given by

$$P(z, s) = [1 - e^{-\mu s}(1-z)]^{n_{t-1}} \exp[-\kappa A(s)(1-z)], \quad (25)$$

where $A(s) = 1 - e^{-\mu s}$. Now expand the first term and use the power series expansion of the exponential term to rewrite (25) as

$$P(z, s) = \exp[-\kappa A(s)] \left[\sum_{m=0}^{n_{t-1}} \binom{n_{t-1}}{m} (e^{-\mu s} z)^m A(s)^{n_{t-1}-m} \right] \left[\sum_{n=0}^{\infty} \frac{z^n [\kappa A(s)]^n}{n!} \right]$$

$P_n(s)$ is equal to the coefficient on z^n in $P(z, s)$. When s has run to the end of the period, this coefficient gives us the probability of observing n_t firms in the market at the end of period t . It is therefore the density for n_t , conditional on its lagged value n_{t-1} and on (u_t, v_t) , which enter only through λ and μ . Denote this pdf $f(n_t|n_{t-1}, u_t, v_t)$. It is

$$f(n_t|n_{t-1}, u_t, v_t) = \exp(-\pi_t) \sum_{m=0}^{M_t} B_{mt}, \quad (26)$$

where $M_t \equiv \min\{n_{t-1}, n_t\}$, $\pi_t \equiv \kappa_t(1 - e^{-\mu_t})$, and B_{mt} is defined as

$$B_{mt} \equiv \binom{n_{t-1}}{m} \frac{\pi_t^{n_t-m}}{(n_t-m)!} (e^{-\mu_t})^m (1 - e^{-\mu_t})^{n_{t-1}-m} \quad (27)$$

Finding $f(n_t|n_{t-1})$ requires integrating out the unobserved heterogeneity:

$$f(n_t|n_{t-1}) = E_{u,v} [f(n_t|n_{t-1}, u_t, v_t)] = E_v \{ E_{u|v} [f(n_t|n_{t-1}, u_t, v_t)] \} \quad (28)$$

Begin with the inner expectation and integrate out u (which enters through λ). Due to the assumption that u has a gamma distribution, conditional on v , the inner expectation may be found in closed form, leading to

$$f(n_t|n_{t-1}) = \int_0^{\infty} f(n_t|n_{t-1}, v_t) \mathcal{G}(\delta, \sigma_v^2; v) dv_t, \quad (29)$$

⁴⁸In the rest of this section, s should, strictly speaking, be Δs , the time elapsed in the current period.

where

$$f(n_t|n_{t-1}, v_t) = \left(\frac{1}{\tilde{\pi}_t + 1}\right) \sum_{m=0}^{M_t} \tilde{B}_{mt} \left[\frac{\Gamma(n_t - m + \gamma)}{\Gamma(\gamma)} \left(\frac{1}{\tilde{\pi}_t + 1}\right)^{n_t - m} \right], \quad (30)$$

$\tilde{\pi}_t \equiv \pi_t \sigma_u^2 v_t^\tau / u_t$, \tilde{B}_{mt} is as in (27) but with $\tilde{\pi}_t$ replacing π_t , \mathcal{G} is as in (6), $M_t \equiv \min\{n_{t-1}, n_t\}$, and restrictions (10)–(11) are imposed. The remaining integral in (29) cannot be solved analytically, and so numerical integration is used to evaluate the density (29); see Prieger (2004b) for details.

Regarding identification, note that λ appears in the likelihood only through $\tilde{\pi}$. However, μ is separately identified through the last two terms in (27), which are recognizable as the binomial probability of seeing m out of n_{t-1} firms not exit given exponential failure rate μ . In this sense variation in n_{t-1} identifies the failure rate, which (in conjunction with (10)–(11)) allows identification of the entry rate from $\tilde{\pi}$.

Table 1: Changes in Entry and Exit in Response to Cost Increases

Entry of New Firms	Exit of Incumbents	Nomenclature
decreases	increases	competitor neutral
decreases	decreases	incumbent favoring
increases	increases	entrant favoring

Table 2: Description of Data

Variable	mean	s.d.
Adult population disabled (percentage, log)	2.36	0.22
Area (log sq. miles)	6.51	0.76
Capital cost (real, x 100, log)	1.71	0.09
EEOC charge rate (x 1000), 1992-1993	0.18	0.59
EEOC charge rate (x 1000), 1994-1996	0.60	1.12
FEP (state had strong pre-ADA disability law, 1=yes, 0=no)	0.32	0.47
Labor cost (real, in thousands, log)	2.58	0.20
Per capital income (real, in thousands, log)	2.46	0.22
Population (log)	10.17	1.38
Region: Midwest (1=yes, 0=no)	0.34	0.48
Region: South (1=yes, 0=no)	0.45	0.50
Region: West (1=yes, 0=no)	0.14	0.34
SIC 54 establishments, large, 1988-1997	5.62	17.68
SIC 54 establishments, large, 1988-1991	5.46	17.67
SIC 54 establishments, large, 1992-1993	5.65	17.52
SIC 54 establishments, large, 1994-1997	5.85	17.78
SIC 54 establishments, medium, 1988-1997	5.09	12.81
SIC 54 establishments, medium, 1988-1991	5.33	13.47
SIC 54 establishments, medium, 1992-1993	4.91	12.14
SIC 54 establishments, medium, 1994-1997	4.81	12.08
SIC 54 establishments, small, 1988-1997	48.46	149.09
SIC 54 establishments, small, 1988-1991	49.33	149.30
SIC 54 establishments, small, 1992-1993	48.23	150.33
SIC 54 establishments, small, 1994-1997	47.17	147.90
SIC 54 establishments, total, 1988-1997	59.17	177.33
SIC 54 establishments, total, 1988-1991	60.13	178.52
SIC 54 establishments, total, 1992-1993	58.79	177.67
SIC 54 establishments, total, 1994-1997	57.83	175.10
Title III case rate (x 100,000), 1992-1993	0.01	0.08
Title III case rate (x 100,000), 1994-1996	0.12	0.35

Note: unit of observation is a U.S. county, yearly 1988-1997.

Table 3: Estimation Results for the Number of Food Stores—Specification A (Differences in Means Before and After the ADA)

	Poisson Regression 1		Poisson Regression 2		Fixed Effects Poisson Regression	
	estimate	s.e.	estimate	s.e.	estimate	s.e.
<i>Difference-in-mean estimates</i>						
1989	-0.010**	(0.002)	-0.011**	(0.002)	0.002	(0.003)
1990	-0.008*	(0.003)	-0.010**	(0.003)	0.011**	(0.004)
1991	-0.007	(0.004)	-0.008	(0.004)	0.016**	(0.005)
1992	-0.004	(0.004)	-0.005	(0.004)	0.025**	(0.006)
1993	-0.062**	(0.006)	-0.063**	(0.006)	-0.023**	(0.008)
1994	-0.069**	(0.007)	-0.071**	(0.007)	-0.022*	(0.009)
1995	-0.084**	(0.008)	-0.086**	(0.007)	-0.029**	(0.010)
1996	-0.108**	(0.009)	-0.111**	(0.008)	-0.045**	(0.011)
1997	-0.133**	(0.011)	-0.137**	(0.010)	-0.065**	(0.012)
<i>Other variables</i>						
area	-0.040*	(0.019)	-0.049**	(0.018)		
population	0.942**	(0.012)	0.932**	(0.012)	0.354**	(0.065)
per cap income	0.161	(0.089)	0.225**	(0.073)	-0.048	(0.054)
labor cost	-0.139	(0.083)	-0.180*	(0.081)	0.094	(0.079)
constant	-6.102**	(0.224)	-6.107**	(0.240)		
state dummies	no		yes		n.a.	
Log likelihood	-129,899		-119,961		-70,139	
Pseudo R^2	0.942		0.947		0.969	

* = 5% significance level; ** = 1% significance level.

Notes: Dependent variable is total number of food stores (SIC 5400) in county in year. $N = 30,578$ in all estimations. Standard errors (s.e.'s) are calculated with the Huber-White sandwich estimator, and are robust to overdispersion and clustering within each county; s.e.'s for the fixed effects regression are calculated via bootstrap with 400 repetitions. The excluded year dummy is 1988. The fixed effects regression is a “within county” specification and is estimated by conditional MLE (assuming the effects are gamma distributed).

**Table 4: Estimation Results for Entry and Exit from $CM_t/CM_t/\infty$ Model—
Specification A (Differences in Means Before and After the ADA)**

	No Heterogeneity		Heterogeneity	
	estimate	s.e.	estimate	s.e.
Entry rate parameters				
<i>Difference-in-mean estimates</i>				
Years 93-94	-0.049 **	(0.016)	-0.149 **	(0.023)
Years 95-97	-0.088 **	(0.014)	-0.084 **	(0.019)
<i>Other variables</i>				
Area	0.044 **	(0.009)	0.015	(0.015)
Population	1.025 **	(0.007)	0.708 **	(0.010)
Per cap income	0.010	(0.044)	0.233 **	(0.058)
Capital cost	0.676 **	(0.061)	-0.102	(0.103)
Labor cost	-0.154 *	(0.062)	-0.224 **	(0.066)
Midwest	-0.243 **	(0.023)	-0.226 **	(0.037)
South	0.152 **	(0.021)	0.129 **	(0.036)
West	-0.233 **	(0.033)	-0.074	(0.044)
Constant	1.298 **	(0.021)	0.765 **	(0.036)
Failure rate parameters				
<i>Difference-in-mean estimates</i>				
Years 93-94	0.102 **	(0.015)	0.209 **	(0.021)
Years 95-97	0.068 **	(0.014)	0.131 **	(0.019)
<i>Other variables</i>				
Area	0.081 **	(0.008)	-0.006	(0.011)
Population	0.065 **	(0.006)	-0.153 **	(0.009)
Per cap income	-0.095 *	(0.040)	-0.048	(0.047)
Capital cost	1.148 **	(0.054)	1.273 **	(0.078)
Labor cost	0.009	(0.056)	0.088	(0.060)
Midwest	0.056 **	(0.020)	0.167 **	(0.025)
South	0.255 **	(0.018)	0.205 **	(0.025)
West	-0.022	(0.029)	0.145 **	(0.033)
Constant	-1.910 **	(0.019)	-2.530 **	(0.026)
Nuisance parameters				
σ_u^2			0.041 *	(0.017)
σ_v^2			0.274 **	(0.007)
τ			-0.542 **	(0.146)
ρ (correlation)			-0.688	
Log likelihood	-77836.5		-73989.15	
Pseudo R^2	0.446		0.090	
N	30,578		30,578	

* = 5% significance; ** = 1% significance.

Note: Dependent variable: number of food stores (SIC 5400) in county in year. The excluded period dummy is the pre-ADA period 1988-1992. Standard errors (s.e.) are robust to clustering within county. Heterogeneous likelihood evaluated by 20 point Gauss-Laguerre quadrature. Pseudo R^2 is $1-L_1/L_0$, where L_0 is the likelihood of an intercepts only (plus σ_u^2 , σ_v^2 , and ρ in the heterogeneous model) model and L_1 is the likelihood of the full model.

**Table 5: Estimation Results for the Number of Food Stores—Specification B
(ADA-Specific Variables)**

	Poisson Regression 1		Poisson Regression 2		Fixed Effects Poisson Regression	
	estimate	s.e.	estimate	s.e.	estimate	s.e.
<i>Difference estimates</i>						
% adults disabled, 1993-94	-0.056 *	(0.027)	-0.070 **	(0.018)	-0.050**	(0.016)
% adults disabled, 1995-97	-0.001	(0.035)	-0.052 *	(0.023)	-0.039	(0.021)
EEOC charge rate, 1993-94	-0.075 **	(0.011)	-0.018 **	(0.004)	-0.010**	(0.003)
EEOC charge rate, 1995-97	-0.058 **	(0.009)	-0.014 **	(0.004)	-0.006	(0.003)
Title III case rate, 1993-1994	-0.161 **	(0.058) [†]	-0.008	(0.013) [†]	-0.011	(0.024) [†]
Title III case rate, squared, 1993-1994	0.033 **	(0.009) [†]	0.005 **	(0.002) [†]	0.005**	(0.031) [†]
Title III case rate, 1995-1997	0.005	(0.010)	0.003	(0.004)	0.000	(0.004)
<i>Difference-in-difference estimates</i>						
Strong FEP state, 1993-94	0.010	(0.008)	0.027 **	(0.008)	0.022**	(0.007)
Strong FEP state, 1995-97	0.012	(0.012)	0.025 *	(0.011)	0.015	(0.010)
<i>Main effects (apply to all years)</i>						
% adults disabled	0.171 **	(0.040)	0.058 **	(0.016)	0.029*	(0.013)
FEP state	0.091 **	(0.019)	0.173 **	(0.067)	n.a.	
State dummies	no		yes		n.a.	
Log likelihood	-133,726		-119,791		-70,085	
Pseudo R^2	0.941		0.947		0.969	

* = 5% significance level; ** = 1% significance level.

[†] S.e. shown is calculated the usual way, but significance stars are based on Efron's (1981) percentile interval (using the $\alpha/2$ and $1-\alpha/2$ quantiles of the bootstrapped distribution of the coefficient, with 3,999 replications, where α is the significant level), because bootstrapping reveals that the distributions of the quadratic terms for Title III case rate, 1993-94, are skewed and t -tests using the bootstrap s.e.'s may be misleading.

Notes: Dependent variable is total number of food stores (SIC 5400) in county in year. $N = 30,578$ in regressions 1 and 2; $N = 30,528$ in regression 3. Each standard error (s.e.) is robust to clustering within each county; s.e.'s for the fixed effects regression are calculated via bootstrap with 400 repetitions. All estimations include all controls from Specification A (Table 3), including year dummies. All *Difference* estimates are differences from the pre-ADA period. The fixed effects regression is estimated by conditional MLE and exploits variation within each county only to identify the coefficients.

**Table 6: Estimation Results for Entry and Exit from $CM_t/CM_t/\infty$ Model—
Specification B (ADA-Specific Variables)**

	No Heterogeneity		Heterogeneity	
	<i>estimate</i>	<i>s.e.</i>	<i>estimate</i>	<i>s.e.</i>
Entry rate parameters				
<i>Difference estimates</i>				
% adults disabled, 1993-94	-0.692 **	(0.066)	-0.357**	(0.106)
% adults disabled, 1995-97	-0.076	(0.073)	-0.046	(0.092)
EEOC charge rate, 1993-94	-0.331 **	(0.013)	-0.089**	(0.020)
EEOC charge rate, 1995-97	-0.040 **	(0.010)	-0.017	(0.014)
Title III case rate, 1993-1994	-0.084 *	(0.036)	-0.062	(0.068)
Title III case rate, 1995-1997	0.134 **	(0.021)	0.114**	(0.032)
<i>Difference-in-difference estimates</i>				
Strong FEP state, 1993-94	-0.101 **	(0.031)	-0.056	(0.049)
Strong FEP state, 1995-97	-0.043	(0.026)	-0.071	(0.038)
<i>Main effects (apply to all years)</i>				
% adults disabled	0.154 **	(0.043)	0.125*	(0.055)
Strong FEP state	-0.002	(0.020)	0.006	(0.025)
Failure rate parameters				
<i>Difference estimates</i>				
% adults disabled, 1993-94	-0.489 **	(0.059)	-0.462**	(0.088)
% adults disabled, 1995-97	-0.151 *	(0.068)	-0.212**	(0.082)
EEOC charge rate, 1993-94	-0.528 **	(0.013)	-0.476**	(0.017)
EEOC charge rate, 1995-97	-0.022 *	(0.009)	-0.001	(0.012)
Title III case rate, 1993-1994	0.013	(0.046)	-0.125	(0.115)
Title III case rate, 1995-1997	0.131 **	(0.018)	0.140**	(0.026)
<i>Difference-in-difference estimates</i>				
Strong FEP state, 1993-94	-0.163 **	(0.028)	-0.100**	(0.037)
Strong FEP state, 1995-97	-0.017	(0.024)	0.031	(0.034)
<i>Main effects (apply to all years)</i>				
% adults disabled	0.035	(0.042)	0.121*	(0.051)
Strong FEP state	-0.032	(0.019)	-0.046*	(0.023)
Includes Controls from Model A	Yes		Yes	
Pseudo R^2	0.451		0.073	
Log likelihood	-77077.1		-73,548.5	

* = 5% significance; ** = 1% significance. $N = 30,578$.

Dependent variable: total number of food stores (SIC 5400) in county in year. The excluded period dummy is the pre-ADA period 1988-1992. Specification also includes all variables in specification A, table 4.

**Table 7: Instrumental Variables Estimations for Specification B
(ADA-Specific Variables)**

	OLS Regression		IV Regression	
	estimate	s.e.	estimate	s.e.
<i>Difference estimates</i>				
% adults disabled, 1993-94	-0.101 *	(0.041)	-0.190 *	(0.087)
% adults disabled, 1995-97	-0.069	(0.047)	-0.356 **	(0.126)
EEOC charge rate, 1993-94	-0.037 **	(0.007)	-0.049 *	(0.025)
EEOC charge rate, 1995-97	-0.040 **	(0.006)	-0.089 **	(0.023)
Title III case rate, 1993-1994	-0.014	(0.026)	-0.010	(0.038)
Title III case rate, squared, 1993-1994	0.013 **	(0.004)	0.011 *	(0.005)
Title III case rate, 1995-1997	0.044 **	(0.011)	0.018	(0.012)
<i>Main effects (apply to all years)</i>				
% adults disabled	0.046	(0.046)	0.190	(0.174)
State dummies	yes		yes	
Hansen J Statistic (OverID test)		n.a.		3.469
<i>p</i> -value of Hansen J Statistic		n.a.		0.628

* = 5% significance level; ** = 1% significance level.

Notes: Dependent variable is the square root of the total number of food stores (SIC 5400) in county in year. Sample is restricted to years 1991-1997. $N = 21,406$. Each standard error (s.e.) is robust to clustering within each county. All estimations include all controls from Specification A (Table 3), including year dummies. *Difference* estimates are differences from the pre-ADA period.

**Table 8: Estimation Results for the Number of Food Stores—Specification C
(ADA-Specific Variables, Differenced over Store Sizes)**

	Poisson Regression 1		Poisson Regression 2		Fixed Effects Poisson Regression	
	estimate	s.e.	estimate	s.e.	estimate	s.e.
Small stores differenced off large stores						
<i>Difference-in-difference estimates</i>						
% adults disabled, 1993-94	-0.115 *	(0.047)	-0.131 **	(0.033)	-0.128**	(0.030)
% adults disabled, 1995-97	-0.179 **	(0.052)	-0.159 **	(0.039)	-0.164**	(0.037)
EEOC charge rate, 1993-94	-0.066 **	(0.015)	-0.020 **	(0.006)	-0.014**	(0.005)
EEOC charge rate, 1995-97	-0.027 *	(0.012)	-0.010	(0.007)	-0.004	(0.006)
Title III case rate, 1993-94	-0.239 *	(0.268) [†]	-0.011	(0.036) [†]	-0.014	(0.040) [†]
Title III case rate, squared, 1993-1994	0.061 **	(0.386) [†]	0.009	(0.034) [†]	0.008	(0.049) [†]
Title III case rate, 1995-97	0.009	(0.015)	-0.017 **	(0.007)	-0.018**	(0.007)
<i>Difference-in-difference-in-differences</i>						
Strong FEP state, 1993-94	0.013 **	(0.015)	0.028	(0.016)	0.028*	(0.013)
Strong FEP state, 1995-97	0.034 **	(0.021)	0.044 *	(0.021)	0.040*	(0.018)
Medium stores differenced off large stores						
EEOC charge rate, 1993-94	-0.084 **	(0.020)	-0.019	(0.013)	-0.017	(0.011)
EEOC charge rate, 1995-97	-0.041 **	(0.015)	-0.025 **	(0.010)	-0.022**	(0.008)
State dummies	no		yes		n.a.	

* = 5% significance level; ** = 1% significance level.

[†] S.e. shown is calculated the usual way, but significance stars are based on Efron's (1981) percentile interval (using the $\alpha/2$ and $1-\alpha/2$ quantiles of the bootstrapped distribution of the coefficient, with 3,999 replications, where α is the significant level), because bootstrapping reveals that the distributions of the quadratic terms for Title III case rate, 1993-94, are skewed and t -tests using the bootstrap s.e.'s may be misleading.

Notes: $N = 30,578$ in each estimation, using SIC 54 data. Estimates are differences across sizes of stores (as noted in first column) in differences over time (as noted in row headings; compared to the pre-ADA period). For each specification there are three separate underlying estimations (one for each of small, medium, and large stores). All variables from Specifications A and B are included in each estimation; only the estimates of interest are reported in the table. Each standard error (s.e.) is robust to clustering within each county, and is calculated via bootstrap with 3,999 repetitions to account for covariance between coefficients that are differenced.

**Table 9: Estimation Results for Entry and Exit from $CM_t/CM_t/\infty$ Model—
Specification C (ADA-Specific Variables, Differenced over Store Sizes)**

	No Heterogeneity		Heterogeneity	
	<i>estimate</i>	<i>s.e.</i>	<i>estimate</i>	<i>s.e.</i>
<i>Small stores differenced off large stores</i>				
Entry rate parameters				
<i>Difference-in-difference estimates</i>				
% adults disabled, 1993-94	-0.999**	(0.171)	-0.643**	(0.205)
% adults disabled, 1995-97	-0.023	(0.162)	0.001	(0.185)
EEOC charge rate, 1993-94	-0.234**	(0.033)	-0.020	(0.038)
EEOC charge rate, 1995-97	0.009	(0.024)	0.024	(0.027)
Title III case rate, 1993-94	-0.460*	(0.193)	-0.301	(0.213)
Title III case rate, 1995-97	0.059	(0.048)	0.046	(0.057)
<i>Difference-in-difference-in-differences</i>				
Strong FEP state, 1993-94	-0.203**	(0.075)	-0.153	(0.090)
Strong FEP state, 1995-97	0.056	(0.065)	0.016	(0.076)
Failure rate parameters				
<i>Difference-in-difference estimates</i>				
% adults disabled, 1993-94	-0.838**	(0.181)	-0.784**	(0.212)
% adults disabled, 1995-97	-0.270	(0.163)	-0.338	(0.186)
EEOC charge rate, 1993-94	-0.370**	(0.034)	-0.318**	(0.040)
EEOC charge rate, 1995-97	0.002	(0.027)	0.008	(0.031)
Title III case rate, 1993-94	-0.390*	(0.193)	-0.322	(0.232)
Title III case rate, 1995-97	0.022	(0.051)	0.034	(0.060)
<i>Difference-in-difference-in-differences</i>				
Strong FEP state, 1993-94	-0.372**	(0.078)	-0.337**	(0.091)
Strong FEP state, 1995-97	0.064	(0.069)	0.081	(0.081)
<i>Medium stores differenced off large stores</i>				
Entry rate parameters				
EEOC charge rate, 1993-94	0.049	(0.037)	0.068	(0.039)
EEOC charge rate, 1995-97	0.028	(0.029)	0.032	(0.030)
Failure rate parameters				
EEOC charge rate, 1993-94	0.088*	(0.039)	0.123**	(0.045)
EEOC charge rate, 1995-97	0.086**	(0.031)	0.071*	(0.034)

* = 5% significance; ** = 1% significance. $N = 30,578$. Dependent variable: total number of food stores (SIC 5400) in county in year. The excluded period dummy is the pre-ADA period 1988-1992. Specification also includes all variables in specification A, Table 4.

Table 10: Effect of the ADA on the Number, Entry, and Exit of Food Stores (Based on Specification C)

	Direct Estimates from Standard Count Data Models			Indirect Estimates from $CM_t/CM_t/\infty$ Model					
	Poisson Regression 1	Poisson Regression 2	Fixed Effects Poisson Regression	No Heterogeneity			Heterogeneity		
	$\Delta(\text{Number of Stores})$	$\Delta(\text{Number of Stores})$	$\Delta(\text{Number of Stores})$	ΔEntry	ΔExit	Implied $\Delta(\text{Number of Stores})$	ΔEntry	ΔExit	Implied $\Delta(\text{Number of Stores})$
Initial ADA Period: 1993-1994									
Small Stores	-2,505	-2,402	-2,050	1,600	3,057	-1,457	486	1,141	-655
% Δ in small stores	-1.7%	-1.6%	-1.4%	17.1%	21.5%	-1.0%	5.2%	8.0%	-0.4%
Medium Stores	-1,150	-395	-400	62	410	-348	161	554	-393
% Δ in medium stores	-7.7%	-2.6%	-2.7%	1.7%	9.1%	-2.3%	4.4%	12.3%	-2.6%
<i>Total</i>	-3,654	-2,798	-2,450	1,662	3,467	-1,804	647	1,695	-1,048
% Δ in small & medium stores	-2.2%	-1.7%	-1.5%	12.8%	18.5%	-1.1%	5.0%	9.1%	-0.6%
Later ADA Period: 1995-1997									
Small Stores	-1,618	-2,660	-2,052	2,130	1,996	134	763	504	259
% Δ in small stores	-1.1%	-1.8%	-1.4%	20.3%	15.2%	0.1%	7.3%	3.8%	0.2%
Medium Stores	-956	-1,029	-925	-48	350	-399	30	319	-289
% Δ in medium stores	-6.5%	-7.0%	-6.3%	-1.1%	7.5%	-2.7%	0.7%	6.8%	-2.0%
<i>Total</i>	-2,574	-3,689	-2,977	2,082	2,346	-264	793	823	-30
% Δ in small & medium stores	-1.6%	-2.3%	-1.9%	14.1%	13.2%	-0.2%	5.4%	4.6%	-0.02%

Notes: All figures are difference-in-difference estimates (net of trends for large stores) and are relative to a counterfactual “no ADA” regime. In the counterfactual *Title III case rate* is set to zero and *Strong FEP state* for the ADA periods is set to one. For the medium stores, in addition *EEOC charge rate* is set to zero in the counterfactual. $\Delta(\text{Number of Stores})$ for the direct estimates is based on coefficients from the estimations from Table 8. ΔEntry is calculated as the difference in $\hat{\lambda}$ [equation (3)] and ΔExit as the difference in $N_{t-1}\hat{\mu}$ [$\hat{\mu}$ from equation (4)] relative to the counterfactual, based on coefficients from the estimations from Table 9. *Implied $\Delta(\text{Number of Stores})$* is calculated as ΔEntry minus ΔExit . All figures are calculated at the county level and aggregated to the national level.

Figure 1:
Percentage Changes in the Number of Retail Establishments by SIC

