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Seasonal Demand and Net Entry

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Abstract

This paper explores the relationship of seasonality of demand with net entry. Using data on the poured concrete contracting industry from 2007-2012, it is shown that increases in the seasonality of demand, as measured by the ratio of first quarter to annual construction payroll, predict less exit within each county in the time period around the Great Recession. IV estimation uses weather patterns to instrument payroll measures and supports conclusions. It is suggested that in seasonal industries, firms may reach capacity constraints in the high season, in turn reducing competition and reducing exit through increased profits. A model of Bertrand competition with capacity constraints and seasonal demand is presented.

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1 Introduction

Seasonal demand is a prevalent aspect of many industries: tax preparation, travel, clothing, and many others. In such industries, firms exist in the market through low and high-demand seasons, presumably with minimal differences in their capital stock and production capacity. This paper uses data from the poured concrete contracting industry over the years 2007-2012 to examine the relationship of seasonality of demand with net entry. Demand for poured concrete is measured by the payroll to construction workers at the county level. Seasonality of demand is measured by the ratio of first quarter to annual payroll. It is shown that an increase in seasonality, conditional on total demand, (a decrease in first quarter payroll relative to annual payroll) is associated with a decrease in net exit. It is posited that fluctuations in seasonality cause firms to reach capacity constraints in the high demand season, reducing the ability of firms to compete and increasing profits. With increased profits, net exit may decrease.

This paper contributes to two literatures, (1) seasonality of demand and (2) strategic exit. Implications of seasonal (or cyclical) demand have been studied regarding markups and collusion. One strand of literature predicts that collusion is more susceptible to break down in the low demand state (see Borenstein and Shepard 1996 and Ellison 1994). This conclusion is not universal. Papers with a contrary conclusion include Rotemberg and Saloner (1986) and Kandori (1991). The present paper adds to this literature by suggesting that even in competitive markets, seasonal demand can influence profits and net entry, specifically that highly seasonal demand may increase profits and decrease exit. Other related work has studied implications of supply seasonality (see Winfree et al. 2004 and Arnade and Pick 2000). The theme of such literature is that seasonal supply allows for market power when some firms are not active in the market.

Regarding strategic exit, Takahashi (2015) studies the declining movie theater industry in the 1950s and shows that firms strategically do not maximize profits by being the first to exit a market. Similarly, demand for poured concrete declined during the Great Recession. This resulted in net exit from the poured concrete contracting industry. The primary effect identified in this work is that greater seasonality within a county slowed the rate of net exit, presumably resulting from higher profits due to limited competition caused by capacity constraints.

The main difficulty in estimating implications of seasonal demand is the need for plausibly exogenous variation in the degree of seasonality. To this end, the concrete industry is a natural lens through which to study the effects of seasonality. Weather patterns determine if a market has demand for concrete which is concentrated in summer (if a market-year has a harsh winter), or spread out throughout the year (if a market-year has a mild winter). In addition, there is minimal interaction in the concrete industry across geographic markets. It is reasonable to assume that implications of seasonality in the concrete market may be relevant in a variety of other markets, although estimating effects may be difficult due to the lack of exogenous variation.

The concrete industry has attracted the interest of economists in answering many other questions.[1] A specific example is Collard-Wexler's (2013) study of the volatility of demand over years and the effects on market composition. Collard-Wexler finds that smoothing demand in the ready-mix concrete industry across years would increase entry by 39%, presumably decreasing market power. While similar in spirit, this paper examines a different mechanism. The year-to-year demand volatility as studied by Collard-Wexler is neither predictable nor associated with firms charging higher markups systematically. Seasonal demand differs because it may allow firms to garner higher profits due to capacity constraints limiting competition in the high season. Thus, the two forms of demand volatility imply opposite effects on profits and entry.

This paper proceeds with presentation of the model motivating the proposed mechanism, a description of the data and empirical strategy, presentation of empirical results, and concludes with discussion.

2 Model

There are two *states*, L and H, interchangeably referred to as *seasons*. The market is in state H a fraction $\lambda \in (0, 1)$ of the year. In the market there is a measure of M_H consumers which purchase in the high state, and M_L which purchase in the low state. Each consumer has demand for one unit of concrete in each state. Demand is inelastic up to a choke price of $\bar{p}$, above which consumers do not purchase. Such price inelastic demand may seem unreasonable, however concrete is a small portion of construction costs, and demand is typically modeled as price inelastic (see Collard-Wexler 2013 and Syverson 2004). Each firm has a capacity constraint representing the quantity it can provide in a unit of time, κ. In state H, a firm cannot sell more than $\kappa_H := \lambda\kappa$ units, similarly in state L a firm cannot sell more than $\kappa_L := (1 - \lambda)\kappa$ units.[2] Firms pay an annual cost of χ to maintain operations (representing property taxes and overhead costs).

Each firm has the same constant marginal cost of production, $c < \bar{p}$, and is aware of the number of firms, N. Firms set their state-dependent price, p_{Si}, in expectation of other firms' prices. Consumers make their purchases given the resulting set of prices and the choke price. Thus, the model is based on Bertrand competition with capacity constraints, subject to a choke price.[3] This is similar in spirit to Ryan (2012) who models cement production as a Cournot game with capacity constraints. In addition, Collard-Wexler (2013) notes in his empirical results that the ready-mix concrete industry echoes Bertrand-like competition. An *equilibrium* is defined by a set of prices for each firm such that all firms maximize profits given prices chosen by all other firms. Equilibrium is presented in cases.

[1] Among others, papers using the concrete industry include Syverson's (2004) study of differences in productivity and demand concentration, Chicu and Ziebarth's (2013) analysis of multi-market contact, Albaek et al.'s (1997) study of public prices reducing oligopoly price competition, and Collard-Wexler's (2014) evaluation of the high fixed costs of the industry slowing post-merger entry following a merger.

[2] In applications (such as what follows) there may not be strict capacity constraints, however firms may face rapidly increasing, convex, marginal costs and act as if they face capacity constraints.

[3] Previous work regarding Bertrand competition with capacity constraints includes Peters (1984) which includes a consumer search problem and Lambson (1994) and (1995) who considers penal codes in a collusive outcome. Brock and Scheinkman (1985) consider the effects of additional firms on the collusive outcome.

2.1 Equililbrium

2.1.1 $\mathbf{M_S \leq (N-1)\kappa_S}$

If $M_S \leq (N-1)\kappa_S$, then either one firm sells quantity of 0, or there are at least two firms for which the capacity constraint does not bind. Competition reduces to standard Bertrand competition with a choke price. The unique pure strategy equilibrium is $p_{Si} = c$ for all firms. Expected profits are 0. There do exist asymmetric equilibria with zero profits, but their existence does not impact analysis.

2.1.2 $\mathbf{(N-1)\kappa_S < M_S < N\kappa_S}$

In this setting the capacity constraint can bind for all but a single firm. The unique symmetric, mixed strategy equilibrium is presented, however the mathematical derivation is suppressed for brevity. Each firm mixes their price chosen over the set $[p_{S0}, p_{S1}]$ with continuous density F. The quantity sold by firm i is $M_S - \kappa_S[N-1]$ if all firms charge a lower price, and quantity is κ_S if at least one firm charges a higher price. In equilibrium it must be that firms are indifferent between all $p_{Si} \in [p_{S0}, p_{S1}]$. The mathematical derivation of the equilibrium-defining F solves to: $F(p_{Si})^{N-1} = \frac{(p_{S1}-c)(M_s-[N-1]\kappa_S)-(p_{Si}-c)\kappa_S}{[p_{Si}-c](M_S-\kappa_S N)}$.

Furthermore, $p_{S0} = \frac{(p_{S1}-c)(M_S-[N-1]\kappa_S))}{\kappa_S} + c > c$ and $p_{S1} = \bar{p}$. In this mixed-strategy equilibrium, each firm draws a price from $[p_{S0}, \bar{p}]$ as determined by F. The firm with the highest price sells quantity equal to $M_S-(N-1)\kappa_S$. All other firms sell quantity equal to their capacity, κ_S. Solving for expected profit prior to choosing price is straightforward because the expected profit is the same when charging any $p \in [p_{S0}, p_{S1}]$. Consider the maximum price, $p_{S1} = \bar{p}$. Expected profit is $(\bar{p}-c)(M_S - \kappa_S[N-1])$. (Note that quantity is $M_S - \kappa_S[N-1]$ because all opposing firms will charge a price lower than $\bar{p}$ with probability 1, thus selling quantity equal to their capacity constraint). This expression is the expected profit of charging any price in the mixed strategy. Expected profits are therefore $(\bar{p}-c)(M_S - \kappa_S[N-1])$.

2.1.3 $\mathbf{N\kappa_S \leq M_S}$

The capacity constraint always binds for all firms regardless of the prices chosen. The rational outcome is for all firms to charge $\bar{p}$, obtaining expected profits $(\bar{p}-c)\kappa_S$.

2.1.4 Exit

The exit of a firm is defined by a liquidity constraint, L. If the value of a firm drops below L the firm must exit. Let V_{t-1} denote value at the end of time $t-1$ and π_t profit at time t. The evolution of value is $V_t = \pi_t + V_{t-1}$. Firms exit if $V_t < L$.

2.2 Discussion

The equilibrium prices charged are increasing in M_S. When κ_S is large relative to M_S such that capacity constraints are never binding, firms function as Bertrand competitors, charging marginal cost. When κ_S and M_S are such that the capacity constraint can not bind for all firms, but can bind for all but one firm, competition generates a mixed strategy equilibrium, mixing over prices $[p_{S0}, \bar{p}]$. When capacity constraints bind for all firms, the choke price is charged.

The following function of M_S defines profit in state s.

$$\pi_S(M_S) = \begin{cases} 0 & M_S \leq [N-1]\kappa_S \\ (\bar{p}-c)(M_S - \kappa_S[N-1]) & \kappa_S[N-1] < M_S < N\kappa_S \\ (\bar{p}-c)(\kappa_S) & N\kappa_S \leq M_S \end{cases}$$

Annual profit is

$$\pi = \pi_L(M_L) + \pi_H(M_H) - \chi$$

In this setting *seasonality* of demand is defined by the relative values of M_H and M_L. This paper suggests that, conditional on total demand, $M := M_H + M_L$, that seasonality will affect profits, and therefore net exit, through the binding of capacity constraints which may reduce competition. The key to the proposed mechanism is that profit in the low state may be generally unaffected by fluctuations in M_L, while profit in the high state may be strongly affected by fluctuations in M_H. More specifically, suppose that both M_H and M_L have baseline levels, however are subject to (perhaps correlated) shocks each year. The baseline of M_L may be low such that $M_L \leq [N-1]\kappa_L$ for all values of M_L which are realized, however the baseline level of M_H may be such that the capacity constraint binds for many or all firms depending on fluctuations in M_H. In this setting, should seasonality increase while holding total demand fixed (M_H increasing and M_L declining), average profits increase.

If liquidity constraints and profits influence exit as modeled, positive shocks to seasonality within a market will reduce exit. It is difficult to argue that increased profit resulting from shocks to seasonality should affect year-to-year entry. Entry decisions are made by forward-looking agents. If shocks are persistent then such entry may be rational. It is possible that boundedly rational agents may consider entry based on past market profits, although this paper does not focus on undue appeal to the *ad hoc*. It is suggested that the mechanism resulting in net entry is a decrease in exit. The empirical application focuses on an industry and time which exhibits net exit. The results imply a decrease in exit rather than an increase in entry.

3 Data and Methodology

3.1 Data

The model describes how the realized degree of seasonality in a market can influence profits and affect net entry (note that the ex ante expectation of seasonality does not play a role). The ideal data set for analysis to test this hypothesis would be measures of the seasonality of demand and total demand, as well as data on capacity (or marginal cost), quantity, and price at the firm-quarter or firm-month level. Due to the restricted nature of such data, analysis proceeds in a reduced form manner to analyze the effects of seasonality on net exit. Data are drawn at the county level from the 2006-2012 County Business Patterns (CBP). The outcome variable is the number of firms with North American Industry Classification System (NAICS) code, 23811 "Poured Concrete Foundation and Structure Contractors". Poured concrete contracting is used rather than the ready-mix concrete production because there are a larger number of smaller contracting firms, thus entry and exit are more prevalent allowing for the needed variation to identify effects. Data are restricted to county-years in for which the lag observation had two or more firms.

Due to data limitations, it is difficult to confirm rigorously that results are driven by capacity constraints. Future work may attempt to incorporate restricted-use data to estimate capacity and test the predictions of this paper more rigorously. This paper only presents an empirical observation and suggests a plausible mechanism.

The CBP includes two measures of payroll, first quarter and annual. In analysis, the measure of demand in market j during year t, M_{jt}, is the annual payroll in the construction industry, firms in NAICS codes beginning with 236 and 237. These codings include residential, nonresidential, civil, utility, and other civil construction including highway and bridge construction. The explanatory variable of interest is the ratio of first quarter and annual payroll. Payroll in the first quarter is almost always less than one-fourth of total payroll, therefore larger numbers of this measure correspond to more evenly dispersed payroll and less seasonality. This measure assumes that the low season is the first quarter of the year. This is reasonable because the first quarter is typically the coldest of the year. The use of payroll to proxy demand relies on the assumption that payroll of construction firms is related to how much concrete construction firms are demanding. Observations are excluded for which either of these payroll measures is zero for either NAICS code 236 or 237 because this indicates true values are withheld to protect confidentiality.

The use of first quarter payroll to define the low season's demand imposes the assumption that $\lambda = .75$. This is beneficial in the sense that it is not cherry-picked to provide significant results, it is detrimental in that λ cannot be estimated. This is not a concern because the mechanism described relies only on the existence of two subsets of a year that are characterized by different total quantity demanded.

Payroll to construction employees is likely jointly determined with the change in the number of concrete contractors. To instrument the above payroll measures, data on average monthly high temperatures are collected from the Center for Disease Control for each county-month from 2006 to 2011. Specifically, the average high temperatures in January and July are respectively used as instruments for the ratio of first quarter to annual payroll, and annual payroll. The use of weather instruments relies on the assumption that weather influences net entry of concrete contractors only through affecting demand from the construction industry.

Table 1 shows the average number of firms, and net entry, split by whether the lag ratio of construction payroll was above or below the median (the median ratio is .215). County-years above the median (less seasonal) had, on average, 1.30 firms exit, while county-years below the median had average net exit of .62 firms. This is consistent with less seasonality being associated with greater competition in the high season driving profits down and resulting in exit. On average, observations with below-median seasonality (above-median payroll ratio) did have more firms, 18.67 compared to 11.42. Formal estimation includes county fixed effects as well as a cubic polynomial for the lag number of establishments. Furthermore, the IV strategy is designed to rigorously account for selection. The bottom panel of table 1 shows that average high temperatures in January are predictive of the seasonality of demand. Observations with below-median (40.105) average high in January, have average construction payroll ratios of .198. Observations with above-median average January high temperatures had an average ratio of .226. Similarly, the bottom panel shows that observations with above median July temperatures had greater average annual construction payroll. Raw data imply that first stages for these instruments will be strong.

Table 1: Summary Statistics

	Lag Ratio of Construction Payroll	
	Below Median	Above Median
Establishments	11.42	18.67
	(14.55)	(29.35)
Net Entry	-.62	-1.30
	(2.03)	(3.52)
N	3,776	3,776
	Lag Average High in January	
	Below Median	Above Median
Lag Ratio of	.198	.226
Construction Payroll	(.035)	(.030)
N	3,776	3,776
	Lag Average High in July	
	Below Median	Above Median
Lag	79,678	92,198
Construction Payroll (1,000s)	(183,437)	(271,746)
N	3,775	3,777

Notes: *Observations are at the county-year level. Data are 2007-2012. Restricted to observations with two or more concrete contracting firms in the previous year. Median ratio is .215. Median average high is 40.105 in January and 86.93 in July. Ratio of payroll is the ratio of first quarter to annual payroll.*

3.2 Methodology

Empirical work estimates the effects of the within-county variation in seasonality on net entry. As mentioned previously, OLS estimates of the relationship between entry and seasonality will likely not reflect a causal relationship. Empirical work uses IV regressions with weather variables as instruments to provide a causal interpretation to estimates of the following equation.

$$Entry_{jt} = \alpha_j + \alpha_t + \gamma_1 Ratio_{jt-1} + \gamma_2 M_{jt-1} + \Gamma Q + \varepsilon_{jt} \quad (1)$$

Where $Entry_{jt}$ represents the change in the number of firms from time $t-1$ to t in market j, M_{jt-1} represents the total payroll of construction employees in county j in year $t-1$, $Ratio_{jt-1}$ represents the payroll in the first quarter divided by the total annual payroll. Payroll measures are normalized to be in standard deviation units to ease interpretation of coefficients.[4] Γ is a vector of coefficients for Q, a controls vector either representing a linear term for the lag number of firms, or a cubic polynomial for the lag number of firms. The instruments used are average high temperatures at time $t-1$ in county j for the months of January and July. The exclusion restriction requires the assumption that weather only affects entry and exit into the concrete market through changes in construction demand. Standard errors are clustered at the county level.

[4] Unreported estimation normalized these variables within each county, rather than across the full sample. Qualitative results were unchanged.

4 Results

Table 2 shows OLS estimates of equation (1). Without controls or fixed effects, a one standard deviation increase in the ratio of first quarter payroll to annual payroll is associated with a change in net entry of -.189. This coefficient is significant at the 1% level. The estimate gets smaller in absolute value with controls, being -.115 with the full controls vector as described previously, however is always significant at the 1% level. Increases in the ratio of first quarter to annual payroll (decreases in seasonality) are strongly correlated with greater net exit.

Table 2: OLS: Effect of Seasonality on Net Entry

	Net Entry				
Lag Ratio of Payroll	-0.189**	-0.150**	-0.152**	-0.138**	-0.115**
	(0.040)	(0.040)	(0.041)	(0.039)	(0.038)
Lag Annual Payroll	-1.125**	-1.124**	-1.342*	2.217*	0.781
	(0.241)	(0.241)	(0.597)	(0.984)	(0.833)
Year FE	X	✓	✓	✓	✓
County FE	X	X	✓	✓	✓
Linear Lag # Firms	X	X	X	✓	✓
Cubic Lag Firms	X	X	X	X	✓
N			7,552		
Counties			1,763		

Notes: *The outcome variable is net entry in the poured concrete contracting industry. Payroll measures are of the construction industry and in standard deviation units. Ratio of payroll is the ratio of first quarter to annual payroll. Standard errors are clustered at the county level. ** p<0.01, * p<0.05.*

First stage and IV estimates are presented in table 3. The first two columns show that instruments do exhibit strong first stages. Column 3 shows the estimated effect while only including year fixed effects. The estimated coefficient is of the predicted sign and of decent magnitude, -.949, however insignificant. Columns 4, 5, and 6 add county fixed effects and add other controls, with column 6 including the full controls vector. Estimated coefficients range from -1.872 to -2.205, and all are highly significant. All estimates are consistent with the claim that higher seasonality is correlated with less net exit. Furthermore, the highly significant IV estimates justify that this mechanism can be interpreted as a causal. IV estimates are much larger in magnitude than OLS estimates. It may be that IV estimates better isolate variation in the effect of seasonality.

Table 3: IV: Effect of Seasonality on Net Entry

	Lag Ratio	Lag Payroll	Net Entry			
Lag Ratio of Payroll			-0.949	-1.872**	-2.132*	-2.205**
			(2.111)	(0.716)	(0.953)	(0.824)
Lag Annual Payroll			2.169	-3.277	24.719	20.796
			(10.388)	(1.873)	(25.717)	(14.558)
Lag Avg January High	0.014**	-0.008**				
	(0.003)	(0.002)				
Lag Avg July High	0.007*	0.005**				
	(0.003)	(0.001)				
Year FE	✓	✓	✓	✓	✓	✓
County FE	✓	✓	X	✓	✓	✓
Linear Lag # Firms	X	X	X	X	✓	✓
Cubic Lag Firms	X	X	X	X	X	✓
N	7,552					
Counties	1,763					

Notes: *Columns 1 and 2 are first stage regressions. Payroll measures are of the construction industry and in standard deviation units. Ratio of payroll is the ratio of first quarter to annual payroll. Columns 3 through 6 use lags of average January and July high temperatures as instruments. Standard errors are clustered at the county level. ** p<0.01, * p<0.05.*

Estimates of table 3 represent the effect of a shock to seasonality of demand within a county. Unreported between effects regressions show an increase in net exit of .407 firms with each standard deviation increase in the lag ratio of construction payroll. It is difficult to causally interpret this result due to market heterogeneity.

5 Conclusion

This paper empirically shows that higher seasonality of demand was correlated with less net exit in the poured concrete contracting industry during the Great Recession. It is posited that firms reach capacity constraints when demand is concentrated more strongly in a high season, in turn reducing competition and increasing profits. Other possible mechanisms could be that seasonality is correlated with increases in the choke price in the high season (or other forms of decreases in price elasticity), that seasonality of demand is positively correlated with total demand, or systematic changes in collusive behavior with seasonality. The particular concern regarding the correlation of seasonality of demand with total demand is accounted for by including total demand (annual payroll) in the linear model. In unreported robustness checks, observations with extreme values of annual payroll and ratio of payroll were excluded. Results are robust. Future work may utilize restricted-use data to explore the hypothesis of this paper, and other hypotheses, more rigorously.

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