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The Effect of Demand Density on Firm Productivity in the Restaurant Industry

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Abstract

Many researchers have investigated the factors influencing productivity. However, the majority of studies have focused on the supply side variables and hence, the research focusing on demand side factors is small. Following the theoretical framework presented by Syverson (2004), we analyze the determinants of firm productivity and firm size in the restaurant industry in Sweden by focusing on the impact of demand density and substitutability. In the study we use data over firms in the Swedish restaurant industry between the years of 2007 and 2014. We test three different estimations; a simple bivariate OLS model, a year fixed effects model and a year fixed effects model with controls for local market variables. We use two different measures for labor productivity in the analysis; revenue per employee and value added per employee. Furthermore, we calculate five local market variables in order to illustrate the dispersion, central tendency and minimum productivity level. We find that demand density has a slight effect on firm productivity. The findings suggest that firm productivity dispersion is larger in markets with higher demand density. We find evidence that suggests that the minimum productivity level is lower in more demand dense markets. We do not find evidence suggesting that demand density has an effect on firm size.

Keywords: Demand density, labor productivity, substitutability, restaurant industry.

JEL: D1, L0, L1, R3

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1 Introduction

Productivity is the ability to turn inputs into outputs. It has been a topic of interest in many studies throughout the years and, as a result, a large literature has emerged. In many of the studies it has been evident that large dispersions in firm productivity exist, in even narrowly defined industries. Researchers have therefore analyzed the variables affecting firm productivity and they have found various factors that could explain these large and lasting productivity variations across firms within the same market. A majority of the research has focused on various supply-side factors, such as technological advancements, agglomeration mechanisms and management influences (Combes et al. (2012), Griffith et al. (2006), Keller and Yeaple (2009)). However, the literature regarding demand-side features, such as the effect of substitutability, remains small.

Substitutability is the ability of consumers to substitute between goods provided by different firms in the same market. There are many factors determining substitutability, such as spatial, physical or brand driven aspects. The substitution barriers resulting from spatial aspects, stems from the difficulty of substituting a product that is offered by one firm for a product that is offered by another firm due to the distance between the firms and the consumers Syverson (2004).

Syverson (2004) analyzed substitutability by testing the effect of demand density on firm productivity. The basis of the theory is that if a market experiences an increases in demand density, measured as demand per unit area, entry by other firms will be induced. This is the result of an increase in the expected productivity gains from entering the market. As the number of firms in the market increases, the distance between the firms decreases and consumers can more easily substitute between the output of the firms in the market. When the distance between restaurants decreases, we expect consumers to substitute to the most productive firms in the market, i.e. the firms with the lowest price at the best quality, and hence, the least productive firms would be forced to exit. This theory suggests that higher substitution barriers facilitate the survival of the least productive firms and, considering the previously stated relationship between demand density and substitutability, dispersion is assumed to be larger in less demand dense markets (Syverson, 2004). Although it is likely that other substitution factors also influence the results obtained in this analysis, it is not in the scope of this study to distinguish between the various factors of substitution.

In this paper we use a dataset over all limited liability companies between 1998 and 2015 to analyze the Swedish restaurant industry. We focus on the period between 2007 and 2014 and estimate the effect of demand density on firm productivity within the restaurant industry. We follow the theoretical framework presented by Syverson (2004) in order to test whether the results presented in that study also applies to a different industry. Syverson (2004) looks at the ready mixed concrete industry which in many aspects differ from the restaurant industry (manufacturing industry and service industry). A common aspect of the industries, however, is the dependence on the local market, where the restaurant industry is tied to the location and the ready mixed concrete industry experiences large transportation costs. The differences between the industries makes it an interesting case to look more into, while the similarities enables us to test spatial substitutability. In the study, we estimate three models; a simple OLS regression, a year fixed effects regression and a year fixed effects regression with local demand variables. Furthermore, we calculate five local market variables that will illustrate how dispersion, central tendency and minimum productivity level is affected. We use two measures for labor productivity; revenue per employee and value added per employee. Additionally, we analyze the effect of demand density on firm size. With this study, we attempt to further the research related to factors determining productivity by providing a study with Swedish data that is focusing on demand side variables.

Researchers in various fields of economics have shown great interest for the topic productivity. The purpose of this study is to provide further research within the area and find more evidence regarding the relationship between demand density and productivity. Additionally, this paper has implications for many areas within economics such as urban agglomeration and industrial organization. Furthermore, the Swedish government has in recent years focused more on the Swedish food sector. They believe that promoting the firms that are active within the entire food supply chain will benefit society by providing employment opportunities, sustainable growth and public goods (Ministry of Enterprise and Innovation, 2017). Through an increased interest in the well-being of the restaurant industry, it is important to further the understanding of factors affecting productivity.

The remainder of the thesis is structured as follows. First we provide an overview of the existing literature of productivity and substitutability. We continue by outlining the theoretical framework of the thesis in section 3 and provide background information of the Swedish restaurant industry in section 4. In section 5, we present the dataset that is used and descriptive statistics over key variables followed by a description of the empirical analysis in section 6. Furthermore, the results from the main empirical analysis for both of the labor productivity measures and results from the robustness checks are presented in section 7. Finally, we turn to the discussion of the results in section 8, before we presenting the conclusion of the thesis in section 9.

2 Literature Review

In this section, we present an overview of previous literature related to productivity and substitutability. We begin by presenting a sample of the literature related to productivity. Productivity has been a topic of interest for many researchers throughout the years and the research has therefore, grown far too large to discuss in detail in this study. We begin by providing examples of studies that are analyzing various factors that have been considered to be causes for the observed productivity variances. Following the initial review of the literature related to productivity, we provide an overview of studies that are focusing on substitution effects. The literature that is presented in this section will be the basis of the theoretical and empirical analysis of this paper.

2.1 Productivity

Productivity is a topic that has been widely researched throughout the years. The studies within the field have analyzed the effect on firm productivity stemming from different variables such as management practices, research and development and ownership on firm productivity (Lichtenberg and Siegel (1991) and Shaw et al. (1997)). Furthermore, large dispersions in productivity across firms within the same industry have been observed. Hsieh and Klenow (2009), present a study in which they analyze manufacturing establishments in China and India. They find that productivity dispersion in India can be as large as a ratio of five to one between firms in the 90th percentile and firms in the 10th percentile. Similar results were found in the manufacturing establishments in China. Furthermore, the dispersion in firm productivity has been observed to often be large and persistent. As a result, many studies have focused on determining the cause of these variances in productivity (Syverson, 2011).

Many researchers have attempted to explain how large variations in productivity can persist and various factors driving dispersion in productivity has been identified. Bartelsman and Doms (2000) provide an extensive overview of studies using longitudinal data in order to identify factors affecting productivity growth and productivity dispersion. Furthermore, a large literature analyzing the effect of technological advancements and market structure on productivity has been presented. Collard-Wexler (2010), presents a study in which he illustrates the relationship between sunk cost and productivity. He uses the ready mixed concrete industry in the US in order to provide a study where he finds evidence that high sunk costs influences low-productivity firms to remain in the industry longer than they would have otherwise. Furthermore, Griffith et al. (2006) investigates the effect of spillovers from research and development on productivity. They find that spillover effects regarding R&D affects the firms productivity. This suggests that it is of importance for companies to choose the location of their R&D expenses thoroughly and place them in an area where the firm can benefit from the spillover effects.

A topic of interest for researchers has also been various factors related to employees that could affect productivity. Some variables of interest has been identified regarding this topic. As an example, Bandiera et al. (2010) provide evidence regarding the social contact between employees within the company. Their study provides evidence of a positive relationship between the social connection among the employees at the firm and firm productivity. This implies that firms that promote good worker relationships are likely to be more productive.

Trade is another topic that has been studied thoroughly in relation to productivity and productivity dispersion. Melitz (2003) among others have illustrated the positive relationship between trade and productivity. He developed a dynamic industry model in order to explain the effects of trade on productivity. Furthermore, Pavcnik (2002) evaluated plants in Chile in order to determine the effect of trade liberalization on firm productivity. She finds that trade liberalization has a positive effect on plant productivity.

2.2 Substitutability

Competition and the relationship between competition and productivity has been studied extensively over the years. Syverson (2011) discusses the mechanisms through which competition can affect productivity and provides an overview of studies within this field. The positive relationship between competition and productivity has been accepted by many researchers. Schmitz (2005) presents a study on the iron ore mining industry in the US and hence, illustrating the increase in productivity resulting from an increase in the international competition.

Furthermore, competition has shown to affect productivity in two different ways;

an increased incentive to become more productive and substitution effect. The first mechanism means that as competition increases, the firms have an incentive to take measures in order to increase productivity in order to survive in the market. These can often be costly measures that would not have been taken otherwise. The second mechanism acts through a process where the low-productivity firms are forced out of the market as competition and substitution increases (Syverson, 2011).

As mentioned above, competition has been deemed to affect productivity in various ways. One of the mechanisms at work is related to substitutability. Substitutability is defined as the ability of consumers to switch between products from one firm to similar products produced by another firm (Syverson, 2004). There are many different substitution barriers that can be active in the market, such as locational, brand-driven or driven by quality differences. However, in a market with no substitution barriers and homogeneous products, customers would base their purchasing decision solely on the price. Goldmanis et al. (2010) analyze three different industries by using e-commerce in order to illustrate the effect of a lower search cost. They obtain results suggesting that lower search costs will move consumers from high-cost to low-cost producers. This implies that in a market with lower search costs the consumers will substitute to the low-cost producers.

As mentioned earlier, an increase in substitutability is expected to enforce a pressure on the least productive firms in the market and hence, they would be forced to exit the market. Foster et al. (2006) find evidence of this when looking at the retail industry in the U.S. They find evidence suggesting that the productivity growth in the retail industry mainly results from the exit of less efficient firms and the replacement of more efficient firms. This is in line with the theoretical framework presented by Syverson (2004). Furthermore, Disney et al. (2003) find similar results when analyzing UK manufacturing industries. They find evidence that productivity increases as the least productive firms are forced to exit. A study by Ding and Niu (2019) enhances these results. They investigate manufacturing industries in China and find evidence that a larger market size will force the firms with higher costs to exit the market.

Syverson (2004) developed a model in order to test the effect of demand density on firm productivity and firm size. He studied the ready-mixed concrete industry in the US to explain how productivity variations can exist in even narrowly defined industries and to contribute to the understanding of how demand-side factors can influence the productivity distribution in the markets. He finds evidence suggesting that an increase in substitution leads to a shift from high cost producers to low cost producers that forces the least productive firms out of the market. This in turn is expected to increase the average productivity level within the industry. The shift from low-productivity firms to more productive firms also leads to a decrease in firm productivity dispersion. Morikawa (2011) finds similar results when looking at productivity in the service industry. They find evidence suggesting that when demand density increases by the double, an increase in productivity between 7% and 15% follows. This provides further evidence of the importance of demand density on firm productivity.

3 Theoretical Framework

The theoretical framework of this paper follows the model introduced by Syverson (2004). Syverson (2004) extends the work of Salop (1979) and presents a simple two-stage model portraying the relationship between demand density, substitutability and size distribution. In this study, we follow the model in order to test the effect of demand density and in turn substitutability, on productivity in the restaurant industry. We analyze the dispersion, central tendency and minimum level of firm productivity across firms within the restaurant industry in order to provide further insight into the effect of demand density on productivity. Furthermore, we analyze the effect of demand density on firm size.

Demand density is defined as the demand per unit area, where demand is measured as the number of consumers in the market. Following the study by Syverson (2004), we treat demand density as exogenous. Treating demand density as exogenous is intuitive since, even though residents often are drawn towards areas with a larger selection of stores, restaurants and other community attributes, it is more likely that the restaurant's make a location choice based on the population in the markets and not the opposite.

The baseline of the theory relates to the increased attractiveness for firms to enter a market following an increase in demand density. When demand increases, the expected return from entering that market also increases and hence, more firms are willing to enter. The new entrants in the market causes a decrease in spatial distance between the producers, leading to an increase in substitutability and competition (Syverson, 2004). This in turn, decreases the barriers of substitution and hence, consumers can more easily substitute between products from different firms within the same markets.

Based on previous literature, consumers are expected to substitute to firms that provide the best food experience at the lowest price (the more productive firms) and hence, the least productive firms would be forced to exit the market. The more productive firms, however, remain active and therefore, average productivity increases. Furthermore, the firms that are active in the market are expected to be more heterogeneous in terms of productivity. As a result, we should observe an upward shift in productivity for firms in markets with an above average demand density. Furthermore, following Syverson (2004) study we expect to observe less dispersion in firm productivity across firms in the markets with higher demand density compared to markets with lower demand density. This follows from the notion that the markets with higher demand density are more homogeneous. Additionally, we expect the productivity level of the least productive firms to be higher in markets with high demand density compared to the least productive firms in markets with a lower demand density.

As a continuation of the thesis, we will analyze the effect of demand density on firm size. As mentioned above, we expect the least productive firms in the market to be forced to exit as demand density increases. When firms are forced to exit the market, fewer firms remain active. As a result, an the active firms can expect to experience an increase in sales in order to account for the market demand. One of the features of the restaurant industry is the limited supply that they have. Restaurants only have a certain number of spots in their restaurants and hence, they cannot sell more as a response to an increase in demand. Folmer and Leen (2013) present a study that investigates the effect of an increase in demand in the restaurant industry. They find evidence that restaurants will increase their prices enough to benefit from the increase in demand. However, they will only raise prices enough to continue experiencing a long term demand.

Syverson (2004) focuses on the spatial component of substitutability in his study. The restaurant industry is a more heterogeneous industry than the ready mixed concrete industry and hence, it is likely that other factors also will be of importance in determining substitutability. In this study, we test the effect of substitutability in terms of spatial aspects on firm productivity. Further, it is likely that the quality of food is a large factor determining the substitutability. It is, however, not in the scope of this study to determine which factors of substitutability that are at work or the magnitude that the various factors affect productivity.

For the analysis, we use labor productivity in order to measure productivity within the restaurant industry. Labor productivity is one of the most commonly used measures for productivity. As mentioned earlier, we will use to different measures of labor productivity. Bartelsman and Doms (2000), provide an overview of some of the productivity measures that can be used. In the study, labor productivity is defined as follows:

$$LP_{it} = (\frac{y_{it}}{l_{it}}) \tag{1}$$

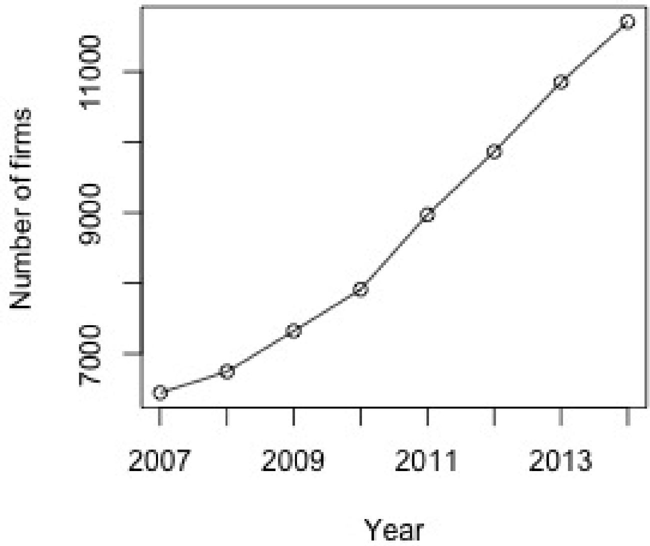
where LP denotes the output of the labor productivity measure. Furthermore, y denotes the output and l denotes the input. As mentioned by, Grönroos and Ojasalo (2004), we cannot distinguish between productivity and quality when calculating labor productivity for the service industry. Hence, we assume that productivity differences also can result from differences in quality of food. Therefore, we assume that the shift in consumer preferences are determined based on the spatial distance to the restaurant, the prices and the quality. Hence, quality is also a source determining substitutability. It is, however, not in the scope of this thesis to determine to what extent either quality affects the results. Furthermore, it is reasonable that other factors influence the consumer preferences.

4 The Swedish Restaurant Industry

The Swedish restaurant industry experienced a large and steady growth during the years up until 2017 in both employment and revenue. In 2017 and 2018, however, the industry experienced a downturn in the development. As expected, the downturn coincided with the decrease in household consumption. In the beginning of 2019, the trend has turned and is now pointing upwards. However, the outlook for restaurants in the industry might have som hard years ahead (Visita, 2019). In figure 1 we present a graph illustrating all firms in the Restaurant and mobile food service activities industry in Sweden. This includes all firms within the two-digit industry category "56" according to the Swedish National Industry (SNI) code. The firms included in this category are restaurants, coffee shops and others.

As shown in Figure 1, the number of firms in the restaurant industry between 2007 and 2014 has continuously increased over the years. This is likely the result of two government interventions that were implemented during these years. In 2008, the Swedish Government launched a policy initiative called "Culinary Sweden". According

Figure 1: Number of firms within the restaurant industry



Note: Source is IFN's corporate database provided by the Research Institute of Industrial Economics (IFN). Authors own rendering

to a report released by The Ministry of Enterprise and Innovation, "The Government believes that food production and the food supply chain in Sweden are well placed to contribute to society in the form of employment, sustainable growth and public goods.". The initiative has a long run ambition to increase employment in the wide food sector, stimulate tourism as well as the export of Swedish food by supporting the expansion and growth of markets that build on food. This is intended to include the entire supply chain within the food sector from crops to the consumption of food at for example restaurants products (Ministry of Enterprise and Innovation, 2017). Furthermore, in 2012 the government implemented a reduction in the VAT for firms in the restaurant industry[1].

The large growth in the industry as well as the restaurant's dependency on the local markets makes it an interesting industry to look at in my study. The majority of products sold by the firms are indulged at the restaurant and hence, the local market is likely to have a great impact on the productivity and size of the firms. As we are attempting to measure substitutability in this analysis, especially in terms of spatial substitutability, we consider this an appealing characteristics of the industry that we will investigate further. Additionally, the restaurant industry can be considered to be "simple". This means that the firms are not dependent on for example research and development, patents, innovations or technological advancements. By selecting an industry that is not heavily reliant on the above mentioned factors, we minimizes the risk that technological differences on productivity heterogeneity is not controlled for in the analysis. Furthermore, the growing interest from the Swedish government

[1] The VAT was reduced from 25% to 12% (Tillväxtanalys, 2015)

increases the importance of learning about the various variables affecting productivity within the sector.

5 Data and Descriptive Analysis

The dataset that is used in this study is provided by the Research Institute of Industrial Economics (IFN). The IFN Corporate Database provides full accounting information for all limited liability companies in Sweden from 1998 to 2015. The data has been collected over time by the consulting agency Bisnode and the Swedish Companies Registration Office in order to provide a comprehensive database over the Swedish business sector. Each firm in the dataset is associated with a SNI code (Swedish Industrial Classification code) and as mentioned earlier, we look at the five-digit SNI code "56000" which includes restaurants. The SNI code is used in order to divide firms into groups based on their main business activity (Statistics Sweden, 2019b). In this study we use data between 2007 and 2014.

The dataset includes firm level data and firms are identified by a unique organization number that allows us to follow companies over time. The majority of organization numbers occur only once per year. However, we also observe organization numbers that occur two or more times in the same year. This is the result of firms submitting more than one annual report in a given year to the Swedish Companies Registration Office. For these observations, we only include the latest observation for that year and hence, each organization number will only occur once per year. Number of firms in the market is one of the measures that we use in this study. As a result, it is important that we do not include the same firm twice for one year since that would overestimate the number of firms.

The dataset is a collection of the annual reports of all limited liability firms in Sweden. The main variables of interest for this analysis are net revenue, number of employees and value added per employee. Net revenue is presented in terms of the annual net revenue in thousands of Swedish kronor. Furthermore, number of employees is presented as the average annual full-time-adjusted employees within each firm. Individual companies can, however, use other definitions. Value added is calculated in advance within the dataset and it is defined as the operating profit adjusted for depreciation and labor costs. Labor costs includes salaries and employee compensations, social fees and retirement expenses. Furthermore, the dataset includes a municipality code that allows us to connect each firm with a specific location.

Furthermore, we obtain data from Statistics Sweden. that provides us with population data over all 290 municipalities in Sweden. This dataset provides us with data over the population and population density per municipality per year in Sweden. The dataset is over all 290 municipalities in Sweden from 2007 to 2014. Similar to the dataset provided by IFN, this dataset includes a municipality code.

The dataset from Statistics Sweden also includes demographics of the municipalities. We use the following variables in the analysis; the ratio of inhabitants above the age of 25 in each municipality, the fraction of married per 1,000 population, the fraction of the population with a university degree and the logged median disposable income in each municipality.

5.1 Measurement

We begin by explaining the productivity and firm size measures that are used in the analysis. The key part of the study is related to the calculation of the productivity and firm size measures that are used in the empirical analysis. Following the theoretical framework and empirical implementation of Syverson (2004), we calculate five local market variables. The variables illustrate the productivity dispersion, minimum productivity level and overall central tendency.

We begin by calculating the variable that is used to analyze dispersion of productivity across firms within the same market. We use an interquartile range method which is denoted as IQR in the remainder of this paper. The IQR measures the difference in productivity between the firms in the 25th percentile and firms in the 75th percentile. Hence, the interquartile range provides a measure of the difference in productivity level between the least productive firms and the most productive firms in the middle 50% in each market. As the overall dispersion of firm productivity in a market increases, we would therefore see an increase in the IQR. Furthermore, using the IQR minimizes the risk of possible outliers to impact the results.

We continue by calculating two measures that illustrate the central tendency of firm productivity in the market. To measure the productivity of firms producing at the average productivity level we calculate the median as well as the weighted average productivity. The median is simply the firm producing at the median productivity level within each market for each year. The weighted average productivity, however, is a measure that accounts for any productivity growth that follows from an increase in the firm's market share (Syverson, 2004). We calculate the weighted average productivity by multiplying firm productivity with a weight that is based on the firm's market share. The market share is determined by the firm's output compared to total output in the industry.

As an indication of the market's minimum productivity level, we use the tenth-percentile firm. This measure will indicate how the minimum firm productivity level is affected by an increase in demand density. The benefit of using the tenth-percentile instead of using the least productive firm in each market, is the decreased risk of the results being impacted by possible outliers in the dataset. However, there is still a risk that outliers are affecting the result.

As a final measure we calculate the measurements for firm size. We use the deflated average logged revenue. By using the average logged revenue we will receive an indication of the medium output in each market for each. This will allow us to test the effect of demand density on firm size.

5.1.1 Productivity and Firm Size

As mentioned earlier, the theoretical framework that we use as a basis for this study, analyses the effect of demand density on the productivity distribution in local markets. The theory suggests that the inefficient firms will not survive in markets with higher demand density and hence, they will be forced to exit the market. Additionally, the most efficient firms are supposed to survive in the market, which would drive up the average productivity in the market. In the study, we assign firms into three separate groups; entrants, incumbents and exits. Entrants are defined as the firms that were not present in the market in the previous year, but are included in the current year.

Incumbents are the firms that were active in the market in the previous year, current year as well as in the following year. Exits are firms that are present in the market in the current year but is not present in the following year. As a result, firms can be defined as both an entrant and an exit for a specific year. This is if the firm enters and exits the market in the same period.

Table 1: Number of entrants, exits and incumbents per year

	2008	2009	2010	2011	2012	2013
Entrants	620	981	1063	1412	1458	1408
Incumbents	4869	4957	5397	5803	6618	7426
Exits	390	489	439	617	459	553

Note: This table presents the number of firms that have been identified as an entrant, incumbent or exit for a specific year.

Table 1 presents the number of firms in each of these three groups. As seen in the table, the number of incumbents increases over the years. Furthermore, we observe an increase in the number of entrants over the years. This is not surprising if we look at Figure 1 once again. In the graph we observed that the number of firms within the restaurant industry has increased over the years. Considering this, it is clear that the number of either entrants, incumbents or both must have increased during the years between 2007 and 2014. The number of exiting firms, however, does not seem to follow a specific pattern and instead we see that the number of exiting firms increases during some years and decreases in others.

Following Syverson's study, we exclude the entrants from the analysis. In this study we want to test the effect of exits of low-productivity firms and hence, we do not want to include the effect of exits resulting from the newly entering firms. A large literature exists that shows evidence that firms entering a new market has a higher risk of failure. Dunne et al. (1989), among others, provide evidence of this. By analyzing plants in the US manufacturing sector, Dunne et al. (1989) find a negative relationship between plant failure rates and the size and age of the plants. This indicates that younger plants have a higher risk of failure. As a result, moving forward, we exclude the entrants per year from the analysis leading to the removal of, on average, 726 firms per year. By excluding entrants, we obtain a dataset of 26,808 observations spanning over 6 years[2].

In order to account for changes in prices over the years, we calculate the deflated revenue. We use the Consumer Price Index (CPI) provided by Statistics Sweden. By using the CPI we can account for the developments in prices (Statistics Sweden, 2019a). We use the deflated revenue to calculate the productivity measures. As mentioned earlier, we use two measures of labor productivity; revenue per employee and value

[2] As observed in the table, we only use data between the years of 2008 and 2013 in this stage (the dataset of use includes data between 2007 and 2014). This is because of the definition of entrants, incumbents and exits. Since we must be able to identify whether the firms have been active in the years prior to/after the current period, we cannot use data from the first/last year of the dataset. In the remainder of the thesis, we will therefore only continue with data between 2008 and 2013.

added per employee. The productivity measures are simply the output variable divided by the input variable. The output variables in this thesis are net revenue and value added and the input variable that we use is number of emplouees. As mentioned earlier, the variable employees in the dataset is counted as the average yearly full-time employees for each firm.

5.1.2 Local Markets

In the theoretical framework that is used in this study, it is important to define suitable local markets that can be assumed to be separate markets. This means that restaurants in one market only competes with firms in the same market and there should hence, not be any cross border competition. This is important since we are testing the effect of demand density in the market that the firm is active in on firm productivity. If there exists a significant trade between the markets, we will hence, be unable to account for all of the relevant demand in the analysis.

We use municipalities in Sweden when defining separate local markets. As mentioned earlier, there are 290 municipalities in Sweden. The borders for the municipalities are located around larger cities and in most cases, in remote areas that are densely populated. Although it is likely that there are some trade across borders in terms of consumption, we believe that it is minimized due to the nature of the restaurant industry. Since transactions often demand customers to be at the restaurants location, restaurants will often be located close to where people reside i.e. closer to larger cities and further away from the municipality borders. Furthermore, we obtain some indication of the importance of demand in close proximity of the firms by looking at research related to the retail industries. As an example, Öner (2016) provides evidence that retailers that are located close to areas with a higher demand density experiences a higher level of productivity. Drawing from this, we believe that the cross-border trade is minimized. However, we cannot exclude that there are some trade in terms of consumption between the municipalities.

Furthermore, it is important that all firms in the market are interconnected with each other. This is important since we want the restaurants in a market to be affected by the same market forces. The markets must therefore be small enough to ensure that all firms compete with each other. We cannot ascertain that all restaurants in the same market compete with each other. However, we consider municipalities to be the best division in order for the markets to neither be too large nor too small.

Table 2: Number of restaurants per municipality

	Mean	Min	p25	Median	p75	Max
Full Sample	19.9	1	3	6	16	1435
Est Sample	32.9	3	7	14	28	1435

Note: This table presents descriptive statistics over the number of firms in each market for each year. Full sample includes all incumbent restaurants prior to the removal of municipalities with fewer than three firms for a given year. Est sample includes all incumbent restaurants after the removal of municipalities with fewer than three firms for a given year. Full sample includes data over 282 municipalities. Est sample includes data over 228 municipalities.

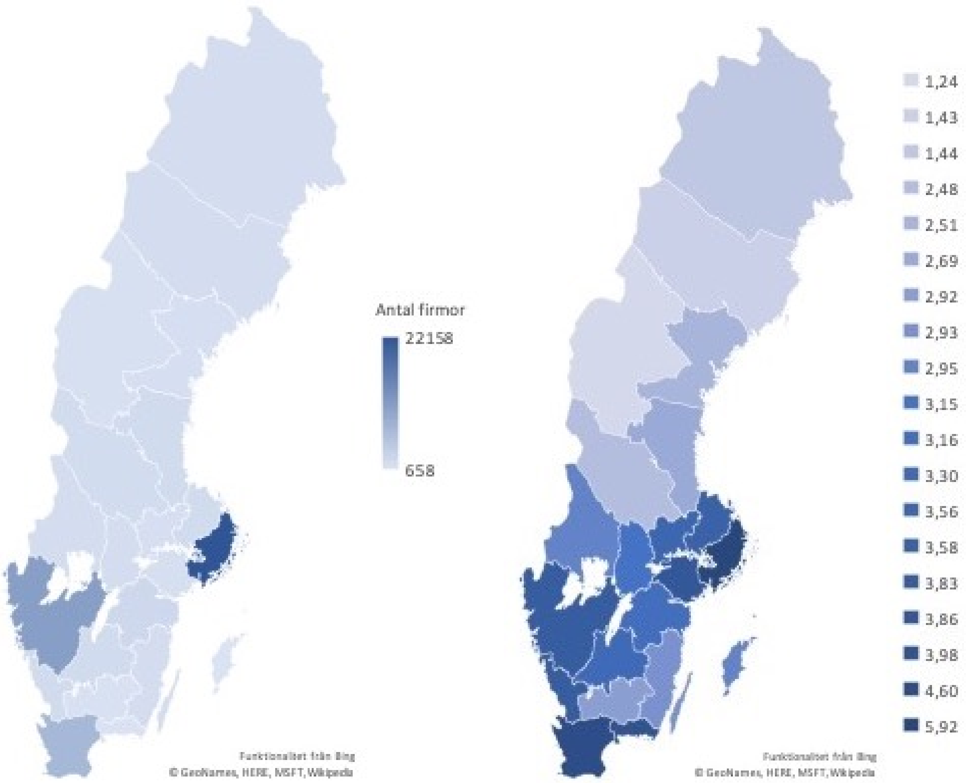
We continue by looking at the data for the various markets. In table 2, we present descriptive statistics over the number of firms in each market per year. Full sample denotes the descriptive statistics of all incumbent firms. As observed in the table, at least one municipality only has one incumbent restaurant active in the market. In the analysis that we are using, we choose to exclude markets with less than three measuring points, i.e. less than three firms in the market. This is of importance because of the local market variables (IQR, median productivity and 10th percentile) that we explained previously. For example, by calculating the local market variables in firms that only have 2 restaurants, the firm that would be selected in for the 10th percentile would also be included in the measurement of the IQR as well as the median sproductivity. Hence, we exclude the municipalities that have fewer than three incumbent firms for a given year. The descriptive statistics over the number of firms in each market for each year are presented in Table 2 in the row Est sample. Furthermore, we note that the previous sample included data over 282 municipalities and the current sample includes data over 228 municipalities.

5.1.3 Demand Density

Demand density is measured as the main consumers per unit area. For the restaurant industry it is intuitive to assume that the customers are inhabitants. Therefore, we use the population density, measured as the number of inhabitants per square kilometer, as the measure of demand density. By using the log of the population density we obtain the measure for demand density. Furthermore, as mentioned earlier, the separate markets are divided into the municipalities in Sweden.

As in the study by Syverson (2004), we treat demand density as the main exogenous factor in the estimation. Demand density is empirically treated as exogenous in nature since an increase in population would be based on many other factors than an increase in the number of restaurants in the area. Examples of such factors are income streams, employment opportunities, amenities and other factors that increases the living standard in that area (Sjaastad (1962), Vanderkamp (1971) among others). Considering the number of factors leading to an increase/decrease in inhabitants in a market (i.e shifts in demand in this model), the influence on peoples decision to move to an area stemming from the existence of restaurants in that area is small in comparison ot other factors. Drawing from this, it is likely that causation moves from population increases to an increase in restaurants and not the opposite direction.

Figure 2: Population density and average firms per region



(a) *Average no. of firms, 2007 to 2014. Source: Statistics Sweden, IFN corporate database. Authors own rendering.*

(b) *Average population density between 2007 and 2014. Source: Statistics Sweden. Authors own rendering.*

Population density varies greatly across the various regions in Sweden. In Figure 2 we present two Figures in order to illustrate the density of firms and population density per region in Sweden. In Figure 2a, we present firm density. As expected, we observe that the three metropolitan areas; Gothenburg, Malmö and Stockholm, are the most dense markets. It is intuitive that restaurants are located in or around larger cities. Furthermore, in Figure 2b, we present population density and we observe that the least dense areas are located in the north of Sweden. Additionally, similar to firm density, we note that the population density is larger in the larger cities which is also according to expectations.

5.2 Descriptive Statistics

We begin this section by providing summary statistics over the variables that we use in this study. In Table 3, we present descriptive statistics for the variables; Net revenue, number of employees, revenue per employee, value added per employee and demand density. The dataset includes 26,808 observations. By observing Table 3, we observe that the mean revenue per employee is larger than the mean value added per employee.

Additionally, we note that the dispersion of value added per employee is smaller than the dispersion of revenue per employee. This could lead to us seeing less of a variability in the results when using the value added per employee as a productivity measure. Furthermore, we observe that demand density has a large standard deviation. This is in conjunction with the figures presented in the previous section (2)

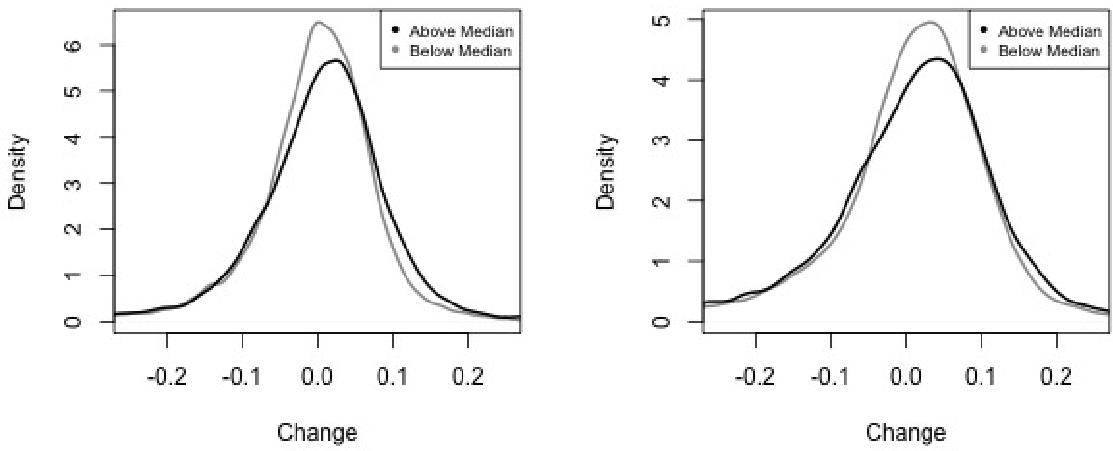
Table 3: Descriptive statistics − Key variables from dataset

	N	Mean	Std.Dev.	Min	25th pctl	75th pctl	Max
Net revenue	26,808	9,152	45,463	1	2,066	7,586	1,785,432
No of employees	26,808	10	44	1	3	9	1,814
Revenue per employee	26,808	739	625	0.5	517	858	50,482
Value added per employee	26,808	350	294	1	239	422	31,957
Demand density	26,808	1,467	1,890	1	64	4,308	4,916

Note: The table provides summary statistics for the main variables from the dataset. The numbers are rounded off to the nearest integer.

Following Syverson (2004), the theoretical framework of this thesis relates to a shift upwards in productivity in markets with higher demand density. Figures 3a, 3b and 4 provide initial evidence of this mechanism. The graphs show the kernel density estimates of the two measures of labor productivity and of firm size. The distributions are expressed in terms of deviations from the average, across all plants in a given year. Two series are shown in each graph representing the firms in my sample that are located in markets with above median or below median demand density.

Figure 3: Kernel density estimates − Productivity

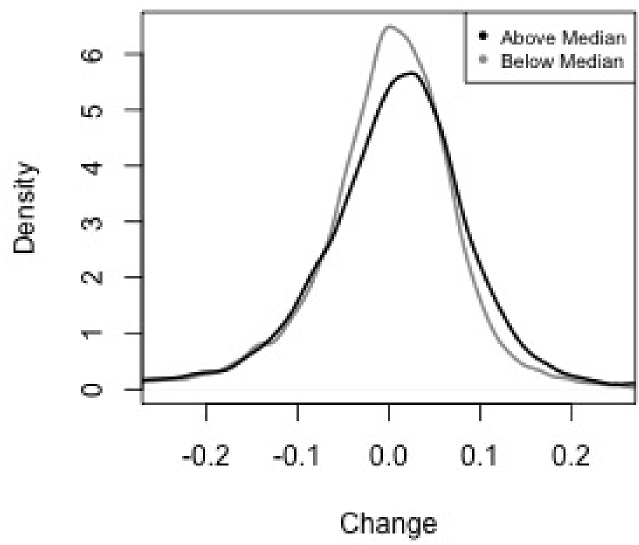


(a) Labor Productivity

(b) Value added

By observing graph 3a, we note that the series representing the firms in the higher dense markets is shifted upwards. This suggests, according to the theory, that firms in more demand dense environments are more productive than firms in the less dense markets. The kernel density estimates for Value added per employee illustrates similar results in Graph 3b. We note, however, that the shift is smaller in the graph for value added than in the graph for revenue per employee. In graph 4 we can also observe initial evidence of the effect of demand density on firm size. This left truncation of the series of the firms in the above median density markets suggests that those firms are larger than the firms in less dense markets. The dispersion of productivity and firms size is, however, hard to determine from these graphs.

Figure 4: Kernel density estimate − Firm size



We obtain further evidence of the effect of demand density on the productivity and firm size measures by looking at the descriptive statistics. In Table 4 we present the summary statistics of firms in the above and below median density markets. The average revenue per employee productivity of firms in above median density is slightly higher than in the below median density markets (5.52 and 5.48). We also note that the mean value added per employee productivity is the same for the firms in the below median density markets as in the above median density markets. We note, however, that the 75th percentile firm has a higher productivity level in the above median density markets than in the below median density markets. This suggests that there is a shift in the productivity level, however, it is not as evident when using value added per employee as a productivity measure. We can also observe that the average firm size, mean firm size, is higher in the above median density markets. This is in accordance to the previously stated theory.

Table 4: Descriptive Statistics − Productivity and firm size

	Revenue/emp		*VA/emp*		*Firm Size:*	
	Above	Below	Above	Below	Above	Below
Mean	6.49	6.46	5.70	5.70	8.38	8.19
Std Dev	0.57	0.48	0.66	0.60	1.23	1.04
Median	6.54	6.50	5.79	5.78	8.38	8.22
p10	5.92	5.95	5.00	5.08	6.96	6.95
p25	6.25	6.25	5.46	5.50	7.67	7.61
p75	6.79	6.72	6.07	6.02	9.09	8.78
p90	7.05	6.93	6.32	6.25	9.83	9.43

Note: This table shows descriptive statistics for the kernel density estimates for the measures; revenue per employee, value added per employee and firm size. The columns are divided into the productivity and firm size measures. Furthermore, they are divided into above and below. This illustrates that the numbers represents the above median demand density markets (Above) and the below median demand density markets (Below)

The descriptive statistics of both firm size and firm productivity, provide initial indication of the effect of demand density on dispersion in the market. As we can see the standard deviation for firm productivity for both productivity measures is higher in above median density markets than in the below median density markets. This is contrary to the evidence by Syverson (2004). We see similar results in the standard deviation for firm size, which indicates that there is a higher dispersion of both firm size and firm productivity in the higher dense markets than in the other markets (0.55 and 0.47).

In Table 5 we present descriptive statistics over the local market variables that we previously calculated (section 3). In the rows we divide the table into the measures revenue per employee, value added per employee and the firms size measure, revenue. By observing the table we note that there are large differences in productivity across markets. As an example, the standard deviation across markets for median productivity levels is 0.09 for revenue per employee and 0.12 for value added per employee. Furthermore we note that the dispersion of firm productivity (IQR) across firms show a standard deviation of 11% for revenue per employee and 14% for value added per employee. This indicates that there are variances in productivity level across markets. We also observe that the mean of the IQR is higher when using the value added per employees compared to the revenue per employees measure. Furthermore, we observe that the logged net revenue has a standard deviation of 24%.

Table 5: Key Variables − Productivity and firm size

Statistic	N	Mean	St. Dev.	Min	25th Pctl	75th Pctl	Max
				Revenue per employee			
IQR	26,808	0.49	0.11	0.01	0.42	0.58	1.29
Median	26,808	6.52	0.09	5.45	6.49	6.57	7.26
OW	26,808	0.63	0.02	0.20	0.64	0.64	0.64
10p	26,808	5.95	0.18	3.88	5.89	6.04	6.67
				Value added per employee			
IQR	26,808	0.55	0.14	0.05	0.46	0.62	2.01
Median	26,808	5.78	0.12	3.98	5.73	5.86	6.33
OW	26,808	0.58	0.02	0.17	0.59	0.59	0.59
10p	26,808	5.07	0.28	2.28	4.95	5.23	6.11
				Revenue			
Mean	26,808	8.14	0.24	6.35	8.00	8.32	9.05

Note: This table shows descriptive statistics for the local market variables; Interquartile Range (IQR), Median productivity (Median), Output Weighted average productivity (OW), 10th percentile firm (10p) and the logged average revenue (Mean). We present the results for the productivity measures, Revenue per employee and Value added per employee, and firm size, logged average revenue

6 Empirical Analysis

We continue the analysis by estimating the empirical specification. The five local market variables that we previously calculated (The Inter Quartile Range, Median, Weighted Average Productivity, Tenth-percentile and the Average Logged Revenue), will be used to continue the analysis of how demand density affects firm productivity. We estimate three different panel data models according to the following specification.

$$y_{it} = \beta_0 + \beta_d dens_{it} + \boldsymbol{X}_{c,it} B_c + \epsilon_{it} \tag{2}$$

The above specification illustrates the dependent variable, y_{it}, as a function of demand density in the local market, *dens*. The dependent variable represents one of the variables mentioned above. Additionally, $\boldsymbol{X}_{c,it}$, includes local demand variables as well as year fixed effects. Additionally, ϵ_{it} denotes an the error term that is also included in the specification.

Following the study by Syverson (2004), we estimate three different specifications. We begin by estimating a simple OLS bivariate regression of the dependent variable on demand density. In this model we only analyze the effect of demand density on the productivity and firm size measures in solitude. Additionally, we continue by estimating a year fixed effects model. This specification allows us to control for variables that are constant across the firms but varies over time. As a third and final specification, we include both year fixed effects and a number of local demand variables. In this model we will, hence, account for both changes over time as well as other variables that is likely to affect firm productivity in the restaurant industry.

As mentioned above, we include a number of local demand variables in the third specification. We include the following variables as local demand influences; Age, Marriages, Education and logged median disposable income. The age variable includes data over the ratio of people in each municipality above the age of 25. The variables Marriages and Education includes datapoints of the ratio of the population in each municipality in the respective category. Additionally, we include a control over the logged median disposable income in each municipality.

7 Results

As described in Section 6, we estimate three specifications; a simple bivariate OLS regression, a bivariate fixed effects model and a fixed effects model with controls for local demand variables. Furthermore, we use two measures of labor productivity; revenue per employee and value added per employee. The main regression results are presented in Table 6 for revenue per employee and Table 7 for value added per employee. In the columns we present the results from the three specifications where Model (1) is the simple OLS regression, Model (2) is the fixed effects regression and Model (3) is the fixed effects regression with controls for local demand variables. In the rows we observe the local market variables that we previously calculated. For each specification we present the estimated demand density coefficient and robust standard error. Since we only use deflated revenue as a measure of firm size, the results for firm size is only reported in Table 6.

Model (1) in Table 6 presents the estimated coefficients for demand density from the OLS regression when revenue per employee is used as a measure of labor productivity. We note that all coefficients are significant, suggesting that demand density has an effect on productivity. We observe that the coefficients for median productivity and output-weighted productivity has a positive sign, as expected. This suggests that the central tendency of firm productivity is larger within markets with a higher demand density than in other markets. Furthermore, the coefficient for productivity dispersion, measured as the Interquartile Range (IQR), has a positive sign suggesting that productivity dispersion across firms in the same market is higher in more demand dense markets. Additionally, we observe that the coefficient for the 10th percentile is negative. The results for both the IQR and the 10th percentile are contrary to the theoretical framework provided by Syverson (2004). Moreover, we note that the coefficients for the measures of firm size, measured as the average deflated revenue, is positive and significant at the 10% significance level.

Model (2) and (3) in Table 6 present similar results to Model (1). The coefficients for demand density keep the same sign in all the regressions and remain significant. However, we note that the magnitude of the coefficients change. The largest changes can be observed in the results of Model (3), the fixed effects model that includes controls for local demand variables. We note that all of the estimated coefficients decrease in magnitude. This might be an indication that the initial model overestimated the effect of demand density. Additionally, by observing the R^2's it seems that the estimated specifications only explain a modest portion of the variability in the data. We note that the R^2 is the highest in Model 3 for all of regressions, which is according to expectations since we include more variables in this estimation. We observe the largest R^2 for the IQR and the mean, suggesting that these estimations include a larger part

Table 6: Results − Revenue per employee

		Specification:		
		Model (1)	Model (2)	Model (3)
	$Coef$	0.025***	0.025***	0.007***
IQR	se	(0.0003)	(0.0003)	(0.001)
	R^2	0.217	0.221	0.269
	$Coef$	0.011***	0.011***	0.003***
Median	se	(0.0003)	(0.0002)	(0.001)
	R^2	0.067	0.076	0.094
	$Coef$	0.0003***	0.0003***	0.002***
OW	se	(0.00001)	(0.00001)	(0.0001)
	R^2	0.002	0.006	0.013
	$Coef$	−0.016***	−0.016***	−0.015**
10p	se	(0.0005)	(0.0005)	(0.001)
	R^2	0.037	0.042	0.051
	$Coef$	0.0559***	0.056***	0.013***
Mean	se	(0.0006)	(0.001)	(0.002)
	R^2	0.2299	0.239	0.363
No. of Observations		26,808	26,808	26,808
Time fixed effects		*no*	*yes*	*yes*
Demand Variables		*no*	*no*	*yes*

*Note: The table presents the estimated coefficients of demand density when the various local market variables are regressed on demand density and, for Model(3), the local market variables. The IQR denotes the Interquartile Range, Median is the median productivity, OW is the Output Weighted average productivity, 10p represents the 10th percentile firm (10p) and Mean is the logged average revenue. Model (1) presents the results of the simple OLS estimation, Model (2) presents the results of the fixed effect estimation and Model (3) presents the results of the fixed effects estimation with local market variables. The heteroskedasticity robust standard errors are presented in parenthesis for all estimation. Furthermore, the significance levels are presented as; *p<0.1; **p<0.05; ***p<0.01* of the variability in the data compared to the other regressions. The ability of demand density to explain the mean revenue seems to be the strongest, however.

The results for the regressions using value added per employee as a productivity measure is presented in Table 7. Model (1) presents the estimated coefficients for demand density from the bivariate OLS regression. The results are similar to the previously presented results in most aspects and hence, we note that all coefficients are significant. Furthermore, the coefficients for the Interquartile range, median productivity and output-weighted productivity has a positive sign. This is the same as in the results for the revenue per employee measure and suggests that the central tendency as well as dispersion of firm productivity is higher within markets with a higher demand density than in other markets. Additionally, we observe that the coefficient for the 10th percentile is negative, which is also similar to in the previous estimations. Furthermore, we observe that the results of Model (2) are similar to the results in Model (1) in both sign and magnitude. We note, however, that the R^2's are higher for Model (2) than for Model (1) for the majority of the estimations.

Table 7: Results − Value added per employee

		Specification:		
		Model (1)	Model (2)	Model (3)
	Coef	0.028***	0.028***	0.012***
IQR	*se*	(0.0004)	(0.0004)	(0.001)
	R^2	0.181	0.181	0.210
	Coef	0.006***	0.006***	−0.013***
Median	*se*	(0.0003)	(0.0003)	(0.001)
	R^2	0.012	0.199	0.255
	Coef	0.0003***	0.0003***	0.001***
OW	*se*	(0.00005)	(0.00005)	(0.0001)
	R^2	0.002	0.006	0.013
	Coef	−0.028***	−0.028***	−0.031***
10p	*se*	(0.001)	(0.001)	(0.002)
	R^2	0.046	0.089	0.112
No. of Observations		26,808	26,808	26,808
Time fixed effects		*no*	*yes*	*yes*
Demand Variables		*no*	*no*	*yes*

Note: Please see note for Table 6 *p<0.1; **p<0.05; ***p<0.01

In Model (3) in Table 7, the results are somewhat different to the results in Model (1) and Model (2). When estimating the fixed effects model where we include local demand variables, the coefficient for Median productivity turns negative but remains significant. This is contrary to theory since it suggests that median firm productivity is lower in markets with a higher demand density. The coefficients for the IQR and output-weighted average remains positive and significant. Furthermore, the coefficient for the 10th percentile continues to be negative and significant at the 10% significance level. The R^2's remain small in magnitude and hence, the models still only explain a small part of the variability in the data. We observe that the R^2's are still the highest in Model (3) for all of regressions.

The results found for both of the productivity measures are similar in sign and significance for most of the estimates. For the IQR, all models provide evidence suggesting that demand density has a positive effect on the dispersion of firm productivity. The results for the output-weighted average remains constant in sign and significance in all models as well. Furthermore, the results of all regressions suggests that the 10th percentile in terms of firm productivity is lower in markets with higher demand density than in other markets. Regarding the median productivity, however, we obtain contradicting results for Model (3) when using value added as the productivity measure. Additionally, the results obtained for the value added is contrary to the theory. Since we include more controls in Model (3), it should be the preferred model we must discuss this result further. In section 9 we will discuss what conclusions can be drawn from these results. Furthermore, the results for the mean output illustrate a positive relationship between the variables and demand density. It is, however, important to keep in mind that the results should be interpreted carefully because of limitations of the study that will be discussed in section 9.

7.1 Robustness Checks

In the previous section, we presented the results of the main regressions. As mentioned above, we estimated the effect of demand density on five local market variables; IQR, Median, output-weighted average revenue, the 10th percentile and the mean net revenue. We run three models; the OLS regression, the fixed effects regression and the fixed effects regression with controls for local demand variables. Furthermore, we use two measures of labor productivity; revenue per employee and value added per employee. The obtained results suggest that according to theory, demand density has a significant effect on firm productivity and firm size. Contrary to theory, however, we find evidence that the dispersion of firm productivity across firms in the same market is larger in markets with higher demand density. Furthermore, the result suggests that the 10th percentile firm, in terms of firm productivity, has a lower productivity level in markets with higher demand density.

We perform four robustness checks in order to validate the results; a control for market size, altering of the maximum employees in the firms, the inclusion of entrants in the analysis and the altering of the minimum number of establishments in each market. We only present the results for Model (1) and Model (3) in this section, in order to not make it too cluttered. Furthermore, only the most significant results from the robustness checks are presented. For the complete results from the robustness checks, please see the Appendix A.

We begin by analyzing how market size affects firm productivity. This study assumes that demand density, and not only market size, has an effect on firm productivity. It is, however, likely that market size itself has an effect on firm productivity and firm size. In order to analyze the validity of the results, we must hence estimate a model where we account for market size. Following the study by Syverson (2004), we use the logged population in each municipality as a measure for market size and reestimate the previous regressions.

Table 8: Robustness check − Revenue per employee with a control for market size

		Specification:			
		Model (1):		*Model (3):*	
		Baseline Results	Robustness Check	Baseline Results	Robustness Check
	Coef	0.025***	0.030***	0.007***	0.006***
IQR	*se*	(0.0003)	(0.001)	(0.001)	(0.001)
	R^2	0.217	0.181	0.269	0.269
	Coef	0.011***	0.001***	0.003***	0.001***
Median	*se*	(0.0003)	(0.001)	(0.001)	(0.001)
	R^2	0.067	0.072	0.094	0.099
	Coef	0.0003***	0.0004***	0.002***	0.001***
OW	*se*	(0.00001)	(0.0001)	(0.0001)	(0.0001)
	R^2	0.0017	0.002	0.013	0.014
	Coef	−0.016***	−0.059***	−0.015**	−0.006***
10p	*se*	(0.0005)	(0.001)	(0.001)	(0.001)
	R^2	0.037	0.066	0.051	0.061
	Coef	0.0559***	−0.020***	0.013***	−0.006***
Mean	*se*	(0.0006)	(0.001)	(0.002)	(0.002)
	R^2	0.2299	0.378	0.363	0.408
No. of Obs		26,808	26,808	26,808	26,808
Time FE		*No*	*No*	*yes*	*yes*
Demand Var		*No*	*No*	*yes*	*yes*

*Note: The table presents the estimated coefficients of demand density when we restimate Model (1) and Model (3) with a control for market size. The IQR denotes the Interquartile Range, Median is the median productivity, OW is the Output Weighted average productivity, 10p represents the 10th percentile firm (10p) and Mean is the logged average revenue. Column 1 and Column 3 (Baseline Results) presents the estimated coefficients that was estimated in Section 7. Model (1) presents the results of the simple OLS estimation and Model (3) presents the results of the fixed effects estimation with local market variables. The heteroskedasticity robust standard errors are presented in parenthesis for all estimation. Furthermore, the significance levels are presented as; *p<0.1; **p<0.05; ***p<0.01*

The results of Model (1), when we include a control for market size is presented in Table 8 in Model (1) Robustness Check. We observe that all coefficients remain significant and with the same sign as in the main regression results. The coefficients for many of the regressions remain constant in magnitude but we also see a decrease in the magnitude in some cases. We observe that the coefficient for median firm productivity has decreased in the magnitude. The coefficient for mean revenue, however, changes sign and becomes negative. From these results we can conclude that demand density has an effect on firm productivity that is separate from the effect resulting from the market size. However, we cannot conclude that demand density has an identifiable influence on firm size, measured as mean revenue. The most notable change can be observed regarding the estimated coefficient for minimum productivity level, measured as the 10th percentile. The estimated coefficient has increased in magnitude while remaining significant and with the same sign. This gives us further evidence that demand density has an effect on the minimum firm productivity level. Furthermore, the coefficient for the IQR increases slightly in magnitude.

In Table 8, we observe the estimation of Model (3) when including a control for market size. We observe that the estimated coefficients for Median productivity as well as for output weighted average productivity, remain positive and significant. This is according to theory and suggests that demand density has a positive effect on average firm productivity in the markets. Furthermore, we note that the estimated coefficient for IQR also remains significant and positive, suggesting that demand density has an effect on the dispersion of productivity across firms within the same market. Furthermore the coefficient for the 10th percentile remains significant and negative. This enforces the previously obtained results. The coefficient for mean revenue, however, changes sign and becomes negative. The results for mean revenue are similar to the results obtained for Model (1). Furthermore, we note that the estimated coefficient for market size on the mean revenue is significant and positive. However, this coefficeint is not presented in the table.

We continue by looking reestimating the specifications, when using value added as a productivity measure. The results of Model (1), is presented in Table 9 in Model (1) Robustness Check. We observe that all coefficients remain significant. However, the sign for the median productivity level alters sign and turns negative compared to the main regression results. This suggests that the effect that we previously observed in the estimation for value added per employee might have been driven by the effect of market size. Furthermore, we note that the estimated coefficients for the dispersion of firm productivity, IQR, and the minimum productivity level, 10p, keep the same signs as in the previous estimations. The magnitude of the coefficient for the 10th percentile firm increases while the coefficient for the IQR remains constant compared to previous estimates. Further, the estimated coefficient for the output weighted average productivity level remains constant in magnitude and sign.

In Table 11, we observe the estimation of Model (3) when including a control for market size, when using value added per employee as a productivity measure. As in Model (1) and the previous results for Model (3), the estimated coefficient for Median productivity turns negative while remaining significant when including a control for market size. The magnitude of the coefficient has increased compared to the main regression results. However, we note that the magnitude of the coefficient is in line with the estimated coefficient for Model (1). The coefficients for output weighted

Table 9: Robustness check − Value added per employee with a control for market size

		Specification:			
		Model (1):		*Model (3):*	
		Baseline Results	Robustness Check	Baseline Results	Robustness Check
	Coef	0.028***	0.030***	0.0012***	0.014***
IQR	*se*	(0.0004)	(0.001)	(0.001)	(0.001)
	R^2	0.181	0.181	0.210	0.211
	Coef	0.006***	−0.017***	−0.013***	−0.019***
Median	*se*	(0.0003)	(0.001)	(0.001)	(0.001)
	R^2	0.012	0.072	0.255	0.272
	Coef	0.0003***	0.0004***	0.001***	0.001***
OW	*se*	(0.00005)	(0.0001)	(0.0001)	(0.0001)
	R^2	0.002	0.002	0.013	0.014
	Coef	−0.028***	−0.059***	−0.031***	−0.039***
10p	*se*	(0.001)	(0.001)	(0.002)	(0.002)
	R^2	0.046	0.066	0.0112	0.118
No. of Obs		26,808	26,808	26,808	26,808
Time FE		*No*	*No*	*yes*	*yes*
Demand Var		*No*	*No*	*yes*	*yes*

Note: Please see note for Table 8 *p<0.1; **p<0.05; ***p<0.01

average productivity and the interquartile range remains positive and significant and the coefficients are constant in magnitude. Furthermore, the coefficient for minimum productivity level remains negative and significant. Additionally, we observe that the R^2's increase for both models when including the variable for market size. We also observe that the R^2 is the highest for Model (3), which is according to expectation.

The second robustness check that we perform relates to the exclusion of entrants and whether this alters the results. As mentioned earlier, we exclude entrants from the analysis since our main purpose with the thesis is to investigate the effect of firms being forced out of the market from competition. Hence, as many researchers have found evidence that young firms are more often forced to exit the markets, we exclude the firms to not include the exits resulting from young firms. Parsa et al. (2005) perform a study on the restaurant industry in an attempt to explain why firms are forced to exit. Their study finds that only a relatively modest part of the restaurants fail during the first year of being in business. This suggests that, by excluding exits, we may have overlooked the effect from firms that we should have included in the analysis. In this section, we reestimate the initial regressions where we use data over all restaurants and test whether the results hold when entrants are included in the analysis.

The results of the estimation of Model (1) and Model (3), when we include entrants in the analysis, are presented in Appendix A. The estimated coefficients for the local market variables are in line with previous results and hence, they remain significant and with the same sign. For the productivity measure Value added per employee when estimating Model (3), the coefficient for median productivity alters sign and turns negative while remaining significant. We observed similar results in the previous robustness check and hence, we obtain further evidence that the we cannot draw conclusions regarding the results for median productivity level for value added per employee.

As a third robustness check, we look at the number of employees per firm. As mentioned earlier, the dataset that we use consist of firm level data and not establishment data. This might lead to problems since the study is focused on connecting demand density to the restaurant active in the market. It is, however, likely that one firm will own multiple establishments. Furthermore, these establishments may be located in different municipalities compared to each other. In order to account for this, we perform a robustness check on the small and medium sized firms. These firms are less likely to have multiple establishments located in various municipalities and hence, we can test whether the results hold for the smaller firms. According to the Swedish Agency for Economic and Regional Growth, 96% of all firms in Sweden are small firms with a number of employees between 0 and 10 during 2017. Furthermore, approximately 40% of the total revenue is created by firms with employees between 0 and 50 employees (Persson, 2019). Because of this, we use 50 as a threshold for number of employees and only include firms that hold for this criteria. The exclusion of the larger firms might give us a better indication of the effect of demand density on the individual establishments within the restaurant industry.

The results are presented in Appendix A. As expected, the number of observations decreases when excluding the firms with more than 50 employees. However, we note that the number of observations only decrease slightly (previously 26,808 and now 26,365). Additionally, we note that the estimated coefficients do not change in significance or sign when we exclude the restaurants with more than 50 employees.

This suggests that the patterns hold even for the smaller firms in the sample. Furthermore, we do not see any large changes in magnitude on the estimated coefficients. Following our reasoning that smaller firms are less likely to have more than one establishment, the results indicate that the results are not sensitive to the existence of multi-establishment firms. Syverson (2004) analyzed the ready mixed concrete industry and found similar results, i.e. that the inclusion of multiplant firms in the analysis does not alter the effect of demand density on firm productivity. However, the results must be interpreted carefully since we do not have establishment data and hence, we can only make assumptions.

In the analysis, we enforce an exclusion criteria where we only include municipalities that have three or more firms. As a final robustness check, we analyze whether the results change if we alter this requirement. We exclude the municipalities with fewer than three firms because of the local market variables that we are using in the analysis. However, what happens with the results when we exclude municipalities with less than five active firms.

The results are presented in Appendix A. We observe that the observations decrease from 26,808 to 24,149. Furthermore, the estimated coefficients do not change in sign or significance when altering the exclusion criteria. We observe that the coefficient for median productivity for value added per employee turns negative (as in the previous robustness checks). Furthermore, we observe that the estimated coefficient for IQR turns insignificant while remaining positive when estimating Model (3) with value added per employee as a productivity measure. We also observe that the coefficient for output-weighted average productivity turns insignificant when estimating Model (1) with value added per employee. However, for the other local market variables we note that the coefficients are not affected in most estimations when using the large market sample.

The results change for some of the estimations when testing for robustness. The most notable change occurs when including a control for market size. When accounting for market size we note that some of the estimated coefficients alter sign or becomes insignificant suggesting that market size likely was a driving force in the previous estimations. Furthermore, the median productivity level for value added per employee does not hold for any of the robustness checks. In the main regression results, we also observe that the coefficient for median productivity turns negative when testing Model (3). The results from the robustness check are in line with this result. We will continue discussing the results in the following section. Furthermore, we will discuss possible reasons and implications.

8 Discussion and Limitations

The main regression results are presented in section 7. Furthermore, we have performed robustness checks in order to test the validity of the results. Overall, we find evidence that suggests that demand density might have an impact on firm productivity. However, we note that the effect is not large and not robust. As an example, we find inconclusive results regarding the effect of demand density on firm size and hence, we cannot draw any conclusions regarding this. In this section we will discuss the results as well as possible explanations and previous literature related to the topic. We begin by discussing the results found for the productivity and size measures. It is important be aware that the results should be interpreted carefully due to limitations of the study that we will discuss in the final part of this section.

The results for the central tendency when using revenue per employee as a productivity measure, remain positive and significant in all regressions. This implies that the middle section of firms, in terms of productivity, in markets with higher demand density perform at a higher productivity level than similar firms in less dense markets. This is in accordance to the theoretical framework provided by Syverson (2004). The results when using Value Added as the productivity measure are also positive and significant for the estimations of Model (1) and Model (2). However, we note that when estimating Model (3), the fixed effects model with controls for local demand variables, the coefficients turn negative while remaining significant. Since the coefficients alter sign when estimating Model (3), this might indicate that demand density does not have an significant effect on the median value added per employee. We also observe that the coefficient remains negative but significant for many of the robustness checks. Furthermore, this might indicate that value added is not a good measure to use in this study. Bartelsman and Doms (2000), provide evidence that the use of value added as a measure of labor productivity might have drawbacks when the output is affected by quality improvements. They argue that there might be a downward bias in productivity from using value added. As discussed in the theoretical framework, we argue that the productivity measure also includes an aspect related to quality. Therefore, substitution will also be dependent on the quality of the products provided by the restaurants. With the value added measure there is therefore a risk that the increase in quality is not reflected in the productivity.

In most of the regressions, the coefficients for demand density on dispersion of firm productivity, measured as the interquartile range, is significant and positive. When estimating the specification using revenue per employee as a productivity measure, the results for all regressions suggest that demand density has a significant and positive effect on productivity dispersion, which is contrary to the study by Syverson (2004). When estimating this specification, we also observe a positive relationship between market size and productivity dispersion, suggesting that both market size and demand density affects the dispersion of firm productivity individually. Berry and Waldfogel (2010), perform a study on the restaurant industry that illustrates the relationship between market size and the dispersion of quality and variety of products. Since we consider quality as a part of the increase in firm productivity resulting from and increase in demand density, the mechanism explained in the study by Berry and Waldfogel (2010) might explain parts of our results, i.e. that market size and perhaps density increases the quality and in turn, firm productivity. However, as mentioned in previous section, when estimating Model (3) when only including municipalities with more than 5 restaurants while using value added per employee as a productivity measure, the coefficient turns insignificant. Furthermore, as mentioned above, we should interpret the results carefully since there are drawbacks when using the value added per employee as a measure on disaggregated data (Bartelsman and Doms (2000)(2000)).

The results for the minimum productivity level, measured as the 10th percentile, also remains constant in most regressions and we note that the coefficients are negative and significant, which is contrary to the theory by Syverson (2004). There are some reasons, that might explain why we observe these differences between the results in this study and the results in Syverson (2004). Firstly, in this study we use labor productivity as a measure of productivity dispersion in relations to quality and more product differentiation in more dense markets. However, Syverson uses Total Factor Productivity. Furthermore, both of the measures that we use includes price. However, the productivity measure used by Syverson, only includes the quantity. Furthermore, the restaurant industry is a more heterogeneous industry than the ready-mixed concrete industry. As a result, consumers will not substitute between the firms in the restaurant industry in the same manner as in the concrete industry due to product differentiation. The mechanism explained in Syverson (2004) might not be as evident in the restaurant industry. We should also keep in mind the recent work by Schiff (2015). Schiff (2015) investigates the restaurant industry in the US and finds evidence suggesting that markets with a higher demand density has a higher product variety. Hence, markets with higher demand density are likely to be more heterogeneous.

The coefficients for firm size, measured as mean revenue, are positive and significant for most specifications. Furthermore, we note that the coefficients for mean revenue are larger in magnitude than the other coefficients are. This is in accordance to previous research provided by Syverson (2004) and suggests that firms sell more products or at a higher price in markets with higher demand density. However, we note that the sign of the coefficient becomes negative when we control for market size. This might suggest that market size, and not demand density, has an effect on the average deflated revenue.

Although there are limitations to the study, some of the results obtained hold for a number of specifications and are in line with previous research on productivity within the restaurant industry or the effect of demand density. However, in general we note that estimates change in the sign and significance in some of the regressions and hence, there is uncertainty in the possibility of drawing conclusions from the results. Overall, the results suggests that dispersion as well as the central tendency of industries increase as demand density increases. Furthermore, the results suggests that the minimum productivity level is lower in markets with higher demand density. The estimates for firms size, however, provide inconclusive results. Therefore, we do not obtain evidence that firm size increases as demand density increases. As stated, though, results should be interpreted with precaution because of the limitations of the study discussed previously.

8.1 Limitations

There are some limitations in the study. The first limitation is related to the definition of local markets. According to the theoretical framework in the study, it is important that there is little overlap between the geographic markets. However, it is likely that consumers visit restaurants in neighboring municipalities as well. Hence, we are at risk of underestimating the demand that is affecting the restaurants. However, as mentioned earlier previous research has illustrated the importance of the local demand on firms within the service industry (Öner (2016)). However, it cannot be ascertained that there is no overlap between the municipalities and hence, we must consider this when interpreting the results.

Furthermore, there are limitations in regards to the data that is used. The dataset that we use is on firm level and not on the establishment level. Because of this, there might be multiple establishments that are located in different municipalities but are counted in the same firm. As a result, the revenue might be connected to the wrong municipality. Previously, we performed a robustness check in order to account for this. We tested an estimation where we only include smaller firms in the sample. The results suggests that the inclusion of larger firms, that are likely to be the multi-establishment firms, does not alter the results. Furthermore, Syverson (2004) provides sensitivity tests in his analysis of demand density and firm productivity dispersion on the inclusion of multiunit plants. He finds that including multiunit plants does not change the observed effects of demand density on firm productivity. For future studies, however, it would be good to use establishment level data.

On a final note, the regressions might suffer from omitted variable bias since there may be other local demand variables that could affect firm productivity and firm size. The variables that have been chosen are, however, considered sufficient in accounting for demand variables. We must, however, be careful when we draw conclusions from the results obtained in the study.

9 Conclusion

Productivity has been a topic of interest for many researchers throughout the years. Furthermore, many researchers have focused on explaining the evident productivity dispersion that can be observed within industries. A majority of this research has focused on the supply-side factors. This study attempts to answer the question of how demand-side variables, in the form of substitutability, affects firm productivity dispersion and firm size. By following the theoretical framework presented by Syverson (2004), we analyzed the effect of demand density on firm productivity in the restaurant industry. The baseline of the theory implies that as demand density increases, the consumers would substitute to the most productive restaurants forcing the less productive restaurants out of the market. Not only would this increase the average productivity in the market, but also the result would be a decreases in the amount of dispersion of firm productivity within the market. In the study we assume that the most productive restaurants are the restaurants that can provide the best price considering the quality of food.

The findings in this study provide some indication of the relationship between firm productivity and demand density. We obtain some evidence that demand density has a slight effect on firm productivity. The most evident result is related to the productivity dispersion. The results suggests that firm productivity dispersion is higher in markets with larger demand density compared to markets with lower demand density. This is contrary to the evidence provided by Syverson (2004). As discussed by Syverson (2004), however, the effect of substitutability will be the most evident in homogeneous industries. Furthermore, as discussed previously this is in line with previous research regarding the restaurant industry and hence, it might indicate that as demand density increases, quality and product variability increases. Furthermore, in the study we have received some indication regarding the effect of demand density on the minimum productivity level in the markets. The results indicate that the minimum productivity level is lower in markets with higher demand density. The results for these estimations have varied and hence, the results should be interpreted with caution. Furthermore, the results regarding the median productivity level are inconclusive. We must be careful when interpreting the results as there are some limitations to the study.

This study furthers the knowledge of factors affecting firm productivity. The results give further insights regarding the effect of demand side variables on productivity which can be of value for researchers within the field of industrial organization and urban economics. Furthermore, this study can be of value for the research analyzing the relationship between demand density or market size and quality and product variability.

Although a lot of research has been done on the topic of productivity, little is still known about the demand-side effects. This emphasizes the need for future research within the subject in order to understand the various factors influencing firm productivity. Future research regarding the topic should address the limitations that we mentioned earlier by using establishment level data and by including a measure that accounts for the overlap between markets. Furthermore, future research should attempt to measure the effect of other factors of substitution.

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Appendix

A Results Robustness Checks

Table 10: Robustness check − Revenue per employee Model (1)

		Specification:				
		Results	1	2	3	4
	Coef	0.025***	0.030***	0.026***	0.025***	0.024***
IQR	*se*	(0.0003)	(0.001)	(0.0003)	(0.0003)	(0.0003)
	R^2	0.217	0.181	0.199	0.212	0.245
	Coef	0.011***	0.001***	0.009***	0.010***	0.010***
Median	*se*	(0.0003)	(0.001)	(0.0002)	(0.0003)	(0.0002)
	R^2	0.067	0.072	0.047	0.056	0.083
	Coef	0.0003***	0.0004***	0.0003***	0.0004***	0.005***
OW	*se*	(0.00001)	(0.0001)	(0.00005)	(0.0001)	(0.0001)
	R^2	0.002	0.002	0.001	0.002	0.003
	Coef	−0.016***	−0.059***	−0.022***	−0.016***	−0.016***
10p	*se*	(0.0005)	(0.001)	(0.0005)	(0.001)	(0.0004)
	R^2	0.037	0.066	0.063	0.038	0.051
	Coef	0.0559***	−0.020***	0.052***	0.045***	0.050***
Mean	*se*	(0.0006)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.2299	0.378	0.225	0.172	0.250
No. of Obs		26,808	26,808	31,627	26,365	24,189
Time FE		*No*	*No*	*No*	*No*	*No*
Demand Var		*No*	*No*	*No*	*No*	*No*

*Note: The table presents the estimated coefficients of demand density when the various local market variables are regressed on demand density and, for Model(3), the local market variables. The IQR denotes the Interquartile Range, Median is the median productivity, OW is the Output Weighted average productivity, 10p represents the 10th percentile firm (10p) and Mean is the logged average revenue. Results denote the main regression results obtained in section 7. R1 is robustness check 1 where we include a control for market size. R2 is robustness check 2 where we include the entrants in the analysis, R3 is robustness check 3 where we exclude firms with more than 50 employees. R4 is robustness check 4 where we exclude municipalities with fewer than 5 restaurants for a given year. The heteroskedasticity robust standard errors are presented in parenthesis for all estimation. Furthermore, the significance levels are presented as; *p<0.1; **p<0.05; ***p<0.01*

Table 11: Robustness check − Revenue per employee Model (3)

		Specification:				
		Results	R1	R2	R3	R4
IQR	*Coef*	0.007***	0.006***	0.012***	0.007***	0.011***
	se	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.269	0.269	0.258	0.260	0.316
Median	*Coef*	0.003***	0.001***	0.005***	0.003***	0.002***
	se	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.094	0.099	0.084	0.081	0.112
OW	*Coef*	0.002***	0.001***	0.001***	0.002***	0.002***
	se	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
	R^2	0.013	0.014	0.011	0.014	0.016
10p	*Coef*	−0.015**	−0.006***	−0.015***	−0.008***	−0.010***
	se	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.051	0.061	0.097	0.062	0.100
Mean	*Coef*	0.013***	−0.006***	0.011***	0.004***	0.024***
	se	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
	R^2	0.363	0.408	0.340	0.328	0.373
No. of Obs		26,808	26,808	31,627	26,365	24,189
Time FE		*yes*	*yes*	*yes*	*yes*	*yes*
Demand Var		*yes*	*yes*	*yes*	*yes*	*yes*

Note: Please see note for Table 10 *p<0.1; **p<0.05; ***p<0.01

Table 12: Robustness check − Value added per employee Model (1)

		Specification:				
		Results	R1	R2	R3	R4
	Coef	0.028***	0.030***	0.027***	0.026***	0.030***
IQR	*se*	(0.0004)	(0.001)	(0.0004)	(0.0004)	(0.0004)
	R^2	0.181	0.181	0.156	0.164	0.225
	Coef	0.006***	−0.017***	0.006***	0.005***	0.008***
Median	*se*	(0.0003)	(0.001)	(0.0003)	(0.0003)	(0.0004)
	R^2	0.012	0.072	0.012	0.009	0.010
	Coef	0.0003***	0.0004***	0.0003***	0.0004***	0.0001
OW	*se*	(0.00005)	(0.0001)	(0.00004)	(0.0001)	(0.0001)
	R^2	0.002	0.002	0.002	0.002	0.003
	Coef	−0.028***	−0.059***	−0.039***	−0.028***	−0.032***
10p	*se*	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.046	0.066	0.079	0.048	0.063
No. of Obs		26,808	26,808	31,627	26,365	24,189
Time FE		*no*	*no*	*no*	*no*	*no*
Demand Var		*no*	*no*	*no*	*no*	*no*

Note: Please see note for Table 10 *p<0.1; **p<0.05; ***p<0.01

Table 13: Robustness check − Value added per employee Model (3)

		Specification:				
		Results	R1	R2	R3	R4
	Coef	0.0012***	0.014***	0.015***	0.0013***	0.002
IQR	*se*	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.210	0.211	0.178	0.188	0.278
	Coef	−0.013***	−0.019***	−0.014***	−0.014***	−0.016***
Median	*se*	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	R^2	0.255	0.272	0.223	0.255	0.355
	Coef	0.001***	0.001***	0.001***	0.002***	0.003***
OW	*se*	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0003)
	R^2	0.013	0.014	0.012	0.014	0.017
	Coef	−0.031***	−0.039***	−0.040***	−0.032***	−0.026***
10p	*se*	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
	R^2	0.112	0.118	0.123	0.112	0.168
No. of Obs		26,808	26,808	31,627	26,365	24,189
Time FE		*yes*	*yes*	*yes*	*yes*	*yes*
Demand Var		*yes*	*yes*	*yes*	*yes*	*yes*

Note: Please see note for Table 10 *p<0.1; **p<0.05; ***p<0.01