A Note on Methodology Used to Assess the Initial Impact of the COVID-19 Recession by Firm Size Class (1 of 3)

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Studying how the COVID-19 recession impacted Minnesota businesses by size class requires a good grasp of the conceptual and methodological issues that are involved in analyzing the relationships between employment changes and business size class. In fact, evidence abound in the literature on the sensitivity of these relationships to such issues. For example, in the famous debate surrounding the role of small firms on job growth conclusions run the gamut from most significant role to no role, and often derived from analysis of the same data[1].

This article gives a brief review of the major elements in the methodology used to capture the COVID-19 recession impacts on employment and businesses by business size class. Specifically, compiling the monthly business employment dynamics, measuring the COVID-19 recession early impact, and assigning these measures and businesses to size classes are highlighted.

In addition, this article gives the size distributions of firms, establishments, and employment for the months of February in 2019 and 2020. The results of the COVID-19 recession impact by firm size are discussed in separate articles which are available here:

Assessing the Initial Impact of the COVID-19 Recession on Minnesota Businesses: Executive Summary

Assessing the Initial Impact of the COVID-19 Recession on Employment by Firm Size Class

Assessing the Initial Impact of the COVID-19 Recession on Establishments by Firm Size Class

A. Compile Monthly Business Employment Dynamics

The business employment dynamics are measures of the changes in employment that occur at businesses and capture the dynamics that give rise to the net changes in employment. They are derived from the monthly employment at each Minnesota establishment available from the quarterly census of employment and wages (QCEW) microdata. The QCEW defines monthly employment as the count of workers who worked for an establishment during, or received pay for, the pay period that includes the 12th day of the month. In addition, an establishment is a single physical location where goods and services are produced.

Statistics of monthly business employment dynamics require developing a longitudinal database from establishments microdata. To build this database, the QCEW establishment data for first quarter 2019 through fourth quarter of 2020 are linked. Then, monthly employment dynamics for a given month are computed by comparing the employment level in the given month to the employment level in the previous month[2]. In each (call it "current") month, five categories of establishments are created.

- Expanding establishment: is an establishment with nonzero employment in both current and previous months and employment in current month is higher than employment in previous month.
- Opening establishment: is an establishment with nonzero employment in current quarter and zero employment in previous month.
- Contracting establishment: is an establishment with nonzero employment in both current and previous months and employment in current month is smaller than employment in previous month.

- Closing establishment: is an establishment with nonzero employment in previous month and zero employment in current month.

- Stable establishment: is an establishment with nonzero and equal employment in both current and previous months.

These categories of establishments form the building blocks in measures of monthly business employment dynamics as shown by equations 1 to 6 below:

Job creation = jobs created at expanding establishments + jobs created at opening establishments. (1)

Job destruction = jobs destroyed at contracting establishments + jobs destroyed at closing establishments. (2)

Net employment change = job creation – job destruction. (3)

Job creating establishments = expanding establishments + opening establishments. (4)

Job destroying establishments = contracting establishments + closing establishments. (5)

Net establishments change = opening establishments - closing establishments. (6)

B. Measuring COVID-19 impact

To capture the impact of COVID-19 on Minnesota businesses in March-April of 2020, I apply a statistical technique called the difference-in-differences to measures of monthly business employment dynamics. For each measure, call it X and which represents counts of jobs or establishments, the COVID-19 impact on X is given by equations 7 and 8.

COVID-19 impact on X =
$[(X_{Mar2020} - X_{Feb2020}) + (X_{Apr2020} - X_{Mar2020})] - [(X_{Mar2019} - X_{Feb2019}) + (X_{Apr2019} - X_{Mar2019})]$ (7)

Equation 7 is rewritten as:

COVID-19 impact on X = $[(X_{Apr2020} - X_{Feb2020})] - [(X_{Apr2019} - X_{Feb2019})]$ (8)

This difference-in-differences gives the change in measure X, say jobs destroyed at contracting establishments, that have occurred in March-April 2020 on top of what would be expected to occur normally as during March-April 2019. Thus, it is a good approximation of COVID-19 impact on X.

C. Defining size classes

Assigning the above measures, defined in equations 1 to 8, to business size classes appears, deceptively, straightforward: simply assign businesses into size classes by their employment levels. On the contrary, it is fraught with pitfalls because analyzing employment changes by business size class involves various economic and statistical challenges. The three most serious ones and how they are treated in this analysis are discussed next.

1. Size classes: First, what size class intervals to use? Many size class intervals exist in the literature to meet specific analytical needs of researchers and reporting standards of government agencies. One such set of intervals is developed by the BLS to publish QCEW-based establishment size data. It has nine size class intervals[3] but, for the sake of analytical tractability, I collapse it into five class intervals that match size classification used by DEED in other programs, such as the job vacancy program. Thus, our size classes are very small: 1 to 4 employees[4], small: 5 to 9 employees, medium: 10 to 49 employees, large: 50 to 249 employees, and very large: 250 or more employees.

2. Firms vs. establishments: Second, should the unit of analysis be an establishment or a firm? An establishment describes a physical location, such as a shop or store, which produces goods or provides services in one, or predominantly one, type of economic activity. A firm, or a company, may have one or more establishments, where each establishment may participate in different economic activities. For firms that operate a single establishment, monthly business employment dynamics are equal regardless of whether they are measured at the establishment level or the firm level. In addition, for these employers, the size class is the same at both levels.

However, for firms that operate more than one establishment the monthly business employment dynamics and the size classification may not coincide between the establishment and the firm levels, because the employment level at the firm represents the sum of the employment levels of the firm's establishments. In this case, defining size classes based on the employment size of establishments may skew the employment dynamics and conclusions towards either the small or large size class, while measuring employment dynamics at the level of firms underestimates these dynamics.

Table 1 illustrates these conflicting business employment dynamics and size class definitions derived from using establishments and firms. In the hypothetical economy of Table 1, there is a net employment change of "minus" 10 jobs. But what business size class did these job losses originate at?

Table 1. Monthly Business Employment Dynamics: at the Establishment Level vs at the Firm Level

Firms	Establishments	Employment		Net Employment Change	Business Employment Dynamics Type	Size Class (Average employment of two months)
		Previous Month	Current Month			
A	A-1	4	0	-4	Closing	Very small (2)
A	A-2	2	0	-2	Closing	Very small (1)
A	A-3	5	7	2	Expanding	Small (6)
A	A-4	5	9	4	Expanding	Small (7)
A	**All**	**16**	**16**	**0**	**Stable**	**Medium (16)**
B	B-1	3	1	-2	Contracting	Very small (2)
B	B-2	3	1	-2	Contracting	Very small (2)
B	B-3	6	4	-2	Contracting	Small (5)
B	B-4	8	4	-4	Contracting	Small (6)
B	**All**	**20**	**10**	**-10**	**Contracting**	**Medium (15)**
Economy (A & B)		**36**	**26**	**-10**	**Contracting Economy**	

Source: Author's analysis.

Clearly, the answer depends upon the unit of analysis used. If the analysis is based on establishments only, then the very small establishments are responsible for the loss of ten jobs and the closure of two businesses. And if the analysis is based on firms only, then the underlying dynamics that occur at the level of establishments are completely lost. And as Table 1 shows, one medium firm, B, is responsible for the ten jobs lost in the economy while the other medium firm, A, is defined as stable even though all its establishments experienced non-zero employment changes and two of them closed. Finally, if the analysis is based on establishments which are then classified into size classes of their firms, then the ten job losses are attributed to firms of medium size class and reported at the very small establishments of which two closed. Obviously, this latter approach of analysis gives a more realistic picture of the relationship between net employment change and business size class.

As this hypothetical example shows, to better assess the impact of COVID-19 across different size classes of businesses, measures of monthly business employment dynamics need to be classified based upon the firm level. Explicitly, our unit of analysis for the monthly business employment dynamics is the establishment but the business size class is defined at the level of the firm. This is workable using the QCEW microdata as firms are identified through the Federal Employer Identification Number (FEIN). The employment level of firms is determined by summing the employment of all establishments that belong to the same FEIN which is then used to assign firms to the appropriate size class.

3. Sizing method: Finally, the most complicated challenge deals with how to size employers into size classes. Three methods of defining size classes are common in the literature: base-sizing, end-sizing, and mean-sizing[5]. In base-sizing, analysts use the employment in the previous period as the basis to define the business size class while in end-sizing they use the employment in the current period as the basis. Both methods have been found to suffer from a bias known as "regression to the mean bias" that overstates the impact of small and large firms on employment change.

The regression to the mean bias arises because of the natural movement of businesses between size classes during the year. A business experiencing a transitory negative shock to its employment, such as with COVID-19, may appear into a smaller size class than normal. Then, as employment starts to rebound employment growth is attributed to the smaller size class because of the regression to the mean (or normal). Generally, under base sizing employment growth would seem to come mostly from small firms and employment decline would seem to come mostly from large firms. On the other hand, end-sizing would indicate that employment growth would come mostly from large firms and employment decline would come mostly from small firms. Table 2 shows how different sizing methodologies affect which size class is credited with job growth or decline.

In addition, base-sizing and end-sizing methods suffer from another statistical shortcoming. They attach different rates of job expansion and contraction for the same level of job growth and decline. For example, in Table 2, "Establishment A" lost two jobs in April then gained them back in May. Using base-sizing, "Establishment A" lost 33% of its jobs in April but gained 50% of its jobs in May while the job change is the same in absolute value, 2 jobs. This phenomenon is called "lack of symmetry" between expansion and contraction of similar magnitudes. A good sizing method should not exhibit "lack of symmetry" property.

Finally, rates of employment change derived from base-sizing and end-sizing are not bounded (See Table 2, "Establishment B"). With base-sizing, large increases in employment results in extremely high rates of employment growth, especially at small businesses, while rates of employment loss are capped at 100 percent. The reverse is true with the end-sizing method. Large reductions in employment result in extremely high rates of employment loss, especially at small businesses, while rates of employment growth can't exceed 100 percent.

Table 2. Effect of Different Establishment Sizing Definitions on Assigning Net Employment Change to Size Classes

Variable	Establishment A			Establishment B		
Month	**March**	**April**	**May**	**March**	**April**	**May**
Employment	6	4	6	12	2	12
Net employment change		-2	2		-10	10
Base-sizing: size class		Small	Vey small		Medium	Vey small
percent change		-33%	50%		-83%	500%
End-sizing: size class		Very small	Small		Very small	Medium
percent change		-50%	33%		-500%	83%
Mean-sizing: size class		Small	Small		Small	Small
percent change		-40%	40%		-143%	143%

Source: Author's analysis.

The mean-sizing method, which uses the average employment of the pervious and current periods, fulfills "the symmetry" property and yields rates of net employment changes that lie between those obtained from the base-sizing and end-sizing methods. Although these qualities are nice to have, averaging over only two successive months may miss the appropriate size class of the firm when seasonality is typical[6]. In fact, all three methods are sensitive to large changes in employment levels that are due to seasonality.

To circumvent the weaknesses of sizing methods, in this study I apply a variant of the mean-sizing method by modifying how the average employment is computed so it suits our cohort analysis of firms at the onset of COVID-19 shock. For our cohort of firms (and establishments) that were in business in February, the average employment is computed not only over two months (previous and current) but over the months of positive employment during the previous twelve months. Likewise, for new firms (and establishments) that start operation after February while not in business in the previous 12 months, the average employment is computed over the months of positive employment during the seven months of March through December. Since employment often fluctuates from month to month, this method of defining average firm size and its size class provides a good classification of the firm's scale of operation.

Firm Size Distributions

Figure 1 contrasts the distributions of firms, establishments, and employment by firm size for the month of February between 2019 and 2020. All three distributions are almost identical between the two years; however, the levels of firms, establishments, and employment are different. In February 2019, Minnesota had 116,328 firms that operated 142,493 establishments and a payroll of 2,842,122 jobs. By February 2020, these numbers increased to 118,117 firms, 144,484 establishments, and 2,861,097 jobs.

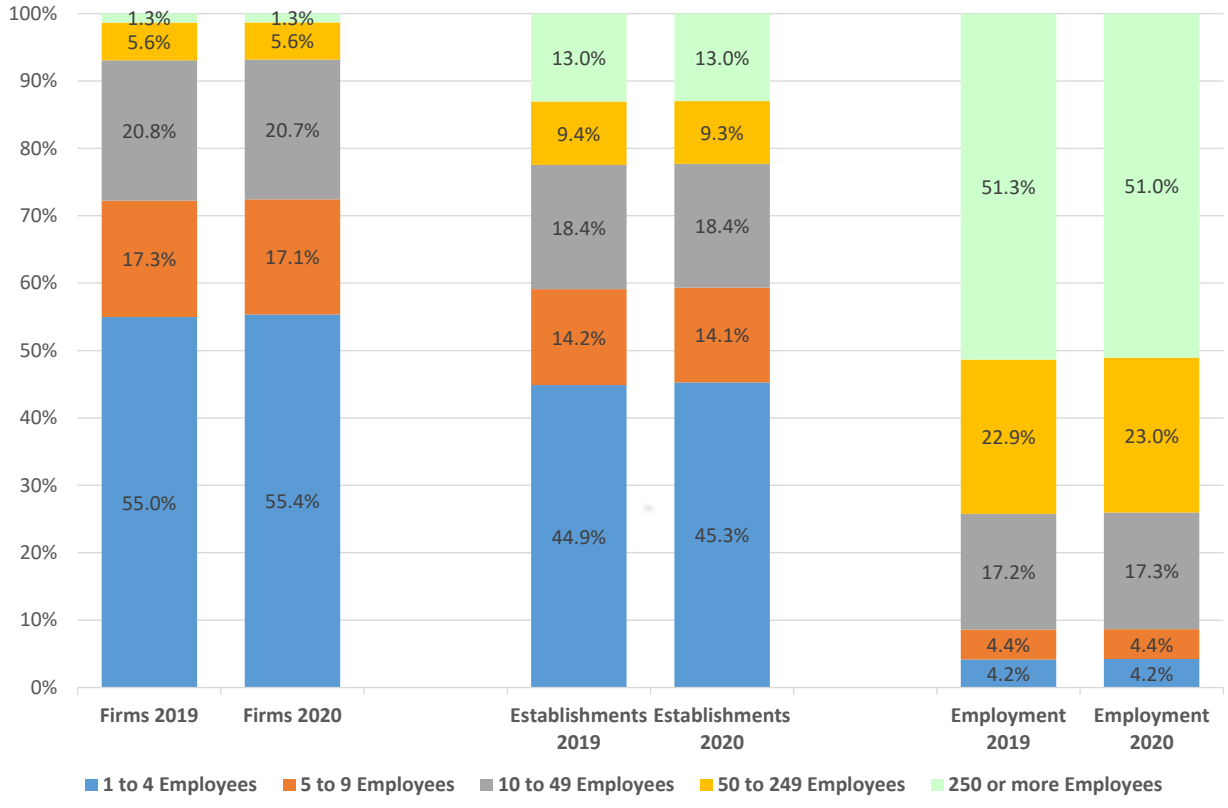
The firm size distribution is dominated by firms with less than 10 employees, accounting for almost three-fourths of firms. Statistically speaking, the firm size distribution is highly skewed---too many observations on the left side of the distribution and few observations on the right side of the distribution. In February 2020 and

before COVID-19 hit, 55% of firms were very-small (1 to 4 employees), 17% of firms were small (5 to 9 employees), 21% of firms were of medium size (10 – 49 employees), 5.6% were large firms (50 to 249 employees) and 1.3% were very large firms (250 or more employees).

As expected, the dominance of very small and small firms is translated into a large share of total establishments (59%). And just as the very small firms dominate alone the firm size distribution, they account for the largest share of establishments, or 45%. While all these establishments are themselves very small (1 to 4 employees)[7], they don't represent the whole population of very small establishments (72,022 establishments in February 2020). In fact, 91% of very small establishments (65,420) are operated by very small firms, two percent (1,226) by small and medium firms jointly, three percent (1,944) by large firms, and five percent (3,432) by the very large firms.

The remaining 41% establishments is shared between medium firms with 19% of establishments, large firms with 9%, and very large firms with 13%. Each of these firm size classes operate establishments that belong to more than one establishment size class. For example, in February 2020 there were 1,531 very large firms operating 18,739 establishments, of which only 1,461 were very large establishments, or eight percent. Most of their other establishments (75%) had less than 50 employees distributed among medium establishments with 39% and small and very small establishments each with 18%.

Figure 1. Size Distribution of Firms and the Distributions of Establishments and Employment by Firm Size Class, February 2019 vs February 2020, Minnesota



The third set of distributions in Figure 1 describes how total employment is divided among firms of different size classes. Unlike with the firm and establishment distributions, the employment distribution is dominated by the few large and very large firms, which account for approximately three-fourths of total employment. Amazingly, the relatively tiny (1.3%) group of very large firms alone account for over half of total employment. In contrast, very small firms, which represent the bulk (55%) of all firms, constitute only four percent of total employment.

Even combining very small and small firms together they barely make up one-tenth of total employment, despite their large share (72%) of all firms. These results indicate that the employment share by firm size class is inversely related to firm size.

Recognizing the firm size distributions of firms, establishment, and employment not only helps to understand how COVID-19 impacted firms of different size, but also to provide valuable information to policymakers on the effectiveness of response and recovery initiatives.

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[1] Davies, Phil. 2010. "Sizing Up Job Creation: Are small businesses truly the engine of job growth? It depends on how you look at it." Federal Reserve Bank of Minneapolis. https://www.minneapolisfed.org/article/2010/sizing-up-job-creation

[2] The monthly business employment dynamics follow the same concepts used by the Bureau of Labor Statistics (BLS) in the quarterly business employment dynamics (BED) program but apply them to monthly employment levels. For details on the BED program see: https://www.bls.gov/bdm/

[3] The BLS size levels are: 1 to 4; 5 to 9; 10 to 19; 20 to 49; 50 to 99; 100 to 249; 250 to 499; 500 to 999; and 1,000 or more employees. See: https://www.bls.gov/cew/classifications/size/size-data-info.htm

[4] The Small Business Administration, for purposes of federal contracting, defines a small business as an employer with 100 to 1,500 employees depending on the industry of the business. Many analysts studying labor dynamics consider these cut-offs as too high and use much lower levels such as 10, 20 or 50 employees.
For the SBA Small Business Size Standards see: https://www.sba.gov/sites/default/files/2019-08/SBA%20Table%20of%20Size%20Standards_Effective%20Aug%2019%2C%202019_Rev.pdf

[5] There is a fourth, less common method referred to as dynamic-sizing used by the BLS in its BED program. This method allows for a business employment changes to be allocated to each size class in which the employment change occurs. For example, consider a business that goes from 11 employees to 3 employees, thus experiencing a loss of 8 jobs. By size class, 2 jobs losses are allocated to size class 10 to 49 employees, 5 job losses are allocated to size class 5 to 9 employees, and one job loss is allocated to size class 1 to 4 employees. This method is computationally intensive and more suited for time series analysis, thus not considered in this analysis.

[6] Consider the following monthly employment levels for a particular establishment:

Mar 2019	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 2020	**Feb**	**Mar**
0	9	13	20	18	18	12	10	9	2	1	**1**	**0**

Under the three sizing methods, we would classify it as very small. However, if we consider its employment over the last twelve months (Mar 2019 – Feb 2020) it would be a medium size with an average monthly of 10 jobs.

[7] In our sizing method based on average employment, a very small firm does not necessarily imply that it operates only very small establishments. It is possible for a multi-establishment firm in a particular size class to have one or more establishments in a size class that is higher than the firm size class.