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Self-employment duration during the COVID-19 pandemic: A competing risk analysis

Jasper Grashuis

143C Mumford Hall, Division of Applied Social Sciences, University of Missouri, Columbia, MO, 65211, USA

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ABSTRACT

The COVID-19 pandemic has caused hardship to both individuals and businesses. Aggregate data indicate large increases in unemployment and bankruptcy since the beginning of the pandemic, but it is unclear which individuals and businesses are the most vulnerable. With “work absence”, “wage employment” and “unemployment” as three competing risks or events, we study the relationships of owner characteristics to self-employment duration during the COVID-19 pandemic (January-December 2020) in the United States with data from 19,174 respondents to the Current Population Survey. We find that several owner characteristics relate significantly to self-employment duration during the COVID-19 pandemic. Specifically, young, female, and non-White self-employed individuals face a relatively high risk of unemployment. These and other findings have profound implications for policymakers.

1. Introduction

In late 2019, the novel coronavirus disease (COVID-19) emerged in China and then gradually spread throughout the world. The COVID-19 pandemic has caused a profound transformation of many aspects of human society. Citizens and consumers must often choose between public and financial health. Certainly, from an economic perspective, COVID-19 has caused hardship to consumers and producers alike. In the United States, the government passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act in March 2020 to financially help both individuals and business organizations. In April 2020, the government also enacted the Paycheck Protection Program and Health Care Enhancement Act in response to the COVID-19 pandemic. However, in spite of governmental help, the unemployment rate in the United States skyrocketed from 4.4% in March to 14.4% in April 2020 (U.S. Bureau of Labor Statistics), and during the first half of 2020 commercial bankruptcies grew by 26% over the same period in 2019 (Al-Muslim 2020).

There is already a large amount of research on the impact of the COVID-19 pandemic from a general business perspective (Verma and Gustafsson 2020). Considering the increase in the number of bankruptcies, an important yet overlooked topic is small business survival. In the United States, 99.9% of all business organizations are small (U.S. Small Business Authority). There is direct evidence of an elevated number of closures among relatively small businesses during the COVID-19 pandemic (Crane et al., 2020). However, small business survival varies across owner characteristics. During the early stage of the COVID-19 pandemic, small business survival as proxied by self-employment in the United States varied across race and other demographic characteristics (Fairlie 2020). For example, self-employment decreased disproportionally for female owners and black owners. However, it is necessary to address three shortcomings in Fairlie (2020). First, Fairlie (2020) only covered the early stage of the COVID-19 pandemic (i.e. February-June 2020). A longer time period with more observations must be considered to test the robustness of the early observations. Second, Fairlie (2020)

E-mail address: grashuisj@missouri.edu.

1 According to the U.S. Small Business Authority, a small business has fewer than 500 employees.

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only considered unemployment as an alternative to self-employment, thus disregarding other common statutes (e.g., absence, wage employment). Third, Fairlie (2020) favored descriptive work over empirical work, thus missing an opportunity to estimate the multiple interrelationships of owner characteristics to self-employment duration. Considering the foregoing, applied research is necessary in order to quantify how much owner characteristics relate to various transitions away from self-employment to unemployment. Our research question is therefore as follows: which owner characteristics explain self-employment duration during the COVID-19 pandemic?

To answer the question, we use recent data from the Current Population Survey and construct a comprehensive and representative panel for the January-December 2020 period (N = 58,174). Following Block and Sandner (2009) and Millán et al. (2012), we estimate the relationships of owner characteristics to self-employment duration while distinguishing between “work absence,” “wage employment” and “unemployment” in a competing risk model. Among other findings, we conclude that young, female, and ethnic (i.e., non-White) self-employed individuals face a relatively high risk of unemployment. Our novel study relates to the vast literature on self-employment duration (e.g., Georgellis et al., 2005; Rybczynski 2015) and small business survival (e.g., Van Praag 2003; Headd and Kirchhoff 2009), and particularly the scarce literature on small business survival in times of disaster in general (Marshall and Schrank 2020) and the COVID-19 pandemic in particular (Brown and Rocha 2020; Gallant et al. 2020; Kuckertz et al., 2020; Thorgren and Williams 2020). Some of the latter literature is discussed in the next section to contextualize the remainder of the study.

2. Background: small business survival in times of crisis

Generally, crisis management is hardly researched in the context of small businesses (Spillan and Hough 2003; Herbane 2010). Responses to an exogenous shock are often analysed from the perspective of larger businesses with different demographic and financial characteristics. Recent exceptions come from two large-scale crises in the 21st century: Hurricane Katrina in the Gulf Coast region of the United States in 2006 (Runyan 2006; Marshall and Schrank 2020), as well as the global financial crisis of 2008–2010 (Cowling et al., 2012; Conti et al., 2019). In addition to lack of planning (Runyan 2006), a common obstacle experienced by small businesses in such situations is capital constraints. In an empirical study of UK small businesses during the 2008–2010 period, Cowling et al. (2012) concluded that financial institutions use firm size as a primary criterion to make lending decisions, thus revealing how micro enterprises are the most likely to face a credit crunch. In the United States, venture capitalists reduced their level of financial commitment to startups with relatively high risk profiles (Conti et al., 2019).

The COVID-19 pandemic has facilitated a large influx of research on small business survival in times of crisis. Evidence is available from across the world. In a large-scale survey of U.S. small businesses in March and April of 2020, Bartik et al. (2020) observed how mass layoffs and closures had already occurred at the time. Similar observations came from Sweden, where deferring investments, layoffs, labor expense reductions, general expense reductions, and contract renegotiations were the most common responses from small businesses in the early stage of the COVID-19 pandemic (Thorgren and Williams 2020). As observed in prior crises, such responses are likely fueled by capital constraints. In the United Kingdom, Cowling et al. (2020) observed that only 39% of small businesses built cash flow reserves in advance of the COVID-19 pandemic. In Germany, Kuckertz et al. (2020) detailed how a particular subset of small businesses (i.e., innovative startups) often failed to meet the criteria for support from federal and financial institutions. During the first quarter of 2020, Chinese startups experienced a 60% year-over-year decrease in investment (Brown and Rocha 2020).

3. Methodology

3.1. Current Population Survey

The Current Population Survey (CPS) is a popular data resource across the social sciences (Drew et al., 2014). For example, CPS data have been used recently in the context of food insecurity (Jernigan et al., 2017), unemployment (Dunn et al., 2018), and immigration policy (Wang 2019). The CPS is a monthly survey conducted by the U.S. Census Bureau for the U.S. Bureau of Labor Statistics. The survey respondents are households and their individuals. The sample size is approximately 70,000 households or 140,000 individuals who are representative of the overall population in the United States. The survey has a rotating panel design of 4-8-4 months, so upon entering the sample households and their individuals are surveyed for four consecutive months, then excluded for eight consecutive months, and then again surveyed for four consecutive months. In spite of the longitudinal character of the CPS, most researchers only use cross-sectional data because matching households and individuals across months is difficult (Drew et al., 2014).

To estimate the relationship of owner characteristics to self-employment duration during the COVID-19 pandemic, we extract data for the January-December 2020 period (Flood et al., 2020). In the United States, COVID-19 began circulating in February 2020, and from mid-March onward many local and state authorities began issuing stay-at-home directives. We therefore expect to be able to observe an impact of the COVID-19 pandemic on self-employment duration from February 2020 onward. There are two inclusion criteria: the individual (i) must have a minimum of two survey responses during the January–December period, and (ii) must have been self-employed for at least one month during the January–December period. The number of individuals who meet the criteria is 19,174. Because of the rotating panel design of the CPS, no individual is present more than four months in one sample. The total number of observations is 58,174.

3.2. Outcome variable: self-employment duration

The outcome variable is determined by two variables, namely employment status and worker classification. The base situation is
comprised of individuals who report to be self-employed and to be working. Then, in the next survey period, there are four scenarios: (1) the individual is still self-employed, (2) the individual is still self-employed but did not work during the last week, (3) the individual is employed by another individual or organisation, or (4) the individual is unemployed. The individual “survives” self-employment in scenario (1) but “fails” self-employment in scenarios (2), (3), and (4). For the sake of convenience, we refer to scenario (2) as “work absence”, scenario (3) as “wage employment”, and scenario (4) as “unemployment”. Our approach is similar to Gallant et al. (2020), who instead interpreted “work absence” as “temporary unemployment”. Scenarios (2), (3), and (4) are competing risks or events. As in, the individual can experience one event but not the other event in the same period (e.g. one can be absent but not unemployed at the same time). Upon experiencing an event, the individual exits the sample.

In Table 1 we report the summary statistics of the owner characteristics. Overall, approximately 63% of the self-employed individuals were male, and more than 77% were White. Furthermore, more than half possessed some type of post-secondary education degree (i.e. Associate’s, Bachelor’s, Master’s, Professional, or Doctorate). According to Pearson $\chi^2$ tests, all the owner characteristics are significantly different across the three scenarios at the 99% confidence level. Table 2 reports the total number of observations by month and scenario. Overall, the number of transitions away from self-employment were higher in the beginning and the end of the calendar year, yet lower during the summer period.

Considering the foregoing, the appropriate empirical method is the competing risk model, which is an extension of the basic Cox (1972) survival model. The competing risk model is common in the small business survival literature and the self-employment duration literature (e.g. Caroni and Pierri 2020; Millán et al., 2012; Rybczynski 2015; Van Praag 2003). For technical details of survival analysis and the competing risk model we refer the interested reader to Appendix 1.

4. Results: presentation and discussion

In Table 4, we report the results of the competing risk model regression with work absence as the event of interest and wage employment and unemployment as the competing events in the left column. The right column contains the results when reversing the analysis and having unemployment as the event of interest and work absence and wage employment as the competing events. Because transitions from self-employment to wage employment are not our primary focus, we only report the results of the competing risk model regression with wage employment as the event of interest in the appendix (see Appendix 2). The reported parameters are sub-hazard ratios. Generally, a ratio below one indicates a negative effect on the hazard function (i.e. positive effect on the survival function),

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$^2$ The prior literature is focused on immigrants as opposed non-citizens. Because of the high correlation between citizenship and immigration history, only the former is included in the model. When replacing citizenship with immigration history, the relationship to self-employment duration is still nonsignificant.
and a ratio above one indicates a positive effect on the hazard function (i.e. negative effect on the survival function). Specifically, each parameter indicates the relative change in the sub-distribution hazard function associated with a one-unit change in the given variable (Austin and Fine 2017). As all our variables are categorical, each parameter indicates the change relative to the base category.

Age played a significant role in explaining the transitions from self-employment to both work absence and unemployment. However, age related differently to the two events. Generally, self-employed individuals above the age of 24 exhibited a relatively high hazard of work absence, yet a relatively low hazard of unemployment. In the case of work absence, relatively young self-employed individuals may have perceived the least risk of experiencing severe health effects of the coronavirus and therefore decided to continue work, although U.S. individuals in the 18–24 age category did not differ significantly with individuals in higher age categories in terms of attitudes toward public health directives such as stay-at-home orders (Czeisler et al., 2020). In the case of unemployment, our result in part relates to Van Praag (2003), who observed a positive effect of age on self-employment duration among a sample of young and White individuals in the United States. Cueto and Mato (2006) observed the same positive relationship in the context of Spain. The positive effect alludes to lack of experience, human capital, knowledge, and other tangible and intangible assets on the part of relatively young self-employed individuals. Of course, without additional information, it is impossible to determine which age-related mechanisms may explain our own finding.

During the COVID-19 pandemic, self-employed women experienced a higher hazard of both work absence and unemployment as compared to men. The difference is approximately 13% in the case of work absence and 24% in the case of unemployment. Possible explanations come from prior comparisons of self-employed men and women. For example, female-owned businesses are smaller, younger, are more retail and service-oriented (Robb and Wolken 2002). Self-employed women also have less capital, less experience, and mixed business objectives, which may all explain why male-owned businesses are generally more successful (Fairlie and Robb 2009). Rybczynski (2015) also listed children as an obstacle to business survival among women, which is an important consideration as schools and day care facilities have been impacted by the COVID-19 pandemic.

In relation to work absence, race is nonsignificant as a predictor. However, the rate of the occurrence of unemployment is affected significantly by the race of the self-employed individual. Relative to White self-employed individuals, self-employed individuals who identify as Black, Asian, or mixed all experienced a higher hazard of unemployment. The estimated rate of event occurrence is the highest for self-employed individuals of mixed ethnicities. Our result corroborates the dated observation of Ahn (2011), who found a relatively short self-employment duration for minorities in 1979. Lee and Rendalli (2001) also observed a relatively low frequency and duration of self-employment in relation to Black men and women, especially the latter, as compared to their White counterparts. Our result may relate to differences in the health conditions and labour market profiles of ethnic and non-ethnic individuals, as is also observed by Platt and Warwick in England and Wales (2020). However, another possible explanation is discrimination, a hypothesis raised by Gezici and Ozay (2020) in the context of an unexplained gap between the likelihood of unemployment among ethnic and non-ethnic employed individuals in the United States after controlling for occupation.

The relationship of household income to self-employment duration is rather straightforward in the case of unemployment. Self-employed individuals who reported a household income of $25,000 or less experienced the highest risk of unemployment. Linearity of the income-survival relationship is feasible. Self-employed individuals who fall into the highest category of $150,000 or more in household income experienced the lowest risk of unemployment. The linear effect is not visible in the case of work absence. While self-employed individuals in the bottom category again experienced the highest risk of work absence, the estimate is not significantly different in relation to some other categories (i.e. $25,000–49,999, $75,000–99,999). Our result corresponds to the wealth of evidence regarding the liquidity constraints facing individuals in terms of both becoming and remaining self-employed (e.g. Carrasco 1999; Disney and Gathergood, 2009; Fairlie 2005; Fairlie and Krashinsky 2012).

In terms of education, self-employed individuals with a college degree (i.e. Bachelor’s) or a graduate degree (i.e. Master’s, Professional, Doctorate) experienced a relatively low risk of both work absence and unemployment during the COVID-19 pandemic. While the prior literature is inconclusive on the education-survival relationship, we find support for our result in several studies. For example, Millán et al. (2012) observed a positive effect of formal education on self-employment duration. In Europe, increasingly more self-employed individuals are highly educated (Van Stel and Van der Zwan, 2020). While producing mixed evidence, Block and Sandner (2009) observed a positive effect of the type of education but not the length of education on self-employment duration in Germany.

The relationship of citizenship status to self-employment duration is nonsignificant in the case of unemployment, and only significant at the 90% confidence level in the case of work absence. Citizens and non-citizens did not differ significantly in terms of the rate of the occurrence of unemployment, which is in contrast to observations by Fairlie (2005) and Georgrakos and Tatsiramos (2009) in the context of the United States. The same effect is observed elsewhere. While having a higher rate of self-employment than natives, non-western immigrants in Sweden also experienced a higher rate of exit from self-employment (Joona 2010).

Self-employed individuals who are incorporated as some type of legal business structure are significantly less susceptible to unemployment during the COVID-19 pandemic as compared to unincorporated self-employed individuals. The difference is estimated at approximately 47%. There is an apparent lack of literature to compare and contrast our finding. However, according to U.S. Census Bureau data, incorporated self-employed individuals are more likely to be wealthy, White, male, and highly educated, characteristics that we already connected positively to self-employment duration.

Not surprisingly, full-time workers (i.e. self-employed individuals who work more than 35 h per week) are significantly less likely to transition from self-employment to either work absence or unemployment. Our result goes against the findings of Millán et al. (2012), who observed no significant differences in the amount of time worked by self-employed individuals who subsequently remained self-employed or transitioned to wage employment or unemployment.
The COVID-19 pandemic has triggered a profound transformation of human society, including the economy. With large increases in unemployment and bankruptcy, applied research at the micro-level is necessary to better understand which individuals and businesses are most vulnerable. We addressed the gap in the literature with an empirical study of self-employment duration during the COVID-19 pandemic. Within a competing risk framework, we related owner characteristics to the occurrence of three types of transitions from self-employment: (1) work absence, (2) wage employment, and (3) unemployment. Our study indicates that unemployment during the COVID-19 pandemic is predicted significantly by the age, sex, race, income, and education of self-employed individuals.

Policymakers may take action on numerous issues in light of the variability in small business survival across owner characteristics. For example, it is worth exploring (i) if access to economic relief facilitated by the government (e.g. Paycheck Protection Program, Economic Injury Disaster Loan program) is proportional across the population of self-employed individuals, (ii) if eligibility criteria for future economic relief should in part be based on age, sex, race, or other demographic characteristics, (iii) if entrepreneurship education is a viable (temporary) alternative to relatively young self-employed individuals who transition to unemployment, or (iv) if child care reliability and affordability can be improved to help self-employed women with children. One example of a country which shaped its policy response to COVID-19 on the basis of demographic characteristics is Canada (OECD, 2020). Early during the COVID-19 pandemic, Canada invested CAD 20.1 million in Futurpreneur Canada, a national non-profit organisation dedicated to help entrepreneurs in the 18–39 age group. Canada also committed additional capital (CAD 15 million) to the Women Entrepreneurship Strategy, part of a CAD 5 billion investment to support female-owned small businesses. The Canadian government also pledged a CAD 306 million support package for small businesses owned by indigenous people.

From a research perspective, there is an obvious need to further refine our findings. While producing knowledge of the relationship of demographic characteristics to self-employment duration is an important step in the right direction, more research is necessary to understand the underlying mechanisms. While complex, it is also necessary to consider more individual-level (e.g. child age), firm-level (e.g. size), and industry-level (e.g. sector) characteristics. When doing so, it may be possible to answer questions such as: Why are young, female, and ethnic self-employed individuals more vulnerable to unemployment during the COVID-19 pandemic? Are young entrepreneurs more active in sectors or industries in which physical distancing is difficult or even impossible? Is child care a motivating factor for self-employed women to transition to unemployment? Do ethnic self-employed individuals have less access to financial help? In addition, more research is necessary to consider other conditions and characteristics. Are there differences in self-employment duration across sectors and industries? Are self-employed individuals with employees less vulnerable to unemployment? Which policy responses...

### Table 2
Number of observations by month and employment status.

| Month     | Self-Employment | Work Absence | Wage Employment | Unemployment | Total |
|-----------|-----------------|--------------|-----------------|--------------|-------|
| January   | 4488            | 0            | 0               | 0            | 4488  |
| February  | 5407            | 135          | 143             | 164          | 5849  |
| March     | 4699            | 201          | 137             | 218          | 5255  |
| April     | 3781            | 456          | 165             | 366          | 4768  |
| May       | 3800            | 137          | 109             | 164          | 4210  |
| June      | 3804            | 93           | 99              | 141          | 4137  |
| July      | 4109            | 138          | 9               | 77           | 4333  |
| August    | 4422            | 118          | 91              | 138          | 4769  |
| September | 4858            | 112          | 125             | 170          | 5265  |
| October   | 5135            | 142          | 162             | 220          | 5659  |
| November  | 4862            | 166          | 151             | 247          | 5426  |
| December  | 3509            | 185          | 136             | 185          | 4015  |
| **Total** | **52,874**      | **1883**     | **1327**        | **2090**     | **58,174** |

### Table 3
Overview of model variables.

| Variable          | Measurement                                                                 |
|-------------------|----------------------------------------------------------------------------|
| Age               | 0 if 24 years or younger; 1 if 25–34 years; 2 if 35–44 years; 3 if 45–54 years; 4 if 55–64 years; 5 if 65 years or older |
| Sex               | 0 if male; 1 if female                                                     |
| Race              | 0 if White; 1 if Black; 2 if Hispanic; 3 if Asian; 4 if other/mixed         |
| Income            | 0 if less than $25,000; 1 if $25,000–49,999; 2 if $50,000–74,999; 3 if $75,000–99,999; 4 if $100,000–149,999; 5 if $150,000 or more |
| Education         | 0 if high school degree or less; 1 if associate’s degree; 2 if bachelor’s degree; 3 if graduate degree |
| U.S. Citizenship  | 0 if not U.S. citizen; 1 if U.S. citizen                                   |
| Business          | 0 if not incorporated; 1 if incorporated                                  |
| Incorporation     |                                                                           |
| Work Status       | 0 if part-time worker; 1 if full-time worker                               |
| Metropolitan Size | 0 if less than 100,000; 1 if 100,000–249,999; 2 if $500,000–999,999; 3 if 1,000,000–2,499,999; 4 if 2,500,000–4,999,999; 5 if 5,000,000 or more |
| Region            | 0 if New England; 1 if Middle Atlantic; 2 if East North Central; 3 if West North Central; 4 if South Atlantic; 5 if East South Central; 6 if West South Central; 7 if Mountain; 8 if Pacific |

5. Conclusion
have a positive impact on the survival of self-employed individuals? We look forward to future research endeavors to help answer such questions.

Author contribution

Jasper Grashuis: Conceptualization, Methodology, Formal analysis, Writing

Declaration of competing interest

None.

Appendix A. Survival Analysis and Competing Risk Model

In survival analysis terminology, let $T$ be a non-negative random variable representing the time until an event, in this case “exit from self-employment”. The survival function is defined as

$$ s(t) = Pr(T \geq t) = 1 - f(t) = \int_t^\infty f(x)dx \quad (1) $$

where $t$ denotes time, $T$ denotes the survival time, and $f(t)$ is a density function of $T$. The survival function estimates the probability of the event not having occurred by duration $t$, which is the outcome variable. The direct counterpart to the survival function is the hazard function, which is given by

$$ \lambda(t) = \lim_{dt \to 0} \frac{Pr\{t < T < t + dt | T \geq t\}}{dt} \quad (2) $$

and represents the probability of the event occurring in period $t, t$ given survival up until period $t$. The relationship between the hazard function $\lambda(t)$ and the survival function $s(t)$ is

Table 4

Results of competing risk model regressions.

| Owner Characteristic | Failure: Work Absence | Failure: Unemployment |
|----------------------|-----------------------|-----------------------|
|                      | SHR  | SE   | p    | SHR  | S.E. | p    |
| Age (<25)            |      |      |      |      |      |      |
| 25-34                | 1.235| 0.219| 0.235| 0.527| 0.059| 0.000|
| 35-44                | 1.448| 0.246| 0.029| 0.360| 0.039| 0.000|
| 45-54                | 1.516| 0.236| 0.014| 0.337| 0.037| 0.000|
| 55-64                | 1.385| 0.233| 0.053| 0.476| 0.049| 0.000|
| 65 or older          | 1.559| 0.263| 0.008| 0.921| 0.092| 0.410|
| Female               | 1.128| 0.053| 0.011| 1.239| 0.057| 0.000|
| Race (White)         |      |      |      |      |      |      |
| Black                | 1.064| 0.114| 0.562| 1.436| 0.136| 0.000|
| Hispanic             | 0.971| 0.089| 0.750| 1.097| 0.089| 0.252|
| Asian                | 1.093| 0.120| 0.417| 1.329| 0.146| 0.010|
| Other/Mixed          | 1.207| 0.179| 0.205| 1.542| 0.199| 0.001|
| Income (<$25,000)    |      |      |      |      |      |      |
| $25,000–49,999       | 0.931| 0.081| 0.411| 0.820| 0.061| 0.008|
| $50,000–74,999       | 0.843| 0.075| 0.056| 0.756| 0.058| 0.000|
| $75,000–99,999       | 0.898| 0.083| 0.244| 0.671| 0.057| 0.000|
| $100,000–149,999     | 0.754| 0.072| 0.003| 0.620| 0.053| 0.000|
| $150,000 or more     | 0.792| 0.073| 0.012| 0.611| 0.052| 0.000|
| Education (High School) |      |      |      |      |      |      |
| Associate’s Degree   | 1.033| 0.076| 0.659| 0.891| 0.067| 0.124|
| Bachelor’s Degree    | 0.852| 0.051| 0.008| 0.873| 0.051| 0.020|
| Graduate Degree      | 0.822| 0.060| 0.007| 0.837| 0.060| 0.013|
| U.S. Citizen         | 1.246| 0.147| 0.062| 1.036| 0.103| 0.726|
| Incorporated         | 0.983| 0.050| 0.739| 0.526| 0.029| 0.000|
| Full-Time Worker     | 0.717| 0.038| 0.000| 0.678| 0.034| 0.000|
| Metropolitan Size    |      |      |      |      |      |      |
| Included             |      |      |      |      |      |      |
| Census Region        |      |      |      |      |      |      |
| Included             | 58,174/19,174 | 58,174/19,174 |
| Log Pseudo-Likelihood | -16,578.50 | -18020.10 |
| Wald Chi²            | 148.97 | 1050.99 |
| Prob > Chi²          | 0.00 | 0.00 |
so if either the hazard function or the survival function is determined, the other function is also determined. Although there are various approaches to modeling the hazard function $\lambda(t)$ in the firm survival literature (Manjón-Antolín and Arauzo-Carod, 2008), arguably the most common is the Cox (1972) method because there is no rigid assumption of the shape of the hazard function (e.g. exponential, log-log). The basic Cox regression model to be estimated is defined as

$$ h(t|x_1, \ldots, x_n) = h_0(t) \exp(\beta_1 x_1 + \ldots + \beta_n x_n) $$

(4)

where the hazard $h$ at time $t$ for individual $i$ is the product of the baseline hazard function $h_0(t)$ and the vector of covariates $x$. However, considering the presence of two types of risks or events, we follow common procedure in the small business survival literature and the self-employment duration literature by specifying a competing risk model (e.g. Caroni and Pierri 2020; Millán et al., 2012; Rybczynski 2015; Van Praag 2003). In the presence of multiple types of risks or events, Equation (4) produces upward biased estimates of the incidence rate of the event of interest (Austin and Fine 2017; Putter et al., 2007). We therefore need to introduce cause-specific hazard functions. Again, using survival analysis terminology, let the cause-specific hazard function be given by

$$ \lambda_k(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T \leq t + \Delta t, \varepsilon = k | T \geq t)}{\Delta t} $$

(5)

which provides the instantaneous risk of occurrence of the event of interest among individuals who survived self-employment until time $t$ or later. The event type is indicated by $\varepsilon = k$, where $k = 1, 2$. The cumulative incidence of event $k$ is a function of the cause-specific hazard of event 1 ($\lambda_1(t)$) and the cause-specific hazard of event 2 ($\lambda_2(t)$). Consequently, the cumulative cause-specific hazard of event $k$ is given by

$$ \overline{\lambda}_k(t) = \int_0^t \lambda_k(s) \, ds $$

(6)

and the corresponding survival function by

$$ S_k(t) = \exp\left(-\overline{\lambda}_k(t)\right) $$

(7)

Finally, the cumulative incidence function (CIF) of event 1 is given as

$$ CI_1(t) = \int_0^t \lambda_1(s) \, P(T \geq u) \, du = \int_0^t \lambda_1(s) \exp\left(-\{\overline{\gamma}_1(u^-) + \overline{\gamma}_2(u^-)\}\right) \, du $$

(8)

which provides the probability of the occurrence of event 1 before time $t$ in the presence of event 2. The CIF of event 2 is analogous. As explained by Austin and Fine (2017), the model estimates the relative change in the subdistribution hazard function. Put differently, the estimates denote the effect of the covariates on the rate of the occurrence of events. Table 3 lists all the model variables. Equation (8) is estimated by means of the Fine and Gray (1999) method in Stata 16 (Cleves et al., 2016).

Appendix B. Results of Competing Risk Regression with Wage Employment

| Owner Characteristic | Failure: Wage Employment |
|----------------------|--------------------------|
|                      | SHR | SE  | p    |
| **Age (<25)**        |     |     |      |
| 25-34                | 0.646 | 0.084 | 0.001 |
| 35-44                | 0.438 | 0.056 | 0.000 |
| 45-54                | 0.444 | 0.056 | 0.000 |
| 55-64                | 0.384 | 0.049 | 0.000 |
| 65 or older          | 0.254 | 0.035 | 0.000 |
| **Female**           |     |     |      |
|                      | 1.033 | 0.060 | 0.576 |
| **Race (White)**     |     |     |      |
| Black                | 1.323 | 0.147 | 0.012 |
| Hispanic             | 1.265 | 0.115 | 0.010 |
| Asian                | 1.348 | 0.153 | 0.009 |
| Other/Mixed          | 1.045 | 0.207 | 0.822 |

(continued on next page)
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