The Startup Calculator Manual

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1 Data

The BDS includes publicly available information (among other things) on the number of firms and employment by firm age. For our purposes, we use the following age-bins: 0 (startups), 1, 2, 3, 4, 5, 6 to 10 and all. We use information on the number of firms, their employment and their exit rates by age. From this information, we can also construct aggregate employment. We use the entire sample period, ranging from 1977 to 2016.

The **number of firms** by age, $n_{a,t}$, is directly observable in the BDS data, as is employment by age, $e_{a,t}$. We use employment by age and the number of firms by age to compute **average firm size** as $s_{a,t} = e_{a,t}/n_{a,t}$.[1] Finally, we are also interested in survival rates of firms by age. We compute these by using the information on **firm deaths**, $d_{a,t}$, which give the number of firms of a given age in which all establishments shut down. We define the **survival rate** as $1 - x_{a,t} = 1 - d_{a,t}/n_{a,t}$.

Given that firms aged 6 to 10 years are grouped together, we need to interpolate the information.[2] In addition, given that the sample period ends in 2016, it is necessary to extrapolate the information to 2019. From 2020 on we consider various scenarios. We discuss both the interpolation within age groups and the extrapolation through 2019 below.

2 Interpolation

Because firms aged 6 to 10 are grouped together, we interpolate information for each of the ages.

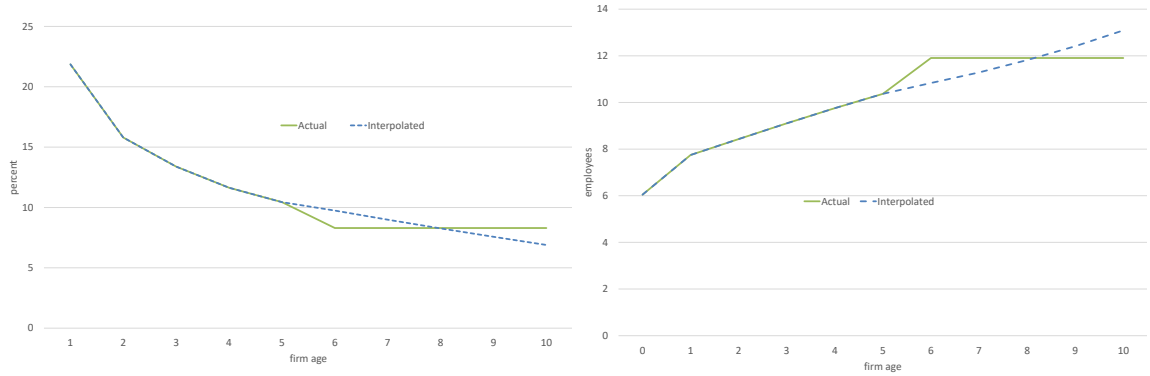
Number of firms and exit rates. We interpolate information on the number of firms aged 6 to 10 years old in the following way. First, we assume that exit rates between the ages of 5 and 6 are linearly related such that

$$x_{a,t} = x_{a-1,t-1}(1 - \Delta_x) \quad \text{for } a = 5, ..., 10,$$

[1] This is the so-called "current-year" definition of size.

[2] Not interpolating gives similar results but overstates the impact of changes in startups. This is because when new firms reach the age of 6, they are assigned the average size of 6 to 10 year old firms. This exacerbates the impact of changes in startups on aggregate employment.

Figure 1: Actual and interpolated exit and size by age



where $\Delta_{x,t}$ is a year-specific growth rate, but which is the same for firms between the ages of 5 and 10. Given the exit rates by age, we can compute the number of firms between the ages 6 and 10 as

$$n_{a,t} = n_{6-10,t} \frac{\Pi_{j=1}^{a-5}(1 - x_{a-j+1,t-j+1})}{\sum_{a=6}^{10} \Pi_{j=1}^{a-5}(1 - x_{a-j+1,t-j+1})} \quad \text{for } a = 6, ..., 10.$$

The above therefore takes the observed number of firms aged 6 to 10 years and decomposes it into the shares of 6, 7, 8, 9 and 10 year old firms where the shares are computed using the age-specific survival rates.

Finally, we compute $\Delta_{x,t}$ by minimizing

$$|x_{6-10,t} - \sum_{a=6}^{10} \frac{n_{a,t}}{\sum_{a=6}^{10}} x_{a,t}|.$$

Firm size. We interpolate firm size for businesses aged 6 to 10 in the same way as above. We assume that firm size is linearly increasing between the ages of 5 and 10 such that

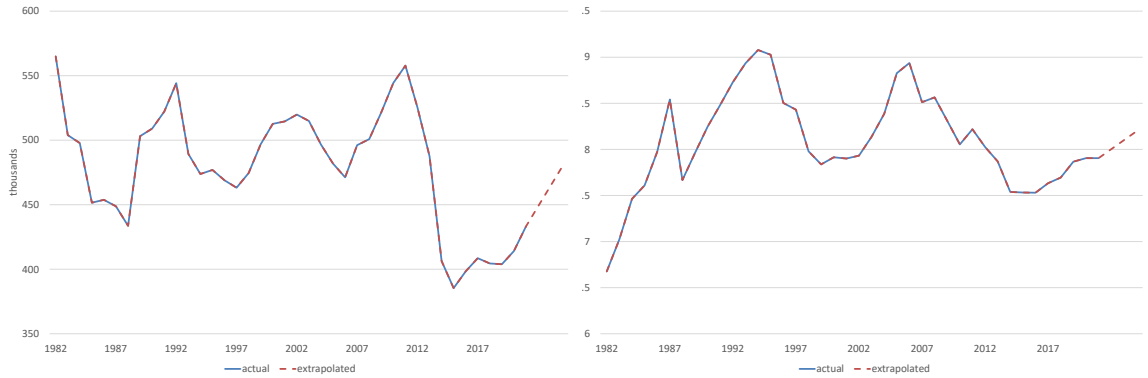
$$s_{a,t} = s_{a-1,t-1}(1 - \Delta_{s,t}) \quad \text{for } a = 5, ..., 10,$$

where Δ_s is a year-specific growth rate, but which is the same for firms between the ages of 5 and 10. Given the above exit rates, we then compute $\Delta_{s,t}$ by minimizing

$$|s_{6-10,t} - \sum_{a=6}^{10} \frac{n_{a,t}}{\sum_{a=6}^{10}} s_{a,t}|.$$

Figure 1 shows the actual and the interpolated data.

Figure 2: Actual and interpolated number of startups and size of 0 to 5 year old firms



3 Extrapolation

Because the BDS data ends in 2016, we extrapolate the information to 2019. From then on, we consider different scenarios.

Information on startups and young firms. The underlying assumption is that between 2017 and 2019 survival rates, firm sizes by age and the number of startups linearly converge to their 1977-2016 averages:

$$x_{a,2016+t} = x_{a,2016} + \frac{t}{3}(\overline{x}_a - x_{a,2016}) \quad \text{for } t = 1, 2, 3,$$

$$s_{a,2016+t} = s_{a,2016} + \frac{t}{3}(\overline{s}_a - s_{a,2016}) \quad \text{for } t = 1, 2, 3,$$

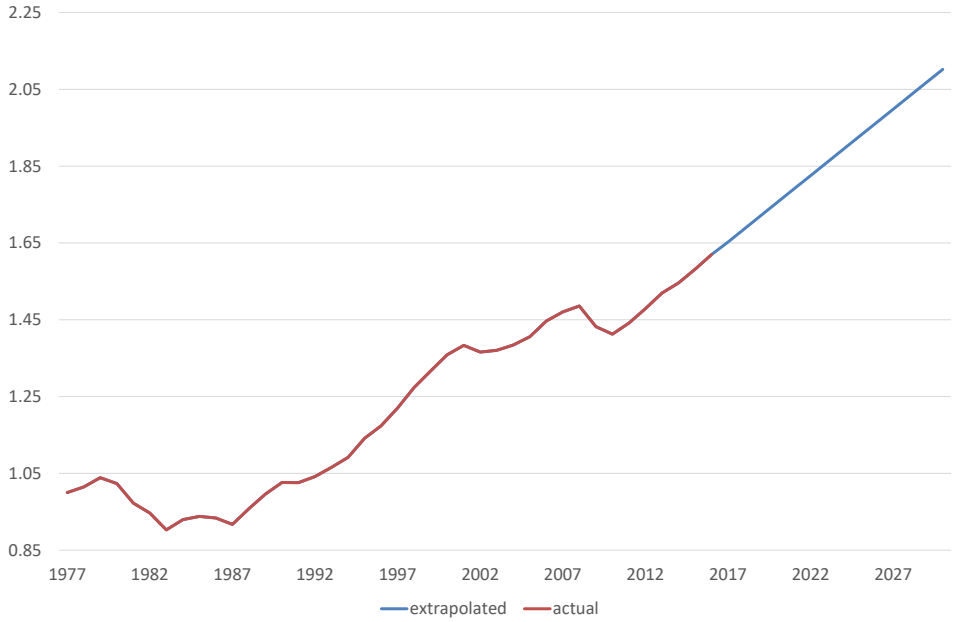
$$n_{0,2016+t} = n_{0,2016} + \frac{t}{3}(\overline{n}_0 - n_{0,2016}) \quad \text{for } t = 1, 2, 3,$$

where $\overline{x}_a$ and $\overline{s}_a$ denote the 1977 to 2016 averages of age-specific exit rates and firm sizes, respectively.[3] Using the above, we can then recover the number of firms for the ages of 1 to 10 as $n_{a,t} = n_{a-1,t-1}(1 - x_{a,t})$, for $a = 1, 2, ..., 10$ and $t = 2017, 2018, 2019$. Figure 2 shows the actual and extrapolated number of startups, exit rate of 1 to 10 year old firms and average size of 0 to 10 year old firms.

Number of older firms. The number of all businesses in the US economy has been steadily increasing over the sample period. This is, however, essentially entirely because of an increasing number of older firms. This can be seen from Figure 2 which shows that the *number* of startups has fluctuated cyclical around a relatively stable mean.

[3]Only startups are observed from 1977. Therefore, averages of older businesses of age a are taken over the period 1977+a to 2016. For instance, the averages for two-year-old firms is based on 1979 to 2016.

Figure 3: Actual and interpolated employment in 11+ year old firms



The increasing number of firms is then reflected in rising aggregate employment. Given that we are only considering firms 10 years and younger, we need to account for the trend growth of older firms. We do so by estimating a linear trend for employment in firms aged 11 years and more, using the period between 2010 and 2016. Using this estimated trend we then extrapolate employment in this group of firms for the years 2017 to 2030. Figure 3 shows the actual and extrapolated employment in firms aged 11 and more, where we scale both time-series by their values in 1977.

4 COVID scenarios

Having the above information, we are ready to conduct scenarios starting in 2020 and running through to 2030. We consider three types of margins: (i) changes in the number of firms, (ii) changes in growth potential and (iii) changes in survival rates.

Scenarios involving (i) and (iii) are straightforward. Upon impact, we lower the number of startups and/or the survival rates of firms of *all ages* by a certain value ("impact magnitude") and keep this value for a certain period ("length of impact"). Growth potential works on the same principle, but applies to the *cohort* of startups which enters in 2020. Therefore, lowering the growth potential by a certain percentage value results in the entire *growth profile* of firms born in 2020 shifting downwards. Importantly, the size of firms older than 0 years in 2020 is unaffected.

Our calculator can also accommodate bounce-back scenarios. These are always defined as certain values above the 1977-2016 averages of the number of startups, average sizes and survival rates by age. Recall that all these margins coverge precisely to the respective 1977-2016 averages by 2019.

In all scenarios, aggregate employment in a given year is computed simply as the sum of employment of firms aged 0 to 10 and the (extrapolated) employment of firms older than 11 years. Therefore, we are being conservative in the sense that we are not allowing businesses aged 11 and more years to be affected by the criss. While the margins of startups and growth potential would only "kick in" after 2030 for these older firms, their survival rates may very well be affected in 2020 already.