**Online Appendix 1: Worker Churn at St Paul’s**

This appendix explains our approach to churn at St Paul’s Cathedral. Worker churn has three main components. Firms add or cut jobs, as demand increases or falls. Firms fire some workers while other workers quit, and replacements are hired. And firms are established or fail. Measures of turnover depends on how many of these channels of hiring and separation are observed, and the basis for measuring worker churn varies in important ways between studies.

Measures of turnover also depend on how employment is captured. Where employment is measured via a quasi-census at intervals, some types of churn are omitted. For example, present day measures for Germany and other settings utilize data that capture employment at sequential cross sections: Bachmann et al (2020) consider a laborer to be working for an establishment if she is employed at the end of the quarter. The number of jobs at the end of the quarter follows from this (J*it*); the number of hires (H*it*) is the number of workers who were not working at the end of the previous quarter; and the number of separations (S*it*) is the number who had been working at the end of the previous quarter and who have now left (Bachman et al:5, 25-28). Turnover *within* a quarter is not observable in this approach. Alternatively, some sources, such as the LEHD dataset studied by Davis et al (2006), include all worker transitions of whatever duration. Measures of this kind produce much higher rates of hiring and separation than those that focus on ‘full quarters’ (Davis et al 2006:6).

Our dataset is organized into periods of one or more month’s duration and reports all workers employed in an accounting period (month, quarter or longer) as laborers and watchmen, including short employment spells. We construct measures of job and worker flow within St Paul’s based on the available accounting periods. Where the duration of the accounts is a month, we define the number of jobs, J*it*, as the number of workers employed as day laborers within that month (excluding workers employed solely as watchmen). The number of laborers who appear in the records in that month but not in the previous month gives us our count of hires, Hit. The number of laborers who were not retained from the previous month is our count of separations, S*it*. We compute net monthly job flow as JF*it* = J*it* – J*it-1*. Job creation JC*it* occurs where employment increases (JFit>0) and job destruction JDit occurs when it falls (JFit<0). Because more workers may be hired or separated in a period than jobs (i.e. Hit>JCit>0), we also report the churn (Chit), as defined by Burgess et al (2000).

Chit=(Hit-JCit)+(Sit-JDit)

We follow the normal convention (Davis et al 1996) in converting hiring and separation flows into rates by dividing totals by the average of employment in the previous and current period, so the hiring rate is defined as:

HRit=Hit/(Jit+Jit-1)\*1/2

Other rates (separation, job creation, job destruction and churn) are defined in the same manner. This approach constrains growth rates to between -200 and +200 percent. We report rates based on monthly accounts which survive for much of the construction phase. These calculations are restricted to periods for which two sequential accounts are of one-month duration. For quarterly estimates, the period commonly found in the modern literature, we carry out the same calculation using three-month windows and taking the first quarter as January to March, to align with general practice.

The measures we report are the equivalent to ‘all transition’ figures, because they count every person employed, no matter how long they stayed. Workers who were only hired for a few days on one occasion still count as a hire and a separation, even though they just appeared in a single month or quarter, respectively. Workers who had been employed previously, but had been absent for a period, are also counted as new hires.

For comparison, we also compute ‘full quarter’ figures. We report two variants on the quarterly data. First, in our ‘quarterly (any)’ calculations we treat workers as employed if they are hired at any point within a quarter. From this definition, follows the number of jobs at the cathedral, the number of hires (workers who had not been active in the previous quarter), and separations (workers who were no longer active from the previous quarter). These figures have the advantage of observing all transitions of any period.

Second, in our ‘quarterly, (quasi-census)’ calculations we treat workers as employed if they are employed in the final month of a quarter (March, June, September, December). This is the closest we can come to the approach taken by Bachmann et al (2020) who define employment based on a worker being employed at the end of a quarter. These figures neglect short-term employment in other months and are oriented towards identifying longer-term hiring. These figures are useful for comparison, but should be treated with caution, given that short periods of work were the norm and they will be particularly shaped by the specifics of hiring in the final month of each the quarter.

The number of months falling into observation in the monthly series is reported in the main text. The number of quarters in observation is given in Table 1.1. To estimate churn, we require a quarter to be part of a continuous sequence of accounts, ensuring we observe the previous and the next quarter in order to work out hiring and separations.

**Table 1.1: Quarters in observation for churn estimates by quinquennia.**

|  |  |  |
| --- | --- | --- |
| Period | Quarters observed (n) | Share of quarters observed (%) |
|  |  |  |
| 1675- | 17 | 85 |
| 1680- | 11 | 55 |
| 1685- | 15 | 75 |
| 1690- | 20 | 100 |
| 1695- | 7 | 35 |
| 1700- | 14 | 70 |
| 1705- | 20 | 100 |
|  |  |  |
| Total | 97 | 69 |

Our data allow us to distinguish permanent from temporary separation and hiring. Permanent hiring and separation are defined as occurring on a workers’ first and last appearance in the Cathedral records. Because temporary absences where workers appear in one period and then return to work after a period of absence are common in the St Paul’s records, the permanent hiring and separation rates are substantially below the job creation and job destruction rate.

Where the numbers employed increased, this is job creation. Where the numbers decrease this is job destruction. When there is no creation/destruction, the figure is set to zero. The closest modern equivalent would be the flow of workers into and out of zero-hours contracts with highly unstable monthly labor demand. Aggregate rates in the literature are calculated using seasonally adjusted series. We do not adjust for seasonality, given that we are dealing with a single site with highly volatile employment.

**Table 1.2: Churn Estimates, Monthly**

Job Creation Rate (monthly)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 7.78 | 12.21 | 0 | 51.43 | 50 |
| 1680- | 6.64 | 14.31 | 0 | 70.97 | 32 |
| 1685- | 6.96 | 12.21 | 0 | 54.21 | 41 |
| 1690- | 5.21 | 6.18 | 0 | 34.78 | 45 |
| 1695- | 2.47 | 4.07 | 0 | 13.33 | 15 |
| 1700- | 4.53 | 7.91 | 0 | 31.58 | 41 |
| 1705- | 7.24 | 21.75 | 0 | 120.61 | 60 |
| Total | 6.26 | 13.62 | 0 | 120.61 | 284 |

Job Destruction Rate (monthly)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 10.28 | 15.35 | 0 | 48.78 | 50 |
| 1680- | 9.19 | 13.39 | 0 | 49.06 | 32 |
| 1685- | 8.86 | 14.38 | 0 | 54.95 | 41 |
| 1690- | 2.67 | 7.25 | 0 | 38.60 | 45 |
| 1695- | 5.76 | 9.79 | 0 | 28.57 | 15 |
| 1700- | 2.80 | 9.94 | 0 | 60.00 | 41 |
| 1705- | 5.88 | 21.60 | 0 | 134.18 | 60 |
| Total | 6.50 | 14.92 | 0 | 134.18 | 284 |

Hiring Rate, first starts (monthly)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 4.96 | 6.52 | 0 | 30.86 | 50 |
| 1680- | 1.45 | 3.73 | 0 | 16.13 | 32 |
| 1685- | 8.69 | 11.96 | 0 | 54.21 | 41 |
| 1690- | 4.10 | 3.91 | 0 | 14.93 | 45 |
| 1695- | 1.27 | 2.37 | 0 | 6.90 | 15 |
| 1700- | 3.75 | 6.49 | 0 | 27.59 | 41 |
| 1705- | 3.45 | 5.37 | 0 | 35.90 | 60 |
| Total | 4.19 | 6.89 | 0 | 54.21 | 284 |

Hiring Rate, starts & returns (monthly)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 14.23 | 13.42 | 0 | 51.43 | 50 |
| 1680- | 9.79 | 14.83 | 0 | 74.19 | 32 |
| 1685- | 11.04 | 13.13 | 0 | 57.94 | 41 |
| 1690- | 8.03 | 6.35 | 0 | 34.78 | 45 |
| 1695- | 3.68 | 4.22 | 0 | 13.33 | 15 |
| 1700- | 6.41 | 9.48 | 0 | 42.11 | 41 |
| 1705- | 9.42 | 21.46 | 0 | 120.61 | 60 |
| Total | 9.58 | 14.26 | 0 | 120.61 | 284 |

Separation Rate, final (monthly)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 7.66 | 8.01 | 0 | 32.89 | 50 |
| 1680- | 3.85 | 5.57 | 0 | 23.53 | 32 |
| 1685- | 8.25 | 8.73 | 0 | 35.56 | 41 |
| 1690- | 3.40 | 5.01 | 0 | 22.86 | 45 |
| 1695- | 5.47 | 7.66 | 0 | 22.64 | 15 |
| 1700- | 2.02 | 3.74 | 0 | 20.00 | 41 |
| 1705- | 2.26 | 4.94 | 0 | 35.44 | 60 |
| Total | 4.57 | 6.72 | 0 | 35.56 | 284 |

Separation Rate, temporary & final (monthly)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 16.77 | 14.75 | 0 | 48.78 | 50 |
| 1680- | 12.34 | 13.32 | 0 | 52.83 | 32 |
| 1685- | 12.96 | 14.05 | 0 | 54.95 | 41 |
| 1690- | 5.50 | 7.60 | 0 | 38.60 | 45 |
| 1695- | 6.96 | 10.09 | 0 | 28.57 | 15 |
| 1700- | 4.69 | 10.55 | 0 | 60.00 | 41 |
| 1705- | 8.06 | 21.61 | 0 | 134.18 | 60 |
| Total | 9.83 | 15.19 | 0 | 134.18 | 284 |

**Table 1.3: Churn Estimates, Quarterly, Any**

Note: these figures report rates based on any appearance by a worker in each quarter.

Creation Rate (quarterly, any)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 6.32 | 9.95 | 0 | 29.70 | 16 |
| 1680- | 5.38 | 9.02 | 0 | 33.33 | 20 |
| 1685- | 14.54 | 26.45 | 0 | 90.00 | 20 |
| 1690- | 10.94 | 12.81 | 0 | 46.81 | 20 |
| 1695- | 9.49 | 14.53 | 0 | 51.53 | 20 |
| 1700- | 15.92 | 24.62 | 0 | 88.37 | 20 |
| 1705- | 7.80 | 9.03 | 0 | 30.05 | 20 |
| Total | 10.17 | 16.87 | 0 | 90.00 | 136 |

Job Destruction Rate (quarterly, any)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 13.95 | 12.81 | 0 | 31.93 | 16 |
| 1680- | 9.10 | 10.49 | 0 | 26.09 | 20 |
| 1685- | 13.07 | 17.54 | 0 | 71.60 | 20 |
| 1690- | 8.37 | 17.05 | 0 | 52.42 | 20 |
| 1695- | 10.22 | 19.63 | 0 | 73.17 | 20 |
| 1700- | 13.74 | 29.89 | 0 | 100.00 | 20 |
| 1705- | 3.87 | 9.21 | 0 | 30.93 | 20 |
| Total | 10.23 | 17.92 | 0 | 100.00 | 136 |

Hiring Rate, first starts (quarterly, any)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 11.27 | 12.86 | 0 | 49.29 | 16 |
| 1680- | 4.80 | 6.26 | 0 | 21.73 | 20 |
| 1685- | 18.87 | 25.19 | 0 | 86.67 | 20 |
| 1690- | 11.35 | 8.38 | 0 | 28.57 | 20 |
| 1695- | 7.39 | 8.41 | 0 | 34.57 | 20 |
| 1700- | 8.59 | 11.03 | 0 | 32.32 | 20 |
| 1705- | 9.15 | 8.05 | 0 | 27.12 | 20 |
| Total | 10.17 | 13.30 | 0 | 86.67 | 136 |

Hiring Rate, starts & returns (quarterly, any)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 17.90 | 15.14 | 0 | 51.43 | 16 |
| 1680- | 12.35 | 11.92 | 0 | 36.00 | 20 |
| 1685- | 23.21 | 26.91 | 0 | 91.67 | 20 |
| 1690- | 17.30 | 12.37 | 0 | 46.81 | 20 |
| 1695- | 14.50 | 15.07 | 0 | 57.14 | 20 |
| 1700- | 18.30 | 25.26 | 0 | 88.37 | 20 |
| 1705- | 12.18 | 9.89 | 2 | 33.16 | 20 |
| Total | 16.49 | 17.83 | 0 | 91.67 | 136 |

Separation Rate, final (quarterly, any)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 8.76 | 5.85 | 0 | 17.39 | 16 |
| 1680- | 7.16 | 7.03 | 0 | 22.22 | 20 |
| 1685- | 9.43 | 10.81 | 0 | 46.96 | 20 |
| 1690- | 6.89 | 9.67 | 0 | 36.19 | 20 |
| 1695- | 8.14 | 11.37 | 0 | 38.36 | 20 |
| 1700- | 5.89 | 11.70 | 0 | 49.23 | 20 |
| 1705- | 8.27 | 16.76 | 0 | 74.01 | 20 |
| Total | 7.76 | 10.89 | 0 | 74.01 | 136 |

Separation Rate, temporary & final (quarterly, any)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 27.54 | 16.06 | 2 | 55.88 | 16 |
| 1680- | 17.60 | 12.51 | 0 | 41.03 | 20 |
| 1685- | 20.72 | 16.80 | 2 | 56.99 | 20 |
| 1690- | 22.36 | 33.25 | 0 | 136.36 | 20 |
| 1695- | 16.87 | 23.06 | 0 | 85.71 | 20 |
| 1700- | 20.28 | 40.03 | 0 | 126.67 | 20 |
| 1705- | 8.53 | 10.93 | 0 | 37.31 | 20 |
| Total | 18.88 | 24.32 | 0 | 136.36 | 136 |

**Table 1.4: Churn Estimates, Quarterly, Quasi-Census**

Note: these figures report rates based on any appearance by a worker in the final monthly account of a quarter, replicating the ‘end of quarter’ approach.

Job Creation Rate (quarterly, quasi-census)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 11.73 | 19.48 | 0 | 72.82 | 16 |
| 1680- | 5.59 | 10.38 | 0 | 24.00 | 8 |
| 1685- | 17.93 | 30.03 | 0 | 85.71 | 14 |
| 1690- | 10.35 | 12.41 | 0 | 46.81 | 20 |
| 1695- | 11.28 | 18.06 | 0 | 41.03 | 6 |
| 1700- | 10.46 | 18.68 | 0 | 63.83 | 13 |
| 1705- | 8.29 | 10.72 | 0 | 32.50 | 20 |
| Total | 10.93 | 17.73 | 0 | 85.71 | 97 |

Job Destruction Rate (quarterly, quasi-census)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 15.65 | 20.93 | 0 | 59.83 | 16 |
| 1680- | 11.66 | 13.60 | 0 | 30.77 | 8 |
| 1685- | 19.99 | 26.33 | 0 | 75.47 | 14 |
| 1690- | 7.37 | 11.30 | 0 | 40.00 | 20 |
| 1695- | 16.74 | 22.49 | 0 | 47.06 | 6 |
| 1700- | 5.43 | 18.43 | 0 | 66.67 | 13 |
| 1705- | 4.29 | 8.34 | 0 | 23.20 | 20 |
| Total | 10.59 | 17.81 | 0 | 75.47 | 97 |

Hiring Rate, first starts (quarterly, quasi-census)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 4.81 | 8.28 | 0 | 32.82 | 16 |
| 1680- | 0.42 | 1.20 | 0 | 3.39 | 8 |
| 1685- | 7.84 | 10.52 | 0 | 30.36 | 14 |
| 1690- | 3.32 | 4.01 | 0 | 15.91 | 20 |
| 1695- | 1.98 | 1.55 | 0 | 3.33 | 6 |
| 1700- | 3.71 | 7.95 | 0 | 27.59 | 13 |
| 1705- | 2.66 | 2.33 | 0 | 8.62 | 20 |
| Total | 3.81 | 6.49 | 0 | 32.82 | 97 |

Hiring Rate, starts & returns (quarterly, quasi-census)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 17.60 | 12.54 | 0 | 42.67 | 16 |
| 1680- | 10.70 | 8.80 | 0 | 24.00 | 8 |
| 1685- | 14.68 | 17.42 | 0 | 56.00 | 14 |
| 1690- | 10.44 | 10.36 | 0 | 38.30 | 20 |
| 1695- | 7.25 | 9.83 | 0 | 26.67 | 6 |
| 1700- | 6.93 | 12.26 | 0 | 38.30 | 13 |
| 1705- | 7.24 | 6.23 | 0 | 25.53 | 20 |
| Total | 10.93 | 11.81 | 0 | 56.00 | 97 |

Separation Rate, final (quarterly, quasi-census)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 6.68 | 8.91 | 0 | 34.91 | 16 |
| 1680- | 6.94 | 6.16 | 0 | 16.33 | 8 |
| 1685- | 8.13 | 8.24 | 0 | 26.59 | 14 |
| 1690- | 4.63 | 6.07 | 0 | 21.54 | 20 |
| 1695- | 8.90 | 10.78 | 0 | 26.47 | 6 |
| 1700- | 2.75 | 5.66 | 0 | 20.51 | 13 |
| 1705- | 3.61 | 5.33 | 0 | 23.63 | 20 |
| Total | 5.47 | 7.17 | 0 | 34.91 | 97 |

Separation Rate, temporary & final(quarterly, quasi-census)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | mean | sd | min | max | count |
| 1675- | 29.93 | 18.84 | 6 | 67.92 | 16 |
| 1680- | 19.58 | 13.34 | 7 | 40.68 | 8 |
| 1685- | 29.97 | 24.41 | 2 | 79.25 | 14 |
| 1690- | 15.57 | 13.90 | 0 | 52.31 | 20 |
| 1695- | 20.09 | 23.21 | 0 | 50.00 | 6 |
| 1700- | 10.68 | 17.37 | 0 | 66.67 | 13 |
| 1705- | 9.87 | 9.33 | 1 | 29.83 | 20 |
| Total | 18.80 | 18.36 | 0 | 79.25 | 97 |

**Online Appendix 2: Robustness Checks and Alternative Specifications**

This appendix considers whether the results for the intensity of work are robust to changes in how “full-time” is defined, to the use of a fractional logit model, to the inclusion of external shocks that may have affected hiring at St Paul’s, and to the exclusion of possible foremen.

**2.1. Are our main results robust to changes in the “full time” boundary?**

The 85% of max days worked in a period boundary includes 7,189 of 19,861 (36.18%) observations for the construction period excluding the first few years and those working their first shift. Table 2.1 shows that lowering or raising the boundary causes the percent of observations considered full-time to increase or decrease. At an 80% boundary, over half of observations are included as full-time workers. At a 95% boundary, less than one quarter of observations are included as full-time.

**Table 2.1: Percent of workers full time and not full time at different boundaries**

|  |  |  |
| --- | --- | --- |
|  | % Full time | % Not full time |
| Full time > 75 | 57.99 | 42.01 |
| Full time > 80 | 50.86 | 49.14 |
| Full time > 85 | 36.18 | 63.82 |
| Full time > 90 | 26.03 | 73.97 |
| Full time > 95 | 18.40 | 81.60 |

Figure 2.1 gives the density of observations across 5-year buckets of the percent of maximum days worked by any laborer in the period. Over half of observations are past 80% of maximum days worked. The 85% boundary excludes the clusters of observations around 80% to capture the top end of the distribution in terms of days worked. Figure 2.2 gives this histogram by decade. The 80% breakpoint is noticeable in each decade, especially after 1700.

**Figure 2.1: 5-year bucket density observations with percentage of maximum days worked by any laborer in the period**



**Figure 2.2: 5-year bucket density observations with percentage of maximum days worked by any laborer in the period by decade.**



Table 2.2 gives the coefficients and marginal effects from a logit model for the probability of a laborer working full time during an accounting period. The independent variable of interest is tenure in terms of the percentile rank of cumulative days worked previously. Columns (1) and (2) are the results where a worker is considered full time at more that 80% of the maximum days worked during the accounting period. (3) and (4) give the results for the assumed full-time boundary of 85%. (5) and (6) use a full-time boundary of over 90%, and (7) and (8) use a full time boundary of over 95%.

Table 2.3 is structured the same way, capturing tenure through the percentile rank of elapsed time since the worker began at the cathedral.

Both Table 2.2 and Table 2.3 indicate that the relationship of tenure to the intensity of work during an accounting period is robust to changing the boundary for when a worker is considered full time. In all models in Table 2.2, the marginal effects indicate that a one quartile increase in a laborer’s percentile rank of tenure in terms of cumulative days corresponds to over a 10 percentage point increase in the probability that the laborer worked full time during an accounting period, even as the boundary for full time is adjusted (p < 0.001, 25 \* 0.0040 = 0.10). Likewise, the models in Table 2.3 indicate that a one quartile increase in a laborer’s percentile rank of tenure in terms of elapsed time corresponds to over a 7.5 percentage point increase in the probability that the laborer worked full time during an accounting period, even as the boundary for full time is adjusted (p < 0.001, 25 \* 0.0030 = 0.075).

**Table 2.2: Probability of a laborer working full time at different full time boundaries**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | FT 80 - Coef | FT 80 - Margins | FT 85 - Coef | FT 85 - Margins | FT 90 - Coef | FT 90 - Margins | FT 95 - Coef | FT 95 - Margins |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|  |  |  |  |  |  |  |  |  |
| Tenure - Cum. Days | 0.0235\*\*\* | 0.0047\*\*\* | 0.0267\*\*\* | 0.0049\*\*\* | 0.0295\*\*\* | 0.0045\*\*\* | 0.0329\*\*\* | 0.0040\*\*\* |
|  | (0.0020) | (0.0004) | (0.0023) | (0.0004) | (0.0027) | (0.0004) | (0.0030) | (0.0005) |
| Constant | -3.5724\*\*\* |  | -3.7217\*\*\* |  | -6.6361\*\*\* |  | -7.4575\*\*\* |  |
|  | (0.2160) |  | (0.2213) |  | (0.5982) |  | (0.9737) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Num. of observations | 19861 | 19861 | 19861 | 19861 | 19861 | 19861 | 19861 | 19861 |
| Num. of individuals | 798 |  | 798 |  | 798 |  | 798 |  |
| Pseudo R2 | 0.163 |  | 0.172 |  | 0.189 |  | 0.184 |  |

Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

**Table 2.3: Logit models for the probability of a laborer working full time at different full time boundaries**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | FT 80 - Coef | FT 80 - Margins | FT 85 - Coef | FT 85 - Margins | FT 90 - Coef | FT 90 - Margins | FT 95 - Coef | FT 95 - Margins |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|  |  |  |  |  |  |  |  |  |
| Tenure - Elap. Time | 0.0148\*\*\* | 0.0031\*\*\* | 0.0180\*\*\* | 0.0035\*\*\* | 0.0205\*\*\* | 0.0033\*\*\* | 0.0235\*\*\* | 0.0030\*\*\* |
|  | (0.0023) | (0.0005) | (0.0026) | (0.0005) | (0.0030) | (0.0005) | (0.0033) | (0.0005) |
| Constant | -2.7713\*\*\* |  | -2.8929\*\*\* |  | -5.7406\*\*\* |  | -6.5117\*\*\* |  |
|  | (0.2051) |  | (0.2206) |  | (0.6447) |  | (1.0644) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Num. of observations | 19861 | 19861 | 19861 | 19861 | 19861 | 19861 | 19861 | 19861 |
| Num. of individuals | 798 |  | 798 |  | 798 |  | 798 |  |
| Pseudo R2 | 0.126 |  | 0.131 |  | 0.146 |  | 0.139 |  |

Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

**2.2: Are our main results robust to a non-binary dependent variable?**

We can also check the robustness of our results by using a fractional dependent variable for the raw percentage of maximum days worked in a period. The model specification is a fractional logit model with year and month fixed effects. These results are given in Table 2.4.

Columns (1) and (2) use the percentile rank of cumulative days previously worked as the measure of tenure. The marginal effect indicates that a one quartile increase in percentile rank of tenure corresponds to a 10.75 percentage point increase in the percent of maximum days worked in an accounting period (p<0.001, 25\*0.0043 = 10.75). Columns (3) and (4), using elapsed time percentile rank as the measure of tenure, indicate that a one quartile increase in percentile rank of tenure corresponds to a 7.8 percentage point increase in the percent of maximum days worked in an accounting period (p<0.001, 25\*0.0031 = 7.8). Figure 2.3 graphs the marginal effects for the model in (1) and (2). As the percentile rank increases, the percent of maximum days worked increases.

**Table 2.4: Fractional logit models for percent of maximum days worked in the accounting period**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Tenure - Margins | Elap. Time Tenure - Coefficients | Elap. Time Tenure - Margins |
|  | (1) | (2) | (3) | (4) |
|  |  |  |  |  |
| Tenure | 0.0215\*\*\* | 0.0043\*\*\* | 0.0150\*\*\* | 0.0031\*\*\* |
|  | (0.0017) | (0.0003) | (0.0019) | (0.0004) |
| Constant | -2.5237\*\*\* |  | -1.9146\*\*\* |  |
|  | (0.1677) |  | (0.1575) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes |
| Num. of observations | 19861 | 19861 | 19861 | 19861 |
| Num. of individuals | 798 |  | 798 |  |
| Pseudo R2 | 0.107 |  | 0.078 |  |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

**Figure 2.3: Marginal effects for the model (1) and (2) in Table 2.4, showing percentile rank and percent of maximum days worked.**



**2.3: Are our main results robust to the inclusion of external shocks which may have affected St Paul’s?**

Over the period of the reconstruction of St Paul’s, there were numerous external shocks which could have shaped the tightness of the construction labor force. In this Appendix, we briefly examine whether some of the major shocks of the period affect our main results on the relationship of tenure to the amount of days worked in each accounting period. We control for four types of historical shocks in our analysis in this Appendix: temperature, wars, mortality, and financial volatility (after 1688).

Because construction is an extremely seasonal industry, variations in the weather patterns across years could affect the intensity of work in a given month. We control for these variations by including the mean monthly temperature of Central England in our analysis. This monthly time series is taken from Manley (1974).[[1]](#footnote-1)

Wars are disruptive to general economic activity and can draw young male laborers out of the workforce. As this population might overlap the laborers we observe at St Paul’s, we include a dummy variable in our analysis indicating whether England was engaged in a war during each accounting period. This variable is based on Peter Brecke’s Conflict Catalog, which gives the start and end dates of international conflicts during this period.[[2]](#footnote-2)

We also include a measure of general mortality in London to capture the effects of pestilence and disease on the labor force. The data we use is the number of burials each month in London. These data were kindly shared with us by John Landers, who developed the monthly series based on the London Bills of Mortality from 1675-1825.[[3]](#footnote-3)

Finally, we include a measure of the number of bankruptcies in London throughout the period as a proxy for general financial volatility. The Cathedral was a large project that relied heavily on borrowing, and thus employment and hiring at the Cathedral could have been shaped by the state of financial markets. Our annual series of bankruptcies in London is from Julian Hoppitt’s 1987 study of English business, used for the eighteenth century by Schwarz (1992) .[[4]](#footnote-4)

The results of our robustness checks incorporating these additional variables are given in Table 1 and Table 2. Our time series on bankruptcies in London begins only in 1688, so we first present the models without this variable for the entire construction period, and then including this variable but only for the period after 1688.

Table 2.5 indicates that our main results are robust to the inclusion of these additional controls. The marginal effects in column (2) imply that a one quartile increase in the percentile rank of a laborer’s tenure in terms of cumulative days worked increases their probability of working full time by 12.25 percentage points (p < 0.001, 25 \* 0.0049 = 0.1225). This is identical to the main results in the paper. Likewise, the marginal effect for tenure in terms of elapsed time, given in column (5), is also identical. However, the within-laborer effects are not significant with either of these measures of tenure. All of the additional controls we include have the sign that is expected, with work intensity increasing with higher average temperatures, decreasing with wars, and decreasing, though not significantly, with mortality.

**Table 2.5: Logit models for the probability of a laborer working fulltime with controls for historical shocks**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Tenure - Margins | Cum. Days Tenure - Coefficients (FE) | Elap. Time Tenure - Coefficients | Elap. Time Tenure - Margins | Elap. Time Tenure -Coefficients (FE) |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| Tenure | 0.0269\*\*\* | 0.0049\*\*\* | 0.0109 | 0.0181\*\*\* | 0.0035\*\*\* | 0.0085 |
|  | (0.0023) | (0.0004) | (0.0059) | (0.0026) | (0.0005) | (0.0069) |
| Monthly Burials | -0.0001 | -0.0000 | -0.0003\* | -0.0001 | -0.0000 | -0.0003\* |
|  | (0.0001) | (0.0000) | (0.0001) | (0.0001) | (0.0000) | (0.0001) |
| Monthly Avg. Temp | 0.0827\*\*\* | 0.0150\*\*\* | 0.1069\*\*\* | 0.0791\*\*\* | 0.0152\*\*\* | 0.1067\*\*\* |
|  | (0.0140) | (0.0025) | (0.0174) | (0.0134) | (0.0025) | (0.0174) |
| Conflict Indicator | -0.9211\*\*\* | -0.1671\*\*\* | -1.2571\*\*\* | -0.8857\*\*\* | -0.1702\*\*\* | -1.2625\*\*\* |
|  | (0.1162) | (0.0209) | (0.1416) | (0.1106) | (0.0209) | (0.1409) |
| Constant | -2.8397\*\*\* |  |  | -2.0094\*\*\* |  |  |
|  | (0.2884) |  |  | (0.2778) |  |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Laborer Fixed Effects | No | No | Yes | No | No | Yes |
| Num. of observations | 19861 | 19861 | 18921 | 19861 | 19861 | 18921 |
| Num. of individuals | 798 |  |  | 798 |  |  |
| Pseudo R2 | 0.175 |  | 0.163 | 0.135 |  | 0.162 |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

Table 2.6 incorporates the London bankruptcy data into the analysis, which restricts the years of the analysis to 1688-1710. Our results are robust to the inclusion of this variable. The marginal effect of tenure in terms of cumulative days worked increases from 0.0049 to 0.0051 (p<0.001), and the marginal effect in terms of elapsed time also increases from 0.0035 to 0.0041 (p<0.001). As in Table 2.5, the within-laborer effects are not significant. Somewhat surprisingly, the effect of bankruptcies is to increase the intensity of labor at St Paul’s Cathedral.

**Table 2.6: Logit models for the probability of a laborer working fulltime with controls for historical shocks and bankruptcies, 1688-1710**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Tenure - Margins | Cum. Days Tenure - Coefficients (FE) | Elap. Time Tenure - Coefficients | Elap. Time Tenure - Margins | Elap. Time Tenure -Coefficients (FE) |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| Tenure | 0.0289\*\*\* | 0.0051\*\*\* | 0.0042 | 0.0223\*\*\* | 0.0041\*\*\* | 0.0085 |
|  | (0.0030) | (0.0005) | (0.0080) | (0.0031) | (0.0006) | (0.0069) |
| Monthly Burials | -0.0003\* | -0.0001\* | -0.0005\*\* | -0.0003\* | -0.0001\* | -0.0003\* |
|  | (0.0001) | (0.0000) | (0.0002) | (0.0001) | (0.0000) | (0.0001) |
| Monthly Avg. Temp | 0.0042 | 0.0007 | 0.0130 | 0.0036 | 0.0007 | 0.1067\*\*\* |
|  | (0.0145) | (0.0026) | (0.0200) | (0.0139) | (0.0026) | (0.0174) |
| Conflict Indicator | -0.7379\*\*\* | -0.1304\*\*\* | -1.1376\*\*\* | -0.7243\*\*\* | -0.1338\*\*\* | -1.2625\*\*\* |
|  | (0.1436) | (0.0251) | (0.1833) | (0.1361) | (0.0248) | (0.1409) |
| Annual Bankruptcies | 0.0147\*\*\* | 0.0026\*\*\* | 0.0167 | 0.0136\*\*\* | 0.0025\*\* |  |
|  | (0.0041) | (0.0008) | (0.0099) | (0.0041) | (0.0008) |  |
| Constant | -2.0320\*\*\* |  |  | -1.5860\*\*\* |  |  |
|  | (0.3284) |  |  | (0.3189) |  |  |
| Year Fixed Effects | Yes | No | Yes | Yes | No | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Laborer Fixed Effects | No | No | Yes | No | No | Year |
| Num. of observations | 13401 | 13401 | 12733 | 13401 | 13401 | 18921 |
| Num. of individuals | 473 |  |  | 473 |  |  |
| Pseudo R2 | 0.198 |  | 0.168 | 0.167 |  | 0.162 |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

**2.4: Are our main results robust to the exclusion of laborers that might have been foremen?**

During the period of construction, fewer than ten men were paid more than the standard day rates of 16d and 18d. Historical records suggest that these men were foremen, acting in a managerial role.[[5]](#footnote-5) As foremen, they would have worked most days in an accounting period and had significant tenure. It is thus possible that they impacted the relationship we find between tenure and intensity of work.

To check whether this is the case, as a robustness check we run the main models excluding any laborer who earned over 18 pence per day during their time working for St Paul’s. This results in dropping 548 observations representing the work of 7 out of 797 laborers. The results are almost identical to those from the main model, presented in Table 2.7.

**Table 2.7 Logit models for the probability of a laborer working fulltime, with foremen excluded from sample**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Tenure - Margins | Cum. Days Tenure - Coefficients (FE) | Elap. Time Tenure - Coefficients | Elap. Time Tenure - Margins | Elap. Time Tenure -Coefficients (FE) |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
|  |  |  |  |  |  |  |
| Tenure | 0.0256\*\*\* | 0.0046\*\*\* | 0.0114 | 0.0179\*\*\* | 0.0034\*\*\* | 0.0093 |
|  | (0.0023) | (0.0004) | (0.0059) | (0.0027) | (0.0005) | (0.0068) |
| Constant | -3.7124\*\*\* |  |  | -2.9761\*\*\* |  |  |
|  | (0.2295) |  |  | (0.2220) |  |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Laborer Fixed Effects | No | No | Yes | No | No | Yes |
| Num. of observations | 19313 | 19313 | 18447 | 19313 | 19313 | 18447 |
| Num. of individuals | 790 |  |  | 790 |  |  |
| Pseudo R2 | 0.173 |  | 0.155 | 0.140 |  | 0.154 |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

**Online Appendix 3: Change Over Time**

The results presented in Table 4 in the main text indicate that long-standing laborers were given more days of work in each accounting period than laborers with less tenure. How did the relationship between tenure and days worked change over time?

First, St Paul’s was built in stages (Campbell, 2007:102-3). From the late 1660s demolition work was carried out and this was not finally completed until the late 1680s even as the lower walls of the new cathedral were raised, and the masonry walls of the choir were up by 1690. Roofing was carried out throughout the first decade of the new century. One stage of building which challenged the skills of all on site was the construction of the dome from 1705 through completion in 1711. This building phase was experimental and required bricklayers, carpenters and plasterers to work alongside masons with innovations in scaffoldings and materials (Campbell 2007:121-137) which may have required more experience than other general laboring jobs. Without raising wage rates, it is possible that St Paul’s awarded more working days per month, and more consistent working days, to secure experienced laborers to complete the construction of the dome.

Table 3.1 presents three models exploring whether the relationship between tenure and days worked in a month changed during the period of dome construction at the cathedral. The dependent variable is the probability of working full time during the accounting period, defined as in Table 4 in the main text. Prior tenure is measured by cumulative days worked in previous accounting periods in columns (1) and (2), and by elapsed time since the laborer began working at St Paul’s in columns (3) and (4). All models have year and month fixed effects with clustered standard errors.

Column (1), our primary results, give the coefficients and marginal effects of a logit model using the cumulative days measure of tenure. The significant interaction term indicates that the relationship between tenure and whether laborers worked fulltime did change during the period of dome construction. The marginal effects, given in the third panel of Table 3.1, imply that a one quartile increase in a laborer’s tenure percentile rank increases the probability of working full time by 8.5 percentage points in the period prior to dome construction (p < 0.05, 25\*0.0034 = 0.085), and by 13.5 percentage points during the period of dome construction (p < 0.05, 25\*0.0054 = 0.135). Figure 3.1 shows that in both periods, laborers with more tenure were more likely to work full time, but that the returns to tenure were steeper during the period of dome construction.

**Table 3.1: Logit models for the probability of a laborer working full time, dome building vs. rest of building**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cum. Days Logit - Coef | Cum. Days Cond. Logit (FE) - Coef | Elap. Time Logit - Coef | Elap. Time Cond. Logit (FE) - Coef |
|  | (1) | (2) | (3) | (4) |
|  | b/se | b/se | b/se | b/se |
|  |  |  |  |  |
| Tenure - Cum. Days | 0.0232\*\*\* | 0.0094 |  |  |
|  | (0.0027) | (0.0060) |  |  |
| Dome = 1 | 1.3000\* | -0.1795 | 0.8801\* | -0.0696 |
|  | (0.4087) | (0.9003) | (0.4287) | (1.0492) |
| Dome \* Tenure - Cum. Days | 0.0128\* | 0.0313\*\* |  |  |
|  | (0.0057) | (0.0083) |  |  |
| Tenure - Elap. Time |  |  | 0.0136\*\*\* | 0.0079 |
|  |  |  | (0.0032) | (0.0068) |
| Dome \* Tenure - Elap. Time |  |  | 0.0144\*\* | 0.0280\*\* |
|  |  |  | (0.0058) | (0.0087) |
| Constant | -3.4701\*\*\* |  | -2.6447\*\*\* |  |
|  | (0.2360) |  | (0.2318) |  |
|  |  |  |  |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes |
| Laborer Fixed Effects | No | Yes | No | Yes |
| *Average marginal effects* |  |  |  |  |
| Tenure – Cum. Days |  |  |  |  |
| Dome = 0 | 0.0034\*\*\* |  |  |  |
| Dome = 1 | 0.0054\*\*\* |  |  |  |
| Tenure – Elap. Time |  |  |  |  |
| Dome = 0 |  |  | 0.0022\*\*\* |  |
| Dome = 1 |  |  | 0.0047\*\*\* |  |
| Num. of observations | 19861 | 18921 | 19861 | 18921 |
| Num. of individuals | 798 |  | 798 |  |
| Pseudo R2 | 0.175 | 0.158 | 0.136 | 0.157 |

Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Column (2) presents estimates from a conditional logit specification with laborer fixed effects. The results are robust to the inclusion of individual fixed effects, as the interaction effect increases in both magnitude and significance.

Column (3) gives the results from a logit specification using the percentile rank of elapsed time as the measure of prior tenure. The results are similarly striking. A one quartile increase in a laborer’s tenure percentile rank in terms of elapsed time increases the probability of working full time by 5.5 percentage points in before the dome construction (p < 0.01, 25\*0.0022 = 0.055) and by 11.75 percentage points during dome construction (p < 0.01, 25\*0.0047 = 0.1175). These results are robust to the inclusion of laborer fixed effects in column (4).

**Figure 3.1 Returns to tenure through construction phase.**



**Online Appendix 4: Results for the Maintenance Period**

Most of the data collected represents the construction period of St Paul’s through 1711. Less than 3% of the data in our panel is from the maintenance period. This appendix explores whether there was a change in the relationship between tenure and intensity of work during the maintenance period.

Columns (1) and (2) of Table 4.1 indicate that there was a significant relationship between tenure in terms of cumulative days worked and whether a laborer worked full time during the maintenance period. The marginal effects in (2) indicate that a one quartile increase in the laborer’s percentile rank increases the probability of working full time by 8.5 percentage points (p<0.05, 25\*0.0033 = 0.0825). However, this result is not robust to the inclusion of laborer fixed effects in column (3), or to the elapsed time measure of tenure in columns (4)-(6).

The relationship between tenure and whether a laborer worked more than 85% of the maximum days in an accounting period thus was weaker and possibly insignificant during the maintenance period.

**Table 4.1: Logit models for the probability of a laborer working full time during maintenance period**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Tenure - Margins | Cum. Days Tenure - Coefficients (FE) | Elap. Time Tenure - Coefficients | Elap. Time Tenure - Margins | Elap. Time Tenure -Coefficients (FE) |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
|  |  |  |  |  |  |  |
| Tenure | 0.0178\* | 0.0033\*\* | 0.0042 | 0.0130 | 0.0025\* | 0.0057 |
|  | (0.0079) | (0.0013) | (0.0263) | (0.0071) | (0.0012) | (0.0211) |
| Constant | -0.9479 |  |  | -0.6937 |  |  |
|  | (0.5250) |  |  | (0.4775) |  |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Laborer Fixed Effects | No | No | Yes | No | No | Yes |
| Num. of observations | 545 | 545 | 456 | 545 | 545 | 456 |
| Num. of individuals | 54 |  |  | 54 |  |  |
| Pseudo R2 | 0.200 |  | 0.258 | 0.187 |  | 0.258 |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile.

**Online Appendix 5: Tenure and Seasonal Hiring Patterns**

Many breaks in employment at St Paul’s were a by-product of the seasonal volatility of demand for construction work. Most absences began when the arrival of winter brought the peak building period to a close. Almost 40 per cent began in January; another 10 per cent began in December. Those laborers who reappeared did so between February and June, as the weather improved and work intensified. In the peak month of July, there was on average 1,466 days of general laboring work conducted by 49 laborers. In the January dip, there was about half as much labor, averaging 784 days of work conducted by 32 laborers.

Using these seasonal patterns, we can probe deeper into whether the clerk hired more tenured laborers more consistently over the year. We explore whether long-standing laborers were more likely to be kept on during the winter months and, if they were let go, whether they were more likely to be rehired in the spring. Winter work was particularly valuable, as the seasonal slowdown affected construction across the city. We consider specifically the month of March, which is when labor typically picked up again after the steep seasonal decline in January and February.

In Table 5.1, we present two models using a sample of laborers active in the month of March in any year during the construction period. The first model in columns (1) and (2) explores whether workers with longer tenure were more likely to have worked over the seasonal downturn. The dependent variable is an indicator for whether the laborer had worked at the Cathedral in the preceding January and February. The estimates in column (1) indicate that tenure was positively related to the probability of working in these months. The size of this effect is substantial—the marginal effect in column (2) indicates that a one quartile increase in the laborer’s tenure percentile rank increases the probability of working in January and February by 19 percentage points (p<0.001, 25 \* 0.0075 = 0.1875). Longer-standing laborers at the Cathedral were much more likely to be kept on when work slowed over the winter months.

**Table 5.1: Tenure and seasonal hiring patterns for active workers in the month of March**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Prob. of Working in Jan and Feb - Coefficients | Prob. of Working in Jan and Feb - Margins | Prob. of Rehiring in March - Coefficients | Prob. of Rehiring in March - Margins |
|  | (1) | (2) | (3) | (4) |
|  |  |  |  |  |
| Tenure | 0.0467\*\*\* | 0.0075\*\*\* | 0.0341\*\*\* | 0.0053\*\*\* |
|  | (0.0032) | (0.0003) | (0.0051) | (0.0006) |
| Constant | -2.9451\*\*\* |  | -1.2371\* |  |
|  | (0.2546) |  | (0.4814) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Num. of observations | 1613 | 1613 | 565 | 565 |
| Num. of individuals | 533 |  | 282 |  |
| Pseudo R2 | 0.298 |  | 0.323 |  |

Source: See text. Notes: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors in parentheses. Tenure given in cumulative days percentile. The sample contains laborers who were active at the Cathedral in the month of March in any year of the construction phase. The dependent variable in columns (1) and (2) is an indicator for whether the laborer had worked at the Cathedral in the preceding January and February. Columns (3) and (4) restrict the sample to those who did not work in January and February, and the dependent variable is an indicator for whether these workers were rehired in March. Tenure given in percentile rank and is calculated according to cumulative days worked as a laborer.

What about laborers who did *not* work in either January or February of a year? Were more tenured workers more likely to be rehired in March than less tenured workers? In the second model in columns (3) and (4), we look exclusively those active laborers not hired over the winter. The dependent variable is an indicator for whether these workers were rehired in March. The estimate in column (3) and marginal effects in column (4) suggest that more tenured laborers who did not work over the winter were more likely to be rehired in the spring. Among workers who were not hired in January or February, a one quartile increase in the laborer’s tenure percentile rank increases the probability of being hired in March by 13 percentage points (p<0.001, 25 \* 0.0053 = 0.1325).

Long-standing laborers at the Cathedral thus had more stable employment, with an increased chance of being rehired after seasonal downturns in hiring. The seasonality of building work strongly suggests that laborers were not absenting themselves for better offers on other sites. They were laid off in periods when low demand would be widespread across the sector, making a seamless transition to another site unlikely.

**Online Appendix 6: The Ranking of Laborers in the Accounts**

The organization of the accounts suggests that the clerk possessed a clear idea about who was to be hired and what they were entrusted with. In each period, hiring occurred in a sequence, with preferred workers taken on first. In this appendix, we expand on several points that we can only cover briefly in the paper: (1) that the sequence suggests that the clerk deliberately hired laborers in a specific and persistent order; (2) that the pattern of entry and exit argues against laborers being organized into gangs Long-term laborers were allotted a higher place in the queue for whatever work was available. The structure of the account also argues against the idea that laborers were being hired as gangs.

We are able to observe this process because of how the clerk kept the accounts for the majority of the period. For seven years from 1675-1682, the accounts were organized alphabetically; this affects 21% of the series. Before and after this, however, the order of laborers’ names seems to reflect the order of hiring.[[6]](#footnote-6) The only exception to this is that first and last positions were sometimes determined by status, and were at times occupied by the foreman and clerk of works.

**6.1. Ranking & Laborer Status**

The ranking of laborers’ appearances in the accounts was strongly persistent between accounts. Figure 6.1 plots the Spearman correlation coefficient between the order of workers in sequential pairs of accounts with at most a gap of one month between them. There is very little change in the order.

**Figure 6.1 Correlation between the order of workers in pairs of accounts**



NOTE: sample restricted to accounts with more than 30 unique observations of laborers which are separated from the next account by a gap of less than 33 days. Spearman correlations were run on pairs of accounts. All coefficients were significant at the 0.001% level or better. Accounts organized alphabetically are excluded. Only accounts from the construction phase can be formally analysed in this way. The earliest pair of accounts in the discussion are from 1672-3, the last are 1709-10

The persistence of the order in which laborers were named in the accounts – when not alphabetical – suggests that the clerk who hired them had a clear view of which workers to prioritize and take on first.

The factor that appears to explain the clerk’s decision was the laborer’s tenure – their experience on the site. This has a strongly determining effect on the order of hiring. There is a strong negative relationship between this at an individual and grouped effect. Workers who have worked for longer are positioned towards the top of the list.[[7]](#footnote-7) We can also see this occurring dynamically over time: workers move up the order of the listing as their tenure increases. This is conveyed clearly if we graph the average position workers have in the account by the number of months that have elapsed since they began work. As Figure 6.2 shows, workers in their first month are – on average – listed around the 70th percentile of the account, but this declines consistently until they are – again on average – positioned around 50th out of 100. As the time since starting work increases, volatility grows as the number of laborers shrinks. But for the first five years, we have at least 27 laborers active in every month observed, and in the initial few years the sample is based on the position of several hundred laborers.

**Figure 6.2 Ranking in the accounts and tenure**

****

Note: position is calculated for accounts with over 50 individuals observed

The relationship that this generated between tenure and access to work is discussed in depth in the text. Table 6.1 complements Table 5 in the main text, and shows how the different quartiles of the clerk’s list were composed of laborers with widely differing degrees of experience on the Cathedral. Only 0.2% of laborers listed in the top quarter were new entrants to the workforce; 7% of those listed in the fourth quartile of people were new that period. At the other extreme, 91% of those listed in the top quartile of each account had been active for more than a year, as were 71% of those in the second quartile.

**Table 6.1: placement of workers in the clerk’s list and time since entry**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Time since entry to workforce | | | | | |  |  |
| Place in account (quartile) | New | 2-3 months | 4-6 months | 7-9 months | 10-12 months | >1 year | % | N |
| Share of each quartile made up by laborers from each category (row) | | | | | | | | |
| 0-25 | 0.22 | 1.14 | 2.14 | 2.54 | 2.57 | 91.39 | 100.00 | 3,695 |
| 26-50 | 1.65 | 7.19 | 7.40 | 6.87 | 5.98 | 70.92 | 100.00 | 3,813 |
| 51-75 | 8.04 | 20.03 | 10.33 | 6.14 | 5.05 | 50.41 | 100.00 | 3,745 |
| 76-100 | 6.66 | 7.35 | 4.50 | 2.88 | 2.93 | 75.72 | 100.00 | 3,888 |
|  |  |  |  |  |  |  |  |  |
| Total | 4.17 | 8.92 | 6.10 | 4.61 | 4.13 | 72.08 | 100.00 | 15,141 |

Note: table reports workers recorded in non-alphabetical accounts produced during the period of construction

We can explore this relationship econometrically by constructing a measure of the relative ranking of laborers in the accounts. We treat each account (for the month) as the “employment pool” and then construct an index of the relative position of the laborers by dividing the rank by the number of possible positions in the pool. In order to match common notions of rankings, we construct the index such that a lower score (closer to 0) represents a better ranking, and a higher score (closer to 1) represents a lower ranking.

We then a regression where the dependent variable is the laborer’s relative position within the account constructed in this way. The independent variable is our normal measures of tenure. This helps us explore to what extent tenure affects the employer’s hiring preferences, as measured by their relative ranking. The analysis is conducted only for those accounts in which the ranking is not alphabetical.

**Table 6.2: Fractional logit models for the effect of tenure on the laborer’s position in the ordering of names in the account book**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Logit - Margins | Elap. Time Tenure - Coef | Elap. Time Tenure - Margins |
|  | (1) | (2) | (3) | (4) |
| Tenure | -0.0215\*\*\* | -0.0049\*\*\* | -0.0199\*\*\* | -0.0046\*\*\* |
|  | (0.0031) | (0.0006) | (0.0029) | (0.0006) |
| Constant | 1.4572\*\*\* |  | 1.2014\*\*\* |  |
|  | (0.3727) |  | (0.3347) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes |
| Num. of observations | 12303 | 12303 | 12303 | 12303 |
| Num. of individuals | 798 |  | 798 |  |
| Pseudo R2 | 0.058 |  | 0.053 |  |

Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile. The dependent variable is the relative position of the laborer in the account book, where a small value (closer to 0) is the best/higher ranking, and a larger value (closer to 1) is the worst/lower ranking.

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Table 6.1 demonstrates a strong relationship between a laborer’s tenure and their ranking in the account book. Columns (1) and (2) give the estimates with tenure measured in cumulative days. The marginal effects in (2) imply that a one quartile increase in the percentile rank of a laborer’s tenure adjusts their ranking index by -0.1225 (p<0.001, 25\*-0.0049 Laborers with greater tenure thus are more likely to be named near the top of the lists in the account books and have a more privileged position in the hiring order. Our assumption that these rankings reflect a hiring preference for more tenured workers is thus corroborated.

**6.2 Ranking and Gang Labor**

Might laborers have been organized in gangs and supplied by agents who managed them? Gang labor is important in some areas of unskilled labor. However, it does not seem to have been occurring in this part of the London building sector. We can use the order in which the laborers’ names were given in the accounts to demonstrate this.

The order was usually repeated consistently from month to month, as we have seen. This was not wholly mechanical. Laborers did change position. Figure 6.3 illustrates this by showing the relationship between positions of laborers in the sequence of accounts in the four months between March 1687 and July 1687. Each sub-plot shows the position of an individual laborer in two sequential months. The laborers’ position in the first month is plotted along the x-axis. Their position in the second month is plotted on the y-axis. Each month saw some laborers arrive and some leave. The lines of points on the y-axis show groups of laborers being taken on, while laborers left individually – and so are scattered along the x-axis, as they have a position in the first month, but not the second.

**Figure 6.3: Rank of laborers name in the sequence of accounts between March 1687 and July 1687.**



The contrast between the two stages of arrival and departure provides good reason to reject the idea that laborers were being employed as gangs, with an internal management structure separate to their employer. While the hiring of gangs would be compatible with the pattern of clusters of laborers entering the account in a group. That separations were scattered across the list of laborers indicates that no group structure was maintained between workers within the site. We would expect workers to arrive and separate collectively if they were part of a gang. There is no sign of this.

**Online Appendix 7: Measures of Tenure**

In the analysis in the main text, we construct two variables to capture laborers’ prior tenure at the Cathedral. Both measures are relative, comparing the laborer’s tenure to the tenure of all other active laborers in the St Paul’s workforce at each point in time. The first measure is based on the cumulative days the laborer had worked at the Cathedral before the observation, and the second measure is based on the elapsed time they had worked at the Cathedral. We construct a percentile rank of these measures for all workers who were active at the Cathedral in each accounting period. This method of capturing tenure has the benefit of standardizing across time and across accounting periods of differing lengths. However, a valid concern may be that this purely relative, ordinal measure of tenure misses out on relationships that might be captured by a cardinal, continuous measure of tenure.

In this Appendix, we consider alternative measures of tenure as a robustness check for our central results. Table 7.1 columns (1) and (2) replicate our key analysis on the intensive margin using a simple continuous measure of tenure. Tenure is defined as the number of years the laborer had previously worked at St Paul’s before each accounting period. The coefficient given in column (1) and marginal effects in column (2) indicate a strong relationship between tenure and whether a laborer works fulltime at the Cathedral. Specifically, a one-year increase in a worker’s tenure at the Cathedral increases their probability of working fulltime by 3.97 percentage points (p < 0.001). This is a strong confirmation of the results in the main text in Table 4. This simple continuous measure of tenure is also used in Table 6 in the main text to explore non-linear returns to tenure.

**Table 7.1: Logit models for the probability of a laborer working fulltime - robustness to continuous measure of tenure**

|  |  |  |
| --- | --- | --- |
|  | Tenure Years - Coefficients | Tenure Years - Margins |
|  | (1) | (2) |
| Tenure in Years (continuous) | 0.2101\*\*\* | 0.0397\*\*\* |
|  | (0.0268) | (0.0049) |
| Constant | -2.0492\*\*\* |  |
|  | (0.1848) |  |
| Year Fixed Effects | Yes | Yes |
| Month Fixed Effects | Yes | Yes |
| Num. of observations | 19861 | 19861 |
| Num. of individuals | 798 |  |
| Pseudo R2 | 0.147 |  |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given continuously in years.

Table 7.2 Columns (1) and (2) check whether our results are robust to interacting the continuous measure of tenure with indicators for each decade in the period. The results indicate that the effect of tenure on the probability of a laborer working fulltime lessens later in the time period. However, it is impossible to distinguish whether this is represents a true relationship or just an effect of using a continuous measure of tenure. The absolute number of days worked increases strictly with time, confounding any analysis with a time component when a measure that is not relative is used. For example, the maximum tenure in 1679 is around seven years, while the maximum tenure in 1701 is around twenty-nine years. This is borne out in the data – from 1675 to 1680, less than 1% of laborers have more than six years of tenure, whereas from 1701-1710, 14.5% of laborers have more than six years of tenure. This pattern could be driving the small trend shown in Table 7.2 Columns (1) and (2). This is one of the primary strengths of the measure of tenure used in the main text, which standardizes across time and across accounting periods of differing lengths. (Note also that in Appendix C, we find that there are greater returns to tenure during the period of dome construction 1705-1711.)

Columns (3) and (4) in Table 7.2 conduct a robustness check with a different continuous measure of tenure that is scaled by the possible years of tenure available in each year period to address this issue. Columns (3) and (4) give the coefficients and margins of a model when the raw years of tenure are scaled by the number of previous years in which the site was active in our data. Letting y represent the year of the observation and TR the raw years of tenure, the scaled tenure years TS are given by,

TS = (TR / (y-1672))\*100

The marginal effects in column (4) are difficult to interpret, but some examples can be illustrative. In 1690, TS = 55.55 for a worker who had 10 raw years of tenure, while Ts = 61.11 for a worker who had 11 raw years of tenure. This one year increase in tenure thus results in a 4.8 percentage point increase in the probability of a laborer working fulltime at the Cathedral (0.0087\*(61.11-5.55) = 0.048), confirming our main results.

**Table 7.2: Probability of a laborer working fulltime – robustness to year interaction**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Tenure Years Continuous - Coefficients | Tenure Years Continuous - Margins | Tenure Years Scaled - Coefficients | Tenure Years Scaled - Margins |
|  | (1) | (2) | (3) | (4) |
| Tenure in Years (continuous) | 0.5783\*\*\* | 0.0554\*\*\* |  |  |
|  | (0.1241) | (0.0075) |  |  |
| Tenure in Years (scaled) |  |  | 0.0458\*\*\* | 0.0087\*\*\* |
|  |  |  | (0.0052) | (0.0009) |
| Tenure in Years (continuous) \* 1681-1690 | -0.3550\*\* |  |  |  |
|  | (0.1140) |  |  |  |
| Tenure in Years (continuous) \* 1691-1700 | -0.3671\*\* |  |  |  |
|  | (0.1287) |  |  |  |
| Tenure in Years (continuous) \* 1701-1710 | -0.3836\*\* |  |  |  |
|  | (0.1231) |  |  |  |
| 1681-1690 |  | -0.1282\*\*\* |  |  |
|  |  | (0.0340) |  |  |
| 1691-1700 |  | -0.1334\*\*\* |  |  |
|  |  | (0.0392) |  |  |
| 1701-1710 |  | -0.1407\*\*\* |  |  |
|  |  | (0.0361) |  |  |
| Constant | -2.1763\*\*\* |  | -2.5919\*\*\* |  |
|  | (0.1848) |  | (0.2009) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes |
| Num. of observations | 19861 | 19861 | 19861 | 19861 |
| Num. of individuals | 798 |  | 798 |  |
| Pseudo R2 | 0.150 |  | 0.146 |  |

Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given continuously in years.

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Table 7.3 gives the full estimation results for Figure 4b in the main text, estimating how long it takes for the marginal returns to tenure to diminish by allowing the relationship of tenure to the probability of working full time to vary non-linearly. This model uses raw cumulative years worked at St Paul’s as a percentile rank so that the turning point in the relationship can be observed. The results for tenure in raw cumulative years of work at St Paul’s given in Table 7.3 columns (1) and (2) indicate that the returns to tenure in terms of the probability of working full time only diminish very slowly as tenure increases. When tenure is measured in elapsed time associated with St Paul’s in Table 6.3 columns (3) and (4), there is no significant nonlinear effect.

**Table 7.3: Nonlinear returns to tenure: learning models**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cum. Days Tenure - Coefficients | Cum. Days Tenure - Margins | Elap. Time Tenure - Coefficients | Elap. Time Tenure - Margins |
|  | (1) | (2) | (3) | (4) |
| Tenure | 0.3356\*\*\* | 0.0539\*\*\* | 0.1215\*\*\* | 0.0202\*\*\* |
|  | (0.0638) | (0.0087) | (0.0363) | (0.0050) |
| Tenure2 | -0.0098\* |  | -0.0021 |  |
|  | (0.0038) |  | (0.0014) |  |
| Constant | -2.0951\*\*\* |  | -2.0807\*\*\* |  |
|  | (0.1839) |  | (0.1788) |  |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Month Fixed Effects | Yes | Yes | Yes | Yes |
| Num. of observations | 19861 | 19861 | 19861 | 19861 |
| Num. of individuals | 798 |  | 798 |  |
| Pseudo R2 | 0.151 |  | 0.120 |  |

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001. Robust standard errors, adjusted for clustering by individual, are presented in parentheses. Tenure given in percentile rank of all active laborers at the site in an accounting period. Tenure percentile rank is calculated according to cumulative days worked as a laborer in columns (1) and 2 and according to elapsed time at the Cathedral in columns (3) and (4). The outcome variable is whether the laborer worked full time during an accounting period, measured as 85% or more of the maximum days worked in the period.

1. Manley, G. 1974. “Central England Temperatures: Monthly Means 1659 to 1973,” Quarterly Journal of the Royal Meteorological Society, pp. 389-405 [↑](#footnote-ref-1)
2. Brecke, Peter. 2012. Dataset: Conflict Catalogue (Violent Conflicts 1400 A.D. to the Present in Different Regions of the World). Available at <http://www.cgeh.nl/data>. [↑](#footnote-ref-2)
3. Landers, John. 1987. “Mortality and Metropolis: the Case of London 1675-1825.” *Population Studies* 41/1, pp. 59-76. [↑](#footnote-ref-3)
4. Hoppit 1987, p. 45; Schwarz 1992, p. 90-91 n.24. [↑](#footnote-ref-4)
5. See Campbell (2007) pp.42-44. [↑](#footnote-ref-5)
6. Some of the longer accounting records seem to contain several sequential lists of work, which can be identified by the repeated appearance of the laborer who appears to be acting as foreman and then the set of workers that follow. These have been treated as separate accounts for this analysis. The watchmen’s shifts are listed separately after the laborers is finished, so those individuals appear twice in the account [↑](#footnote-ref-6)
7. Regressing position on time since the worker first appeared gives a coefficient of -0.0035\*\*\* (SE 0.0000802) and an R2 of 0.48 with account-level FE. [↑](#footnote-ref-7)