Work Intensity and Worker Safety in Early Twentieth-Century Coal Mining

Online Appendix B: Further calculations

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Alternative plots

Figure B1 shows alternative plots of the estimated work intensity-safety frontier, again passing through the raw sample means but now using estimates of the elasticity of expected fatalities with respect to work intensity from columns (1) and (3) in table 4, instead of column (2). These plots are little different from each other or from figure 5 because the estimated elasticity is robust to alternative Poisson specifications, as shown in table 4. Note that the concave shape in each plot reflects an estimated elasticity less than one.

Estimates from linear specification

To check for robustness, a simple linear fixed-effects specification was estimated for comparison with the Poisson log-log fixed-effects estimates in table 4. Table B1 shows these linear estimates. The dependent variable now is the number of non-disaster fatalities per million worker days. No observations are automatically dropped in the linear model, though again mines with only one observation have no effect on the estimates. A widely-recognized weakness of the linear specification is that it can produce negative predicted fatality rates, which occurred here in about one percent of the sample in each column.

The estimates in table B1 are qualitatively similar to those in table 4. Workers and days of operation both have negative coefficients, showing that mines that are larger or that operate more continuously have lower fatality rates, *ceteris paribus*, though the coefficient of days is not statistically significant. The fraction of output mined by machine has a positive effect on fatalities, but it is not statistically significant. Square terms and the dummy variable for the first observation are not statistically significant.

In this linear specification, the elasticity of expected fatalities with respect to work intensity is not constant, but is given by

$$Elasticity = \frac{\beta_1^*}{1{,}000{,}000} \times \frac{x}{f},$$

where β_1^* denotes the coefficient of (unlogged) work intensity. In the strictly linear specifications (columns (1), (2), and (4)) the average estimate of β_1^* is about 3.64. As noted in section (5) above, output per non-disaster fatality (x/f) was about 261,000 tons in 1921. Thus the linear estimates imply an elasticity of about 0.95 in that year, higher than the estimates in table 4, but still less than unity. The marginal dollar cost of a statistical life in this linear specification is given by

$$MCSL = \frac{1{,}000{,}000}{\beta_1^*} \times P_t \, .$$

In 1921, the average wage per ton paid to pick miners in West Virginia was P_t = \$0.95, so the estimated marginal cost of a statistical life in that year is about \$260,000 (in 1921 dollars). This figure is lower that the main estimates computed at the end of section 5, but still substantially higher than cited estimates of the VSL for the early twentieth century.

In the quadratic specification (column (3)), even β_1^* is not constant, but evaluated at the sample mean of work intensity (from table 2) equals about 3.0. This implies an elasticity of about 0.78 in 1921 and a MCSL of about \$320 thousand (in 1921 dollars).

Gross union effects

The results reported in tables 4 and 5 show that fatalities depend work on intensity, employment (number of workers), and days of operation. Table 5 showed that the union had a small negative effect on work intensity. Did the union influence the number of workers and days of operation as well? Table B2 shows estimates of union effects on employment and days of operation and its square, which are all regressors in table 5. Table B2 shows that the union increased employment by about 7.6 percent, and decreased days of operation and its square, though the last two effects are quite small not statistically significant. It should be admitted these estimates may not have a causal interpretation. Perhaps, for example, the union was more likely to gain a foothold, or remain in place, when a mine's employment was expanding than when it was contracting.

Causality questions notwithstanding, an "indirect" effect of unionism on total fatalities may be computed by multiplying each of these union effects in table B2 by the corresponding coefficients in column (3) of table 5. The result is an increase in fatalities by 5.4 percent. So the "gross" effect of unionism on *total fatalities* equals negative 28.0 percent (as reported in the first column of table 6) plus positive 5.4 percent, or negative 22.6 percent.

Now the *fatality rate* equals total fatalities *per worker per day*. So to obtain the "gross" effect of unionism on the *fatality rate* we must further subtract the effect of unionism on employment, and the effect of unionism on days of operation (both from table B2). The result is negative 29.3 percent. So the "gross" effect of unionism on the fatality rate is quite similar to the figure reported in the first column of table 6, negative 28.0 percent. Intuitively, the two figures are similar because the effects of unionism on employment and days of operation are small (as shown in table B2) and because fatalities are roughly proportional to employment and days of operation (as shown in table 5).

Figure B1: Estimated work intensity-safety frontier

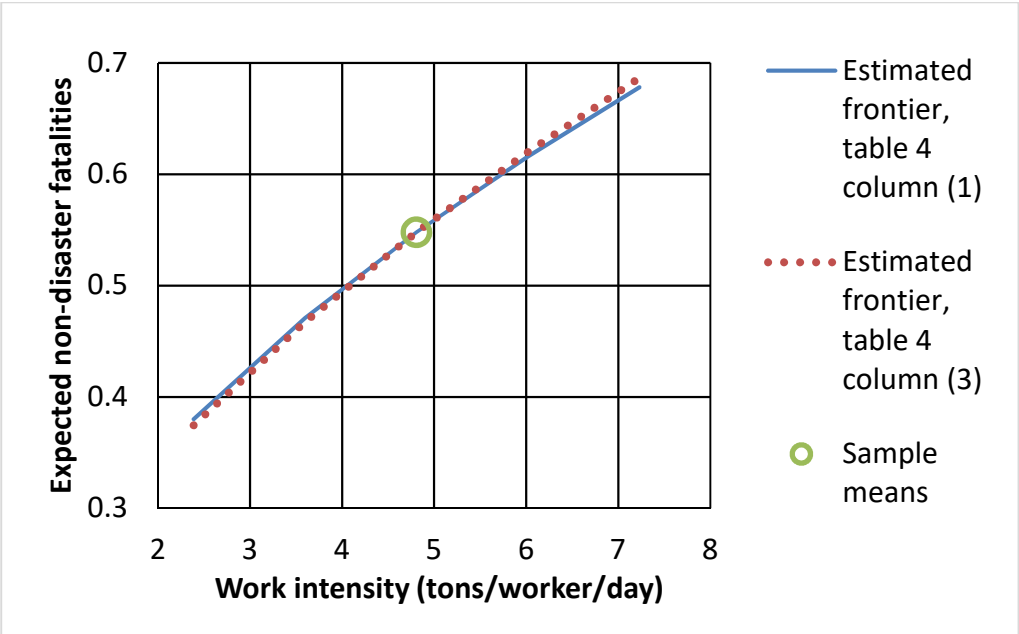

Table B1: OLS FE regressions of non-disaster fatalities

Regressor	(1)		(2)		(3)		(4)	
Work intensity (= tons per worker per day)	3.6195	**	3.6061	**	2.7303	*	3.6915	**
	(1.2261)		(1.2266)		(1.2222)		(1.2488)	
Number of workers	-0.0309	*	-0.0301	*	-0.0488		-0.0280	*
	(0.0144)		(0.0142)		(0.0253)		(0.0133)	
Days of operation	-0.0450		-0.2632		-0.2499		-0.2530	
	(0.0248)		(0.1449)		(0.1447)		(0.1474)	
Fraction of output mined by machine	1.6528		2.3050		2.7748		2.3332	
	(3.4324)		(3.4974)		(3.5316)		(3.5004)	
Days of operation, squared			0.0006		0.0006		0.0006	
			(0.0004)		(0.0003)		(0.0004)	
Number of workers, squared					0.00003			
					(0.00003)			
Work intensity, squared					0.02568			
					(0.03851)			
First observation of each mine (binary variable)							4.7967	
							(5.7411)	
Mine fixed effects?	Yes		Yes		Yes		Yes	
Year fixed effects?	Yes		Yes		Yes		Yes	
Number of mines	521		521		521		521	
Number of (mine x year) observations	7474		7474		7474		7474	
R-square								
Within	0.0311		0.0339		0.0345		0.0342	
Between	0.0009		0.0008		0.0007		0.0013	
Overall	0.0226		0.0255		0.0257		0.0261	
Negative predicted values	113		82		60		72	

Cluster-robust standard errors in (parentheses).
Years 1897, 1899-1928. Data for 1898 are not available.
Dependent variable is non-disaster fatalities per million worker-days.
Dependent variable excludes fatalities from "disasters," defined as incidents in which 5 or more workers were killed (from http://www.wvminesafety.org/disaster.htm). Almost all disasters were explosions.
* indicates estimate is significantly different from zero at 5%.
** indicates estimate is significantly different from zero at 1%.
*** indicates estimate is signficantly different from zero at 0.1%.
A joint test of the coefficients of log-intensity and log-intensity-squared in column (3) yields a chi-square value of 4.72 with a p-value of 0.0093.

Table B2: Impact of unionism on employment and days of operation

Dependent variable	(1)
Log number of workers	0.0761 *
	(0.0333)
Log days of operation	-0.0087
	(0.0211)
Log days of operation, squared	-0.0519
	(0.1935)

Cluster-robust standard errors in (parentheses).
Years 1897, 1899-1928. Data for 1898 are not available.
Control variables include first observation of a mine, fraction of coal mined by machine, and fixed effects for mines and years.
* indicates estimate is significantly different from zero at 5%.
** indicates estimate is significantly different from zero at 1%.
*** indicates estimate is signficantly different from zero at 0.1%.