

Job displacement costs of phasing out coal*

Juan-Pablo Rud

Michael Simmons

Gerhard Toews

Fernando Aragon

Abstract

The reduction of carbon emissions will require a rapid phasing out of coal and the displacement of millions of coal miners. How much could this energy transition cost mining workers? We use the dramatic collapse of the UK coal industry to estimate the long-term impact on displaced miners. We find evidence of substantial losses: hourly wages fell by 40% and earnings fell by 80% to 90% one year after job loss. These losses are persistent and remain significantly depressed fifteen years later, amounting to present discounted value earnings losses of between four and six times the miners pre-displacement earnings. (JEL J30, J63, J64, O4)

*Rud: Department of Economics, Royal Holloway, University of London, IZA and Institute for Fiscal Studies (juan.rud@rhul.ac.uk); Simmons: Umeå University (michael.simmons@umu.se); Toews: New Economics School and LEO, Orléans University. (gerhardtoews@gmail.com); Aragón: Department of Economics, Simon Fraser University (faragons@sfu.ca). We thank Antoine Bertheau, Irina Denisova, Ruben Enikolopov, Kate Koppy, Olga Kuzmina, Anastasiya Nebolsina, Marta Troya-Martinez, Carsten Sprenger, Jonathan Wadsworth and Hosny Zoabi, and different audiences for useful comments and suggestions. This paper is based on the New Earnings Survey Dataset, having been funded, collected and deposited by the Office for National Statistics (ONS) under secure access conditions with the UK Data Service (SN:6706). Neither the ONS nor the Data Service bear any responsibility for the analysis and discussion of the results in this paper. Simmons thanks Handelsbankens forskningsstiftelser under project number Bv19-0010.

We intend to support communities and regions that are particularly vulnerable to the economic, employment and social effects of a global transition away from carbon-intensive activity

Just Transition Declaration, 04.11.2021

U.N. climate change conference COP26

A well-established literature finds that displaced workers suffer substantive earning losses that persist several years after losing their job (Jacobson et al., 1993; Stevens, 1997; Couch and Placzek, 2010; Davis and von Wachter, 2012; Bertheau et al., 2022).¹ These findings raise concerns regarding the future of millions of coal miners who will likely be displaced and forced to switch sectors if plans to reduce carbon emissions by phasing out coal are implemented due to climate change concerns (United Nations, 2022; Ruppert Bulmer et al., 2021).² How much will this energy transition cost mining workers? Answering this question is important to account for the economic losses of phasing out coal and to inform policies aimed at honoring the Just Transition Declaration quoted in the epigraph.

The existing evidence on job displacement costs is, however, unsuitable to quantitatively answer this question. The majority of the existing studies rely on mass layoff events using samples representative of the whole workforce to estimate the costs of job displacement. These estimates of average earnings losses are likely to be well below the costs of job loss for a coal miner who faces the complete phase-out of an industry. The collapse of an entire sector requires sectoral reallocations, whereas sectoral transitions are not compulsory following typically studied layoffs. Since coal mining is a highly specialized occupation (Samuel, 2016), this specificity of human capital may reduce miners' ability to transfer their skills, in particular as they are forced to switch

¹Displacements also have been shown to impact health (Sullivan and von Wachter, 2009; Lindo, 2011; Schaller and Stevens, 2015), schooling (Rege et al., 2011), fertility (Huttenen and Kellokumpu, 2016), divorce (Charles and Stephens, 2012; Eliason, 2012) and retirement decisions (Chan and Stevens, 1999, 2001; Merkurieva, 2019). Losses also vary with the business cycle (Davis and von Wachter, 2012; Gulyas and Pytka, 2020; Schmieder et al., 2022). A related literature also studies the underlying causes of the losses in earnings (Krolikowski, 2017b; Jung and Kuhn, 2018; Burdett et al., 2020; Lachowska et al., 2020; Gulyas and Pytka, 2020; Raposo et al., 2021; Jarosch, 2021; Simmons, 2021; Huckfeldt, 2022; Braxton and Taska, 2022; Leenders, 2022).

²See Section 1 in the Online Appendix for our back-of-the-envelope calculation of the aggregate number of active coal miners adding up to around 5.4 million.

occupations.³ Moreover, most coal miners are employed in remote and rural areas where mining is often the main employer. This feature reduces local economies' capacity to absorb workers after a mine closure and, due to the need to emigrate, may increase workers' job search costs and lengthen periods of unemployment.

The contribution of this paper is to provide estimates of job displacement costs during a well known episode of sector collapse specific to coal miners. We study the dissolution of the UK coal industry that accelerated in the mid-1980s under Margaret Thatcher. This dissolution was comprehensive and fast: in just over a decade, the majority of coal mines in the UK closed and more than 200,000 miners (almost 90 percent of the industry's workforce) lost their jobs ([Glyn and Machin, 1997](#); [Aragon et al., 2018](#)) (see [Figure 1](#)). This setting is one of the few documented experiences of a large and systematic displacement of miners, and thus offers an important opportunity to learn about the possible long-term impact of sectoral collapse and in particular coal phase-out.⁴

Our empirical analysis uses data from the UK New Earnings Panel Survey, which collects earnings information from a representative sample of individuals from 1975 to the present. The richness of the data allows us to construct a longitudinal dataset tracking more than 2,000 displaced coal miners many years before and after job separation. We estimate the impact of the average mine worker's final displacement from a mine on wages and earnings using a panel data model with time and individual fixed effects that is commonly used in the literature. This estimator compares the evolution of earnings of displaced workers relative to a group of observationally similar, non-displaced workers. The baseline control group is constructed by matching coal miners to blue-collar manufacturing workers with similar pre-displacement characteristics. We provide a battery of further findings, in particular, several variations to the definition of the treatment and control groups and show that our results remain robust and quantitatively very similar.

We find evidence of large and persistent earnings losses. Wages for those who found a new job after displacement drop by around 40% during the first years after job loss, and remain around 20% below the wages of the control group fifteen years later. Overall earnings fall by 80% to 90%

³[Neal \(1995\)](#), [Huckfeldt \(2022\)](#) and [Braxton and Taska \(2022\)](#) find that those who switch sectors and occupations following job loss fare worse than those who do not. See [Carrillo-Tudela and Visschers \(2021\)](#) for more work on occupational transitions.

⁴See other recent work by [Haywood et al. \(2021\)](#) looking at the decline in coal mining in Germany.

in the year after displacement and remain depressed by 20% to 30% fifteen years later. Over the fifteen year period, present discounted earnings losses amount to between 4 and 6 times the miners pre-displacement earnings.

Our findings are qualitatively similar to other studies on job displacement. However, the magnitudes are substantially larger. For instance, [Couch and Placzek \(2010\)](#) document more moderate earnings losses of 32-33% in the first year and 13-15% after six years, while [Davis and von Wachter \(2012\)](#) estimate cumulative losses over a twenty year period of around 1.7 times pre-displacement earnings. The large and persistent earning losses in our findings are consistent with coal miners being particularly vulnerable to job displacement, perhaps due to the low transferability of occupation-specific skills or lower labor mobility. Assuming that these conditions apply to coal miners in other settings today, our results suggest that the phasing out of coal could bring substantial disruptions to miners, their families and mining communities. Active labor market policies such as re-training and aiding job search in alternative occupations ([Card et al., 2018](#); [Belot et al., 2019](#); [Van Den Berg and Vikström, 2022](#)) are likely to be particularly important in this context.

The remainder of the paper proceeds as follows. In Section **I** we briefly discuss the dissolution of the UK coal industry. In Section **II** we discuss our empirical strategy and Section **III** presents the results. We conclude in Section **IV**.

I BACKGROUND

Coal played a key role fuelling UK's industrialization process and was an important source of well-paid, manual jobs. By the early 1980s, however, the industry had experienced a long, albeit gradual, decline and was reliant on government subsidies ([NUM, 2021](#); [Glyn, 1988](#)). In 1985, after a year-long strike, the government started withdrawing its support and the mine closures accelerated.

The dissolution of the industry was comprehensive and fast ([Glyn, 1988](#); [Glyn and Machin, 1997](#); [Aragon et al., 2018](#)). In just two years, 1985 to 1986, one-third of coal mines closed. By 1994, when the industry was privatized, only 26 mines were operational out of more than 200 at the beginning of 1980s. By the early 2000s, only a handful of mines remained. The closure of mines was mirrored by a massive displacement of coal miners. Between 1980 and 1994, more than

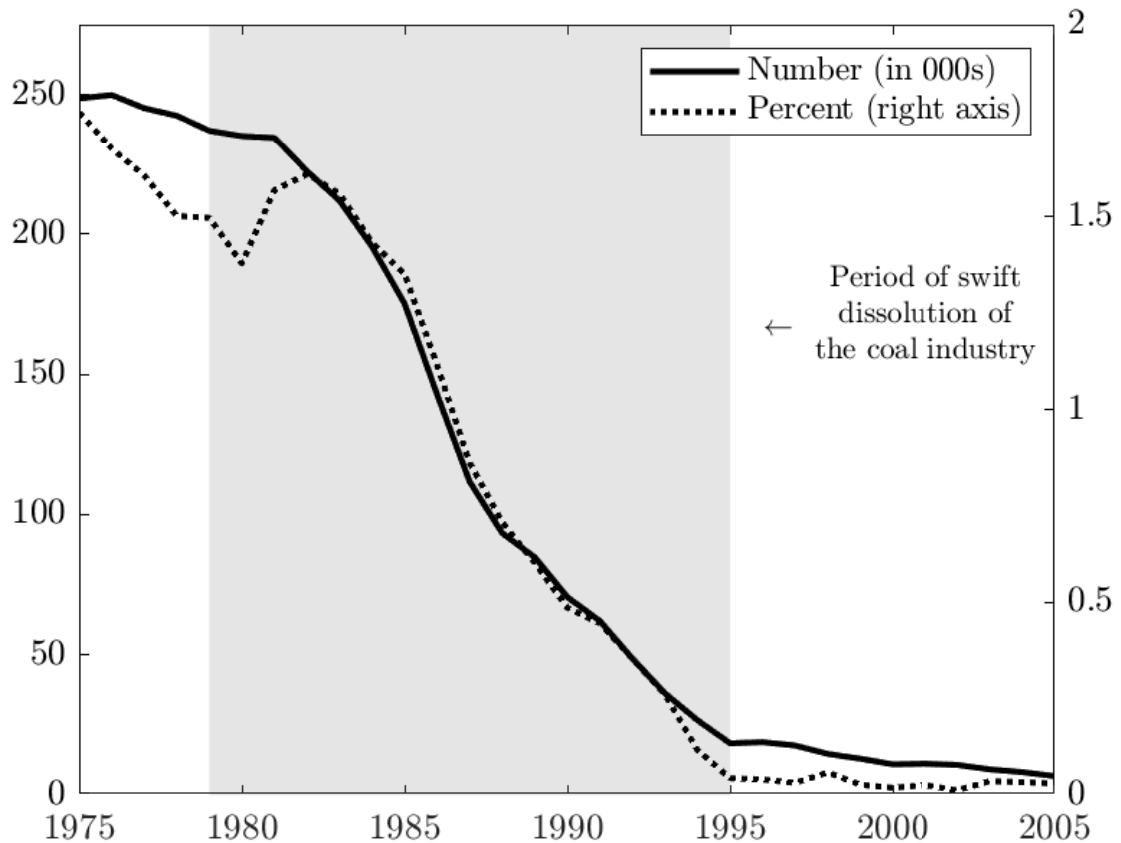


FIGURE 1: Coal mining employment in the UK 1975-2005

Note: The grey area denotes the period where we will entertain separations from in the empirical analysis. Source: The number employed is collected from [National Coal Board \(1970-1993\)](#) and used in [Aragon et al. \(2018\)](#). The percent shown on the right axis was calculated from the New Earnings Survey.

200,000 miners lost their jobs (see Figure 1). This amount represented a reduction of approximately 90 percent of the industry’s workforce.

The socioeconomic impact of coal mine closures, especially at the community level, has been widely studied. These studies document severe and persistent negative impacts on employment and labor force participation rates, demographic and living conditions in the affected mining communities ([Beatty and Fothergill, 1996](#); [Bennett et al., 2000](#); [Beatty et al., 2007](#); [Aragon et al., 2018](#)). Studies focusing on the displaced miners tend to conclude that there are only few, if any, more striking examples of chronic job loss in Western Europe, with nearly all the burden carried

by a few local areas and a specific segment of the workforce – male, manual workers (Beatty and Fothergill, 1996).⁵

There have been several policies aimed at fostering the economic recovery of former mining. These regeneration policies have included re-training of local workers, promotion of small and medium-sized business, and construction of local infrastructure, among others. However, their success has been limited and former mining communities remain among the poorest in the UK (Guy, 1994; Beatty et al., 2007).

II METHODS

II.A DATA

Data: We use data from the 2017 New Earnings Panel Survey (Office for National Statistics, 2017).⁶ This is a longitudinal survey that tracks cohorts of individuals from 1975 to the present and provides annual information on weekly earnings and hours worked. Throughout, we deflate earnings to 2000 prices. Information is also provided on occupation, industry, gender, age, geographical administrative unit, and whether the wage was determined through a collective agreement. Individuals are tracked using their National Insurance number, a unique tax identifier which does not change over the lifetime of a worker. This feature allows us to track individuals even after unemployment spells, and across different employers and locations.

Treatment: Studies focusing on the identification of job displacements, typically rely on mass layoffs in situations in which a firm's employment permanently declines by thirty or more percent over a short period of time such as for example in Davis and von Wachter (2012), Flaaen et al. (2019) and Bertheau et al. (2022). As discussed in the background section, the dissolution of the coal

⁵The existing evidence of the direct impact on miners confirms the deterioration of labor outcomes of the laid-off miners. Fieldhouse and Hollywood (1999) find that in 1991, the employment rate of individuals identified as miners in 1981 was around 30%, much lower than the average rate of 50%. They also find that over half of former miners reported being permanently sick or retired early. Hollywood (2002) further documents that laid-off miners, especially the older and less educated, have been less likely to migrate in an attempt to find new employment relative to workers in other highly-specialized manual occupations, such as metal manufacturing.

⁶This data set has been used to study the effect of minimum wages on wage dispersion and employment (Machin and Manning, 1994), the distribution of top earnings in the UK since WWII (Atkinson and Voitchovsky, 2011), as well as spatial differences in earnings and unemployment (Blackaby and Manning, 1990).

industry proceeded fairly quickly and was unexpected⁷ and plausibly exogenous to the individual coal miner, implying selection is less of a concern. This allows us to study all separations during this period, which is distinguishing us from the previous literature which focuses only on displacements during mass layoffs. Moreover, sectoral dissolution allows us to be confident that reemployment as a coal miner was not an option and so sectoral reallocation was a requirement for future employment.⁸ The dissolution of the coal sector was determined on the national level and brought to a conclusion 30 years later, even though 80% of the task was accomplished within a period of 10 years, by 1995.

Displaced miners: We follow the literature and choose for each year t all workers that work full time at a coal mine. From this group of miners we keep those who are between 25 and 55 years old, and those who were employed by the same firm for at least 2 consecutive years, in t and $t - 1$, before being laid-off between t and $t + 1$. We focus on the periods during which the coal industry collapses, and analyse displacements in the years between, and inclusive of, 1979 and 1995. Since we are interested in displacements associated with being subsequently unable to work in coal mining, we focus on a worker's final separation from a mine. This leaves us with 17 year-specific cohorts and a total of 2,152 displaced miners. Each cohort contains 20 years, 4 prior to displacement and 15 after. Let $k = \{-4, 15\}$ represent these years where a displacement occurs between $k = 0$ and $k = 1$. We discuss alternative adjustments to the sample of displaced miners in Section III.

The New Earnings Survey is based on a 1% random sample of workers enrolled in the pay-as-you-earn (PAYE) scheme. The PAYE is a payroll-deduction system in which employers collect taxes and insurance payments from their employees' wages. The data is collected through a questionnaire that firms are required by law to complete with reference to payrolls. This system, however, does not include the self-employed, a data limitation which is shared by many other studies in the literature such as for example [Jacobson et al. \(1993\)](#), [Schmieder et al. \(2022\)](#) and [Bertheau](#)

⁷One could argue that some miners may have been able to anticipate displacement since most must have been aware of the labour disputes. This concern, however, is not specific to this particular episode. Indeed, recent work has shown that workers appear to correctly anticipate job loss in typical displacements (see [Hendren \(2017\)](#), [Simmons \(2021\)](#), [Grindaker \(2022\)](#) and [Grindaker et al. \(2022\)](#)). Moreover anticipation should reduce the earnings losses of the miners as they have time to reallocate to new industries.

⁸Note that the complete dissolution of the sector also allows us not to worry about mergers, takeovers, or changes in the identification number of firms.

et al. (2022).⁹ These papers deal with this limitation in two distinct ways. On the one hand, periods without any observed labor earnings in the data are interpreted as zero individual earnings, such as in Schmieder et al. (2022) and Bertheau et al. (2022). Using the British Household Panel Survey and studying the costs of job loss in the UK, Upward and Wright (2017) find that reassigning earnings during periods of self-employment as zero makes very little difference to the estimated earnings losses. Bertheau et al. (2022) also find that a similar exercise using Swedish data results in only minor differences. While these studies find the issue to be negligible, we are unable to say whether it is indeed negligible in our case. Thus, we complement our results with a similar approach to Jacobson et al. (1993), and only keep those individuals who report positive earnings within four years of displacement. This latter approach provides a more conservative estimate of displacement costs by focusing on individuals who eventually return to work within a certain time frame.

Baseline control group: In order to estimate the causal effect of being displaced as a coal miner, in an ideal experiment we would randomly displace some miners and force them to switch sectors while allowing other miners, the control group, to continue working at a mine and enjoy similar earnings and employment dynamics as they did prior to displacement. Besides being morally questionable, such an experiment is impossible if the complete sector is being phased out on the national level as is the case for the UK coal miners.¹⁰ Instead, we proceed as follows. Using the pool of non-coal miners in our data, we create several observationally comparable groups of workers and show that the earnings path of the about to be displaced coal miners and the earnings path of the carefully designed controls is close to identical before the treatment.

In the choice of our baseline control group, we keep the restrictions of our donor pool to a minimum and match miners to blue collar manufacturing workers with the same two-digit occupation code using propensity score matching.¹¹ In practice, this involves estimating a probit or logit model with the dependent variable taking the value of 1 if they are in the treated group and 0 otherwise, and then matching treated and control workers with the closest predicted value without

⁹Similarly, a very small amount of low paying jobs are also not included in PAYE. This may result in understating the wage losses and overstating the employment losses after displacement. However, as has been found in recent work and as we discuss further below, ignoring the self employed makes little difference to the results found in the literature.

¹⁰In Figure 7 of the Online Appendix, we use miners who are not yet laid-off as a control group. As expected, in the long run earning losses do not differ significantly between the laid-off miners and those who are simply laid-off later.

¹¹See Figure 3 in Section 2 of the Online Appendix for basic descriptives on the distribution of occupations.

replacement.¹² We match on an array of observable characteristics: age, gender¹³, hours worked, full-time status, geographical administrative unit (county), whether the wage was determined by a collective agreement, as well as the worker’s pre-layoff weekly earnings¹⁴ and hours worked between $k = -4$ and $k = -1$ and employment levels between $k = -4$ and $k = -2$. We do not require the comparison group to be employed during any year after displacement including the displacement year, i.e. for $k > 0$. Such a requirement could lead to systematic differences between displaced and control groups, and possible overestimation of the earnings losses (Krolkowski, 2017a). We discuss alternative adjustments to the sample of control workers in Section III.

In Table 1 we provide basic statistics for the main observable characteristics on which we match before displacement for $k = -4$ and $k = -1$. In columns we show mean and standard deviations for three distinct groups: the treated, the individuals from our baseline matching as well as the individuals from the non-matched control group (blue collar manufacturing workers). In comparison to the non-matched sample, we see that the displaced coal miners are special since they are more likely to be male, a bit older and have higher earnings. As expected, the matching greatly reduces these differences.

II.B EMPIRICAL MODEL

Using the 17 stacked treatment and control cohorts, we run a similar regression model as other studies in the job displacement literature (Jacobson et al., 1993; Couch and Placzek, 2010). In

¹²We use the `psmatch2` function within STATA to perform the propensity score matching (Leuven, 2003).

¹³Female miners make up about 6% of the mining workers in our treatment group. We chose to keep the women in our preferred specification, but the results do not change by removing all female miners. See Table 5 in Online Appendix.

¹⁴Note that in the presence of inter-industry wage differentials and, in particular, large wage premia in the extractive sector, the matching on earnings could result in less productive miners being matched to observationally similar but more productive non-miners. This would be problematic if the earnings dynamics of the matched individuals would greatly deviate post treatment from the hypothetical earnings dynamics of the miners in the absence of displacement. While we cannot exclude this possibility, we do think that it is unlikely that it could strongly bias our results for three reasons. First, there is quite a bit of evidence that inter industry wage differentials are persistent across space and time (Goux and Maurin, 1999; Du Caju et al., 2010). A stylized fact, which has also been documented for the post-war period in the UK (Lawson, 1982). Second, exploiting the longitudinal nature of our data set, we estimate the wage premium of miners conditional on some observable characteristics and individual fixed effects and find the premium to be between 5-10% for individuals who switch into the mining sector before 1984, which is in line with the estimates documented by, for example, Goux and Maurin (1999). Thus, even in the presence of some changes in the wage premium, the bias on our cumulative costs estimates is unlikely to be large. Third, in one of our robustness exercises, we assemble the control group from individuals employed in primary metal manufacturing, an industry which is also known for wage premia which are comparable in magnitude to the wage premia in mining (Lawson, 1982; Goux and Maurin, 1999).

	(1)	(2)	(3)
	Treated	Main control	No matching
	$k = -4$		
Weekly earnings (£)	321.86 (160.12)	317.12 (207.92)	252.50 (190.60)
Employment	.921 (.270)	.907 (.291)	.806 (.395)
Age	39.35 (8.07)	39.26 (7.91)	38.11 (7.67)
Weekly hours	37.21 (2.20)	37.88 (3.82)	37.63 (4.66)
Male	.947 (.225)	.913 (.288)	.764 (.425)
Overtime pay	25.10 (43.45)	24.89 (41.48)	14.82 (31.87)
	$k = -1$		
Weekly earnings (£)	355.29 (148.93)	353.12 (199.20)	328.35 (31.87)
Employment	1.00 (0)	1.00 (0)	1.00 (0)
Age	40.73 (9.10)	40.75 (8.91)	39.67 (8.54)
Weekly hours	37.11 (2.45)	37.37 (4.16)	37.55 (4.47)
Male	.942 (.236)	.913 (.288)	.764 (.426)
Overtime pay	32.02 (54.96)	27.29 (48.68)	18.28 (39.01)
N	2,152	2,152	379,904

TABLE 1: Observables of the treated group, matched control group and non-matched control group

Note: Standard deviations are shown in parentheses. Weekly earnings are in 2000 prices.

particular, we estimate the following panel data model with distributed lags:

$$y_{ik} = a_i + \gamma_k + \mathbf{x}'_{ik}\beta + \sum_{k=-3}^{15} \delta_k D_{ik} + u_{ik}, \quad (1)$$

where y_{ik} is the outcome for individual i at time k , such as earnings, wages, or employment status. a_i and γ_k are person and time fixed effects, respectively. \mathbf{x}_{ik} is a vector of observables (quartic in age). D_{ik} are dummies for year k and u_{ik} is the error term, which we cluster at the individual level.

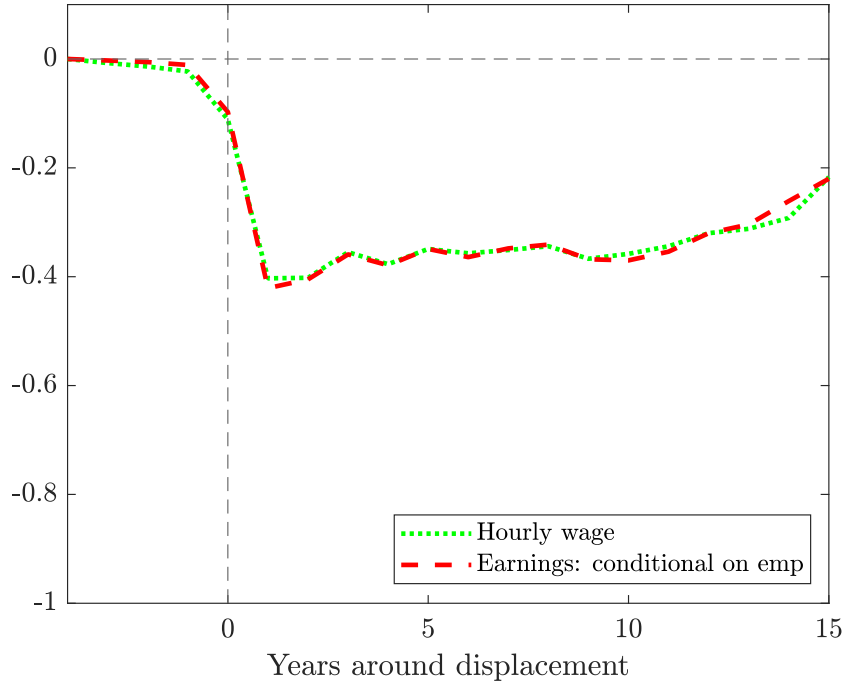
The coefficients of interest are δ_k . These coefficients provide an estimate of the impact of displacement, k years after separation. We normalize the continuous outcome variables (such as earnings and wages) by dividing them by the individual’s pre-displacement average, i.e. for $k < 0$. Thus, we can interpret δ_k as the percentage change relative to pre-displacement values. Similar to previous work, the identification assumption is that, conditional on the control variables, the evolution of the displaced miners’ outcomes would have followed a similar path as the comparison group’s, have they not been displaced.

III RESULTS

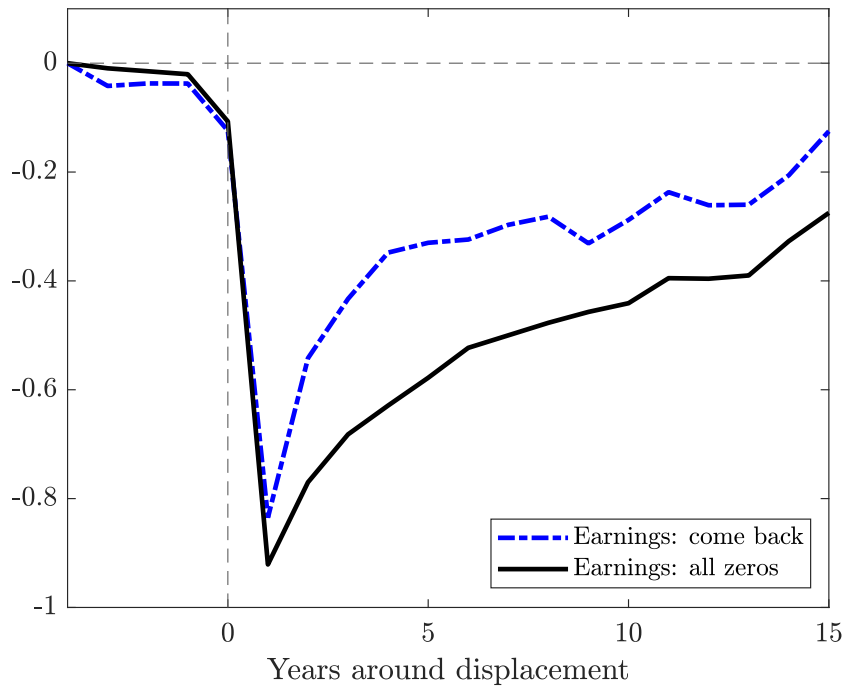
Figure 2 shows our main results. Using the baseline control group we document regression results for specifications in which the dependent variable in (1) takes on hourly wages; weekly earnings conditional on employment; weekly earnings unconditional on employment (including zeros), with only those miners who have positive earnings within four years after job loss, as in [Jacobson et al. \(1993\)](#); and weekly earnings unconditional on employment (including all zeros), as in [Davis and von Wachter \(2012\)](#); [Schmieder et al. \(2022\)](#); [Bertheau et al. \(2022\)](#).

Our estimates show devastating losses for the miners. In the year following job loss, the miners earnings conditional on employment fall by 40% and remains depressed by 20% fifteen years later. These losses are not driven by a reduction in hours worked since the losses in hourly wages (dotted line) and weekly earnings conditional on employment (dashed line) are close to identical.

Unconditional earning losses (solid line) are 90% in the first year, and remain 30% below the earnings of the control group fifteen years later. Even if we focus on the the more conservative earnings losses, where we only include individuals who return to work within four



(a) Wages and earnings conditional on employment



(b) Earnings including zeros

FIGURE 2: The estimated proportional changes in wages and earnings following job loss

Note: “Earnings: come back” refers to the treatment group where we only include those who have positive earnings at some point four years after job loss, while replacing their earnings with a zero if the miner is not observed for any $k > 0$. “Earnings: all zeros” refers to the treatment in which we replace the earning of any miners with a zero if the miner is not observed for any $k > 0$, without any restrictions. We report point estimates and standard errors of all coefficients in Table 1 and 2 of the Online Appendix. In Figure 4 of the Online Appendix we plot the raw data on earnings and employment for the treated and the control group around the year of displacement.

years (dashed-dotted line), the losses are still substantial, at 80% in the first year and 10-20% fifteen years later.

In Table 2 we use our baseline specification to estimate the associated losses in present discounted value (PDV).¹⁵ We use a 5% discount rate to remain comparable to Davis and von Wachter (2012). We estimate present discounted losses in: earnings conditional on employment, earnings conditional on having positive earnings within four years of displacement, and earnings losses including all zeros. In column (1) our estimates range from 3.8 to 6 years of pre-displacement earnings. 6 years of pre-displacement earnings represent our upper bound estimate and is equivalent to around \$140,000 or £100,000 in 2000 prices. Column (2) shows the present discounted earnings of the miners relative to the control.¹⁶ Including all miners who have been displaced, and assuming that they have zero earnings if they do not reappear in our data set, the miners present discounted earnings were 40% of the counterfactual. This number increases to 60% when we exclude miners who do not reappear in the data after displacement and if we focus on those who remain employed. The final two columns split the losses into those due to losses in earnings conditional on employment and those due to losses in employment. By construction, losses in wages were particularly important for the results in the first two rows. However, even if we take into account individuals who never return to work, two-thirds of the losses are still explained by the drop in wages while only a third of the losses are explained by a drop in employment.

In Figure 5 and Figure 6 of the Online Appendix we explore some of the heterogeneity in the data by differentiating between the years in which the miners have been displaced, their age, the industry in which the miners ended up moving into, manufacturing or services, and gender. Overall, the results suggest that miners which have been displaced around the general strike in 1984 ended up having the highest economic losses, while miners which have been displaced either in the late 1970s and early 1980s or the late 1980s and early 1990s ended up being hit less hard. Moreover, older miners, as expected, experienced more significant economic losses relative to their younger mates. We do not find any statistically significant differences when documenting the results by gender and by industry in which the miners found reemployment.

¹⁵The present discounted value of the displacement costs is equal to $\sum_{k=1}^{15} \frac{\hat{\delta}_k}{(1.05)^{k-1}}$.

¹⁶The present discounted earnings for the miners relative to the control is equal to $\sum_{k=1}^{15} \frac{\hat{y}_k^T}{1.05^{k-1}} / \sum_{k=1}^{15} \frac{\hat{y}_k^C}{1.05^{k-1}}$, where \hat{y}^T and \hat{y}^C indicate the estimated earnings from (1) for the treated and control groups, respectively.

	(1)	(2)	(3)	(4)
	PDV losses as a multiple of predisplacement annual earnings	Miners' PDV earnings relative to counterfactual	Due to the losses in wages	Due to the losses in employment
Conditional on employment	3.85	63.9%	100%	0%
Come back	4.02	60.2%	93.8%	6.2%
All zeros	6.01	40.8%	64.0%	36.0%

TABLE 2: The estimated present discounted wage and earnings losses

Note: Column (1) shows the present discounted earnings losses relative to our baseline counterfactual, with the earnings being standardised by the average individual pre-displacement earnings from period $t - 1$ to $t - 4$ and displacement taking place between t and $t + 1$: $\sum_{k=1}^{15} \frac{\hat{\delta}_k}{1.05^{k-1}}$. Column (2) shows the estimated present discounted earnings of the miners as a proportion of the estimated present discounted earnings of the control group: $\sum_{k=1}^{15} \frac{\hat{y}_k^T}{1.05^{k-1}} / \sum_{k=1}^{15} \frac{\hat{y}_k^C}{1.05^{k-1}}$, where T is the treatment and C is the control. Columns (3) and (4) split the losses shown in column (1) into those attributable to losses in wages and those due to losses in employment.

III.A Robustness

We complement our baseline results by choosing alternative control groups. This is important since it may be the case that there exist unobserved and time varying differences between the miners and our baseline control group which may affect our estimates of the earnings losses. To gauge the importance of unobserved heterogeneity, we restrict the pool of workers from which we match to workers who are involved in the creation of primary metal products consisting of iron, aluminum and copper as well as their alloys.¹⁷ Primary metal manufacturing plants traditionally employ male manual workers with sector-specific skills which are difficult to reemploy anywhere else. Workers in this industry are also known to benefit from wage premia (Goux and Maurin, 1999) and due to the nature of their activity are often operating in spatially remote locations. To produce primary metal products, heat from a variety of fuels, most commonly coal, is used for smelting such that metal production plants are often located next to coal deposits to keep transportation costs of coal at a minimum (Michielsen, 2013). Since this control group is chosen from a subset of blue collar manufacturing workers, we are leaning less heavily on the propensity score matching

¹⁷The associated standard industrial classification codes that we chose are 311, 312, 313, 321, 322, 333 (before 1984), 2210, 2220, 2234, 2235, 2245, 2246, 2247 (after 1984).

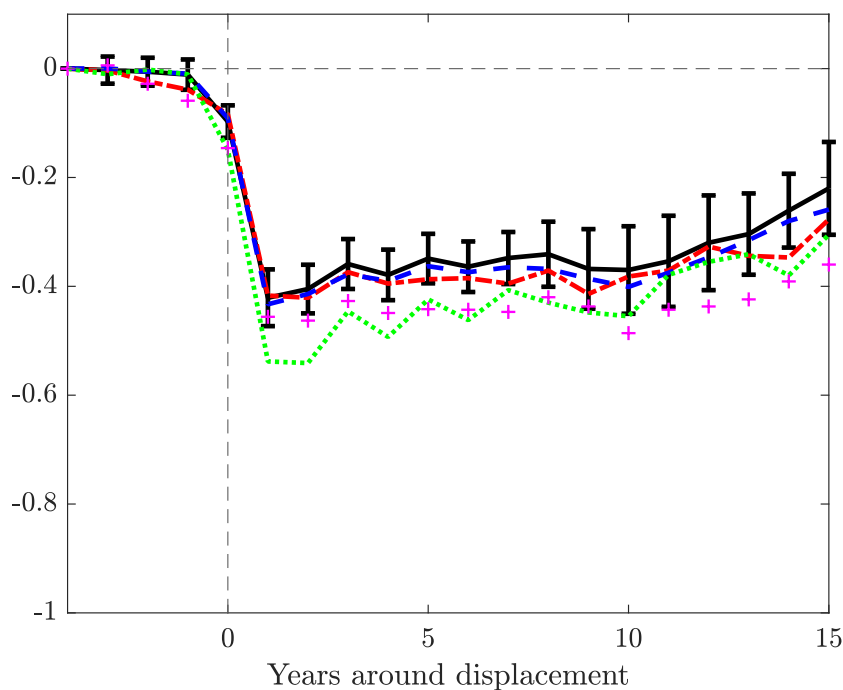
routine relative to the baseline. The advantage to the approach is that this control group may be better suited to capture the dynamics of unobserved characteristics of the displaced miners, such as long-run trends in technological progress and structural transformation as well as changing wage premia dynamics. Alternatively, we aim for a more parsimonious choice of the control group by leaving the pool of all manufacturing workers unrestricted and only match individuals on age and pre-displacement earnings.¹⁸

Instead of changing our control group, we also alter the definitions of our treated group in two ways. First, we only consider those displacements as treated which coincide with mine closure at the county level. This approach is more comparable to strategies employed in the literature on mass-layoffs. Alternatively, we restrict the treated group to miners working underground in the year prior to displacement. The variety of results emerging from changes in the control as well as the treated group are presented in Figure 3 on top of our baseline. Overall, the results clearly indicate that our baseline result represents a lower bound of the economic costs imposed on the displaced coal miners during the phasing out of coal. All the changes to the control as well as the treated group suggest a larger, at times statistically significant, economic costs carried by the displaced miners.

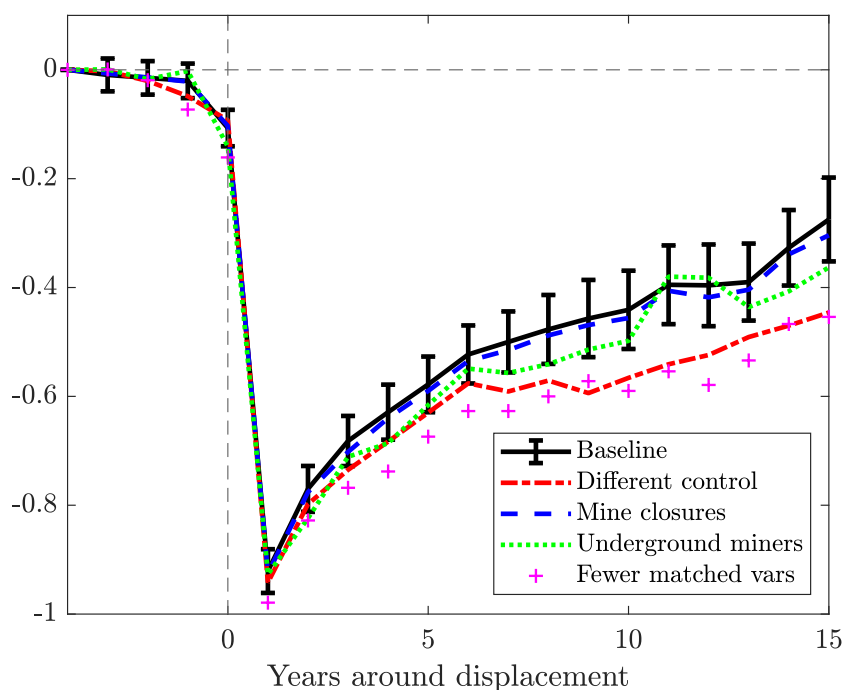
III.B Comparison to the literature

How do our estimates compare to the previous literature on mass layoffs? [Couch and Placzek \(2010\)](#) reconsider the earnings losses estimated in the seminal work of [Jacobson et al. \(1993\)](#), and also review the literature on mass layoffs. The initial loss tends to be in the range of 25 to 50%, with the largest fall in earnings that they report in the first year after displacement being 66%. In a more recent study, [Huckfeldt \(2022\)](#) finds that workers laid-off during a recession and who switched occupation experienced a first year reduction of 42% in earnings and that the relative losses remain around 10-15% a decade later. This is in line with [Lachowska et al. \(2020\)](#) who document first year losses of 45-49% that decline to 15-25% after 5 years. [Upward and Wright \(2017\)](#) use data from the British Household Panel Survey and also find the losses to be below 50% in the year after separation. We, on the other hand, find the initial earning losses to be between 80 and 90%, with the initial losses being around 40% only for the sample of those miners who manage to find another

¹⁸In Table 6 of the Online Appendix we opt for an extreme version of this approach and document the results in which we do not employ the matching procedure prior to the estimation and the results are similar.



(a) Earnings conditional on employment



(b) Earnings including all zeros

FIGURE 3: The estimated proportional changes in earnings following job loss including all zeros over different treatments and controls

Note: "Baseline" shows the estimated costs as well as the 95% confidence interval of job loss using the baseline control group described in Section II. "Different control" shows the estimated costs of job loss in comparison to a more restricted control group, focusing blue collar manufacturing workers who are involved in the creation of primary metal products consisting of iron, aluminum and copper as well as their alloys. We report point estimates and standard errors of all coefficients in Table 3 of the Online Appendix. "Mine closure" reports the costs of job loss using the baseline control group where we only include those miners who experienced job loss when a mine also closed in the county. We report point estimates and standard errors of all coefficients in Table 4 of the Online Appendix. "Underground miners" reports the costs of job loss using the baseline control group, where we only include those miners who were working underground. Finally, "Fewer matched vars" reports the costs of job loss where we only match the miners to a control group using the variables age and pre-displacement earnings.

job, abstracting from those miners who fail to find alternative employment. [Davis and von Wachter \(2012\)](#) find for the US that the cumulative losses over a period of 20 years are close to 1.7 times the displaced workers' pre-displacement earnings, while we find that the miners' losses add up to between 4 and 6 times the pre-displacement earning for a shorter period of 15 years.

III.C Implications for policy during the energy transition

What are the implications of our results for the energy transition? The large losses in earnings signify a low value of unemployment upon job loss for the miners. One can raise the value of unemployment by (i) increasing *contemporaneous consumption*, or (ii) increasing *future returns from job search*. These two channels are naturally interlinked but distinct and the importance of each depends on the situation and efficacy of the policy tool.

First, given the large immediate losses in earnings, transfers to miners are likely welfare improving since they alleviate the immediate liquidity losses.¹⁹ Second, to increase the *future returns from job search*, one should understand why the earnings losses are so large for the miners. We have found that the long-run losses are predominantly due to a decline in wages. We believe, therefore, a likely important explanation is forced switching to new sectors and occupations ([Neal, 1995](#); [Huckfeldt, 2022](#); [Braxton and Taska, 2022](#)). A host of active labour market policies are available to policy makers to help smooth such transitions. Recent work by [Van Den Berg and Vikström \(2022\)](#) shows significant positive effects of a retraining program on future earnings for the unemployed. [Belot et al. \(2019\)](#) shows evidence that providing online advice of relevant alternative jobs and occupations increases the number of interviews job seekers receive.²⁰ Active labour market policies such as these may be particularly powerful for long tenure mining workers who are forced to switch industries.²¹

¹⁹While one must of course worry about the disincentive effects of transfers, it is likely that some level of transfers are beneficial.

²⁰See [Card et al. \(2018\)](#) for a review of the literature estimating treatment effects of active labour market policies.

²¹See [Hanson \(2023\)](#) for a further recent policy discussion.

IV FINAL REMARKS

We examine the impact of job displacement on coal miners' earnings. Our analysis exploits individual panel data from the UK and the dramatic collapse of the coal industry that accelerated in mid-1980s. We find evidence of a substantial reduction in earnings of displaced miners that persists in the long-term. As far as we know, our estimates are the largest in the literature.

While specific to the UK context, these findings suggest that the phase out of the coal industry, a policy which has been repeatedly proposed as one way to reduce carbon emissions, could impose large costs on coal miners, their families and mining communities that may persist in the long term. The external validity of our results may hinge on location, job and worker characteristics at existing coal mines. Overall, the phasing out of coal around the world will displace more than 5 million workers, most of them in China (around 3 million). Just as in the case of the UK in the 1980s, coal mining remains an important employer of male workers with low educational attainment in many remote locations of China, the United States, Poland, India, Indonesia, Russia and South Africa ([Ruppert Bulmer et al., 2021](#)). In these remote locations the capacity of the local labor markets to absorb the displaced miners is limited. All this suggests that the UK experience, given the characteristics of workers and communities in coal mining areas and the speed with which the dissolution of the coal industry took place, makes it similar to the one that coal miners around the world may experience during the upcoming energy transition.

While our analysis can identify the size of the earning losses, we are unable to pin down a possible cause. Previous work suggests that earning losses reflect the loss of occupation of specific human capital. While this could certainly be the case for coal miners, we cannot rule out other possible factors specific to coal mining in the UK such as compensating differentials (due to the higher risk of mining jobs), union wage premiums, or lower labor mobility. Examining these issues warrants further research.

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Online appendix for “The job displacement costs of phasing out coal”^{*}

Juan-Pablo Rud

Michael Simmons
Fernando Aragon

Gerhard Toews

^{*}Rud: Department of Economics, Royal Holloway, University of London and Institute for Fiscal Studies (juan.rud@rhul.ac.uk); Simmons: Umeå University (michael.simmons@umu.se); Toews: New Economics School and LEO, Orléans University. (gerhardtoews@gmail.com); Aragón: Department of Economics, Simon Fraser University (faragons@sfu.ca).

1 MINERS AND THE DISTRIBUTION OF MINES

We use national statistics on formal employment in the mining industry for the seven biggest exporters and producers to construct the time series in Figure 1. China is by far the largest employer of coal miners in the world, followed by Indonesia, India, Russia, South Africa, United States and Australia. Also, China and India consume most of the extracted coal, such that Russia and South Africa replace these two in the top 5 list of global exporters. In Figure 2, we document the locations of industrial mines. As is apparent from the Figure, many of the mines are located in remote parts of the world. Thus, miners are often displaced in remote locations during the closures of coal mines.

To estimate the global number of active coal miners we proceed as follows. First, we use the last available country level information on active coal miners from Figure 1: 43,250 in Australia (2020), 2,750,460 in China (2021), 274,445 in India (2020), 1,381,180 in Indonesia (2017), 137,819 in Russia (2016), 86,919 in South Africa (2018) as well as 42,583 in the US (2021). Combining this information with country level statistics on the total number of industrial mines we can calculate the average number of miners per mine for these countries.¹ Applying this estimate to other countries, for which we did not collect national statistics on the number of active coal miners, we get to a total of approximately 5.4 million active coal miners. Note that this is likely to be lower bound, since we do not account for individuals involved in the informal mining of coal.

¹<https://globalenergymonitor.org/projects/global-coal-mine-tracker/summary-tables/>

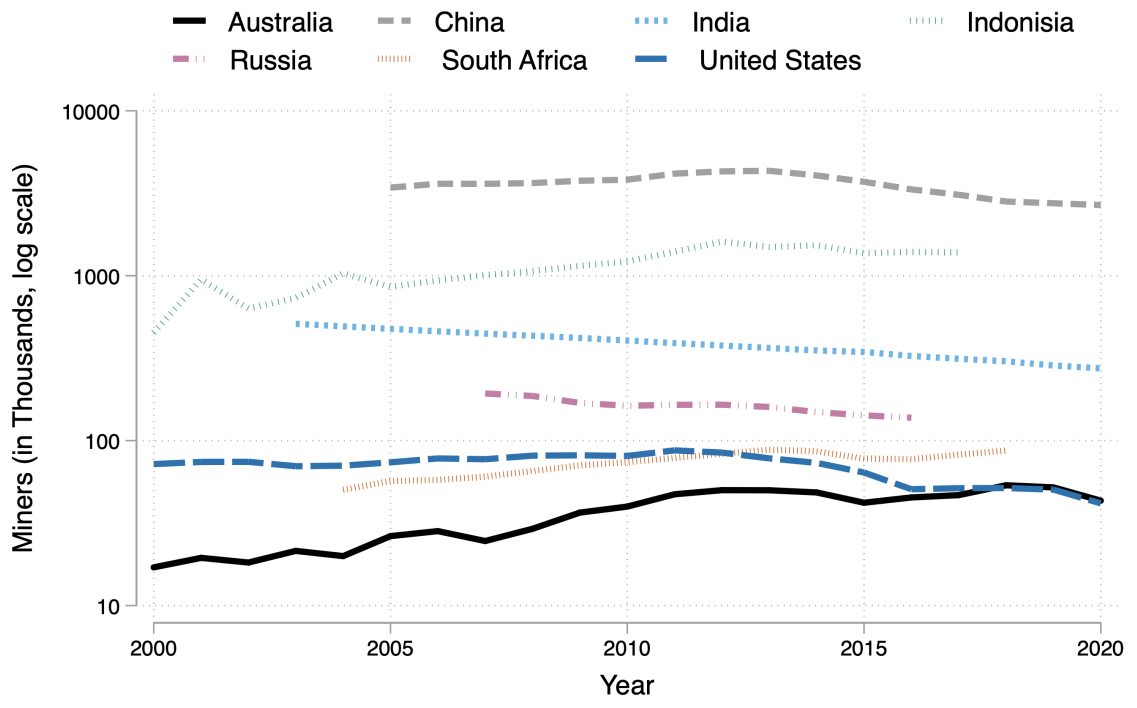


Figure 1: Total number of coal miners by country for the top seven producing and exporting countries

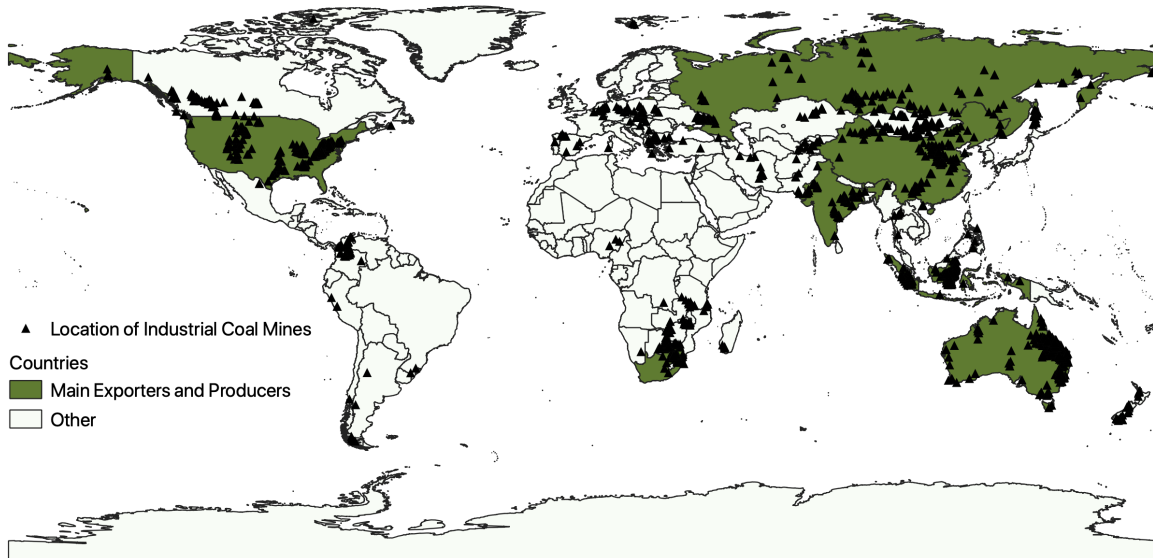


Figure 2: Employment by the top 7 producing and exporting countries

Note: Main exporters and producers are marked in green. The location of coal mines is taken from the SNL Energy Data Set produced by [S&P Global](#) a publicly traded corporation whose primary areas of business are financial information and analytics.

2 ADDITIONAL RESULTS

Occupational distribution

Figure 3 shows the one-digit occupational distribution for all individuals employed in a mine in 1980.² 57% are employed in “Craft and Related Occupations”.

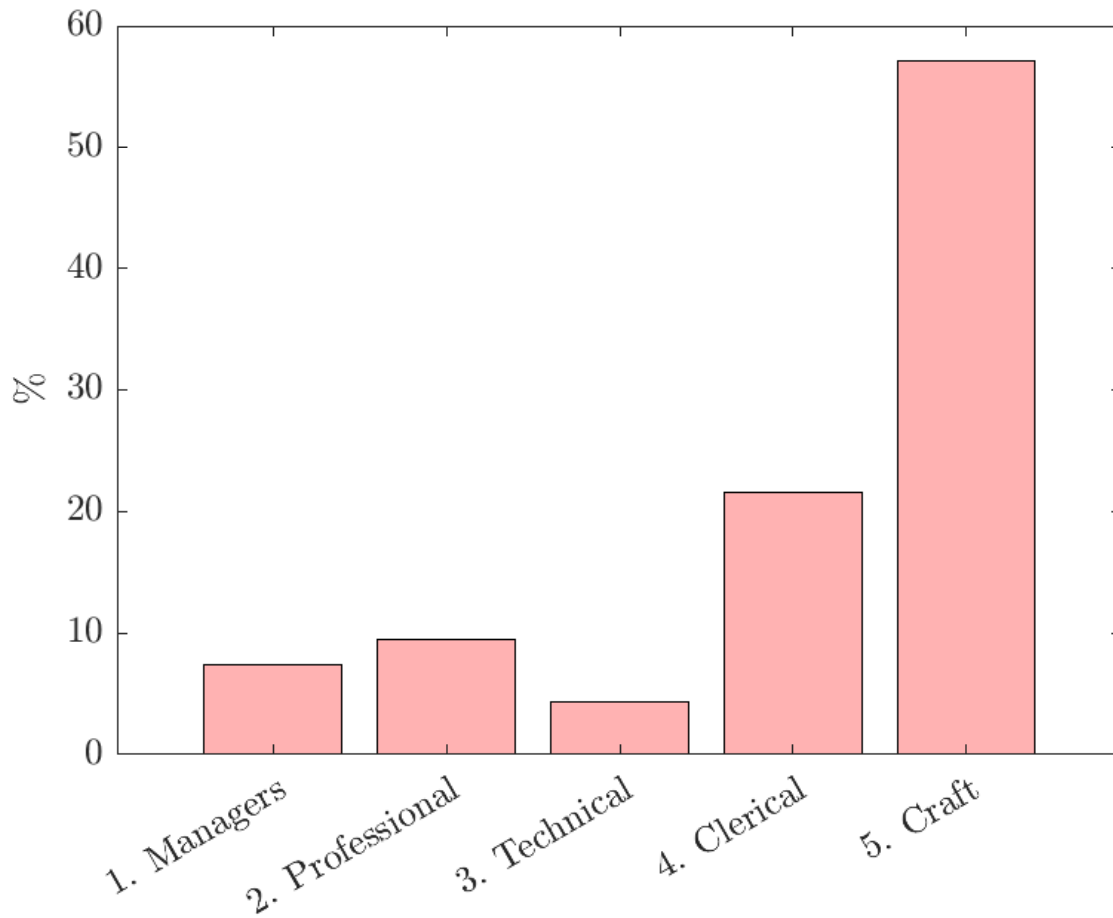


Figure 3: One-digit occupational distribution for all individuals employed in mining in 1975

Note: Full description: 1. Managers and Administrators 2. Professional Occupations 3. Associate Professional and Technical Occupations 4. Clerical and Secretarial Occupations 5. Craft and Related Occupations. No miners were employed in the remaining occupations: 6. Personal and Protective Service Occupations 7. Sales Occupations 8. Plant and Machine Operatives 9. Other Occupations.

²Two-digit includes less than a certain threshold of individuals in particular occupations and, therefore, deemed too disclosive.

Raw earnings and employment

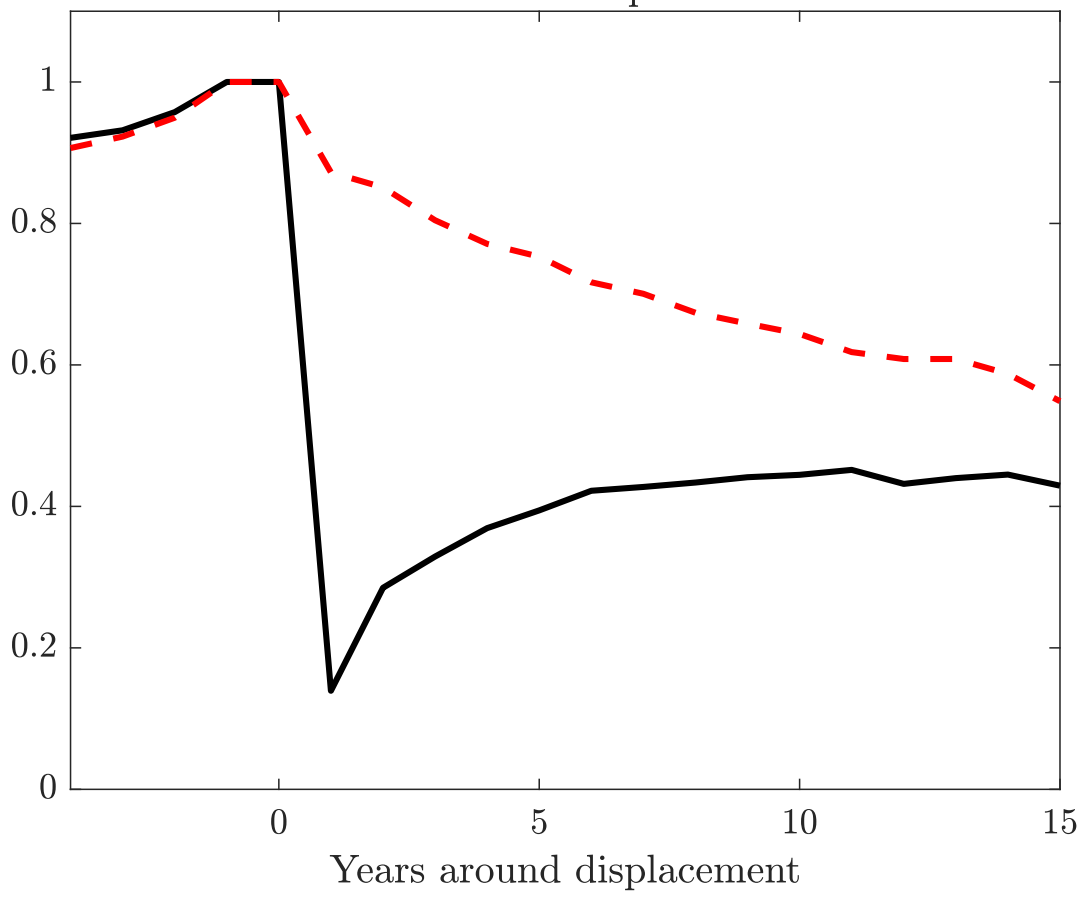
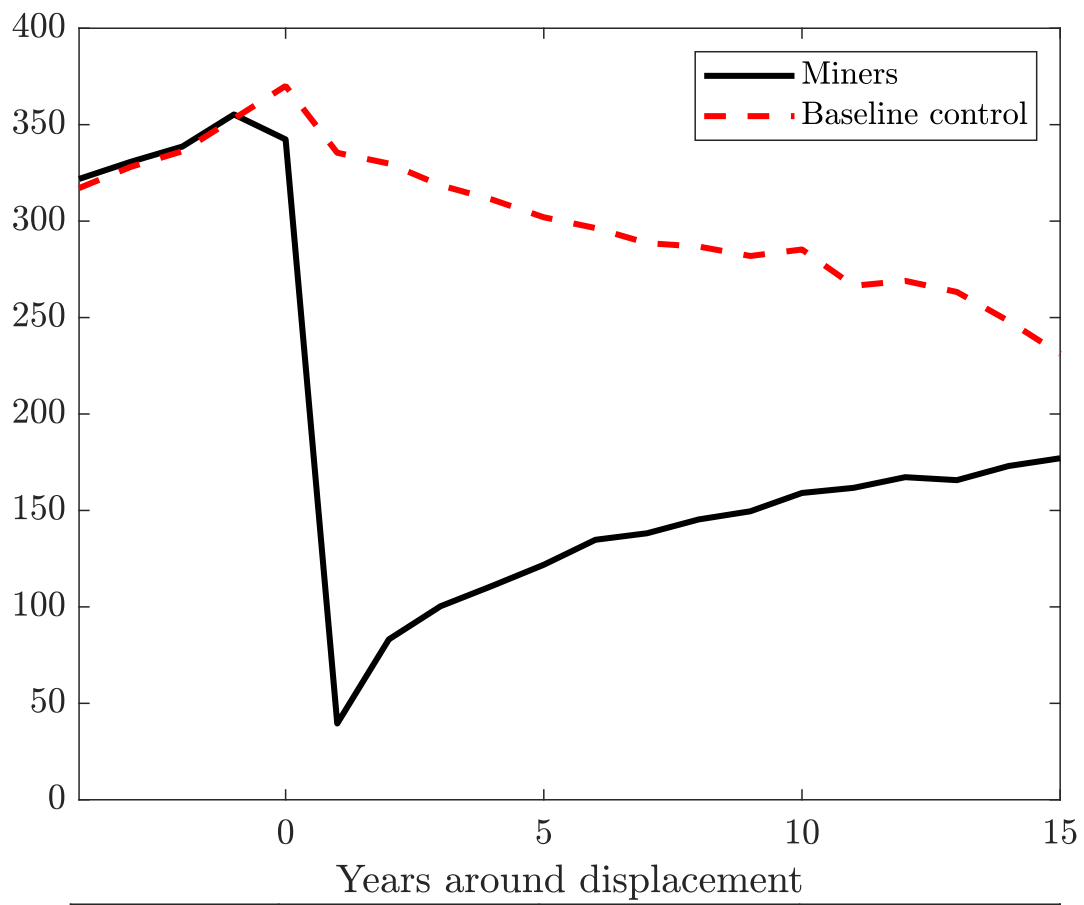


Figure 4: Raw earnings and employment for the miners and baseline control group

Note: The top panel shows weekly earnings in GBP in 2000 prices

Figure 4 shows the average earnings for the treated and matched control group of baseline manufacturing workers. Crucially the miners and control have almost identical earnings and employment dynamics prior to displacement, meaning that the earnings conditional on employment trajectories and job separation rates are close to identical for the miners and selected control group leading up to the displacement year.

Heterogeneity

Figure 5 shows the earnings losses over different displacement periods during the 1979 to 1995 period, and Figure 6 shows further heterogeneity. Figure 5 shows that the earnings losses do vary depending on the displacement period, but are always substantial. This naturally depends on the economic climate, however, and indeed we do find that the initial losses appear to be slightly larger in periods where displacement occurred during high levels of unemployment.

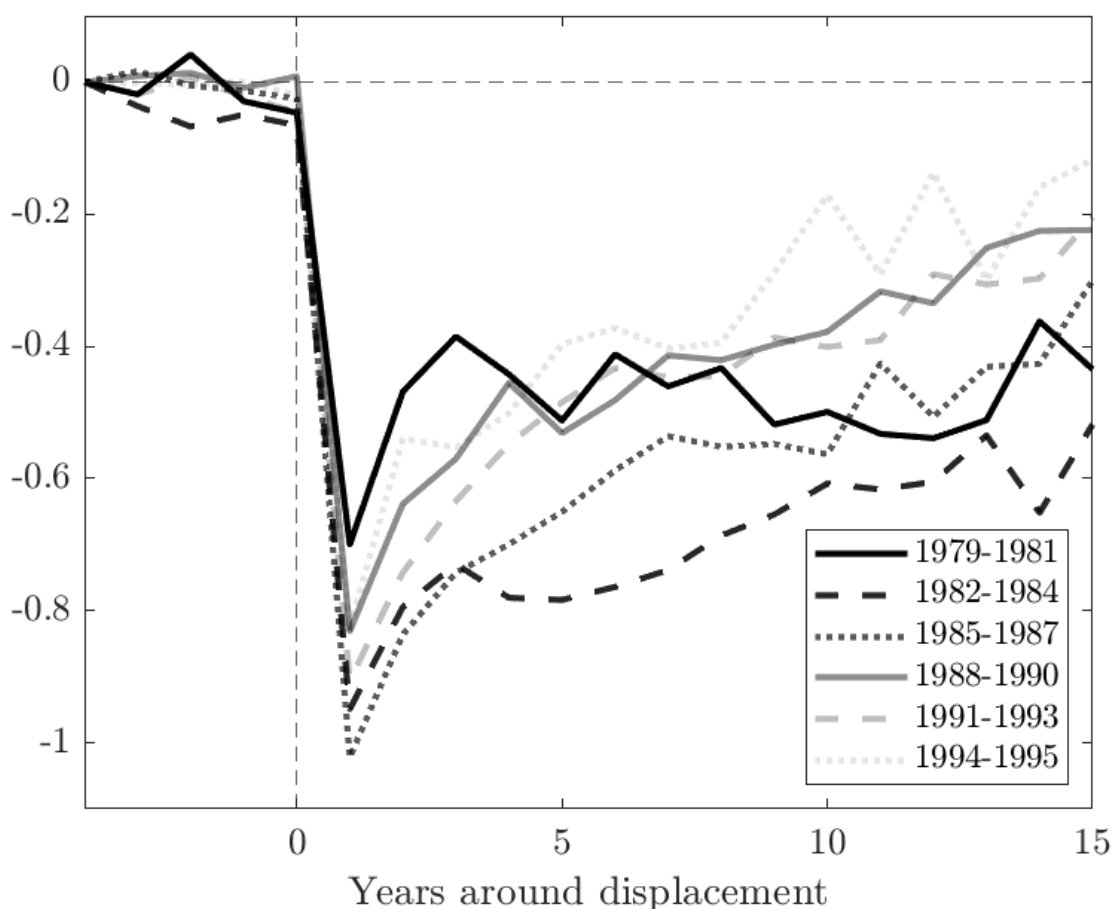


Figure 5: The cost of job loss over different periods of displacement during the collapse

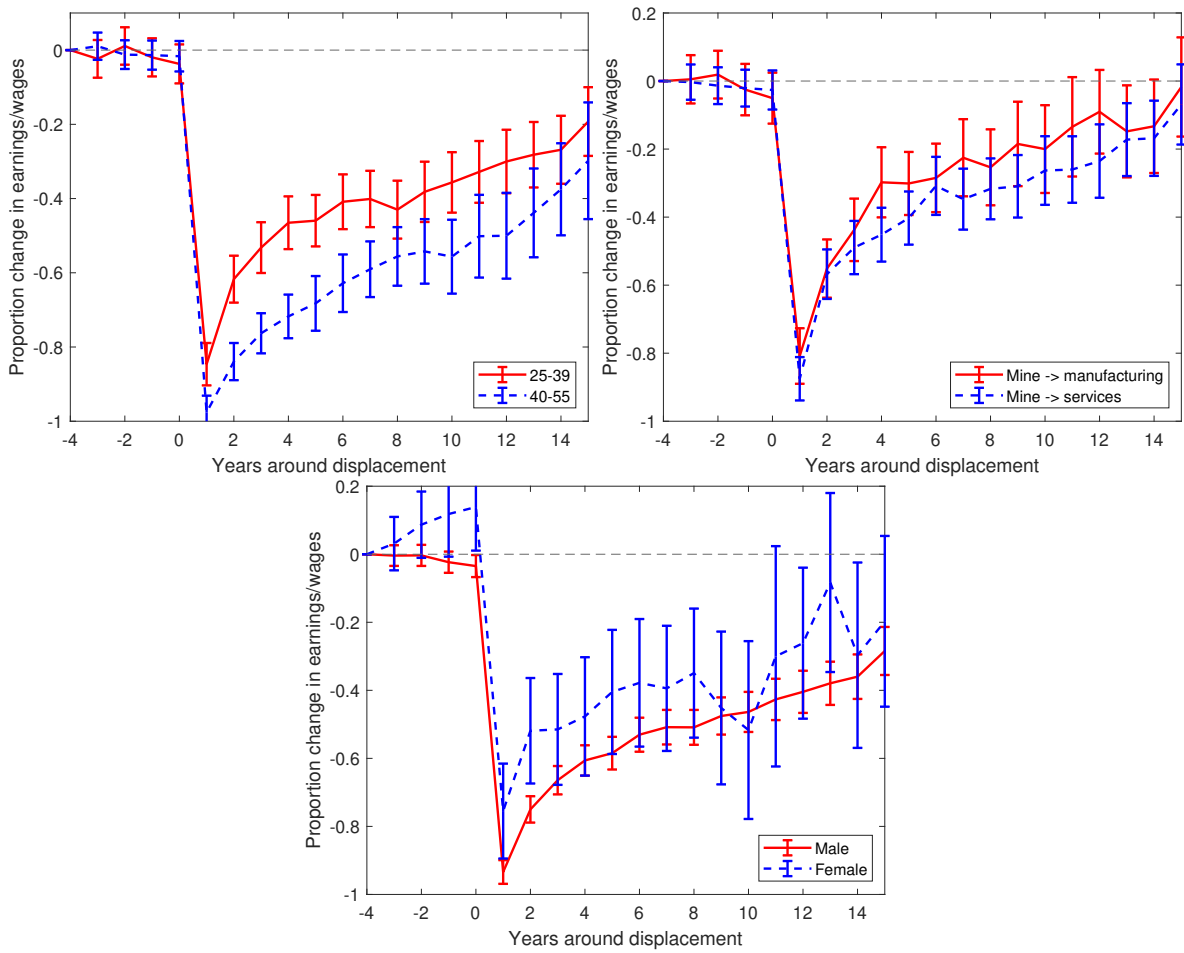


Figure 6: Heterogeneity in earnings losses by age, destination and gender

Compare miners with miners

Figure 7 shows an alternative specification where we compare the earnings trajectories of the miners who lose their job in year k to workers employed in mining but do not lose their job in year k . The control group follows the same restrictions as the in the main text. The earnings losses are around 90% in the year after displacement but, naturally, in the long-run become insignificant since all the control group lose their job.

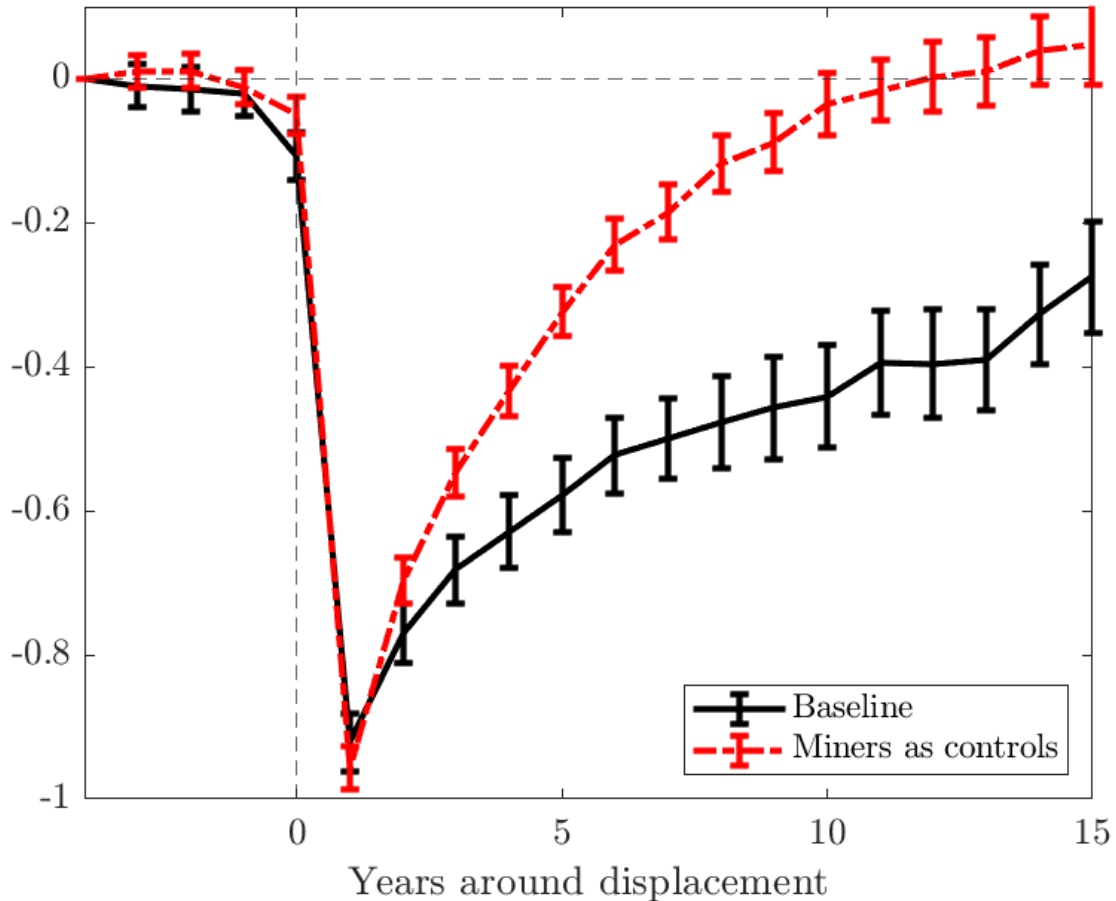


Figure 7: Earnings costs comparing miners with miners

3 POINT ESTIMATES

In the following tables we present point estimates of the earnings, wages, employment and hourly wage consequences of displacement. The estimates in the Tables 1-4 are used for the construction of Figure 2 and Figure 3 in the main body of the paper. We also provide results for different samples. In Table 5 we show the results for male miners only. These are close to identical to those including female miners. We also provide the results for a sample in which we include all manufacturing workers as controls, without any matching. The results are presented in Table 6. Note that the consequences of displacement on earning are larger in the long run when not conducting matching prior to estimation.

VARIABLES	(1) Earnings	(2) Wages	(3) Employment	(4) Hourly wage
δ_{-3}	-0.00941 (0.0154)	-0.00273 (0.0127)	-0.00691 (0.0106)	-0.00745 (0.0121)
δ_{-2}	-0.0148 (0.0157)	-0.00565 (0.0131)	-0.00905 (0.0102)	-0.0138 (0.0125)
δ_{-1}	-0.0203 (0.0162)	-0.0110 (0.0142)	-0.0184* (0.00946)	-0.0229* (0.0135)
δ_0	-0.107*** (0.0171)	-0.0973*** (0.0152)	-0.0182* (0.00950)	-0.111*** (0.0145)
δ_1	-0.921*** (0.0205)	-0.421*** (0.0266)	-0.752*** (0.0142)	-0.403*** (0.0258)
δ_2	-0.770*** (0.0215)	-0.405*** (0.0228)	-0.585*** (0.0159)	-0.402*** (0.0224)
δ_3	-0.682*** (0.0235)	-0.359*** (0.0234)	-0.495*** (0.0168)	-0.355*** (0.0221)
δ_4	-0.629*** (0.0258)	-0.379*** (0.0237)	-0.428*** (0.0175)	-0.377*** (0.0216)
δ_5	-0.578*** (0.0261)	-0.349*** (0.0232)	-0.390*** (0.0180)	-0.349*** (0.0217)
δ_6	-0.523*** (0.0272)	-0.364*** (0.0237)	-0.329*** (0.0188)	-0.357*** (0.0218)
δ_7	-0.500*** (0.0286)	-0.348*** (0.0244)	-0.321*** (0.0195)	-0.351*** (0.0232)
δ_8	-0.477*** (0.0323)	-0.341*** (0.0305)	-0.289*** (0.0199)	-0.344*** (0.0290)
δ_9	-0.457*** (0.0362)	-0.368*** (0.0373)	-0.272*** (0.0206)	-0.367*** (0.0343)
δ_{10}	-0.441*** (0.0367)	-0.370*** (0.0410)	-0.254*** (0.0211)	-0.358*** (0.0364)
δ_{11}	-0.395*** (0.0369)	-0.354*** (0.0427)	-0.227*** (0.0215)	-0.344*** (0.0379)
δ_{12}	-0.396*** (0.0383)	-0.320*** (0.0444)	-0.239*** (0.0221)	-0.320*** (0.0425)
δ_{13}	-0.390*** (0.0361)	-0.304*** (0.0381)	-0.233*** (0.0225)	-0.312*** (0.0412)
δ_{14}	-0.327*** (0.0354)	-0.261*** (0.0346)	-0.207*** (0.0234)	-0.292*** (0.0336)
δ_{15}	-0.275*** (0.0393)	-0.220*** (0.0435)	-0.192*** (0.0238)	-0.217*** (0.0593)
R-squared	0.180	0.054	0.324	0.057

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 1: The costs of job loss including all zeros for earnings

Note: Used to plot Figure 2.

VARIABLES	(1) Earnings	(2) Wages	(3) Employment	(4) Hourly wage
δ_{-3}	-0.0418* (0.0243)	-0.00803 (0.0210)	-0.0256* (0.0152)	-0.00800 (0.0196)
δ_{-2}	-0.0372 (0.0244)	-0.0134 (0.0210)	-0.0192 (0.0147)	-0.0161 (0.0198)
δ_{-1}	-0.0374 (0.0256)	-0.0157 (0.0226)	-0.0260* (0.0143)	-0.0215 (0.0214)
δ_0	-0.124*** (0.0284)	-0.0997*** (0.0254)	-0.0292** (0.0144)	-0.107*** (0.0242)
δ_1	-0.835*** (0.0347)	-0.411*** (0.0319)	-0.602*** (0.0237)	-0.394*** (0.0305)
δ_2	-0.542*** (0.0333)	-0.381*** (0.0300)	-0.282*** (0.0248)	-0.379*** (0.0288)
δ_3	-0.433*** (0.0377)	-0.362*** (0.0305)	-0.162*** (0.0251)	-0.358*** (0.0294)
δ_4	-0.348*** (0.0425)	-0.363*** (0.0321)	-0.0702*** (0.0254)	-0.365*** (0.0299)
δ_5	-0.330*** (0.0422)	-0.348*** (0.0309)	-0.0815*** (0.0263)	-0.349*** (0.0291)
δ_6	-0.324*** (0.0436)	-0.359*** (0.0322)	-0.0727*** (0.0273)	-0.353*** (0.0297)
δ_7	-0.297*** (0.0445)	-0.328*** (0.0329)	-0.0898*** (0.0282)	-0.334*** (0.0325)
δ_8	-0.282*** (0.0541)	-0.308*** (0.0480)	-0.0668** (0.0284)	-0.317*** (0.0460)
δ_9	-0.331*** (0.0622)	-0.384*** (0.0635)	-0.0988*** (0.0293)	-0.378*** (0.0589)
δ_{10}	-0.288*** (0.0475)	-0.335*** (0.0429)	-0.0960*** (0.0298)	-0.333*** (0.0412)
δ_{11}	-0.237*** (0.0479)	-0.306*** (0.0458)	-0.0729** (0.0303)	-0.300*** (0.0443)
δ_{12}	-0.261*** (0.0600)	-0.355*** (0.0710)	-0.0682** (0.0315)	-0.355*** (0.0681)
δ_{13}	-0.260*** (0.0556)	-0.317*** (0.0571)	-0.0758** (0.0322)	-0.315*** (0.0601)
δ_{14}	-0.206*** (0.0533)	-0.282*** (0.0492)	-0.0591* (0.0337)	-0.299*** (0.0478)
δ_{15}	-0.125** (0.0566)	-0.241*** (0.0543)	-0.0326 (0.0342)	-0.252*** (0.0523)
R-squared	0.097	0.068	0.186	0.069

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 2: The costs of job loss including all only those who have one year of positive earnings during the four years after job loss

Note: Used to plot Figure 2.

VARIABLES	(1) Earnings	(2) Wages	(3) Employment	(4) Hourly wage
δ_{-3}	-0.00265 (0.0147)	-0.00343 (0.0115)	-0.00401 (0.0107)	-0.00322 (0.0115)
δ_{-2}	-0.0204 (0.0156)	-0.0235* (0.0125)	-0.00882 (0.0107)	-0.0200 (0.0124)
δ_{-1}	-0.0485*** (0.0156)	-0.0386*** (0.0136)	-0.0255*** (0.00961)	-0.0335** (0.0131)
δ_0	-0.0928*** (0.0161)	-0.0838*** (0.0141)	-0.0246** (0.00967)	-0.0818*** (0.0137)
δ_1	-0.942*** (0.0193)	-0.417*** (0.0263)	-0.762*** (0.0143)	-0.379*** (0.0260)
δ_2	-0.798*** (0.0210)	-0.421*** (0.0219)	-0.581*** (0.0161)	-0.414*** (0.0218)
δ_3	-0.735*** (0.0221)	-0.374*** (0.0227)	-0.511*** (0.0167)	-0.369*** (0.0217)
δ_4	-0.683*** (0.0234)	-0.395*** (0.0223)	-0.440*** (0.0174)	-0.402*** (0.0209)
δ_5	-0.630*** (0.0244)	-0.387*** (0.0225)	-0.389*** (0.0180)	-0.391*** (0.0218)
δ_6	-0.576*** (0.0263)	-0.385*** (0.0239)	-0.343*** (0.0187)	-0.380*** (0.0232)
δ_7	-0.591*** (0.0279)	-0.395*** (0.0255)	-0.338*** (0.0192)	-0.398*** (0.0246)
δ_8	-0.571*** (0.0292)	-0.371*** (0.0279)	-0.327*** (0.0196)	-0.377*** (0.0273)
δ_9	-0.594*** (0.0329)	-0.414*** (0.0329)	-0.327*** (0.0202)	-0.399*** (0.0312)
δ_{10}	-0.566*** (0.0344)	-0.382*** (0.0358)	-0.320*** (0.0204)	-0.371*** (0.0336)
δ_{11}	-0.541*** (0.0320)	-0.371*** (0.0297)	-0.304*** (0.0211)	-0.362*** (0.0295)
δ_{12}	-0.524*** (0.0351)	-0.327*** (0.0356)	-0.302*** (0.0218)	-0.308*** (0.0360)
δ_{13}	-0.491*** (0.0364)	-0.344*** (0.0356)	-0.272*** (0.0225)	-0.330*** (0.0399)
δ_{14}	-0.470*** (0.0406)	-0.347*** (0.0431)	-0.248*** (0.0233)	-0.342*** (0.0418)
δ_{15}	-0.446*** (0.0392)	-0.277*** (0.0412)	-0.258*** (0.0238)	-0.240*** (0.0577)
R-squared	0.205	0.072	0.322	0.069

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: The costs of job loss including all zeros for earnings for a different control group

Used to plot Figure 3.

VARIABLES	(1) Earnings	(2) Wages	(3) Employment	(4) Hourly wage
δ_{-3}	-0.00656 (0.0160)	0.000488 (0.0132)	-0.00489 (0.0108)	-0.00847 (0.0129)
δ_{-2}	-0.0141 (0.0164)	-0.00558 (0.0136)	-0.00591 (0.0105)	-0.0138 (0.0128)
δ_{-1}	-0.0216 (0.0170)	-0.00918 (0.0149)	-0.0186* (0.00982)	-0.0258* (0.0149)
δ_0	-0.103*** (0.0180)	-0.0912*** (0.0160)	-0.0182* (0.00987)	-0.138*** (0.0316)
δ_1	-0.925*** (0.0212)	-0.433*** (0.0283)	-0.758*** (0.0147)	-0.435*** (0.0290)
δ_2	-0.776*** (0.0223)	-0.414*** (0.0239)	-0.588*** (0.0166)	-0.359*** (0.0557)
δ_3	-0.702*** (0.0244)	-0.378*** (0.0243)	-0.507*** (0.0175)	-0.367*** (0.0238)
δ_4	-0.640*** (0.0270)	-0.390*** (0.0249)	-0.429*** (0.0183)	-0.382*** (0.0248)
δ_5	-0.590*** (0.0273)	-0.363*** (0.0242)	-0.396*** (0.0187)	-0.358*** (0.0232)
δ_6	-0.535*** (0.0283)	-0.374*** (0.0247)	-0.333*** (0.0197)	-0.369*** (0.0238)
δ_7	-0.515*** (0.0297)	-0.365*** (0.0257)	-0.326*** (0.0203)	-0.374*** (0.0269)
δ_8	-0.488*** (0.0339)	-0.368*** (0.0317)	-0.287*** (0.0208)	-0.370*** (0.0308)
δ_9	-0.469*** (0.0382)	-0.386*** (0.0394)	-0.275*** (0.0215)	-0.384*** (0.0369)
δ_{10}	-0.456*** (0.0377)	-0.401*** (0.0416)	-0.249*** (0.0220)	-0.386*** (0.0374)
δ_{11}	-0.406*** (0.0388)	-0.375*** (0.0455)	-0.228*** (0.0225)	-0.369*** (0.0410)
δ_{12}	-0.418*** (0.0396)	-0.347*** (0.0462)	-0.243*** (0.0231)	-0.350*** (0.0452)
δ_{13}	-0.404*** (0.0378)	-0.315*** (0.0403)	-0.240*** (0.0236)	-0.330*** (0.0447)
δ_{14}	-0.339*** (0.0368)	-0.280*** (0.0364)	-0.208*** (0.0245)	-0.310*** (0.0363)
δ_{15}	-0.304*** (0.0391)	-0.259*** (0.0410)	-0.198*** (0.0250)	-0.226*** (0.0562)
R-squared	0.183	0.056	0.326	0.038

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: The costs of job loss including all zero earnings and where job loss coincides with the closure of a mine at the county level

Used to plot Figure 3.

VARIABLES	(1) Earnings	(2) Wages	(3) Employment	(4) Hourly wage
δ_{-3}	-0.00813 (0.0158)	-0.00154 (0.0130)	-0.00443 (0.0108)	-0.00662 (0.0125)
δ_{-2}	-0.0135 (0.0161)	-0.00441 (0.0134)	-0.00601 (0.0103)	-0.0124 (0.0128)
δ_{-1}	-0.0238 (0.0166)	-0.0118 (0.0145)	-0.0163* (0.00933)	-0.0235* (0.0139)
δ_0	-0.111*** (0.0175)	-0.0996*** (0.0155)	-0.0159* (0.00938)	-0.112*** (0.0150)
δ_1	-0.910*** (0.0208)	-0.421*** (0.0274)	-0.758*** (0.0143)	-0.410*** (0.0269)
δ_2	-0.764*** (0.0219)	-0.399*** (0.0232)	-0.591*** (0.0161)	-0.404*** (0.0229)
δ_3	-0.676*** (0.0240)	-0.347*** (0.0238)	-0.503*** (0.0171)	-0.354*** (0.0227)
δ_4	-0.628*** (0.0265)	-0.371*** (0.0242)	-0.442*** (0.0178)	-0.380*** (0.0222)
δ_5	-0.575*** (0.0266)	-0.344*** (0.0235)	-0.399*** (0.0183)	-0.353*** (0.0222)
δ_6	-0.523*** (0.0278)	-0.366*** (0.0240)	-0.335*** (0.0192)	-0.367*** (0.0224)
δ_7	-0.500*** (0.0293)	-0.345*** (0.0249)	-0.333*** (0.0200)	-0.355*** (0.0239)
δ_8	-0.483*** (0.0333)	-0.342*** (0.0311)	-0.303*** (0.0204)	-0.348*** (0.0300)
δ_9	-0.456*** (0.0374)	-0.374*** (0.0383)	-0.276*** (0.0212)	-0.378*** (0.0358)
δ_{10}	-0.441*** (0.0379)	-0.369*** (0.0421)	-0.262*** (0.0217)	-0.364*** (0.0379)
δ_{11}	-0.397*** (0.0381)	-0.358*** (0.0440)	-0.235*** (0.0222)	-0.358*** (0.0394)
δ_{12}	-0.394*** (0.0395)	-0.326*** (0.0459)	-0.242*** (0.0227)	-0.337*** (0.0442)
δ_{13}	-0.393*** (0.0370)	-0.306*** (0.0390)	-0.245*** (0.0231)	-0.320*** (0.0427)
δ_{14}	-0.323*** (0.0363)	-0.258*** (0.0352)	-0.213*** (0.0240)	-0.295*** (0.0346)
δ_{15}	-0.263*** (0.0404)	-0.219*** (0.0446)	-0.187*** (0.0246)	-0.230*** (0.0622)
R-squared	0.184	0.055	0.335	0.058

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: The costs of job loss for men only including all zeros for earnings

Not plotted in the main body of the text.

VARIABLES	(1) Earnings	(2) Wages	(3) Employment	(4) Hours
δ_{-3}	-0.0150 (0.0102)	-0.00588 (0.00856)	-0.0185*** (0.00690)	-0.00647 (0.00835)
δ_{-2}	-0.0430*** (0.0109)	-0.0302*** (0.00937)	-0.0306*** (0.00686)	-0.0295*** (0.00907)
δ_{-1}	-0.136*** (0.0111)	-0.0468*** (0.00989)	-0.121*** (0.00651)	-0.0455*** (0.00949)
δ_0	-0.190*** (0.0119)	-0.102*** (0.0107)	-0.120*** (0.00653)	-0.0996*** (0.0102)
δ_1	-0.995*** (0.0135)	-0.425*** (0.0238)	-0.840*** (0.0102)	-0.400*** (0.0233)
δ_2	-0.842*** (0.0144)	-0.419*** (0.0188)	-0.650*** (0.0121)	-0.409*** (0.0188)
δ_3	-0.780*** (0.0152)	-0.383*** (0.0190)	-0.574*** (0.0126)	-0.371*** (0.0180)
δ_4	-0.745*** (0.0158)	-0.408*** (0.0182)	-0.512*** (0.0130)	-0.403*** (0.0164)
δ_5	-0.710*** (0.0161)	-0.409*** (0.0177)	-0.470*** (0.0133)	-0.403*** (0.0167)
δ_6	-0.677*** (0.0168)	-0.420*** (0.0177)	-0.429*** (0.0137)	-0.413*** (0.0164)
δ_7	-0.680*** (0.0175)	-0.426*** (0.0182)	-0.421*** (0.0141)	-0.424*** (0.0170)
δ_8	-0.658*** (0.0178)	-0.413*** (0.0196)	-0.401*** (0.0143)	-0.414*** (0.0189)
δ_9	-0.650*** (0.0184)	-0.435*** (0.0199)	-0.385*** (0.0146)	-0.433*** (0.0187)
δ_{10}	-0.616*** (0.0205)	-0.421*** (0.0241)	-0.368*** (0.0149)	-0.418*** (0.0227)
δ_{11}	-0.611*** (0.0197)	-0.425*** (0.0218)	-0.354*** (0.0151)	-0.420*** (0.0222)
δ_{12}	-0.586*** (0.0227)	-0.371*** (0.0279)	-0.357*** (0.0155)	-0.367*** (0.0292)
δ_{13}	-0.580*** (0.0220)	-0.404*** (0.0247)	-0.335*** (0.0159)	-0.407*** (0.0311)
δ_{14}	-0.551*** (0.0222)	-0.390*** (0.0234)	-0.317*** (0.0163)	-0.407*** (0.0240)
δ_{15}	-0.541*** (0.0266)	-0.347*** (0.0339)	-0.328*** (0.0167)	-0.328*** (0.0535)
R-squared	0.490	0.703	0.345	0.702

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: The costs of job loss including all zeros for earnings where we do not perform a matching exercise prior to estimation

Not plotted in the main body of the text.