The University of Nottingham

research paper series

Globalisation and Labour Markets

Research Paper 2015/06

Off the waterfront:

The long-run impact of technological change on dock workers

by

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GEP

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Acknowledgements
The paper has benefitted from the comments of participants at workshops at the Universities of Nottingham, Sheffield (WPEG 2014), Lund, Birmingham (ETSG 2013) and Copenhagen. The permission of the Office for National Statistics to use the Longitudinal Study is gratefully acknowledged, as is the help provided by staff of the Centre for Longitudinal Study Information & User Support (CeLSIUS). CeLSIUS is supported by the ESRC Census of Population Programme (award ref ES/K000365/1). The authors alone are responsible for the interpretation of the data. This work contains statistical data from ONS which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates. El-Sahli acknowledges funding from the *Stiftelsen foer fraemjande av ekonomisk forskning vid Lunds Universitet*.

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Abstract

We investigate how individual workers and local labour markets adjust over a long time period to a discrete and plausibly exogenous technological shock, namely the introduction of containerisation in the UK port industry. This technology, which was introduced rapidly between the mid-1960s and the late-1970s, had dramatic consequences for specific occupations within the port industry. Using longitudinal micro-census data we follow dock-workers over a 40 year period and examine the long-run consequences of containerisation for patterns of employment, migration and mortality. The results show that the job guarantees protected dock-workers' employment until their removal in 1989. A matched comparison of workers in comparable unskilled occupations reveals that, even after job guarantees were removed, dock-workers did not fare worse than the comparison group in terms of their labour market outcomes. Our results suggest that job guarantees may significantly reduce the cost to workers of sudden technological change, albeit at a significant cost to the industry.

JEL classification: J5, J63, J65, F66

Keywords: Technological change, dock-workers, layoffs, employment

Outline

1 Introduction

Technological change can have dramatic and long-lasting effects on the labour market. Some industries or occupations decline, while others expand as a result of the technological change. This restructuring causes job loss and the displacement of workers from the declining industries or occupations, which can have significant and long-lasting effects on employment and earnings for the affected individuals. Studies for the US include Ruhm (1991), Jacobson et al. (1993) and more recently Couch and Placzek (2010) and Davis and von Wachter (2011). For the UK, to which this paper refers, Upward and Wright (2013) find long-run losses (10 years after displacement) in wages and employment which amount to a permanent reduction in earnings of about 10%. As well as the financial cost, there are also long-lasting effects on other worker outcomes, such as morbidity (e.g. Black et al., 2012), mortality (e.g. Eliason and Storrie, 2009) and family break-up (e.g. Eliason, 2012).

However, the literature on job loss does not in general consider the underlying cause of the displacement.[1] It is therefore difficult to evaluate the adjustment cost of specific technological developments which may simultaneously affect many firms, an entire industry or occupation. This is because such technological changes often occur relatively gradually, or because they are difficult to isolate from other changes which are occurring at the same time, or because the shocks may be themselves determined by the structure of the labour market. In contrast, in this paper we focus explicitly on the labour market response to a sudden, well-defined and exogenous technological shock, namely the introduction of containerisation in UK ports.

Containerisation changed the UK port industry profoundly in the space of only a few years, starting in the late 1960s. The new technology was massively more capital intensive, and its introduction led to a sudden decline in the use of port labour, in particular those workers who loaded and unloaded cargo, known as stevedores, dockers or longshoremen. Containerisation also brought increased economies of scale and a greater concentration of port activity (Hall, 2009). Older ports which were unsuited to the requirements of the new technology (such as deep water, road and rail networks) declined while new ports expanded quickly in more suitable locations. As a large open island economy, the UK was heavily dependent on shipping for its trade. London was one of the largest ports in the world before the advent of the container, and suffered a particularly dramatic decline. The port districts in East London lost some 150,000 jobs between 1966 and 1976 due to the closure of the London Docks, around 20% of all jobs in the area.[2]

Beyond the effect on the port industry itself, containerisation also affected other industries which were traditionally located near ports. Hoare (1986) claims that, in 1964, 40% of

[1] A recent exception is the work of Autor and co-authors (For example Autor et al., 2014), which considers the effect of increased imports from China on workers' patterns of earnings and employment.

[2] Source: The London Docklands Development Corporation (http://www.lddc-history.org.uk/beforelddc/index.html).

all UK exports originated within 25 miles of their port of export, and two-thirds within 75 miles.[3] Containerisation and the associated development of rail and road networks meant that warehouses and manufacturers no longer needed to locate near ports.

Our approach in this paper is to measure the cost of the technological shock to incumbent workers. We use micro-census data to follow dock workers in England and Wales (and various comparison groups) over a 40-year period from 1971 to 2011 to measure the long-run effect. We also consider the likely spillover effect on local labour markets, rather than just those workers directly effected.

As noted, this paper is related to the literature on worker displacement, but rather than measuring the effect of firm-specific events such as closure or layoff, it measures the impact of a more general technological shock whose effects were much more widespread. Our study bears some similarity to, and uses the same data as Fieldhouse and Hollywood (1999), who study the effects of the collapse of the UK mining industry during the 1980s.[4] They find that only one-third of men in mining occupations in 1981 were in employment in 1991. In contrast, half of men in the same age group who were not in mining occupations in 1981 were in employment in 1991. Their results suggest that an industry-level collapse in employment can have extremely large employment effects even after 10 years.[5]

As well as allowing us to follow workers over a very long time period (essentially their entire working lives), the census data also has the advantage that it tracks workers regardless of their labour market state. Typically, administrative data which come from social security records (such as that used by Jacobson et al., 1993) only contain records for those periods when the worker is in employment. But an important development in the UK (and US) labour markets over the last 30 years has been the large increase in the number claiming various disability benefits (see McVicar, 2008, for a survey of the UK evidence). In the US, Black et al. (2002) show that exogenous variation in the value of labour force participation has a significant effect on the use of disability programmes. Our data allows us to see the extent to which the new technology caused existing workers to enter different labour market states such as unemployment, disability or retirement.[6]

Our paper is also related to the literature on the effects of deregulation and containerisation on dock-workers in the United States. Talley (2002) analyzes the earnings of US union dock-workers before and after the passage of the 1984 Shipping Act, using CPS data. The

[3] Hall (2009) notes that "Before containerisation, ports in the developed world were all closely related to a clearly identifiable port-city and hinterland. The huge efficiencies afforded by containers loosened these highly local economic ties ..."

[4] Note that this collapse was not principally caused by a technological development, but rather a combination of political and longer-run economic factors.

[5] In a similar vein, Hinde (1994) studies displaced workers from another industry, shipbuilding, which experienced catastrophic job loss.

[6] But note that both Black et al. (2002) and Black et al. (2005) concern the effect of exogenous shocks on the aggregate local labour market; whereas our focus is on the adjustment cost faced by incumbent workers.

results show that dock-worker earnings *increased* after deregulation, which is attributed to the increase in demand for dock-workers in the period after containerisation[7] and increased capital-labour ratios. Similarly, Hall (2009) estimates the effects of containerisation and deregulation on port worker earnings in US port cities since 1975. He also uses CPS data and constructs difference-in-difference estimates of earnings gaps between truckers, dockers and warehousers and various control groups based on workers in non-transport occupations based in port and non-port cities. He finds that dockers' pay advantage over non-transport workers also increased during the period of containerisation and deregulation. In contrast to these papers, we use longitudinal data which allows us to assess the impact of containerisation and deregulation on *existing* dock workers, rather than a comparison of cross-sections over time.

The paper is organized as follows. In Section 2 we briefly describe the process by which UK ports became containerized as well as the evolution of dock employment in the UK. Section 3 describes the location of English and Welsh ports and provides a district-level comparison of labour markets defined according to the location of ports. Our methods are described in Section 4, and the main set of worker-level results is provided in Section 5. Section 6 concludes.

2 Dock Employment in Great Britain

The development of container technology is described in detail in, for example, Vigarié (1999), Levinson (2006) and El-Sahli (2012). In this section we describe the most important developments as they affected the UK, with a particular focus on the effects of containerisation on port labour and employment in port areas.

Container ships first docked in the UK in 1966, when services were established for the transatlantic trade between the US and European ports in the UK, Netherlands and West Germany (Levinson, 2006). Containerisation required major technological changes in port facilities, and the two largest UK ports of London and Liverpool were unsuited the new technology. London docks, for example, were difficult to navigate even for smaller break-bulk ships,[8] and larger vessels had to unload onto smaller vessels near the mouth of the river. Furthermore, neither London nor Liverpool allowed easy access for onward land transportation. As a result, major investments were made in new docks at Tilbury and Southampton, while Liverpool docks were retro-fitted to handle containers in the early 1970s.

Before containerisation, dock-work was highly paid. The average full-time docker earned

[7] In some ports there actually appears to have been a shortage of dock workers after deregulation.

[8] Break-bulk shipping refers to the traditional method of transporting goods in much smaller containers such as boxes, barrels or pallets.

about 30% more than the average male worker in Britain in the mid-1960s (Levinson, 2006).[9] In the UK, dock-work was highly regulated by the statutory National Dock Labour Scheme (NDLS) of 1947. Under the NDLS, only registered employers were allowed to hire registered dock-workers to perform dock-work. Dock-workers had high levels of unionisation and industrial disputes were common before the introduction of containers (Turnbull, 2012). The introduction of containers caused further industrial conflict: unions imposed a ban on container ships at Tilbury docks in January 1968, which lasted until April 1970. The dispute resulted in the negotiation of a new Dock Labour Scheme, although there were continuing industrial disputes throughout the period of containerisation. The new Dock Labour Scheme introduced permanent employment arrangements[10] and prevented non-registered dockers from working in ports covered by the scheme (Turnbull et al., 1996). Voluntary severance was also offered with generous severance pay. In 1972, another agreement was reached which prevented the use of compulsory redundancy. Even if the port employer went out of business, the worker would be offered dock-work with another employer if he was unwilling to accept voluntary severance (Turnbull and Wass, 1994).

During this period of industrial disputes, an alternative port at Felixstowe was developed (essentially by installing new equipment) which, within a few years, became the largest UK container port. London docks (with the exception of Tilbury) closed from 1967 onwards, with the final closures occurring in 1983.[11] The Dock Labour Scheme, and its associated full employment protection, was finally abolished in 1989, which led to large-scale dismissals in a short period of time. At some ports the entire registered dock labour force was dismissed, and over 7,200 dockers were declared redundant between 1989 and 1992 (Turnbull, 1992; Turnbull and Wass, 1994).

Figure 1 plots the number of dock-workers and the total number of people employed in the port industry between 1961 and 2011. The number of dockers declines slightly from 1961, but falls more quickly as containerisation takes hold from the late 1960s onwards. The total number employed in the Port and inland water transport industry also falls dramatically. Between 1961 and 2001 the industry lost over 72% of its employment, while the occupation of "dock-worker" lost over 90%. The effective disappearance of dock-workers accounted for 60% of the total fall in employment in the industry.

[9] This partly reflected a compensating differential: dock-work was difficult and dangerous, with a high accident rate (Vigarié, 1999).

[10] Previously many dock-workers were hired on a daily basis from the pool of registered workers.

[11] Source: Port of London Authority.

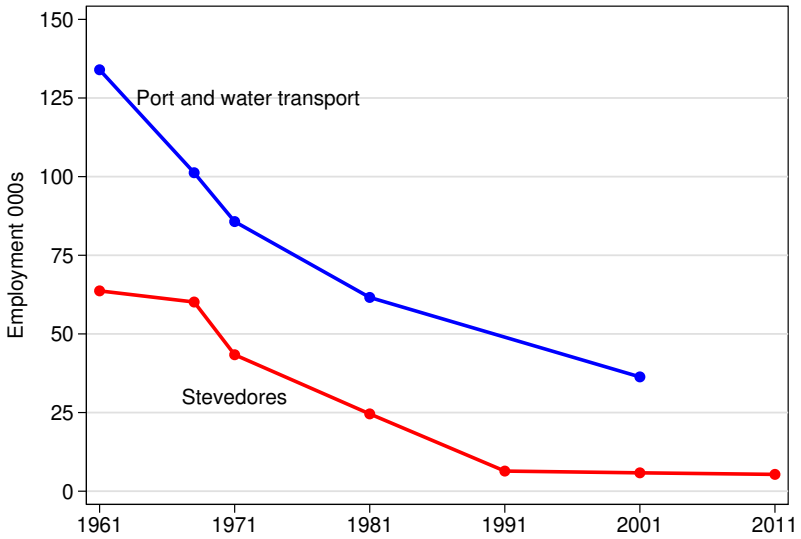

Figure 1. Employment (000s) in port industries and stevedore occupations 1961–2011 in Great Britain. Source: produced by authors based on published census 10% tables (1961, 1971 and 2001), New Earnings Survey (1981, 1991) and Digest of Port Statistics (1968). Industry employment for 1961-1981 is employment in "Port and inland water transport" whereas 2001 is employment in "Water transport" and is therefore not directly comparable. Industry figures are for England and Wales only. Occupation employment is employment as "Stevedore and dock labourer" in Great Britain. Figure for 1967 stevedores is average for the first 37 weeks of 1967 and does not include stevedores hired by ports not covered by the Dock Labour Scheme. The number employed in ports in 1968 does not include inland waterways.

3 District-level evidence

In this section we provide evidence that the process of containerisation had long-lasting effects at the level of the local labour market. We do this by comparing the labour market performance of districts which contained a major port in the 1960s with those that did not. An advantage of this approach is that we can use published census data which includes 1961 (clearly before any containerisation had started), and which covers 10% of the population, rather than 1% as in our worker-level data.

Figure 2 illustrates the location of the major ports which were in operation in England and Wales in the late 1967, before the process of containerisation began in the UK.[12] Also shown are the local authority boundaries which existed at this time in England and Wales.[13] Figure 2 shows clearly the importance of the traditional ports of London and Liverpool before containerisation, and also that port activity was quite widely spread at this time. Figure 3 shows the geographic distribution of workers in port-related industries, aggregated from the 1971 Longitudinal Study.[14] As we would expect, we find concentrations of dock workers in exactly those local authorities which also contained major ports.

In Figure 4 we plot the employment and unemployment rates of port local authorities against non-port local authorities over the period 1961–2011. Panel (a) shows that in 1971 the employment rate in port local authorities was slightly higher than non-port local authorities, but experienced a steeper decline between 1971 and 1981 and did not start to recover until the 1991–2001 period. The employment gap between the two groups of districts is significantly wider even in 2011 than it was in 1961. Panel (b) shows a consistent pattern for the unemployment rate, although here the port-districts already had worse performance in 1971.

Panel (c) of Figure 4 shows the precipitous decline in manufacturing employment that has occurred in the UK over the last fifty years. This decline has been even greater for local authorities which contained major ports in 1961. Finally, panel (d) confirms that employment in transport-related industries was nearly twice as high in port local authorities in 1961 (and in fact increased between 1961 and 1971), but then declined. The timing of these changes is entirely consistent with the idea that the introduction of containers reduced employment both in ports but also in the associated manufacturing industries.

The above graphs may mask very interesting variations in employment patterns across port locations. For instance, the London Docks completely shut down following containerisation (see Section 2). One therefore expects the London labour markets to be especially affected by the technological change. The Port of Liverpool, which was second only to the

[12] Table A1 shows that these major ports accounted for 95% of foreign sea tonnage in 1967. Information from `ports.org.uk` suggests that there were an additional 80 minor commercial ports in existence.

[13] The organisation of local government in England and Wales changed significantly in 1974 following the Local Government Act 1972.

[14] We describe this data more fully in Section 4. The Longitudinal Study is not available before 1971.

Figure 2. Location of the largest English and Welsh ports (measured by foreign tonnage) in 1967 (Digest of Port Statistics 1968). See Table A1 in Appendix A for a list of major ports. The size of each circle is proportional to that port's foreign tonnage in 1967.

Port of London before the technological change in terms of activity, faced severe disruptions but did re-open in the early 1970s. The port was converted into a modern container port and reopened for business in 1972.

In Figure 5, we present evidence from the local London and Liverpool labour markets and compare them with employment patterns in non-port districts. The patterns observed in Figure 4 are seen again, but are more extreme. The employment rate in London fell by nearly 13 percentage points between 1961 and 1991, and went from having an employment rate far higher than in non-port districts to having one which was lower. Liverpool's employment rate grew between 1961 and 1971 but then also collapsed faster than in non-port districts between 1971 and 1991. These changes are mirrored in the unemployment rate, with both London and Liverpool experiencing larger increases than in non-port districts. From 1971

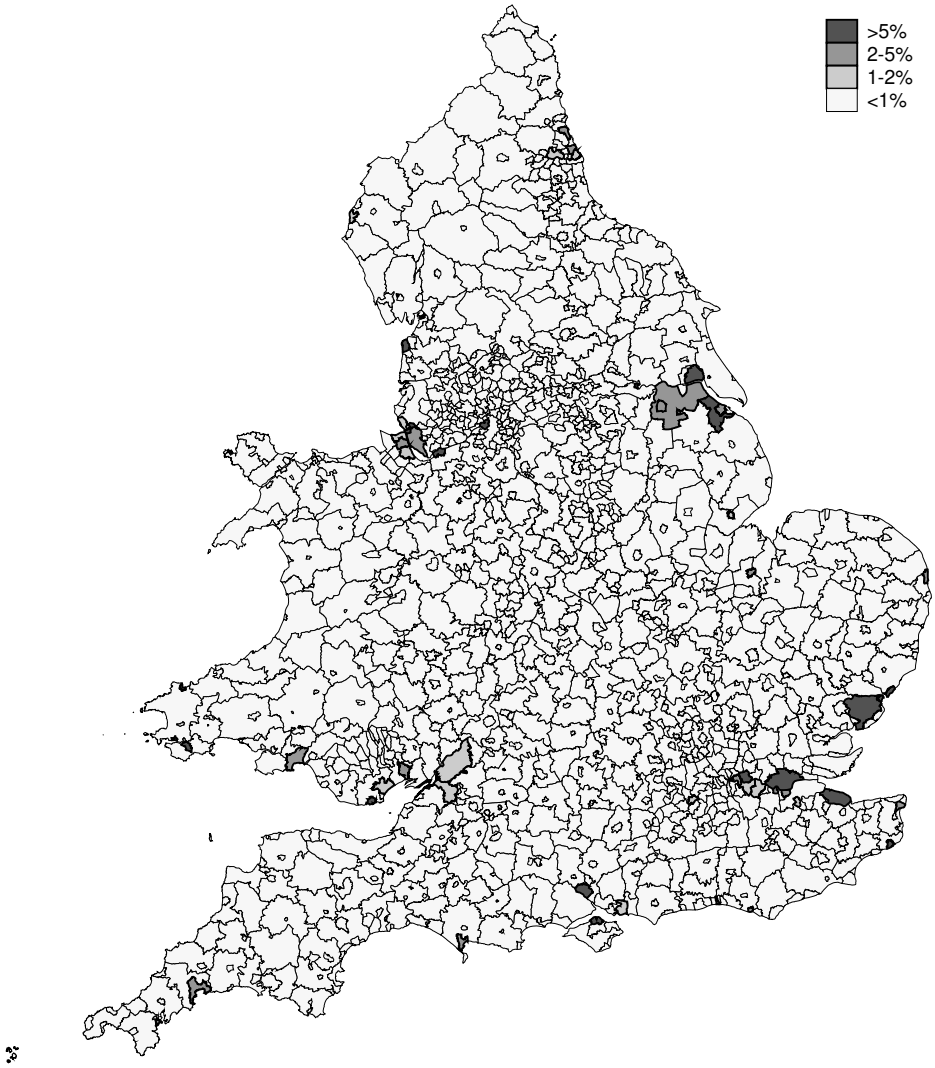

Figure 3. Employment in port-related industries in each Local Authority district in 1971 (Authors' calculations from the 1971 Longitudinal Study). The classification of Local Authorities which contained ports is given in Table A2 in Appendix A.

to 2011 manufacturing and transport employment fell faster in London and Liverpool than in non port-districts, and it is striking that transport employment in London and Liverpool is today barely higher than in non-port districts.

The evidence from local labour markets can be summarised by a district-level difference-in-difference model:

$$y_{dt} = \alpha + \beta D_d + \sum_{s=1981}^{2011} \gamma^s T_t^s + \sum_{s=1981}^{2011} \delta^s (T_t^s \times D_d) + \varepsilon_{dt}, \tag{1}$$

where the dependent variable is the relevant rate (employment, unemployment etc) in district d at time t, and the treatment indicator D_d takes the value 1 if d is a district containing a major port and 0 otherwise. The base year is 1971, rather than 1961 because it was not

Figure 4. Panel (a) shows proportion of population aged 16+ in employment. Panel (b) shows proportion of economically active in unemployment. Panel (c) shows proportion of employment in manufacturing industries. Panel (d) shows proportion of employment in transport industries. Source: UK Census data. Districts containing major ports are identified in Table A2 in Appendix A. The definition of "districts" changes considerably over time (section 3). "Transport industries" are not consistently defined in the 1981 census tables and this year is excluded from panel (d).

possible to construct a consistent district-level series between 1961 and 1971 (because of the redrawing of district boundaries) and because published census tables from 1961 do not cover all districts. The treatment group will in this case be quite broad, and will include many workers who were not directly employed by docks. However, as we argued in the introduction, the containerisation of the docks had profound effects not only on dock-workers, but also on workers whose firms were located close to docks or whose firms provided services related to shipping.

The results are shown in Table 1. The estimate of β shows that the employment rate in 1971 was not significantly different in port districts relative to non-port districts, but the unemployment rate, proportion of employment in manufacturing and the proportion of employment in transport were all significantly higher. The estimates of δ then show how these rates evolved over the next 40 years. Employment rates in port districts are still significantly lower (3.7pp) than those in non-port districts, even in 2011. However, the unemployment

Figure 5. See notes for previous figure. "London" and "Liverpool" refers to those local authority districts within London and Liverpool which contained major ports in the 1960s; see Table A2 in Appendix A.

effect seems to have been less permanent. Presumably this reflects the fact that those workers who lost their jobs as a result of containerisation and the exodus of manufacturing jobs eventually retired or left the area. In the third and fourth column we see that, relative to non-port districts, manufacturing and transport employment is still significantly lower than it was in 1971.

The district-level results from this section suggest that labour markets which contained a major port in the 1960s fared worse than labour markets which did not contain a major port, and that this difference has persisted for many years. Furthermore, the graphical evidence suggests that this difference coincided with the introduction of containerisation in UK ports. This is at least suggestive of the idea that (a) the effects of containerisation were felt more generally than simply within the docks and (b) these effects were very long-lasting.

However, this evidence does not control for the characteristics of the workers or the industries in each district. It seems plausible, for example, that districts which contained ports had different occupational and industrial structures and that these districts might have fared worse than other districts regardless of the introduction of containerisation. In addition, the

	Emp. rate	Unemp. rate	Manuf. rate	Trans. rate
β	0.006	0.015***	0.032**	0.053***
	(0.006)	(0.002)	(0.013)	(0.006)
δ^{1981}	−0.018***	0.009***	−0.042***	
	(0.004)	(0.004)	(0.008)	
δ^{1991}	−0.039***	0.018***	−0.061***	−0.033***
	(0.006)	(0.004)	(0.010)	(0.005)
δ^{2001}	−0.047***	0.004	−0.054***	−0.041***
	(0.008)	(0.003)	(0.010)	(0.006)
δ^{2011}	−0.037***	0.003	−0.047***	−0.045***
	(0.007)	(0.003)	(0.012)	(0.006)
Number of obs.	6,830	6,830	6,830	5,464
Number of districts	1,366	1,366	1,366	1,366
R^2	0.311	0.389	0.418	0.194

Table 1. District level difference-in-difference estimates (1971–2011). Table reports estimates of Equation (1). "Transport industries" are not consistently defined in the 1981 census tables and this year is excluded from the final column.

district-level evidence does not tell us directly about adjustment costs. If, for example, workers move from declining districts (such as those containing ports) to expanding districts, then adjustment costs may be low even though there are large differences in employment growth between districts. In the next section therefore we turn to individual level data which allow us to track incumbent workers, and which allow us to control for the pre-existing characteristics of workers, including occupation and industry.

4 Data and Research Design

Individual micro-level data for England and Wales is taken from the Office for National Statistics Longitudinal Study (LS).[15] The sample comprises individuals born on one of four selected dates during the year, and therefore represents slightly more than 1% of the population of England and Wales. Records are linked across each 10-year census from 1971 to 2011. A weakness of our data is therefore that we first observe workers a few years after the process of containerisation started. Nevertheless, Figure 1 suggests that about two-thirds of stevedores remained by 1971. The data include information on occupation, economic activity, housing, ethnicity, age, sex, marital status and education as well as geographic data. As well as census records, the LS also contain information on events including death and migrations.

The data allows us to follow a sample of employed men in 1971 and trace patterns of employment or re-employment (in new occupations, industries and places of work), unem-

[15] This information on the LS is taken from http://celsius.lshtm.ac.uk/what.html.

ployment or inactivity. Because we can do this over a long time period we can capture, for most workers, their entire working lives. We focus on groups of workers who were likely to have been affected by the introduction of containers. These groups include dock-workers, workers in port industries and workers who work close to docks. We compare these groups to observationally similar workers who are less directly affected by the process of containerisation.

Our complete sample comprises 201,091 individuals who were employed at the time of the census in April 1971 as employees, apprentices, foremen and managers.[16] From these we select only men, since all the individuals identified as stevedores in 1971 were men. This leaves us with 124,335 male workers observed in 1971. The first row of Table 2 shows that 83% of these workers are also observed 10 years later in the 1981 census. About half of those who are not observed in subsequent censuses have died; the remainder could not be traced by ONS. The attrition rate increases over each 10-year interval because the sample ages and therefore the proportion dying increases. The remaining rows of Table 2 summarises our main treatment and control groups.

The first treatment group $D1$ is defined by occupation. The UK classification of occupations in use at the time of the 1971 census (Office for Population Censuses and Surveys, 1970) has a specific category for "Stevedores and dock labourers." We find 397 individuals in this occupational group, which is very consistent with the estimated number of stevedores from the published census tables (see Figure 1). Rather than using all workers who are not stevedores as a control group, we restrict the control group to include only those workers in social classes 3 ("skilled manual") and 5 ("unskilled"), since all stevedores fall into these classes. We also restrict the control group to exclude workers in transport industries to avoid the potential problem that containerisation had effects on other industries in the transport sector.

The second treatment group $D2$ is defined by industry. The UK classification of industries at the time of the 1971 census (Central Statistical Office, 1970) has a classification for "Port and inland water transport". We find 759 men in this industry, which again is consistent with the estimates from published census tables shown in Figure 1. As for $D1$, we also restrict the control group to exclude workers in transport industries.

The third treatment group $D3$ is defined by geography. Using the districts defined in Section 3 (i.e. those that contained major ports in 1971), a worker is in treatment group $D3$ if their place of work falls in one of those districts in 1971, and is in the control group otherwise. To make the distinction between the geographically defined treatment and control groups more clear-cut, we also define two alternative control groups. In $D3a$ we include in the control group only workers whose place of work is in Counties (larger geographic areas)

[16] ONS estimates from survey data that total employment in Spring 1971 was 24.5m, suggesting that our sample is slightly less than 1% (Lindsay and Doyle, 2003).

		1971	1981	1991	2001	2011
	Original sample, excluding self-employed and those above 65 in 1971	124,335	102,860	86,585	66,876	49,450
$D1 = 1$	All stevedores in 1971	397	344	272	191	123
$D1 = 0$	All non-stevedores in unskilled and skilled manual occupations in 1971	51,706	42,707	35,709	27,356	20,206
$D2 = 1$	All workers in port industry in 1971	759	639	501	361	234
$D2 = 0$	All workers not in the transport industry in 1971	112,930	93,375	78,652	60,967	45,268
$D3 = 1$	All workers in districts with a major port in 1971	23,134	19,098	16,055	12,364	9,153
$D3 = 0$	All workers in districts with no major port in 1971 (excludes workers in transport industry)	93,153	77,082	64,933	50,357	37,360
$D3a = 1$	All workers in districts with a major port in 1971	23,134	19,098	16,055	12,364	9,153
$D3a = 0$	All workers in counties with no major port in 1971 (excludes workers in transport industry)	35,821	29,860	25,298	19,732	14,723
$D3b = 1$	All workers in districts with a major port in 1971	23,134	19,098	16,055	12,364	9153
$D3b = 0$	All workers in districts more than 20km from any port (excludes workers in transport industry)	56,560	46,980	39,674	30,789	23005

Table 2. Definition of control and treatment groups. The sample includes only men; all of the workers identified as stevedores in 1971 were men.

which do not contain any major ports. Thus for example all workers in London are excluded from this control group. In $D3b$ we include in the control group only workers whose place of work is at least 20km from any port.[17]

Once we have defined the treatment and control groups, we require information on those same workers in each of the following censuses up to 2011. We create a panel with five observations for each individual ($t = 1971, 1981, 1991, 2001, 2011$). Define y_{it} to be the outcome of individual i at time t. These outcomes will be indicator variables capturing employment status, occupational mobility, geographic mobility and mortality. Define D_i to be an indicator variable which takes the value 1 if individual i is in the treatment group in 1971 and 0 otherwise. Define T_{it}^{81} to be an indicator variable which takes the value 1 if observation i refers to year 1981. T_{it}^{91}, T_{it}^{01} and T_{it}^{11} are defined analogously.

We measure the effect of containerisation by comparing the evolution of y_{it} between individuals in the treatment group and those in the control group. In each case the base year (1971) is such that everyone in the sample has $y_{it} = 1$ because everyone in the sample is in employment (or in the census) in that year, or because their mobility status is undefined. Therefore we estimate a simplified difference model (rather than a difference-in-difference model as before):

$$y_{it} = \alpha + \sum_{s=1991}^{2011} \gamma^s T_t^s + \sum_{s=1981}^{2011} \delta^s (T_t^s \times D_i) + \varepsilon_{it}. \tag{2}$$

The coefficients γ^s capture the evolution of y_{it} over the next three decades for individuals in the control group, while the δ^s coefficients capture the difference in the evolution of y_{it} for the treatment group.

We also need to consider pre-existing observed differences between the treatment and control groups in 1971. For example, the treatment and control group may differ in terms of age, education, occupation and so on. To illustrate the differences between the treatment and control groups in terms of their characteristics, Table 3 compares the mean values for each treatment/control comparison.

For definitions $D1$ and $D2$, the treatment group is significantly older, more likely to be married and more likely to have educational qualifications below A-level.[18] For definition $D3$ (based on geography) the treatment and control groups the pre-existing differences in personal characteristics are much smaller. By definition, the industry and occupation of the treatment and control groups differ for definitions $D1$ and $D2$. 91% of the $D1$ treatment group report that they work in the transport industry. Note that we exclude from the $D1$ and $D2$ control groups those working in transport, to avoid possible spillover effects. 77% of the

[17] Distances are computed between the midpoint of each Local Authority using geodetic distances (Picard, 2010).

[18] Unfortunately the census educational classification from 1971 does not distinguish between any educational qualifications below A-level, which covers the great majority of the sample.

	$D1$ (stevedores vs. other occupations)			$D2$ (port industry vs. other industries)			$D3$ (port district vs. other districts)		
	$D1=1$	$D1=0$	p-value	$D2=1$	$D2=0$	p-value	$D3=1$	$D3=0$	p-value
Age	42.89	38.84	[0.000]	43.54	39.10	[0.000]	39.39	39.22	[0.091]
Marital status (1=single)	0.10	0.24	[0.000]	0.12	0.24	[0.000]	0.23	0.23	[0.382]
Higher degree	0.00	0.00	[0.831]	0.00	0.01	[0.105]	0.01	0.01	[0.014]
Other Degree	0.00	0.00	[0.635]	0.01	0.05	[0.000]	0.05	0.05	[0.086]
Other qualif. above A-level	0.00	0.01	[0.145]	0.01	0.04	[0.000]	0.04	0.04	[0.674]
A-level	0.01	0.03	[0.011]	0.03	0.07	[0.000]	0.07	0.06	[0.098]
Below A-level	0.99	0.96	[0.006]	0.95	0.83	[0.000]	0.84	0.84	[0.018]
Primary industry	0.00	0.06	[0.000]	0.00	0.05	[0.000]	0.01	0.06	[0.000]
Manufacturing	0.06	0.58	[0.000]	0.00	0.48	[0.000]	0.40	0.45	[0.000]
Construction	0.00	0.14	[0.000]	0.00	0.09	[0.000]	0.08	0.08	[0.315]
Energy	0.00	0.03	[0.002]	0.00	0.03	[0.000]	0.03	0.02	[0.000]
Transport	0.91	0.00		1.00	0.00		0.15	0.08	[0.000]
Services	0.03	0.19	[0.000]	0.00	0.35	[0.000]	0.34	0.31	[0.000]
Professional	0.00	0.00		0.01	0.05	[0.000]	0.05	0.05	[0.036]
Intermediate	0.00	0.00		0.08	0.17	[0.000]	0.17	0.16	[0.006]
Skilled non-manual	0.00	0.00		0.12	0.12	[0.959]	0.15	0.11	[0.000]
Skilled manual	0.23	0.84	[0.000]	0.28	0.38	[0.000]	0.36	0.40	[0.000]
Partly skilled	0.00	0.00		0.14	0.18	[0.001]	0.17	0.19	[0.000]
Unskilled	0.77	0.16	[0.000]	0.37	0.07	[0.000]	0.09	0.07	[0.000]
Other occupation	0.00	0.00		0.00	0.02	[0.000]	0.01	0.02	[0.000]
North	0.05	0.08	[0.016]	0.04	0.07	[0.011]	0.09	0.06	[0.000]
Yorkshire and Humberside	0.11	0.12	[0.846]	0.10	0.10	[0.759]	0.05	0.11	[0.000]
North West	0.20	0.14	[0.001]	0.25	0.14	[0.000]	0.28	0.10	[0.000]
East Midlands	0.01	0.08	[0.000]	0.01	0.07	[0.000]	0.00	0.09	[0.000]
West Midlands	0.00	0.13	[0.000]	0.00	0.12	[0.000]	0.00	0.14	[0.000]
East Anglia	0.02	0.03	[0.136]	0.02	0.03	[0.131]	0.03	0.03	[0.063]
South East	0.49	0.29	[0.000]	0.44	0.35	[0.000]	0.37	0.35	[0.000]
South West	0.06	0.06	[0.487]	0.06	0.07	[0.373]	0.09	0.07	[0.000]
Wales	0.07	0.06	[0.466]	0.08	0.05	[0.001]	0.09	0.04	[0.000]
Male unemployment rate (ward)	6.10	4.19	[0.000]	5.59	3.89	[0.000]	4.83	3.70	[0.000]
% unskilled workers (ward)	14.49	8.32	[0.000]	12.38	7.45	[0.000]	9.51	7.07	[0.000]
% semi-skilled workers (ward)	19.59	17.53	[0.000]	18.65	16.73	[0.000]	16.92	16.70	[0.000]
Number of observations	397	51,706		759	112,930		23,134	101,201	

Table 3. Pre-existing differences in sample characteristics in 1971.

$D1$ treatment group are classified as being in social class 5 ("unskilled") and 23% in social class 3 ("skilled manual"). We therefore restrict the $D1$ control group to the same social classes, but note that their distribution across those two classes is completely different. 69% of the $D1$ treatment group have their workplace in the South East and the North West (see Figure 2). We also note that for all three classification $D1$, $D2$ and $D3$, the local labour market unemployment rate and the proportion of unskilled employment in 1971 are significantly higher for the treatment groups than the control groups.

We use two methods to control for these pre-existing differences. First, we include the full set of covariates described in Table 3 in Equation (2). Second, we explicitly "match" treatment observations with observationally similar control observations using the propensity score method proposed by Rosenbaum and Rubin (1983). The propensity score $p(\mathbf{x})$ is defined as the probability of being in the treatment group given a set of pre-existing observable

characteristics, $\mathbf{x}$:

$$p(\mathbf{x}) = \Pr\{D_i = 1 \mid \mathbf{x}_i\}.$$

The scores are estimated from a logit model. The matching method has the advantage that it imposes a common support on the treated and untreated observations. That is, we only include in the control group those observations whose characteristics are such that they have a propensity score similar to some observations in the treatment group. In practice, this means we compare dock-workers, those who work in port industries, or those who work in port districts to workers who were observably similar in 1971. Because we typically have a very large control group we choose the 100 nearest matches to each treated observation but restrict matches to be within 0.001 of the propensity for treated observations.

In Table 4 we report the means of the treatment and control groups after matching. In contrast to Table 3, the observable characteristics of the treated and control samples are almost all insignificantly different from each other. For sample $D1$ we match within occupation, which is why the sample is perfectly balanced across skilled manual (25%) and unskilled (75%). Note that for $D1$ we do not match on industry because the treatment group consists almost entirely of workers in the transport sector, while the control group excludes the transport sector. Similarly for sample $D2$ we do not match on sector because the treatment and control groups are defined by sector. Almost all the treatment observations in Table 3 are also in the matched samples shown in Table 4, which shows that almost all treated observations have one or more observations from the control group with similar characteristics. Thus, the effect of matching is to select from the full control group a subset of observations which are more similar to the treatment group. For example, the matched control group $D1 = 0$ comprises $11,886$ observations drawn from the original control group of $51,706$.

After matching, the effect of containerisation is estimated as the average treatment effect on the treated; see Eqn (25.40) in Cameron and Trivedi (2005) for example. In practice, this is achieved by estimating Equation (2) on the matched treatment and control groups where the observations in the control group are weighted by the weights obtained from the propensity score matching.

	$D1$ (stevedores vs. other occupations)			$D2$ (port industry vs. other industries)			$D3$ (port district vs. other districts)		
	$D1=1$	$D1=0$	p-value	$D2=1$	$D2=0$	p-value	$D3=1$	$D3=0$	p-value
Age	43.02	43.01	[0.974]	43.64	43.69	[0.945]	39.19	39.20	[0.932]
Marital status (1=single)	0.09	0.09	[0.275]	0.12	0.13	[0.727]	0.23	0.23	[0.206]
Higher degree	0.00	0.00		0.001	0.001	[0.989]	0.01	0.01	[0.743]
Other Degree	0.00	0.00		0.02	0.02	[0.581]	0.05	0.06	[0.315]
Other qualif. above A-level	0.00	0.00		0.01	0.01	[0.646]	0.04	0.05	[0.317]
A-level	0.01	0.01	[0.599]	0.03	0.03	[0.872]	0.07	0.07	[0.491]
Below A-level	0.99	0.99	[0.599]	0.95	0.94	[0.530]	0.82	0.82	[0.093]
Primary industry							0.01	0.01	[0.791]
Manufacturing							0.47	0.47	[0.480]
Construction							0.10	0.09	[0.544]
Energy							0.03	0.03	[0.360]
Transport							0.00	0.00	
Services							0.39	0.40	[0.484]
Professional	0.00	0.00		0.01	0.02	[0.767]	0.06	0.06	[0.293]
Intermediate	0.00	0.00		0.08	0.08	[0.843]	0.18	0.18	[0.106]
Skilled non-manual	0.00	0.00		0.12	0.12	[0.698]	0.15	0.16	[0.175]
Skilled manual	0.25	0.25	[1.000]	0.29	0.28	[0.805]	0.36	0.35	[0.134]
Partly skilled	0.00	0.00		0.14	0.14	[0.859]	0.16	0.16	[0.234]
Unskilled	0.75	0.75	[1.000]	0.36	0.37	[0.678]	0.08	0.08	[0.746]
Other Occupation	0.00	0.00		0.00	0.00	[0.805]	0.01	0.01	[0.253]
North	0.05	0.05	[0.863]	0.04	0.04	[0.780]	0.09	0.10	[0.001]
Yorkshire and Humberside	0.11	0.12	[0.514]	0.10	0.09	[0.780]	0.05	0.04	[0.000]
North West	0.18	0.19	[0.078]	0.24	0.25	[0.765]	0.28	0.27	[0.180]
East Midlands	0.01	0.01	[0.863]	0.01	0.01	[0.641]	0.00	0.00	[0.942]
West Midlands	0.00	0.00	[0.054]	0.00	0.01	[0.236]	0.00	0.00	[0.013]
East Anglia	0.02	0.02	[0.787]	0.02	0.02	[0.958]	0.03	0.03	[0.689]
South East	0.49	0.48	[0.263]	0.44	0.43	[0.626]	0.36	0.36	[0.538]
South West	0.06	0.06	[0.466]	0.07	0.07	[0.884]	0.09	0.10	[0.023]
Wales	0.07	0.07	[0.454]	0.08	0.08	[0.888]	0.09	0.09	[0.623]
Male unemployment rate (ward)	5.72	5.89	[0.010]	5.40	5.56	[0.451]	4.71	4.61	[0.003]
% of unskilled workers (ward)	13.47	13.42	[0.706]	11.91	12.05	[0.736]	9.20	9.09	[0.066]
% of semi-skilled workers (ward)	19.45	19.77	[0.002]	18.63	18.54	[0.275]	16.75	16.52	[0.000]
Number of observations	361	11,886		720	35,983		19,053	75,582	

Table 4. Pre-existing differences in sample characteristics in 1971, after propensity score matching. Sample $D1$ are matched within occupations. Industry is not used for matching sample $D1$ because the treatment group consists almost entirely of those working in the transport sector and the control group excludes the transport sector.

5 Results

In this section, we present the results from estimating Equation (2) using the treatment and control group definitions given in Table 2. We estimate a number of models to examine the extent to which the treatment group experienced differential rates of: (1) attrition and mortality, (2) labour market states, (3) geographic and occupational mobility.

5.1 Attrition and mortality

We start by considering the extent to which the treatment and control groups differ in terms of their appearance in the LS. As shown in Table 2, the proportion of individuals who can be linked across 10-year intervals declines from 83% in 1971-1981 to 74% in 2001–2011. Model (1) "In census" therefore examines whether the treatment group are more likely to exit the sample. Of the exits from the sample, around half are not linked because of death of the respondent. The LS records year of death, from which we create an indicator variable which takes the value 1 if the respondent has died before the following census date. Model (2) "Died" therefore examines whether the treatment group are more likely to die.[19] Estimates of Models (1) "In census" and (2) "Died" are shown in Table 5. We estimate each model using treatment and control groups $D1$, $D2$ and $D3$ as defined in Table 2. The top panel shows the raw differences between the treatment and control groups, while the bottom panel shows the differences after matching on observable characteristics.[20]

In panel (a) of Table 5 estimates of α and γ are very similar for samples $D1$, $D2$ and $D3$ because the (very large) control groups are similar in all three samples. Estimates of α shows that 83% of the control group remain in the sample in 1981, while the estimates of γ^s show that a further 13.5% of the control group leave the sample by 1991, 29.7% by 2001 and so on. The estimates of δ for samples $D1$ and $D2$ show that the treatment group had higher attrition rates in 2001 and 2011. In other words, workers who were stevedores in 1971 or who worked in port industries in 1971 are less likely to be observed in the sample in 2001 and 2011. However, for sample $D3$ the differences between the treatment and control groups are much smaller and generally insignificantly different from zero. Estimates of Model (2) show that this difference in attrition rates between the treatment and control groups is entirely due to different death rates. For example, the $D1$ treatment group are 8.1pp less likely to appear in the sample in 2011 than the control group ($\delta^{2011} = -0.081$ with a standard error of 0.023), and this is entirely explained by the fact that they are 9.8pp more likely to have died by 2011 ($\delta^{2011} = 0.098$ with a standard error of 0.025).

[19] Note that if an individual attrits without a recorded year of death then mortality is missing, so the mortality outcome is conditional on appearance in the LS up until the previous census.

[20] For reasons of space, OLS estimates are reported in Appendix C.

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Model (1) In census	Model (2) Died	Model (1) In census	Model (2) Died	Model (1) In census	Model (2) Died
(a) Raw differences						
α	0.826^{***}	0.081^{***}	0.827^{***}	0.079^{***}	0.827^{***}	0.079^{***}
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
γ^{1991}	-0.135^{***}	0.143^{***}	-0.130^{***}	0.137^{***}	-0.130^{***}	0.137^{***}
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
γ^{2001}	-0.297^{***}	0.316^{***}	-0.287^{***}	0.306^{***}	-0.287^{***}	0.306^{***}
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
γ^{2011}	-0.435^{***}	0.478^{***}	-0.426^{***}	0.467^{***}	-0.426^{***}	0.467^{***}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
δ^{1981}	0.041^{**}	-0.012	0.015	0.022^{**}	-0.002	0.002
	(0.017)	(0.013)	(0.013)	(0.011)	(0.003)	(0.002)
δ^{1991}	-0.005	0.020	-0.036^{**}	0.064^{***}	-0.003	0.005
	(0.023)	(0.022)	(0.017)	(0.017)	(0.003)	(0.003)
δ^{2001}	-0.048^{*}	0.051^{**}	-0.064^{***}	0.089^{***}	-0.006^{*}	0.007^{*}
	(0.025)	(0.026)	(0.018)	(0.019)	(0.004)	(0.004)
δ^{2011}	-0.081^{***}	0.098^{***}	-0.093^{***}	0.119^{***}	-0.005	0.008^{**}
	(0.023)	(0.025)	(0.017)	(0.018)	(0.004)	(0.004)
Number of obs.	208,412	193,905	454,756	421,673	465,148	431,429
Number of ind.	52,103	49,965	113,689	108,810	116,287	111,322
R^2	0.114	0.150	0.109	0.146	0.109	0.146
(b) Matched on 1971 characteristics						
α	0.766^{***}	0.099^{***}	0.786^{***}	0.104^{***}	0.826^{***}	0.079^{***}
	(0.008)	(0.005)	(0.004)	(0.003)	(0.002)	(0.001)
γ^{1991}	-0.160^{***}	0.179^{***}	-0.169^{***}	0.188^{***}	-0.130^{***}	0.137^{***}
	(0.009)	(0.008)	(0.006)	(0.006)	(0.002)	(0.002)
γ^{2001}	-0.363^{***}	0.412^{***}	-0.363^{***}	0.407^{***}	-0.290^{***}	0.310^{***}
	(0.011)	(0.011)	(0.006)	(0.006)	(0.003)	(0.002)
γ^{2011}	-0.507^{***}	0.597^{***}	-0.510^{***}	0.584^{***}	-0.432^{***}	0.474^{***}
	(0.010)	(0.010)	(0.006)	(0.005)	(0.003)	(0.003)
δ^{1981}	0.107^{***}	-0.026^{*}	0.056^{***}	0.001	0.001	0.001
	(0.019)	(0.015)	(0.014)	(0.012)	(0.003)	(0.002)
δ^{1991}	0.081^{***}	-0.029	0.045^{**}	-0.011	0.000	0.003
	(0.026)	(0.025)	(0.018)	(0.018)	(0.004)	(0.004)
δ^{2001}	0.065^{**}	-0.045	0.050^{**}	-0.031	0.003	-0.002
	(0.028)	(0.029)	(0.019)	(0.020)	(0.004)	(0.004)
δ^{2011}	0.043^{*}	-0.029	0.031^{*}	-0.020	0.007	-0.005
	(0.025)	(0.028)	(0.018)	(0.019)	(0.004)	(0.005)
Number of obs.	48,988	45,186	146,812	136,691	378,540	350,773
Number of ind.	12,247	11,653	36,703	35,193	94,635	90,534
R^2	0.175	0.216	0.159	0.196	0.110	0.147

Table 5. Differences in attrition rates and mortality between treated and control groups, 1981–2011.

The raw differences in attrition and mortality shown in panel (a) do not account for the significant differences in the characteristics of the treatment and control groups shown in Table 3. Most obviously, stevedores ($D1 = 1$) and those who work in port industries ($D2 = 1$) are older and less educated than the control groups. In panel (b) of Table 5 we therefore report estimates of Equation (2) after matching on characteristics in 1971. The process of matching fundamentally changes the composition of the control group. Comparing the sample sizes in Table 3 with Table 4, we can see that almost all of the $D1$ treatment group are in the matched sample (361 out of 397), but these are matched to only a small fraction of the control group (11,886 out of 51,706). The matched control group are more than four years older than the unmatched control group and they are also far more likely to be in unskilled occupations (75% in the matched control group compared to 16% in the unmatched control group).

These changes to the composition of the control group have large effects on the outcomes shown in Table 5. Consider the attrition rate and mortality rate of the control group. In panel (a) column 1 γ^{2011} is estimated to be -0.435; this increases to -0.507 in panel (b). Similarly, the mortality rate increases from 0.478 to 0.597. Similar increases are observed for sample $D2$. Note that matching has much smaller effects for sample $D3$ because the treatment and control groups are more similar before matching. Now, the matched estimates of δ^s no longer indicate that the treatment group had worse outcomes. δ^s is now positive for Model (1) and negative for Model (2) for all $s = 1981, \ldots, 2011$. Thus, once we restrict the control group to consist of men who are observably similar to stevedores or to those who work in the port industry, the treatment group do *not* have higher attrition rates or higher mortality rates. Indeed, if anything the treatment group have lower attrition rates, albeit the differences are only marginally significant by 2011.

5.2 Employment status

In Tables 6 and 7 we consider outcomes for different employment states. Recall that in our sample everyone in the sample is in employment in 1971. In each successive census, individuals report their labour market status at the time of the census. For men, four labour market states account for the vast majority of observations: employment (including self-employment), unemployment, retirement, sickness/disability. Models (3)–(6) take each of these four states as the dependent variable. Precise definitions of each labour market state change slightly over the 1981–2011 censuses, and are summarised in Table B1 in Appendix B.

First consider the raw probabilities of each labour market state in 1981, shown in panel (a) of Tables 6 and 7. For sample $D1$, estimates of α show that 74% of the control group are in employment, 8% are unemployed, 14% are retired and 3.7% are permanently sick or disabled. As the sample ages the proportion in employment falls and the proportion retired

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Model (3) Emp.	Model (4) Unemp.	Model (3) Emp.	Model (4) Unemp.	Model (3) Emp.	Model (4) Unemp.
(a) Raw differences						
α	0.741^{***}	0.078^{***}	0.764^{***}	0.061^{***}	0.766^{***}	0.060^{***}
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
γ^{1991}	-0.162^{***}	-0.018^{***}	-0.173^{***}	-0.011^{***}	-0.172^{***}	-0.011^{***}
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
γ^{2001}	-0.282^{***}	-0.057^{***}	-0.313^{***}	-0.042^{***}	-0.310^{***}	-0.042^{***}
	(0.004)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)
γ^{2011}	-0.408^{***}	-0.061^{***}	-0.450^{***}	-0.047^{***}	-0.448^{***}	-0.046^{***}
	(0.004)	(0.002)	(0.003)	(0.001)	(0.003)	(0.001)
δ^{1981}	-0.009	-0.025^{**}	-0.052^{***}	0.001	-0.013^{***}	0.005^{***}
	(0.024)	(0.012)	(0.018)	(0.010)	(0.003)	(0.002)
δ^{1991}	-0.174^{***}	0.025	-0.176^{***}	0.030^{**}	-0.024^{***}	0.004^{**}
	(0.030)	(0.017)	(0.022)	(0.012)	(0.004)	(0.002)
δ^{2001}	-0.145^{***}	-0.015^{***}	-0.146^{***}	-0.005	-0.037^{***}	0.003^{*}
	(0.034)	(0.005)	(0.024)	(0.006)	(0.005)	(0.001)
δ^{2011}	-0.178^{***}	-0.000	-0.156^{***}	-0.002	-0.028^{***}	0.003^{**}
	(0.033)	(0.011)	(0.024)	(0.007)	(0.005)	(0.001)
Number of obs.	126,863	126,852	279,875	279,854	286,279	286,258
Number of ind.	44,964	44,964	98,346	98,346	100,620	100,620
R^2	0.089	0.014	0.109	0.010	0.109	0.010
(b) Matched on 1971 characteristics						
α	0.666^{***}	0.118^{***}	0.680^{***}	0.082^{***}	0.763^{***}	0.061^{***}
	(0.011)	(0.008)	(0.006)	(0.004)	(0.002)	(0.001)
γ^{1991}	-0.255^{***}	-0.019	-0.239^{***}	-0.017^{***}	-0.183^{***}	-0.011^{***}
	(0.014)	(0.012)	(0.007)	(0.005)	(0.003)	(0.002)
γ^{2001}	-0.397^{***}	-0.102^{***}	-0.382^{***}	-0.066^{***}	-0.325^{***}	-0.043^{***}
	(0.015)	(0.009)	(0.008)	(0.004)	(0.004)	(0.002)
γ^{2011}	-0.497^{***}	-0.107^{***}	-0.472^{***}	-0.073^{***}	-0.461^{***}	-0.048^{***}
	(0.016)	(0.009)	(0.009)	(0.004)	(0.004)	(0.002)
δ^{1981}	0.068^{**}	-0.064^{***}	0.035^{*}	-0.023^{**}	-0.008^{*}	0.005^{**}
	(0.027)	(0.015)	(0.019)	(0.010)	(0.004)	(0.002)
δ^{1991}	-0.011	-0.018	-0.025	0.008	0.000	0.002
	(0.033)	(0.021)	(0.023)	(0.013)	(0.005)	(0.002)
δ^{2001}	0.057	-0.010	0.005	-0.002	-0.016^{***}	0.003^{*}
	(0.038)	(0.006)	(0.026)	(0.007)	(0.006)	(0.002)
δ^{2011}	-0.012	0.007	-0.058^{**}	0.004	-0.007	0.004^{**}
	(0.037)	(0.013)	(0.025)	(0.008)	(0.006)	(0.002)
Number of obs.	26,673	26,671	83,431	83,426	233,285	233,267
Number of ind.	10,149	10,149	31,108	31,108	81,921	81,921
R^2	0.161	0.028	0.150	0.016	0.115	0.010

Table 6. Differences in employment status between treated and control groups, 1981–2011.

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Model (5) Retired	Model (6) Sick	Model (5) Retired	Model (6) Sick	Model (5) Retired	Model (6) Sick
(a) Raw differences						
α	0.140***	0.037***	0.140***	0.031***	0.140***	0.031***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
γ^{1991}	0.132***	0.041***	0.145***	0.033***	0.145***	0.032***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
γ^{2001}	0.251***	0.078***	0.284***	0.064***	0.281***	0.064***
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
γ^{2011}	0.441***	0.010***	0.476***	0.005***	0.474***	0.006***
	(0.004)	(0.002)	(0.003)	(0.001)	(0.003)	(0.001)
δ^{1981}	0.017	0.021	0.036**	0.018**	0.006**	0.002
	(0.020)	(0.013)	(0.015)	(0.009)	(0.003)	(0.001)
δ^{1991}	0.066**	0.069***	0.076***	0.058***	0.013***	0.007***
	(0.029)	(0.022)	(0.022)	(0.015)	(0.004)	(0.002)
δ^{2001}	0.112***	0.060*	0.090***	0.050**	0.031***	0.003
	(0.036)	(0.031)	(0.026)	(0.021)	(0.005)	(0.003)
δ^{2011}	0.191***	0.002	0.174***	−0.011	0.026***	−0.002
	(0.038)	(0.019)	(0.027)	(0.010)	(0.006)	(0.002)
Number of obs.	126,850	122,643	279,851	269,795	286,255	275,932
Number of ind.	44,964	44,949	98,346	98,312	100,620	100,585
R^2	0.111	0.014	0.128	0.012	0.129	0.012
(b) Matched on 1971 characteristics						
α	0.148***	0.065***	0.182***	0.052***	0.138***	0.034***
	(0.008)	(0.007)	(0.005)	(0.003)	(0.002)	(0.001)
γ^{1991}	0.214***	0.043***	0.208***	0.042***	0.149***	0.038***
	(0.012)	(0.010)	(0.007)	(0.004)	(0.003)	(0.002)
γ^{2001}	0.394***	0.113***	0.369***	0.087***	0.290***	0.073***
	(0.016)	(0.016)	(0.008)	(0.007)	(0.004)	(0.003)
γ^{2011}	0.589***	−0.015	0.541***	−0.013***	0.490***	0.005***
	(0.017)	(0.013)	(0.009)	(0.004)	(0.004)	(0.002)
δ^{1981}	0.001	−0.002	−0.008	−0.001	0.005	−0.003
	(0.021)	(0.016)	(0.016)	(0.009)	(0.003)	(0.002)
δ^{1991}	−0.019	0.040*	−0.026	0.030*	0.004	−0.006**
	(0.033)	(0.024)	(0.023)	(0.015)	(0.005)	(0.003)
δ^{2001}	−0.045	0.006	−0.033	0.008	0.021***	−0.011***
	(0.041)	(0.037)	(0.028)	(0.023)	(0.006)	(0.004)
δ^{2011}	0.024	0.004	0.073***	−0.012	0.005	−0.003
	(0.044)	(0.024)	(0.028)	(0.011)	(0.007)	(0.003)
Number of obs.	26,670	25,589	83,423	79,682	233,264	224,791
Number of ind.	10,149	10,146	31,108	31,098	81,921	81,896
R^2	0.180	0.025	0.166	0.022	0.135	0.013

Table 7. Differences in retirement and sickness status between treated and control groups, 1981–2011.

or sick increases, as indicated by the estimates of γ^s. We observe similar patterns for samples $D2$ and $D3$. There are large differences between the employment patterns of the treatment and control groups in panel (a). For sample $D1$, stevedores are are 17pp less likely to be in employment in 1991, 6.6pp more likely to be retired and 6.9pp more likely to be sick or disabled. A similar picture emerges for sample $D2$, where port-industry workers are 27.6pp less likely to be in employment, 7.6pp more likely to be retired and 5.8pp more likely to be sick or disabled. We also see significant differences for sample $D3$, where the treatment group (those living in port districts) are significantly less likely to be in employment and significantly more likely to be retired or sick in 1991.[21]

Two points are striking about the raw differences in employment outcomes. First, in sample $D1$, large gaps only emerge from 1991 onwards. In fact, employment rates for stevedores are insignificantly different from those for the control group ($\delta^{1981} = -0.009$ with a standard error of 0.024); unemployment rates for stevedores are actually 2.5pp *lower* than the control group. In contrast, a negative employment gap has already emerged in 1981 for samples $D2$ and $D3$. This result is entirely consistent with the pattern of industrial relations described in Section 2. The National Dock Labour Scheme prevented any involuntary redundancy for stevedores until 1989. Second, differences in employment outcomes are vary long-lasting, with significant differences in employment rates and retirement rates even up to 2011.

Panel (b) in Tables 6 and 7 repeats the analysis after matching. As before, matching greatly changes the composition of the control group. For example, in sample $D1$ the unmatched control group have an employment rate in 1981 of 0.741; the same employment rate for the matched control group is 0.666. Similarly, the matched control group have higher rates of unemployment, retirement and disability. As a result the DiD estimates become much smaller and in most cases are no longer significantly different from zero. It is particularly noticeable that, in sample $D1$, estimates of δ^{1981} are now positive for employment (0.068 with a standard error of 0.027) and negative for unemployment (-0.064 with a standard error of 0.015). Employment guarantees clearly worked for stevedores compared to the matched control group. More surprisingly, estimates of δ^{1991}, δ^{2001} and δ^{2011} are generally small and insignificantly different from zero. Overall, employment rates for stevedores and workers in the port industry were no lower in subsequent years than for the matched control group. In part, this reflects the extremely poor employment performance of unskilled men during the period, as documented in for example Nickell and Bell (1995).

[21] One can compare the $D3$ sample results to the district-level results shown in Section 3. Table 1 shows that employment rates were between 4pp and 5pp lower in port districts between 1991 and 2011. Our estimates from the individual-level results are similar (2.4pp in 1991 and 3.7pp in 2001).

5.3 Geographical and occupational movement

One possible effect of containerisation is to force workers to move to different geographical areas, or to change occupation. The LS includes an indicator for whether the respondent is living at a different address as 10 years previously, and we use this as our dependent variable for Model (7). Measuring occupational mobility is more complex because of numerous changes in occupational coding between 1971–2011. However, in each census in the LS (apart from 2011) occupation is coded using the same classification as in the previous census, so for Model (8) we construct an indicator (for those in employment) which takes the value 1 if the individual has the same occupation as 10 years previously. Results are in Table 8.

Estimates of α in panel (a) show that about half the control group changed address in the 10 years between 1971 and 1981. Estimates of γ^s then show that the probability of changing address declines in the control group over each of the following 10 year intervals, which in part reflects the aging of the sample. For example, the probability of changing address falls to 38% between 1981 and 1991 ($0.519-0.135$) and 22% between 2001 and 2011 ($0.519-0.296$). Similar patterns are observed in the control group for samples $D2$ and $D3$. The estimates of δ^s in sample $D1$ are negative, but all insignificantly different from zero. This is true both in the raw data (panel a) and after matching (panel b). In other words, stevedores in 1971 did not exhibit any greater tendency to change address in any of the subsequent decades up to 2011. Thus, despite the dramatic decline in jobs for stevedores in this period, there appears to have been no additional geographic mobility response at all. This result is consistent with the well-established result that geographic mobility in response to shocks is small, in particular among less-skilled workers (e.g. Bound and Holzer, 2000). In sample $D2$ there is some evidence of *lower* geographic mobility (estimates of δ^s are all negative), but this effect largely disappears in panel (b) after matching. In sample $D3$ there does not appear to be a consistent difference between the treatment and control group after matching: we find somewhat lower mobility rates between 1971 and 1981 ($\delta^{1981} = -0.01$), but somewhat higher rates between 1991 and 2001 ($\delta^{2001} = 0.013$). These effects are also very small when compared to the proportion of the control group who move. Thus overall we find no evidence of increased mobility as a result of the dramatic reductions in port employment.

Finally in Model (8) we consider occupational mobility. The sample here consists only of individuals who are observed in employment in consecutive censuses, and the dependent variable takes the value one if individuals are in the same three-digit occupation and zero otherwise. This variable is not available in 2011 because of changes to occupational definitions. Changes in occupation are very common: in the control group only 38% of the sample have the same occupation in 1971 and 1981 ($\alpha = 0.381$), and this increases slightly to 45% between 1981 and 1991 and 40% between 1991 and 2001. As we would expect, for samples $D1$ and $D2$ there is a very strong effect of containerisation on occupation, but again tempered

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years
(a) Raw differences						
α	0.519***	0.381***	0.553***	0.373***	0.551***	0.370***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
γ^{1991}	−0.135***	0.074***	−0.134***	0.070***	−0.131***	0.070***
	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)
γ^{2001}	−0.231***	0.015***	−0.245***	0.002	−0.245***	0.006
	(0.004)	(0.005)	(0.002)	(0.004)	(0.003)	(0.004)
γ^{2011}	−0.296***		−0.320***		−0.318***	
	(0.004)		(0.003)		(0.003)	
δ^{1981}	−0.022	0.167***	−0.072***	0.137***	0.003	0.031***
	(0.027)	(0.031)	(0.020)	(0.024)	(0.004)	(0.005)
δ^{1991}	−0.016	−0.147***	−0.070***	−0.057	−0.014***	0.018***
	(0.030)	(0.045)	(0.022)	(0.035)	(0.005)	(0.006)
δ^{2001}	−0.035	0.104	−0.057**	0.050	0.008	0.001
	(0.032)	(0.072)	(0.023)	(0.052)	(0.005)	(0.008)
δ^{2011}	−0.003		−0.003		−0.006	
	(0.039)		(0.028)		(0.005)	
Number of obs.	121,957	61,634	268,669	138,496	274,817	141,472
Number of ind.	44,277	32,948	96,892	73,876	99,129	75,555
R^2	0.053	0.005	0.060	0.004	0.060	0.004
(b) Matched on 1971 characteristics						
α	0.524***	0.299***	0.513***	0.346***	0.564***	0.374***
	(0.012)	(0.014)	(0.006)	(0.006)	(0.003)	(0.003)
γ^{1991}	−0.176***	0.104***	−0.147***	0.083***	−0.151***	0.071***
	(0.016)	(0.022)	(0.008)	(0.010)	(0.004)	(0.005)
γ^{2001}	−0.228***	0.088***	−0.220***	0.022*	−0.264***	0.005
	(0.018)	(0.026)	(0.008)	(0.012)	(0.004)	(0.006)
γ^{2011}	−0.279***		−0.283***		−0.335***	
	(0.019)		(0.010)		(0.004)	
δ^{1981}	−0.020	0.243***	−0.034	0.162***	−0.010**	0.015***
	(0.030)	(0.036)	(0.021)	(0.025)	(0.005)	(0.005)
δ^{1991}	0.021	−0.112**	−0.013	−0.052	−0.004	0.013*
	(0.034)	(0.050)	(0.023)	(0.037)	(0.005)	(0.007)
δ^{2001}	−0.048	0.090	−0.043*	0.041	0.013**	−0.009
	(0.037)	(0.079)	(0.025)	(0.053)	(0.006)	(0.009)
δ^{2011}	−0.005		0.008		−0.001	
	(0.046)		(0.030)		(0.006)	
Number of obs.	25,545	11,543	80,123	37,833	223,909	115,616
Number of ind.	9,938	6,910	30,608	22,070	80,701	61,789
R^2	0.050	0.049	0.045	0.019	0.064	0.005

Table 8. Differences in geographical and occupational mobility between treated and control groups, 1981–2011

by the effect of employment protection. For both samples $D1$ and $D2$ the treatment group are *more* likely to remain in the same occupation between 1971 and 1981 ($\delta^{1981} = 0.243$ in $D1$ and 0.162 in $D2$). This switches to a large negative effect for stevedores between 1981 and 1991 ($\delta^{1991} = -0.112$ in $D1$) which is consistent with the fact that employment guarantees were removed in 1989 (see Section 2). It is noticeable that the negative occupational effect in 1991 is much weaker for sample $D2$, suggesting that port industry workers as a whole were less affected by the new technology than stevedores in particular. The hypothesis that stevedores or port workers were subsequently sorted into less stable jobs is not borne out. Estimates of δ^{2001} are insignificantly different from zero for both $D1$ and $D2$, showing that the change in occupations which occurred between 1981 and 1991 did not continue. The results for sample $D3$ suggest that wide geographical effects are much weaker.

5.4 Robustness checks

In this section we consider a number of sub-samples to examine whether our results are robust. First, we consider whether the effects of containerisation on stevedores differ according to their initial socio-economic group. Socio-economic group is determined by a combination of occupation and employment status (Hattersley and Creeser, 1995). Unskilled workers who have some supervisory role (foremen) are classified as "skilled manual"; Table 3 shows that 23% of stevedores are classified as skilled manual. In Table C5 we report PSM estimates of Models (1)–(8) for just those stevedores who have no supervisory role i.e. the less skilled, or less senior. These results show that outcomes for these less-skilled stevedores were no worse than for stevedores overall, and in many cases actually more favourable. The treatment group are still more likely to appear in the linked census in subsequent years, they have lower mortality rates, higher employment rates and lower unemployment rates in 1981. Thus, it appears that the employment guarantees in place protected all stevedores and not just those in more senior positions. Indeed, the results from model (8) show that the probability of remaining in the same occupation was even higher for the less-skilled stevedores in 1981 ($\delta^{1981} = 0.261$ in the final column of Table C5) than for the the whole treatment group ($\delta^{1981} = 0.243$ in Table 8).

Our second robustness check modifies sample $D2$ so that it excludes stevedores. The treatment group in this case therefore consists of workers who worked in the port industry in 1971 but who were not stevedores. A comparison of this restricted sample with sample $D2$ allows us to confirm that the employment guarantee protected stevedores far more than other workers in the port industry. Results for Models (1)–(8) are shown in Table C6. Recall that our estimate of δ^{1981} for Model (2) was positive in 1981, showing that port workers actually had higher employment rates than the control group in 1981 (see Table 6). However, in the modified sample $\delta^{1981} = 0.006$ and is insignificantly different from zero.

Our third robustness check considers in more detail the geographical comparisons of sample $D3$. In Table C7 we restrict the control group to include workers in Counties which contain no major ports, while in Table C8 we restrict the control group to include workers who work in districts which are more than 20km from any port. We do this because it seems that the basic geographic control group $D3 = 0$ may include workers who are affected by the process of containerisation because their place of work is near a port, even if it not in a district which includes a port. Results from Tables C7 and C8 show some evidence of negative employment effects (and positive unemployment effects) in 1981, but the size of these effects are still small compared to those from a comparison of occupation and industry.

6 Conclusion

Containerisation provides us with an opportunity to examine the labour market consequences of a technological shock which, in the space of a few years, completely removed the demand for a particular occupation. Linked census data enables us to track the workers in affected occupations and industries over the long-run, and to shed light on the process of adjustment. We have documented that stevedores and the port industry did suffer massive falls in demand for labour between the late 1960s and early 1980s. We have also shown that the districts containing ports experienced worse labour market outcomes which continued and have remained for over 30 years.

However, our worker-level analysis reveals a different picture. After matching stevedores and port-industry workers to observably similar unskilled men in other occupations and industries, we find that subsequent differences in labour market outcomes, mortality and mobility are typically small, insignificantly different from zero and even in some cases positive. Positive differences are most notable in 1981, at which point stevedores were protected from redundancy by the National Dock Labour Scheme. Perhaps more surprisingly, even after employment protection was removed there are not large differences in labour market outcomes between the treatment and control groups. Thus, we can conclude that workers who were stevedores or who worked in the port industry in 1971 did not suffer long-term disadvantage in the labour market over the rest of their working lives.

This result should be interpreted in the light of the unique industrial relations policies which existed for this particular group of workers at the time of the shock. Dock workers were insulated from redundancy for a long time after the technological shock. This itself had consequences for the development of new ports in the UK, such that port activity shifted and concentrated in entirely new locations. One might therefore be concerned that the employment protection merely delayed and possibly amplified the eventual costs in terms of lost jobs. However, this does not appear to be the case because our estimates for 1991–2011 are

also typically small or insignificant for all employment outcomes and for mortality.

There are several important caveats. First, we recognise that the process of containerisation and the associated fall in demand for stevedores began before 1971. Unfortunately, linked census data before 1971 is not available. Our treatment group is therefore a selected sample of workers who remained in that occupation or industry even after it became apparent that their work was changing and their jobs disappearing. However, one might argue that this would bias our results towards finding large negative subsequent labour market outcomes if those workers who did not have better outside opportunities were the ones to remain in 1971.

Second, is it possible that the adjustment process is fast enough that our 10-year intervals from census data miss much of the effect? The existing literature on displaced workers suggests not. Although the literature typically regards the "long-run" as being within 10 years of job loss, the consensus is that losses are still evident at that point. However, results from the US suggest that most of these losses come in the form of wages rather than employment differentials. It therefore seems possible that the men in our sample are suffering wage losses rather than employment losses.[22]

The final issue is the extent to which one can regard the various control groups we use as suitable counterfactuals for the treatment group. A profound technological shock such as the invention of containers may have had consequences far beyond the narrow treatment and control groups as defined here. For example, containerisation may have had a role to play in the growth in world trade which occurred over this period (Bernhofen et al., 2013) which itself affected labour market outcomes more generally (Autor et al., 2014). It is well-known that unskilled workers in general had extremely poor labour market outcomes during the 1980s and 1990s (Nickell and Bell, 1995), and this is clear in the estimated effects for our control group. Our final conclusion must therefore be that stevedores and workers in the port industry fared "no worse" than similar workers in other occupations and industries, rather than actually doing well.

[22]There is no wage information in the LS.

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Appendix A Port locations

Major Port	Foreign Tonnage (000s)	Est. port employment	Est. no. stevedores
London (inc. Tilbury)	35,150	38,600	13,280
Liverpool	22,687	29,330	13,470
Medway and Dover	21,747	2,940	1,180
Milford Haven	19,807	440	190
Southampton	17,092	4,420	2,260
Manchester	10,898	4,900	1,830
Tees and Hartlepool	9,080	2,240	1,060
Hull	5,519	8,780	4,520
Immingham	5,472	3,290	1,820
Bristol	4,248	4,410	1,750
Newport	3,865	1,300	680
Port Talbot	3,360	410	230
Swansea	2,936	2,000	730
Tyne	2,551	2,060	850
Cardiff	1,940	1,870	580
Par and Fowey	1,524	1,190	200
Felixstowe	1,118	400	130
Goole	837	1,600	410
Harwich	817	780	410
Grimsby	792	2,550	1,300
Preston	762	840	320
Whitehaven and Workington	757	310	160
Great Yarmouth	691	370	120
Ipswich	635	240	60
Boston	539	310	220
Plymouth	519	900	180
Shoreham	470	180	30
King's Lynn	449	310	220
Teignmouth	326	130	60
Holyhead	262	160	10
Barrow	172	250	50
All major ports above	177,022	117,510	48,310
All ports England and Wales	185,904	132,750	59,190

Table A1. Major English and Welsh ports by tonnage, 1967 and employment, 1961. Major ports are those listed individually in the Digest of Port Statistics, 1968. Employment is estimated from 10% published census tables, based on recorded employment in the Local Government Districts which contained a major port.

Major Port	Local authorities (1961)	Local authorities (1971)
London (inc. Tilbury)	City of London, Poplar, Stepney, West Ham, East Ham, Barking, Dagenham, Hornchurch, Southwark, Bermondsey, Deptford, Greenwich, Woolwich, Erith, Crayford, Thurrock	Barking, Bexley, City of London, Greenwich, Havering, Lewisham, Newham, Southwark, Tower Hamlets, Thurrock (Tilbury), Gravesend (Tilbury),
Liverpool	Bootle, Crosby, Birkenhead, Wallesey, Bebington, Liverpool	Bebington, Birkenhead, Bootle, Crosby, Ellesmere Port, Liverpool, Runcorn, Wallasey
Medway and Dover	Kent (county remainder)	Gillingham, Chatham, Rochester, Queenborough-in-Sheppey
Milford Haven	Pembrokeshire	Milford Haven, Pembroke
Southampton	Southampton	Southampton
Manchester	Salford, Manchester, Stretford	Salford, Manchester, Stretford
Tees and Hartlepool	Middlesbrough	Hartlepool, Teesside
Hull	Kingston-upon-Hull	Kingston-up-Hull
Immingham	Lincolnshire (parts of Lindsey)	Grimsby
Bristol	Bristol	Bristol
Newport	Newport	Newport
Port Talbot	Port Talbot	Port Talbot
Swansea	Swansea	Swansea
Tyne	Tynemouth	South Shields, Tynemouth
Cardiff	Cardiff	Cardiff
Par and Fowey	Cornwall and the Isles of Scilly	St Austell with Fowey
Felixstowe	Suffolk	Felixstowe
Dover	Kent (county remainder)	Dover
Goole	Yorkshire West Riding (county remainder)	Goole
Harwich	Essex (county remainder)	Harwich, Tendring
Grimsby	Grimsby	Grimsby
Preston	Preston	Preston
Workington	Cumberland	Workington
Whitehaven	Cumberland	Whitehaven
Great Yarmouth	Great Yarmouth	Great Yarmouth
Ipswich	Ipswich	Ipswich
Boston	Lincolnshire (parts of Holland)	Boston
Plymouth	Plymouth	Plymouth
Shoreham	Sussex (county remainder)	Shoreham-by-Sea, Southwick
King's Lynn	Norfolk	King's Lynn
Teignmouth	Devon (county remainder)	Teignmouth
Holyhead	Anglesey	Holyhead
Barrow	Barrow-in-Furness	Barrow-in-Furness

Table A2. Local authority areas classified as containing a major port in 1961 and 1971.

Appendix B Definition of labour market states

	1981	1991	2001	2011
Employed	In a full- or part-time job at any time in the last week	Employed or self-employed in the last week	Same as 1991	Same as 2001
Unemployed	Waiting to take up job or seeking job	Waiting to start job or seeking job	Not working, actively looking for paid work in last four weeks and available to start within two weeks; or waiting to start job	Same as 2001
Retired	Wholly retired from employment	Retired from paid work	Retired	Retired (whether receiving pension or not)
Sick	Permanently sick or disabled	Unable to work because of long term sickness or disability	Permanently sick/disabled	Long-term sick or disabled

Table B1. Definition of labour market states 1981–2011.

Appendix C Additional results

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	In census	Died	In census	Died	In census	Died
γ^{1991}	-0.136^{***}	0.142^{***}	-0.131^{***}	0.136^{***}	-0.131^{***}	0.136^{***}
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
γ^{2001}	-0.297^{***}	0.313^{***}	-0.288^{***}	0.303^{***}	-0.288^{***}	0.303^{***}
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
γ^{2011}	-0.437^{***}	0.470^{***}	-0.428^{***}	0.459^{***}	-0.429^{***}	0.459^{***}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
δ^{1981}	0.143^{***}	-0.086^{***}	0.107^{***}	-0.064^{***}	0.008^{***}	-0.006^{**}
	(0.018)	(0.015)	(0.014)	(0.012)	(0.003)	(0.002)
δ^{1991}	0.094^{***}	-0.052^{***}	0.057^{***}	-0.023^{*}	0.007^{**}	-0.004
	(0.021)	(0.019)	(0.015)	(0.014)	(0.003)	(0.003)
δ^{2001}	0.046^{**}	-0.017	0.027^{*}	0.005	0.004	-0.002
	(0.022)	(0.021)	(0.015)	(0.015)	(0.003)	(0.003)
δ^{2011}	0.022	0.022	-0.001	0.033^{**}	0.006^{*}	-0.002
	(0.021)	(0.021)	(0.014)	(0.014)	(0.003)	(0.003)
Number of obs.	201,672	187,955	440,480	409,232	450,516	418,655
Number of ind.	50,418	48,417	110,120	105,560	112,629	107,985
R^2	0.305	0.435	0.291	0.428	0.291	0.428

Table C1. OLS estimates of differences in attrition rates and mortality between treated and control groups, 1981–2011. These results can be compared to the propensity-score matching estimates shown in the bottom panel of Table 5.

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Emp.	Unemp.	Emp.	Unemp.	Emp.	Unemp.
γ^{1991}	-0.225^{***}	-0.023^{***}	-0.234^{***}	-0.014^{***}	-0.234^{***}	-0.014^{***}
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
γ^{2001}	-0.429^{***}	-0.067^{***}	-0.456^{***}	-0.049^{***}	-0.453^{***}	-0.049^{***}
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
γ^{2011}	-0.632^{***}	-0.076^{***}	-0.669^{***}	-0.057^{***}	-0.668^{***}	-0.057^{***}
	(0.003)	(0.002)	(0.002)	(0.001)	(0.003)	(0.001)
δ^{1981}	0.151^{***}	-0.055^{***}	0.085^{***}	-0.014	0.004	0.004^{*}
	(0.020)	(0.012)	(0.015)	(0.010)	(0.003)	(0.002)
δ^{1991}	-0.019	-0.003	-0.052^{***}	0.012	-0.006^{*}	0.002
	(0.024)	(0.017)	(0.018)	(0.012)	(0.003)	(0.002)
δ^{2001}	0.032	-0.045^{***}	-0.031	-0.022^{***}	-0.020^{***}	0.001
	(0.029)	(0.006)	(0.020)	(0.007)	(0.004)	(0.002)
δ^{2011}	-0.002	-0.027^{**}	-0.047^{**}	-0.017^{**}	-0.008	0.001
	(0.030)	(0.012)	(0.022)	(0.008)	(0.005)	(0.002)
Number of obs.	123,061	123,050	271,737	271,717	277,930	277,910
Number of ind.	43,603	43,603	95,454	95,454	97,653	97,653
R^2	0.405	0.032	0.423	0.027	0.423	0.028

Table C2. OLS estimates of differences in employment status between treated and control groups, 1981–2011. These results can be compared to the propensity-score matching estimates shown in the bottom panel of Table 6.

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Retired	Sick	Retired	Sick	Retired	Sick
γ^{1991}	0.202^{***}	0.040^{***}	0.211^{***}	0.033^{***}	0.211^{***}	0.032^{***}
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
γ^{2001}	0.412^{***}	0.080^{***}	0.437^{***}	0.066^{***}	0.433^{***}	0.066^{***}
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
γ^{2011}	0.684^{***}	0.013^{***}	0.708^{***}	0.009^{***}	0.707^{***}	0.009^{***}
	(0.003)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
δ^{1981}	-0.072^{***}	-0.017	-0.057^{***}	-0.010	-0.002	-0.006^{***}
	(0.015)	(0.013)	(0.011)	(0.009)	(0.002)	(0.002)
δ^{1991}	-0.022	0.031	-0.004	0.031^{**}	0.004	-0.000
	(0.019)	(0.022)	(0.014)	(0.015)	(0.003)	(0.002)
δ^{2001}	0.011	0.018	0.023	0.022	0.023^{***}	-0.006^{*}
	(0.027)	(0.033)	(0.020)	(0.021)	(0.004)	(0.003)
δ^{2011}	0.086^{**}	-0.040^{**}	0.109^{***}	-0.038^{***}	0.016^{***}	-0.010^{***}
	(0.036)	(0.020)	(0.025)	(0.011)	(0.005)	(0.002)
Number of obs.	123,048	118,931	271,714	261,856	277,907	267,788
Number of ind.	43,603	43,592	95,454	95,425	97,653	97,623
R^2	0.533	0.031	0.531	0.032	0.531	0.033

Table C3. OLS estimates of differences in retirement and sickness status between treated and control groups, 1981–2011. These results can be compared to the propensity-score matching estimates shown in the bottom panel of Table 7.

	$D1$ (stevedores vs. other occupations)		$D2$ (port industry vs. other industries)		$D3$ (port district vs. other districts)	
	Moved in last 10 years	Same occ. in last 10 years	Moved in last 10 years	Same occ. in last 10 years	Moved in last 10 years	Same occ. in last 10 years
γ^{1991}	-0.151^{***}	0.083^{***}	-0.150^{***}	0.081^{***}	-0.147^{***}	0.081^{***}
	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)
γ^{2001}	-0.274^{***}	0.044^{***}	-0.288^{***}	0.032^{***}	-0.288^{***}	0.037^{***}
	(0.004)	(0.006)	(0.002)	(0.004)	(0.003)	(0.004)
γ^{2011}	-0.375^{***}		-0.398^{***}		-0.396^{***}	
	(0.004)		(0.003)		(0.003)	
δ^{1981}	0.003	0.247^{***}	-0.028	0.166^{***}	0.001	0.022^{***}
	(0.027)	(0.032)	(0.020)	(0.024)	(0.004)	(0.005)
δ^{1991}	0.010	-0.060	-0.024	-0.025	-0.016^{***}	0.012^{*}
	(0.031)	(0.048)	(0.022)	(0.036)	(0.005)	(0.006)
δ^{2001}	-0.013	0.162^{**}	-0.018	0.076	0.005	-0.006
	(0.033)	(0.074)	(0.024)	(0.052)	(0.005)	(0.008)
δ^{2011}	0.043		0.047		-0.006	
	(0.040)		(0.030)		(0.005)	
Number of obs.	118,357	59,775	261,012	134,405	266,959	137,289
Number of ind.	42,948	31,994	94,071	71,789	96,235	73,421
R^2	0.118	0.023	0.125	0.019	0.126	0.032

Table C4. OLS estimates of differences in geographical and occupational mobility between treated and control groups, 1981–2011. These results can be compared to the propensity-score matching estimates shown in the bottom panel of Table 8.

	Model (1) In census	Model (2) Died	Model (3) Emp.	Model (4) Unemp.	Model (5) Retired	Model (6) Sick	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years
Matched on 1971 characteristics								
α	0.749***	0.104***	0.623***	0.137***	0.162***	0.075***	0.534***	0.239***
	(0.010)	(0.006)	(0.015)	(0.011)	(0.010)	(0.010)	(0.015)	(0.020)
γ^{1991}	−0.170***	0.193***	−0.256***	−0.019	0.213***	0.042***	−0.182***	0.134***
	(0.012)	(0.011)	(0.018)	(0.017)	(0.016)	(0.013)	(0.022)	(0.033)
γ^{2001}	−0.375***	0.433***	−0.371***	−0.119***	0.367***	0.134***	−0.228***	0.136***
	(0.014)	(0.014)	(0.021)	(0.012)	(0.023)	(0.023)	(0.024)	(0.039)
γ^{2011}	−0.515***	0.618***	−0.466***	−0.125***	0.568***	−0.014	−0.280***	
	(0.014)	(0.013)	(0.022)	(0.012)	(0.024)	(0.018)	(0.027)	
δ^{1981}	0.130***	−0.033*	0.092***	−0.078***	−0.006	−0.004	−0.038	0.261***
	(0.022)	(0.017)	(0.033)	(0.019)	(0.026)	(0.019)	(0.036)	(0.043)
δ^{1991}	0.100***	−0.041	0.014	−0.041	−0.016	0.035	0.021	−0.081
	(0.031)	(0.029)	(0.039)	(0.026)	(0.039)	(0.028)	(0.040)	(0.063)
δ^{2001}	0.095***	−0.068**	0.063	−0.010	−0.009	−0.031	−0.056	0.094
	(0.033)	(0.034)	(0.044)	(0.008)	(0.049)	(0.045)	(0.044)	(0.095)
δ^{2011}	0.050*	−0.033	−0.040	0.014	0.036	0.016	0.010	
	(0.029)	(0.032)	(0.040)	(0.018)	(0.053)	(0.034)	(0.057)	
Number of obs.	22,108	20,155	10,767	10,765	10,764	10,356	10,205	4,049
Number of ind.	5,527	5,204	4,360	4,360	4,360	4,358	4,245	2,529
R^2	0.186	0.229	0.158	0.033	0.170	0.022	0.047	0.053

Table C5. Differences in outcomes between stevedores and matched control group, 1981–2011. These results are based on sample $D1$, restricted to include only workers classified as being in the "unskilled" socio-economic group. Contrast with column $D1$ in Tables 5, 6 and 7, which includes workers in unskilled and skilled manual socio-economic groups.

	Model (1) In census	Model (2) Died	Model (3) Emp.	Model (4) Unemp.	Model (5) Retired	Model (6) Sick	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years
Matched on 1971 characteristics								
α	0.801***	0.111***	0.685***	0.063***	0.206***	0.044***	0.501***	0.384***
	(0.003)	(0.003)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.005)
γ^{1991}	−0.174***	0.187***	−0.224***	−0.015***	0.201***	0.031***	−0.127***	0.062***
	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.006)	(0.007)
γ^{2001}	−0.368***	0.399***	−0.375***	−0.047***	0.360***	0.067***	−0.210***	−0.021**
	(0.004)	(0.004)	(0.006)	(0.002)	(0.006)	(0.004)	(0.006)	(0.010)
γ^{2011}	−0.518***	0.575***	−0.462***	−0.054***	0.511***	−0.011***	−0.270***	
	(0.004)	(0.004)	(0.007)	(0.002)	(0.007)	(0.003)	(0.007)	
δ^{1981}	0.030	0.010	0.006	0.002	−0.006	0.000	−0.042	0.058*
	(0.019)	(0.016)	(0.025)	(0.014)	(0.022)	(0.011)	(0.027)	(0.033)
δ^{1991}	0.024	0.007	−0.025	0.023	−0.024	0.019	−0.030	−0.022
	(0.024)	(0.023)	(0.031)	(0.016)	(0.030)	(0.018)	(0.030)	(0.048)
δ^{2001}	0.051**	−0.024	−0.037	0.004	−0.005	0.006	−0.034	−0.024
	(0.025)	(0.025)	(0.032)	(0.010)	(0.036)	(0.026)	(0.032)	(0.068)
δ^{2011}	0.027	−0.019	−0.074**	−0.001	0.095***	−0.025***	0.005	
	(0.023)	(0.024)	(0.032)	(0.008)	(0.035)	(0.008)	(0.039)	
Number of obs.	114,712	107,403	63,769	63,766	63,764	60,705	61,268	28,575
Number of ind.	28,678	27,593	24,153	24,153	24,153	24,145	23,763	16,746
R^2	0.154	0.184	0.143	0.013	0.158	0.017	0.040	0.005

Table C6. Differences in outcomes between stevedores and matched control group, 1981–2011. These results are based on sample *D*2, restricted so that the treatment group includes only workers in the port industry who are not stevedores. Contrast with column *D*2 in Tables 5, 6 and 7, which includes all workers in port industries in the treatment group.

	Model (1) In census	Model (2) Died	Model (3) Emp.	Model (4) Unemp.	Model (5) Retired	Model (6) Sick	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years
Matched on 1971 characteristics								
α	0.821***	0.077***	0.788***	0.047***	0.129***	0.033***	0.585***	0.362***
	(0.010)	(0.007)	(0.011)	(0.005)	(0.008)	(0.006)	(0.013)	(0.015)
γ^{1991}	−0.127***	0.138***	−0.206***	0.009	0.170***	0.023**	−0.131***	0.084***
	(0.011)	(0.009)	(0.016)	(0.011)	(0.014)	(0.009)	(0.020)	(0.024)
γ^{2001}	−0.286***	0.298***	−0.344***	−0.019**	0.315***	0.041***	−0.280***	0.047
	(0.013)	(0.012)	(0.019)	(0.009)	(0.018)	(0.011)	(0.019)	(0.033)
γ^{2011}	−0.404***	0.449***	−0.476***	−0.039***	0.505***	0.002	−0.356***	
	(0.014)	(0.013)	(0.024)	(0.006)	(0.022)	(0.011)	(0.023)	
δ^{1981}	0.005	0.003	−0.033***	0.020***	0.014*	−0.001	−0.030**	0.026*
	(0.011)	(0.007)	(0.011)	(0.006)	(0.008)	(0.007)	(0.014)	(0.016)
δ^{1991}	0.002	0.003	−0.002	−0.004	−0.007	0.011*	−0.046***	0.012
	(0.013)	(0.011)	(0.016)	(0.010)	(0.014)	(0.007)	(0.016)	(0.021)
δ^{2001}	0.004	0.012	−0.021	−0.007	0.005	0.022**	0.007	−0.039
	(0.013)	(0.013)	(0.018)	(0.007)	(0.017)	(0.010)	(0.017)	(0.029)
δ^{2011}	−0.016	0.021	−0.017	0.009***	−0.002	0.002	−0.002	
	(0.013)	(0.014)	(0.021)	(0.002)	(0.022)	(0.009)	(0.019)	
Number of obs.	158,872	147,635	98,751	98,744	98,743	95,158	94,746	49,206
Number of ind.	39,718	38,073	34,524	34,524	34,524	34,512	33,976	26,100
R^2	0.104	0.141	0.120	0.009	0.140	0.009	0.069	0.006

Table C7. Differences in outcomes between stevedores and matched control group, 1981–2011. These results are based on sample *D*3*a*, which is sample *D*3 restricted so that the control group includes only workers in Counties which do not contain a major port. Contrast with column *D*3 in Tables 5, 6 and 7, which includes workers in any district which does not contain a major port.

	Model (1) In census	Model (2) Died	Model (3) Emp.	Model (4) Unemp.	Model (5) Retired	Model (6) Sick	Model (7) Moved in last 10 years	Model (8) Same occ. in last 10 years
Matched on 1971 characteristics								
α	0.831***	0.079***	0.768***	0.056***	0.139***	0.034***	0.562***	0.378***
	(0.004)	(0.003)	(0.005)	(0.003)	(0.004)	(0.002)	(0.005)	(0.006)
γ^{1991}	−0.129***	0.136***	−0.182***	−0.010***	0.151***	0.034***	−0.151***	0.071***
	(0.004)	(0.003)	(0.006)	(0.003)	(0.005)	(0.004)	(0.007)	(0.009)
γ^{2001}	−0.288***	0.308***	−0.327***	−0.040***	0.294***	0.066***	−0.256***	0.004
	(0.005)	(0.005)	(0.008)	(0.003)	(0.007)	(0.005)	(0.008)	(0.012)
γ^{2011}	−0.428***	0.467***	−0.467***	−0.045***	0.489***	0.011**	−0.335***	
	(0.005)	(0.005)	(0.008)	(0.003)	(0.009)	(0.004)	(0.008)	
δ^{1981}	−0.005	0.001	−0.013**	0.010***	0.005	−0.002	−0.009	0.010
	(0.005)	(0.004)	(0.006)	(0.003)	(0.005)	(0.003)	(0.007)	(0.007)
δ^{1991}	−0.005	0.004	−0.005	0.006**	0.002	−0.001	−0.003	0.008
	(0.006)	(0.005)	(0.007)	(0.003)	(0.007)	(0.004)	(0.007)	(0.010)
δ^{2001}	−0.003	−0.001	−0.018**	0.005***	0.016*	−0.005	0.006	−0.012
	(0.006)	(0.006)	(0.008)	(0.002)	(0.008)	(0.006)	(0.008)	(0.013)
δ^{2011}	−0.002	0.001	−0.007	0.006***	0.006	−0.009*	0.000	
	(0.006)	(0.007)	(0.009)	(0.002)	(0.009)	(0.004)	(0.009)	
Number of obs.	242,024	224,747	149,732	149,722	149,720	144,385	143,799	74,528
Number of ind.	60,506	57,964	52,445	52,445	52,445	52,426	51,636	39,612
R^2	0.109	0.145	0.116	0.010	0.135	0.011	0.063	0.005

Table C8. Differences in outcomes between stevedores and matched control group, 1981–2011. These results are based on sample *D*3*b*, which is sample *D*3 restricted so that the control group includes only workers in districts which are more than 20km from any port. Contrast with column *D*3 in Tables 5, 6 and 7, which includes workers in any district which does not contain a major port.