Workplace Accidents and Early Safety Policies: Spain, 1900-1934[*]

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[APPENDICES, FIGURES AND TABLES ARE NOT INCLUDED]
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Abstract

During the nineteenth- and early twentieth-century industrialization, workplace accidents came to be perceived as a serious health problem. Several safety policies were debated, experimented and finally implemented in industrializing nations. However, although some countries, particularly the US, were successful in reducing accidents, this was not the case for other nations. By using an approach based on both qualitative and empirical evidence, this paper offers a case study - Spain - to understand why safety policies had little or no effect on reducing accidents during the early stages of modern economic growth.

Keywords: workplace accidents, intense economic growth, safety policies.

1. Introduction

Economic and social historians discuss the impact of the Industrial Revolution on living standards. This major debate is based on the analysis of a number of economic and non-economic indices. With regard to the "accident question", the evidence is not conclusive. Lewchuk (1991), for France, and Aldrich (1997), for the US, suggest that mechanization and new factory work practices - as two of the main factors - could have increased the level of risk. Whereas, Bartrip and Burman (1983), given the lack of data for pre-industrial times, are reluctant to state whether the British Industrial Revolution increased or decreased risks. In any event, as pointed out by Bartrip and Burman (1983, p. 14), "to an extent, however, the question of magnitude is of limited importance, for the significant point is that industrial injury came to be perceived as a serious issue". As a result, safety policies aimed at reducing workplace accidents were debated, experimented and finally implemented in industrializing nations approximately from the mid nineteenth century to the 1930s. This process benefited from an international dialogue between policymakers and academics both within Europe and across the Atlantic Ocean (Aldrich, 1997; Rodgers, 1998; Witt, 2004).

Legal regulation of safety standards, accompanied by factory inspection and economic penalties, was usually the first public intervention. The impact of this strategy by itself, however, was somewhat limited, and other methods were considered. During the 1920s and early 1930s, the Chief of the Safety Service of the International Labour Organization (ILO) referred to two strategies well-established in the US, to complement the European emphasis on legislation: the use of workers´ compensation programs as an economic incentive for employers to invest in safety, and cooperation between workers and employers, particularly in prevention campaigns (Ritzmann, 1926, 1928, 1929, 1934).[1] From the beginning of the twentieth century, a combination of the three main safety policies reduced accident rates in the US and, to a lesser extent, Britain (ILO, 1931a, 1931b, 1938; McIvor, 2001, ch. 5, Aldrich, 1997). However, this was not the case for a number of continental European countries (ILO, 1931a, 1931b, 1938).

This paper offers a case study, Spain, to understand why safety policies were unable to reduce workplace accidents during the early stages of modern economic growth. By analyzing the qualitative evidence, and estimating "safety regressions", this paper shows that, first, safety standards were weakly enforced. Second, the workers´ compensation program was ineffectively implemented to act as an incentive to improve safety. Finally, cooperation

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[1] Other approaches to safety such as cooperative insurance proved to be less effective (Witt, 2004, ch. 3).

between workers and employers in safety issues was difficult to attain in a context of political and social instability.

2. The effectiveness of safety policies in the nineteenth and early twentieth centuries

2.1. Legal regulation of safety standards

Empirical and qualitative studies of the effectiveness of legal regulation of safety standards tend to show little impact on reducing accidents. Two kinds of shortcomings have been identified: those related to the standard-setting process and those related to the enforcement of the law.[2] First, as ILO reports recognized, safety laws focused on technological causes of accidents - i.e. improper implementation or use of machinery, but not on *organizational* or *behavioural* ones - i.e. inadequate training, tolerance of risks or carelessness (Vernon, 1926; Ritzmann, 1928, 1929, 1934). Moreover, differences in technology or work methods among industries and companies were difficult to encompass in legal regulation, especially during periods of rapid change (ILO, 1928, pp. 125-127).[3]

Second, weak enforcement of legal regulation has been pointed out in empirical analyses by Fishback (1986, 1992), for the US coal mining, and Bartrip and Fenn (1988), for British industries, to explain the fact that there was little or no effect on fatalities. Legal regulation suffered from problems such as the lack of inspectors and funds, the lack of coercive power, ignorance of the laws, and the low level of fines (Bartrip and Burman, 1983; Jones, 1985; Müller, 1985; Fishback, 1986, 1992; Bartrip and Fenn, 1988; Aldrich, 1997; Dumas, 1998; McIvor, 2001; Quinlan et al, 2001).

2.2. Workers´ compensation

Workers´ compensation for accidents was introduced in a number of European countries from the 1880s to WWI (Huberman and Lewchuk, 2003). US states introduced similar schemes during the 1910s and the 1920s (Fishback and Kantor, 2000).[4] Apart from providing post-accident compensation for injured or deceased workers and their families, workers´ compensation systems were also conceived as economic incentives to reduce accidents. An increase in benefits coverage (higher firm costs) should raise firms´ incentives

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[2] Studies of the modern era point out similar reasons to explain modest impacts. See recent reviews in Kralj (2000) and Kniesner and Leeth (2004).

[3] For US mining, also see Fishback (1986, p. 292).

[4] Employer-provided compensation was implemented in some US companies before the arrival of workers´ compensation legislation (Fishback, 1992, ch. 7; Witt, 2004, ch. 4).

to provide safer workplaces. However, the "net" impact of workers´ compensation is not clear (Ruser, 1991; Lanoie, 1992; Fishback and Kantor, 2000; Fortin and Lanoie, 2000). Higher benefits might also induce workers to reduce their accident-prevention effort. Additionally, higher benefits might lead workers to report more accidents, in particular in the case of minor injuries. These moral hazard factors will tend to increase the number of registered accidents.

The review by Fishback and Kantor (2000, pp. 77-82), on studies referring to the US, shows that the results varied. Employers´ reaction to improving prevention dominated employees´ laxity and moral hazard behaviour in manufacturing and railroads, where the costs of prevention were relatively low. In contrast, in the case of the coal industry, where unions had more power to influence shopfloor conditions, accidents increased. For the case of Britain, Bartrip and Fenn (1988) and Bartrip (1987, ch. 6) have proposed that the workers´ compensation system, in fact, encouraged rather than reduced the reporting of accidents.

Nevertheless, it is also true that the introduction of workers´ compensation legislation may have had an indirect impact on reducing accidents by encouraging firms to establish safety departments (Aldrich, 1997). Furthermore, ILO also pointed out the important role of insurance companies (including public insurance institutions) to promote safety. A noteworthy step, in this sense, was the introduction of the experience rating system, i.e. the establishment of premiums paid by employers according, not only to industry classes, but also to firm-specific accident experience (Ritzmann, 1926, 1934; Pfisterer, 1928).

2.3. Participation of workers and unions

The importance of worker participation in accident prevention has been considered from the beginning of safety research.[5] Following the "Safety First" US experience, ILO reports strongly recommended cooperation between workers and employers, in particular through educational campaigns, to reduce the numerous behavioural or organizational accidents (ILO, 1928, 1929; Ritzmann, 1926, 1928, 1929, 1934; Pfisterer, 1928). Aldrich´s (1997) book describes and empirically confirms the improvement in accident prevention in the US during the first four decades of the twentieth century. The improvement in safety was due to an alliance of unionists and workers, employers, managers, and social reformers in response to higher levels of accidents in the country - in contrast to less capital-intensive European nineteenth-century industries. In post-WWI Europe, the establishment of safety committees composed of different parties, and the launch of educational campaigns, was

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[5] Recent reviews include Smallman (2001) and Boal (2003). See also Lewchuk (1991).

probably more relevant in Britain and Germany (ILO, 1923a, 1928). Specifically with regard to unionized workers, Boal (2003) shows their relevance in reducing accidents for early twentieth-century US coal mining. This study refutes previous findings by Fishback (1986), who found a positive relationship between unionism and accidents.

In fact, union-based or independent workers´ reluctance to collaborate with safety regulations might have also been common during this period. This was the case when changes in safety organization were often imposed by authorities influenced by social reformers and technicians, and changed traditions or forced workers to adopt new procedures (Jones, 1985; Fishback, 1986; Ramm, 1986; Aldrich, 1997; Aries, 1998; Rodgers, 1998; Witt, 2004). Additionally, it should not go unremarked how both the General Secretary of the Red Cross and the ILO pointed out how the predominance of wage and economic demands in European unions´ priorities could have affected a better implementation of safety steps (Sand, 1923; ILO, 1924).[6]

3. Safety policies in Spain

3.1. Legal regulation of safety standards

The question of industrial accidents featured in Parliamentary and extra-Parliamentary debates from the late 1880s. However, it was not until 1900 when the first accident-related legislation was enacted. Through the Labor Accidents Law, Spain adopted a typical European safety policy heavily based on the establishment of the legal setting of safety standards. In 1906 the Labor Inspection Service was created with the aim of enforcing the accident law (among other labor laws). However, as in other European countries, a fuller compliance with the accident law was subordinated to the lack of funding and the opposition of different social groups. Factory inspectors´ complaints about the implementation of the law were gathered in their annual reports (Instituto de Reformas Sociales, 1908-1923; Ministerio de Trabajo, 1924-1931).[7] First, they noted the lack of personnel. Second, they demanded more coordination between central and local public administration levels and warned of local employers' influence on local delegations of the Government. Third, the imposition of fines was a slow process, and the instructions given to inspectors put persuasion before penalization.

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[6] The British debate on this issue is analysed in detail by Melling (2003). He proposes that unions presented a predisposition to focus on either monetary or safety issues according to the strategic calculation of their power in each case.

[7] Other contemporary sources are cited in Soto (1989, pp. 643-646).

3.2. Workers´ compensation

The 1900 law also included the replacement of employer negligence liability theory with employer *objective* (no-fault) liability theory, and workers´ compensation was introduced.[8] Before 1933, workers´ compensation for fatal accidents varied between seven months and two years, depending on the number of family members. Compensation for nonfatal accidents depended on the kind of disability. Permanent disabilities were separated into three categories: total (e.g. full paralysis), professional (the inability to do the usual job), and partial (e.g. loss of a leg), which were remunerated with two, one and a half, and one years´ wages respectively. Temporary disability compensation (e.g. a broken arm) was 50 per cent of the wage before 1922, and 75 per cent of the wage between 1922 and 1933. Despite the 1922 reform of the law, it was not until 1933 that workers´ compensation system was seriously transformed, following Spain's compliance with the ILO Geneva Treaty in 1925. Compliance implied the implementation of the mandatory affiliation insurance system, the introduction of life annuities, and the increase in all insurance premiums.

According to several sources, Spanish workers´ compensation system before the 1933 reform presented some important inefficiencies to act as a real incentive to reduce accidents. First, it must be noted that Spanish companies were not experience rated. Second, a number of social reformers, independent or legal and medical state counsellors, pointed out that premiums were insufficient (Silvestre, 2005a).[9] In fact, as shown in Appendix 1 (panels A and B), in a comparative perspective Spanish premiums were low. Compensation for fatal and permanent disabilities around the world took two forms: periodic payments - pensions - or a lump sum, paid once and for all. The Spanish system was based on the less generous lump sums. On the other hand, low levels of compensation for death and permanent disabilities were in contrast to the case of temporary disabilities, as shown in Appendix 1 (panel C). Before the 1922 reform, Spain was in a large group of countries in which the compensation was 50 per cent of the wage. However, the 1922 reform of the law converted Spain to one of the more generous countries. As employers and insurance technicians had cautioned, this change and the lack of a waiting period would have provoked moral hazard

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[8] Following the early British system, the Spanish system before 1933 left firms free to choose between insurance companies (private or employers´ mutual) and their own reserve funds (Montero, 1981).

[9] With reference to the extent of workers insurance in general - accident, sickness, and old-age, the US Department of Commerce and Labor (1911, pp. 2321-2322), reported that the Spanish system, "not a leader in the field", was making the first steps.

behaviour on the part of workers (Instituto Nacional de Previsión, 1933, pp. 28-42; Paris, 1935, pp. 98-99).

Other inefficiencies processing compensations might have also contributed to the fact that workers´ compensation did not generate incentives to invest in safety. Thus, delays and failures were common. Moreover, on other occasions, workers refused to claim compensation, due to ignorance of the regulations and fear of reprisals, or came to agreements with employers in order to hide partial disabilities (Soto, 1989, pp. 675-677). Factory inspectors insisted on the lack of workers education - including illiteracy - as a limiting factor to the success of safety policies (Instituto de Refomas Sociales, 1908-1923; Ministerio de Trabajo, 1924-1931). The law was also imprecise in the definition of permanent disabilities in some cases, and workers received, at best, the smallest benefit of one years´ wage (García-Ormaechea, 1935; Soto, 1989; Martínez-Pérez, 1992). Finally, in 1922, the state created a reserve fund with the aim of assuring workers´ payments in case of employers´ bankruptcy. However, because of the lack of funding, this fund did not come into operation until 1933 (Jordana de Pozas, 1933).

3.3. Participation of workers and unions

The extent of unions´ involvement in workplace safety was, according to available evidence, not clear. Workers mainly affiliated with or supported two unions, the Socialist Unión General de Trabajadores (UGT) and the Anarchist Confederación Nacional del Trabajo (CNT). The former, founded in 1879, spread in services and industrial subsectors like mining, metallurgy or transport, and was more prone to collaborate with employers and public labor and social reform institutions. The latter, founded in 1910, strengthened in agriculture, textiles and construction, and held a more revolutionary and anti-capitalist attitude. The study carried out by Soto (1989) on the history of industrial labor includes some examples of union concern about accidents at local or industry level. However, other studies refer to relatively weak unions and workers participation in safety issues (Byrne, 1992; De la Calle, 1992; Samaniego, 1992).

The analysis of motives for strikes suggests that the demand for better workplace conditions could not have been a priority for Spanish unions. Rather, according to strike statistics, Spanish unions seemed to focus on wage demands, since around 45 per cent of the strikes between 1905 (the first year available) and 1935 were motivated or included wage claims (Soto, 1989). During the period under study, union participation in the design of labor policy in Spain was, in fact, very limited. Not only was it the case that Anarchist unionism

usually rejected (not without internal disagreement) integration in the new labor institutions, but there was also a lack of opportunities granted by successive governments (Silvestre, 2004, 2005a). This was the particular case during the dictatorship of Primo de Rivera (1923-1931), when the state strongly controlled labor institutions set up to manage conflict. Furthermore, during the dictatorship, the Anarchist union was prohibited, and the Socialist union was allowed but under strict control. The increase of wages, and hours reduction (before achieving the eight-hour day in 1919), were the main union claims in a context of limited power.[10]

4. Workplace accidents in Spain

Spanish statistics for fatal and nonfatal accidents before the Civil War (1936-1939) began in 1904 and extended to 1934 (Instituto de Reformas Sociales, 1905-1923; Ministerio de Trabajo, 1924-1935). The early twentieth century represents a remarkable period in recent Spanish history, with the economy and society changing dramatically during those years (Prados de la Escosura, 2003). The country underwent an intense structural change, led by the contraction of the agricultural labor force and the diversification of the industrial sector, with the introduction or rapid growth of intermediate products and investment goods industries. Spain reduced its difference in per capita GDP with the European industrial core, and on the eve of the Civil War the country was far more urbanized than at the turn of the century.

Figure 1 shows the number of fatal and nonfatal accidents reported for the whole period. Two features need to be examined. First, the number of registered accidents decreases around 1920, with factory inspection making no explicit reference to this decline.[11] There are two potential motives for this. On the one hand, the short-run impact of winning the eight-hour day in 1919. On the other hand, and probably more relevant, the dramatic increase in lost working-days.[12] In fact, the increase in labor unrest during these years negatively

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[10] Some references to fatigue as a potential cause for accidents can be found, however, in unions documents (for instance, Largo-Caballero, 1925).

[11] For instance, in the case of mining, the registered number of accidents fell from 4,107 and 4,361 in 1918 and 1919 to 1,323 and 1,253 in 1920 and 1921. In metallurgy, accidents fell from 2,126 and 1,744 in 1918 and 1919 to 863 in 1920. In chemicals, accidents fell from 677 and 758 in 1917 and 1918 to 383, 438 and 57 in 1919, 1920 and 1921 respectively.

[12] Lost working-days rose from around 3,000,000 per year in 1916-1918 to 8,887,779 and 18,154,405 in 1919 and 1920; and fell to 4,486,550, 3,040,463, and 3,373,483 in 1920, 1921, and 1923 (Silvestre, 2004).

affected the number of factory inspections (Instituto de Reformas Sociales, 1921, 1922).[13] Second, one serious figure coherence problem may arise from the fact that the 1922 reform of the Labor Accidents Law increased workers´ compensation for temporary disabilities by 50 per cent - from 50 to 75 per cent of the wage. As explained in previous sections, this phenomenon could have generated the moral hazard problem by increasing the reporting and/or the carelessness of workers. As pointed out by Fishback and Kantor (2000, p. 79), this coherence problem is difficult to completely eliminate even in modern studies.

However, an interesting feature shown in Table 1 is that the evolution of the two kinds of accidents, fatal and nonfatal, is similar. If we consider that, as pointed out by Moore and Viscusi (1990, p. 122), "the more severe accident - death - should reflect very little moral hazard", it is reasonable to think that other factors were also determining the rise of accidents from the early twenties. It is well known that, *caeteris paribus*, the number of accidents is strongly influenced by economic cycles, rising with upsurges and declining during recessions (Saari, 1982; Robinson, 1988; Fabiano et al, 1995; Adnett and Dawson, 1998; Fairris, 1998; Ruhm, 2000).[14] The 1920s was a period of intense economic growth and industrialization in Spain, accompanied by high internal migration rates and changes in the labour market (Prados de la Escosura, 2003; Rosés and Sánchez-Alonso, 2004; Silvestre, 2005b). In fact, it has been suggested that the acceleration of economic activity in Spain during this decade might have provoked more accidents (McIvor, 1982).

Figure 2 shows total accidents and GDP from 1904 to 1934. Following Ruhm (2000), both variables are detrended, using a linear trend, and normalized by subtracting the mean of the detrended variable and dividing by its standard deviation. The Figure illustrates a clear procyclical relationship between GDP and accidents. In order to confirm this relationship, in Table 1, the log of accidents is run on the log of GDP, time, and time squared for 1909-1930,

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[13] A regression (not shown here) of the log of total accidents on the log of lost working-days (controlling for the log of GDP and a constant), yields an elasticity of -0.11 being the coefficient significant at the 10 per cent level. Dickey-Fuller and cointegration test were carried out. Lost working-days were taken from Instituto de Reformas Sociales (1910-1920) and Dirección General del Instituto Geográfico y Estadístico (1921-1931). GDP at factor cost (1958 = 100) has been calculated by Prados de la Escosura (2003).

[14] This results from three main factors: a) During economic upturns there are more new, young and unskilled workers. b) People work more quickly and for longer hours. c) The short-run impact of newly introduced technologies. In the very long run, however, economy-wide accident rates have fallen (for instance, Aldrich, 1997).

the period under further econometric study in Section 5.[15] Estimations yield high elasticities between 1.7 and 3.7.[16] Table 2 reports more evidence, in this case, at spatial level, on the relationship between GDP and accidents. Cross-section regressions are estimated for two dates, 1913 and 1929, for which provincial GDP is available. Regional dummies are included to control for structural differences. Elasticities at spatial level, although smaller than obtained in time series, are also positive and significant.

Appendix 2 shows the distribution of accidents at industry level. Unfortunately, Spanish accident data at industry level do not distinguish between fatal and nonfatal. Accident rates can only be calculated for two population census dates, 1920 and 1930. Rates for some industries are also possible to elaborate for 1910. Appendix 3 (panel A) offers accident rates at census dates. According to Appendix 2 and 3 (panel A), construction, metals (in fact, iron), mining, chemicals and transport, tended to be the industries with the highest level of accidents. Appendix 3 also offers some international comparisons, almost all of them based on ILO data (countries have been chosen based on the use of similar criteria). International comparisons on industrial accidents are very complicated, and these comparisons should be taken very cautiously. The meaning of an accident is not always the same, varying according to, for instance, its severity, the "scope" of the workplace (including, or not, accidents *in itinere*), and, in the case of fatalities, the period passing between the accident reporting and death. In spite of these (and other) problems, Appendix 3 suggests that Spanish accident rates did not vary considerably from those of other countries.

5. Model and data for safety regressions

Difficulties faced in the implementation of early safety policies in Spain have been described in Section 3. In fact, as shown in Section 4, accidents increased as economic

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[15] Estimations using one-year lagged GDP yield slight differences in elasticities. Estimations were also carried out including a dummy variable to capture the legal change from 1922, instead of using time variables. However, the correlation between the 1922 dummy and GDP is very high, 0.88.

[16] Another factor determining the rise of overall accidents can be the employment shift to more risky industries. Following the method proposed in Aldrich (1997, ch. 7), it is possible to calculate the part of the rise in accident rates between two census dates, 1920 and 1930, that was due to employment shifts. Accident rates for all industries in the Spanish case are only possible to elaborate for census dates (annual data on worker population are available only for mining). Using five year moving average accident rates, accident rates in 1930 would have been 6.5 per cent lower had the 1920 industry pattern of employment remained the same. Using five year moving averages for 1922 or 1924 - and thus avoiding the underreporting of accidents in 1920 - yields similar values of 7.5 and 7.1.

growth accelerated during the 1920s - despite the fact that moral hazard effects could account for part of this increase. In this Section, taking into account serious limitations imposed by the scarcity of data, a more formal approximation is attempted with the aim of determining the relative importance of each policy, and a better understanding why accidents did not decline. Previous studies in the field have usually focused on only one or two policies: factory inspection intensity, workers´ compensation, or the role played by unions. Following econometric estimations for coal mining by Fishback (1986, 1987, 1992), we consider the impact of the three main safety policies potentially affecting the level of accidents.

Data at industry level are used to estimate panels for three periods. The first period, 1909-1930, is comprised of all the years for which data are available. Next, the whole period is divided into two sub-periods corresponding to the pre- and to the post-1922 reform situation. As explained in Section 3, the 1922 reform raised compensation for temporary disabilities. Some social and legal historians have also proposed the existence of other changes related to this reform. Thus, the reform has been said to reinforce labor inspection and gave inspectors more capacity to impose fines (Soto, 1989, pp 281-286, 660, 677). Moreover, it has been proposed that the dictatorship of Primo de Rivera (1923-1931) reinforced labor laws such as safety regulation, requiring the implementation of the safety steps and the use of specialized and appropriate machinery and personnel for risky tasks (Gónzalez-Sánchez 1997, pp. 101-105).[17]

Safety equations for the three periods take the following form:

$$\text{Accidents}_{it} = \beta_0 + \beta_1 \text{ Inpection}_{it-1} + \beta_2 \text{ Wage Compensation}_{it} + \beta_3 \text{ Unions}_{it}$$
$$+ \beta_4 \text{ Accidents}_{it-1} + \alpha \text{ Industry} + \gamma \text{ Time} + \varepsilon_{it}$$

The sources and descriptive statistics of all the variables are included in Tables 3 and 4. With regard to the dependent variable, researchers model both accident rates and accident counts. Accident rates can be difficult to construct, especially using historical sources. In our case, data on worker population for some disparate industries are only available for census dates (1910, 1920, and 1930). Therefore, first, accident counts instead of accident rates are used. Other things being equal, factors determining a count would also tend to determine the

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[17] Annual average of inspections per inspector rose from 339 in 1909-1922 to 443 in 1923-1930 (Instituto de Reformas Sociales, 1910-1923; Ministerio de Trabajo, 1924-1931). Spain also signed several ILO agreements on safety during the 1920s (González-Sánchez, 1997). However, it is not clear that these changes had a relevant impact on safety. In fact, according to inspectors´ reports, persuasion was still a priority (Ministerio de Trabajo, 1924-1930).

rate. In any event, secondly, an accident rate is estimated using the worker population included in a complementary source, the *Estadística de Salarios y Jornadas del Trabajo* (Ministerio de Trabajo, 1931). This source is the most comprehensive and systematic across time labor statistic available for the pre-Civil War period, and it was elaborated according to ILO criteria. One of the most important advantages of this source is that its industry-aggregation criteria is the same as the accident statistics. However, it must be taken into account that worker population provided by the *Estadística de Salarios* is a sample, below census recount.[18]

When using accident counts, ordinary least squares can present statistical shortcomings, since the variable can take only non-negative integer values and many (in this case) industries can report no accidents in one or more years (Ruser, 1991; Gray and Jones, 1991a; Boal, 2003; Fenn and Ashby, 2004). The common solution is to use Poisson and negative binomial models suitable for analysing count data. However, the Poisson model assumes that the conditional mean of the dependent variable equals its conditional variance. Since our data present overdispersion (variance greater than mean), we use the negative binomial (NB), which allows the mean and variance to differ.[19] In any event, we also include a log-linear OLS model in order to compare.[20]

Inspection measures the impact of safety regulation through the number of infractions to the Labor Accidents Law in each industry. Since there is no information on fines imposed on firms or industries, this variable is the best proxy for the intensity of prevention policies (Viscusi, 1992; Gray and Jones, 1991a, 1991b; Lanoie, 1992). Alternatively, in regressions not shown here, simply the number of inspections was introduced. However, this variable performed clearly less well. Although its impact on accidents was in general negative, it was not significant in any regression.[21] The one-year lagged variable is introduced because it is plausible to assume that the impact of the enforcement of the law on accidents occurs with a

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[18] The available samples for 1914, 1920, and 1930 number 1,039,086, 1,293,433, and 1,116,591 workers respectively. According to Nicolau (1990), workers reported in the Population Censuses for 1910, 1920, and 1930 are 1,279,800, 1,868,600, and 2,618,000. The figures for the intermediate years have been interpolated.

[19] Test provided by EViews was followed in order to check if data present overdispersion. Theoretical model can be seen in Ruser (1991).

[20] Because of the dependent variable can be zero, the log (accidents + 1) instead of the log (accidents) is used (Gray and Jones, 1991a, 1991b).

[21] There is no evidence in this period for the existence of inspection-related costs paid by employers. According to Viscusi (1992, p. 1991), this will be a potential reason to find that the number of inspections is a better measure of the expected costs than is, in this particular case, the number of infractions.

lag involved in making capital and labor investment decisions related to safety standards (Viscusi, 1992; Lanoie, 1992).[22] The sign of the coefficient of this variable should be negative.

According to factory inspectors´ annual reports, the intensity of labor inspection in each industry depended on the size of worker population (Instituto de Reformas Sociales, 1908-1923; Ministerio de Trabajo, 1924-1931). A more formal test is explored in Table 5 to contrast whether the number of reported infractions depended on other factors. Using regional data, the urbanization rate is employed as a proxy for the concentration of industries in urban areas. Using industrial data, the average establishment size - only available for 1920 - is used as a proxy for the power of employers in each industry to influence the legal process (the higher the average establishment size, the higher the power of employers). Taking into account that the number of observations is very low, Table 5 suggests that the intensity of inspection was not determined by urban concentrations of industries or the existence of bigger firms in each industry.

Average industry wages are used to approximate the generosity of workers´ compensation.[23] As proposed by the literature, the expected sign of this variable is ambiguous, and can only be resolved empirically.[24] Some facts described in Section 3 would suggest, however, that this policy led to important limitations in promoting more employers´ involvement in safety issues. Basically, these were low premiums in the cases of the most serious disabilities (permanent and death) and several deficiencies in the implementation of the system, including the lack of an experience rating system. Moreover, the dramatic increase of the compensation for temporary disabilities in 1922 has been said to provoke the appearance of moral hazard on the part of workers.

In order to disentangle the role of unions in preventing accidents, a proxy for labor pressure is also included. The lack of continuous and disaggregated union density data forces us to use the other traditional proxy for labor pressure, namely strikes. The union variable is compounded by the number of strikers per total workforce at the establishment. The

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[22] In the regressions in which the one-year lagged variable is significant, the impact of the non-lagged variable was not significant for 1909-1930 and for 1923-1930, and significant for 1909-1920. Longer lag variables were significant in some cases, but their impact was lower.

[23] Section 6.2 also follows a common practice of using the net wage replacement ratio obtained by a worker in the case of temporary disabilities - which are the most numerous (Moore and Viscusi, 1990; Ruser, 1991; Lanoie, 1992).

[24] Nevertheless, as shown in the review by Fortin and Lanoie (2000), studies for the modern era tend to find positive effects on the frequency of accidents.

interpretation of this variable should be done cautiously. Strikes are costly, and they generally occur when negotiations fail. More strikers in some industries might reflect, therefore, either better bargaining position or worse working conditions.[25] In order to check whether a strike variable is a good proxy for unionization, it is possible to estimate the correlation between the number of affiliates to the two main unions and the number of strikers at spatial (provincial) level. Correlations can be estimated for two dates, circa 1920 and circa 1930, and they give high values of 0.60 and 0.80 respectively.[26]

Following previous studies, a lagged dependent variable is included as a proxy for the safety conditions inherited from the previous period. Because of the capital-intensive nature of safety investments, firms that are risky are likely to remain so (Bartrip and Fenn, 1988; Viscusi, 1992; Lanoie, 1992). In any event, results without this variable were practically the same. Finally, fixed effects are included to control for unobserved differences across industries. Several attempts were made to incorporate further controls in all the regressions. However, Spanish censuses and labor statistics do no offer systematic and comparable information on industry characteristics for such a long period of time.[27] Therefore, it should be assumed that fixed effects are capturing differences in industry characteristics susceptible to affect the level of accidents, such as productivity, skills, average age, women density, hours of work, or establishment size. Even so, in Section 6.4, it is possible to include some further controls in regressions for the first sub-period (1909-1920). Year fixed effects capture the impact of differences across time that are common to all industries.

6. Empirical results

6.1. The basic model

Tables 6, 7, and 8 report the main results in the cases in which the dependent variable is the accident count. Safety policies are added one by one, controlling for the lagged dependent variable, and industry and time dummies in all the cases. The signs and significance of safety policies when these were added in different orders were the same. Table 6 refers to the whole

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[25] Section 6.3 deals with endogeneity.

[26] Information on the number of affiliates for the two unions is available for 27 provinces – out of a total of 48. Data for UGT correspond to 1918 and 1920, and 1928 and 1931. Data for CNT correspond to 1919 and 1931. Correlations have been done using averages of these years, in the case of unionization, and three year moving averages around 1919 and 1929, in the case of strikers. See Silvestre (2004) for all the sources.

[27] For instance, recent estimations of GDP at industry level by Prados de la Escosura (2003) refer to a highly different aggregation of industries.

period. Inspection is negative (as expected), and significant. The impact of the workers´ compensation variable is positive and significant. This result seems to confirm that workers´ incentives to report more acccidents, or to reduce prevention, dominated employers´ incentives to increase safety. The union variable, although it presents the more common negative impact on accidents, is only significant in OLS regressions. The coefficient of the lagged dependent variable is positive, but it is not significant in NB regressions. In line with Appendices 2 and 3 (panel A), industry dummies show that, with the exception of mining, iron, and transport, the rest of the industries were clearly less risky than construction (the omitted industry). Time dummies reflect the rise of accidents during the twenties, in particular the last years of the decade.

Tables 7 and 8 refer to the pre- and to the post-reform periods respectively. In general, the model performs less well in both cases. Before the 1922 reform (Table 7), while signs are the same, only inspection is significant (apart from column 3). After the 1922 reform (Table 8), inspection is not significant. This result suggests that historians had overestimated the reinforcement of safety regulation related to the law reform and to the political change. With regard to workers´ compensation, although it is significant when the whole period is considered (Table 6), it is not significant either before or after the 1922 reform. Thus, considering each period separately, it was possible that the inefficiencies in the implementation of the system and the low amount of compensation for the most serious disabilities were unable to alter low employers incentives to invest in safety. However, when the whole period is considered, the significant impact seen in Table 6 could have been caused by moral hazard on the part of workers to take advantage of the rise in compensation for the more abundant temporal disabilities.[28] Section 6.2 turns to this issue. With regard to the role played by unions, if we only consider the sign of the coefficients, the positive relationship during the 1920s, although extremely weak, might reflect a greater propensity to report accidents in order to take advantage of the rise in workers compensations. Finally, the lagged dependent variable reduces its impact considerably during the 1920s. This period was less stable than the 1910s, with the rapid economic growth, and structural and technological change more than likely affecting firms´ safety programs and strategies.

In order to confirm these results, Table 9 reports the results using an estimated accident rate instead of the accident count. Taking into account the problems associated with the use of this proxy for the real rate (see Section 5), the results tend to be similar, in particular when

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[28] Unfortunately, it is not possible to estimate the precise number of permanent and temporary disabilities for all, or a significant part, of the years under study.

the whole period is analysed. For the 1910s, inspection is close to being significant at the ten per cent level. For the 1920s, safety policies are also far from significant. The lagged dependent variable is also not significant for the second period.

6.2. A further test of the moral hazard effect

Regressions show that workers compensation presents a significant positive impact only when the whole period is considered. That is to say, only when the 1922 increase in compensation for the most abundant temporary disabilities is captured in the model. However, when the estimations are made separately for the two subsamples, the impact, although positive, is not significant. To provide more evidence on the moral hazard cause of this change, this section substitutes average wages (Wage Compensation) for the net wage replacement ratio obtained by a worker in the case of temporary disabilities (Corrected WC). Thus, the new variable is 50 per cent of the average wage, between 1909 and 1920, and 75 per cent between 1923 and 1930. Larger positive impacts on accidents are expected if moral hazard existed after the 1922 reform, by reporting more (in particular, minor) injuries and/or decreasing the workers´ accident prevention efforts. Table 10 shows that, controlling for the remaining variables, the impact of the Corrected WC is between 37 and 59 per cent larger than the impact of WC in Tables 6 (Columns 3, 4, 7, and 8) and 9 (Columns 3 and 4).[29] These increases approach the 50 per cent increase in compensations for temporary disabilities - from 50 to 75 per cent of the wage.

6.3. A test of the endogeneity of safety policies

Potential endogeneity of safety policies has been discussed in some studies. First, it has been considered that the intensity of legal regulation variables might be determined by the level of accidents (for instance, Bartrip and Fenn, 1988; Viscusi, 1992; Lanoie, 1992). Second, endogeneity has also been considered in the case of workers´ compensation, since this variable is usually based on wages (for instance, Moore and Viscusi, 1990, ch. 9; Fenn and Ashby, 2004).[30] Thus, on the one hand, it has been argued that the more common positive impact might reflect the existence of compensating wage differentials. On the other, because safety can be a normal good, the negative impact might reflect the fact that individuals (industries) with higher incomes would be associated with safer environments. Finally, the

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[29] For instance, the impact of WC increases from 2.28 in Table 6, column 3, to 4.41 in Table 10, column 1.

[30] In Fishback´s (1986, 1987, 1992) models, wage compensation is proxied by dummies. But the endogeneity of wages, included in the models, is also considered.

positive impact of the unions´ effect would be endogenous if workers in riskier industries had more incentives to participate in unions´ activities related to safety (Fenn and Ashby, 2004). However, it could also be possible that safety was not among unions´ priorities, and that the negative impact of the unions´ effect reflects a lower level of union activity in industries with less safe environments.

Researchers usually consider further variables as instruments for potential endogenous safety policies.[31] However, this strategy is not always possible because of the shortage of proper instruments (for instance, Ruser, 1991). An alternative strategy is used here, based on the use of lagged values of endogenous variables as instruments, inspired by the practice in time series and panel data. This approach (not perfect) has been extensively used in this and in other related fields (in this field, for instance, Lanoie, 1992). To test for endogeneity of safety policies, a method based on Hausman (1978) and Wooldridge (2000) is followed, as recently used by Fenn and Ashby (2004) in their study of British workplace accidents. Table 11 reports regressions including safety policies (and controls) and residuals obtained from regressing safety policies, in this case, on their lagged values. If the coefficient of the residual is significant, we conclude that the safety policy is endogenous. The coefficients of the residual from legal regulation and workers compensation are not significant in any regression. In only two regressions, corresponding to the determinants of accident counts for the whole period, the coefficient of the residual from unions is significant at 10 per cent. This evidence, although weak, would support the fact that safety was not one of unions´ priorities.

6.4. Additional controls for regressions for the 1910s

Only for the 1910s is it possible to elaborate some additional systematic variables. The inclusion of these controls will permit to confirm previous findings about the sign of safety policies during the years in which the level of accidents was stabilized. The following socio-economic variables are generally included in the safety literature cited in Section 5. It is expected that industries with high percentages of skilled and older workers will have less accidents. These workers are usually more experienced or careful, and, in particular in the case of the skilled workers, fill the less dangerous task.[32] Similarly, women tend to work in less hazardous occupations.[33] Finally, daily hours are expected to be associated with higher accidents since an increase in the number of hours worked might provoke worker fatigue.

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[31] A more complex simultaneous equation model is developed by Fishback (1986, 1987, 1992).

[32] Also see the review by Salminen (2004).

[33] For Spain during these years, see Silvestre (2005a).

Moreover, the number of hours worked is considered to capture business cycle effects. Table 12 reports new regressions including the four industry characteristics. Skills, Age, and Women present the expected sign and their impact is significant at usual levels in at least two regressions. Hours, unexpectedly, have a negative impact on accidents, but it is not significant in any case. With regard to safety policies, unions and inspection remains negative and, the later, significant. The sign of wage compensation turns negative, but this variable remains no significant.[34]

7. Conclusions

Industrialization processes during the nineteenth and early twentieth centuries generated a demand for social reform. One of the areas of state intervention was workplace safety. In this paper, the case of Spain has been considered in order to analyse the impact - according to safety literature - of the three main policies affecting accidents at work, namely legal regulation, economic incentives generated by workers´ compensation systems, and the role played by unions.

In Table 13, the magnitude of the impact of each safety policy - considered exogenous - on the reduction of accidents has been estimated. For the whole period, the estimated impact of increasing inspection by a standard deviation reduced the number of accidents by between 7 and 15 per cent. The overall impact of unions was similar or smaller, 11 per cent in the best case (and not considering that this variable could be endogenous). However, the sum of these two negative (positive) impacts on accidents (safety) was smaller than the impact of the increase in workers´ compensation. The estimated impact of increasing workers´ compensation by a standard deviation increased the number of accidents around 40 per cent. Whereas, the impact of the corrected- workers´ compensation is even bigger. The impact of safety policies on the estimated accident rates gives similar results. According to contemporaries, evidence shown here, and also evidence for other countries and periods, it is reasonable to think that the dramatic rise in premiums for temporary disabilities generated moral hazard problems.

As stated at the beginning of this paper, the Safety Service of the ILO made a bet on the combination of European and American methods of accident prevention to reduce accidents. European focus on legal regulation should be complemented with the use of workers´ compensation programs as an economic incentive for employers, and the Safety First

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[34] Another problem of these new regressions is that correlations between wage compensation and the four

approach to workers´ education and cooperation between workers and employers. In the case of Spain, qualitative studies and the empirical findings found here suggest that this combination failed. What were the reasons for this?

Spanish legal regulation, although effective according to empirical evidence shown here, had a limited impact. A combination of motives - not exclusive to Spain - has been identified: First, the lack of funds and personnel; second, the weakness of labor inspection to enforce the law and impose fines. In fact, as was remarked by labor inspectors themselves, underlying these problems was the great difficulty in implementing a new and wide-ranging set of early labor laws. Thus, at the time of the First World War Spain was still one of the countries with the lowest levels of legislation in terms of social and labor intervention (Huberman and Lewchuk, 2003). However, on the eve of the Civil War (1936) more than twenty laws had been enacted, putting Spain on the European average (Silvestre, 2005a). Furthermore, the Spanish industrial sector was at that time mainly constituted by low capitalised small and medium-sized companies, with establishment size being one of the main factors in determining the success of safety legislation - as emphasized by a number of safety studies. In any case, legal regulation heavily based on persuasion more than penalization was insufficient to counteract the strong procyclical relationship between the economic cycle and accidents.[35]

Economic incentives derived from the establishment of workers´ compensation had no impact on reducing accidents. In contrast, as in other countries during the same period, employees´ laxity and moral hazard behaviour seemed to dominate employers´ safety prevention. In the particular case of Spain, we may add the low level of compensations in the most severe cases - of death and permanent disabilities, and the fact that companies were not experience rated, to conceive workers´ compensation as a real economic incentive for employers to invest in safety.

Finally, unions had a weak impact on the reduction of accidents. Occupational safety and health practices were not one of the main priorities in Spanish union demands during the industrialization. On the contrary, in a poor country, unions tend to focus on monetary

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industry characteristics are high: 0.6, 0.7, 0.7, and 0.5, for Skills, Age, Women, and Hours respectively.

[35] As pointed out by Kniesner and Leeth (2004), another potential motive that could avoid bigger impacts of regulation is the existence of labor market forces creating compensating wage differentials. In the case of Spain, Silvestre (2005a) finds relatively high compensating wage differentials for male workers. This phenomenon could have been acted as a substitute for legal compliance. Unfortunately, data available only permits the author to estimate compensating wage differentials for 1909-1920.

demands. [36] Moreover, their participation in collective bargaining - including safety issues - was limited both by their reluctance and by successive governments. It is true that, following other European countries during the 1920s, Spanish safety policy partially shifted its orientation from the traditional European focus on the compliance to legal safety standards, to the adoption of new safety policies. However, the new strategy was based on the implementation of technical improvements, but not on American Safety First´s cooperation between parties. Moreover, socio-political instability in Spain during this period was a strong impediment to collaboration between employers and unions. This situation was exacerbated during the 1920s, as a result of the new institutional framework generated by the dictatorship of Primo de Rivera.

Appendix

(Appendices 1, 2, and 3)

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[36] Using the same union variable and controlling for other factors, Silvestre (2005a) finds a positive and highly significant impact on wages.

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(Figures 1 and 2)

(Tables 1-13)