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Bridging the Gap in Understanding Sick Leave Duration after Workplace Injuries

Laura María García Carrizosa

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Doctorate in Economics, Management and Organization (DEMO)

Bridging the Gap in Understanding Sick Leave Duration after Workplace Injuries

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Introduction

According to the European Statistics on Accidents at Work (ESAW, 2020), the year 2020 witnessed an average of 1,466 non-fatal accidents per 100,000 individuals employed across the European Union. Notably, countries within the EU with insurance-based accident reporting systems, namely Portugal, France, and Spain, exhibited the highest rates of non-fatal accidents with corresponding figures of 2,814, 2,598, and 2,384 per 100,000 persons employed, respectively. In Spain, occupational accidents among salaried workers caused more than 20.4 million lost workdays in 2019 (MTYES, 2019). In the United States, according to the National Safety Council (NSC, 2019), work-related injuries totaled 4.65 million in 2019, resulting in 105 million production days lost and estimated total work injury costs of $171 billion.

An employee's absence at work creates difficulties at the personal, organizational, and governmental levels. For workers, it can bring problems that affect mental health as well as reduced productivity, loss of interest, low professional development, and decreased performance. At the organizational level, the consequences of sick leave are associated with the costs and administrative tasks of temporarily replacing the worker, as well as the lost time, reorganization of activities, and income loss due to a decrease in activity and productivity. Similarly, the government incurs costs related to Social Security contributions and the negative impact on GDP resulting from the reduction in productivity.

To a large extent, the costs of an injury are directly associated with the duration of the worker's sick leave: the longer the incapacity period, the higher the economic costs to the company and society. At first glance, one might think that the number of days a worker is on sick leave corresponds to the time the worker needs to recover from injuries. Nevertheless, the starting point of this thesis is that the duration of sick leave may not be exclusively determined by medical criteria. As argued in Chapter 1, the time workers take to return to work following an occupational injury is influenced by a moral hazard context, which enables the injured worker to behave opportunistically.

There is a vast literature, theoretical and empirical, that analyzes the incidence and consequences of work-related accidents as well as factors predicting disability outcomes. However, studies focused on analyzing the determinants of workdays lost due to sick leave remain very scarce and incomplete. This thesis contributes to filling this gap in several ways. First, it synthetizes a conceptual framework to explain the multifaceted

nature of the duration of sick leave following work-related accidents and its main sources and drivers. In particular, the thesis delves into the factors that could motivate and facilitate opportunistic behavior by injured workers that may lead to an undue extension of the incapacity period.

Second, it provides a comprehensive empirical analysis based on an unusually large database of all non-fatal work accidents that occurred in Spain from 2015 to 2021 in different contexts and industries: manufacturing, services, and construction. Unlike the majority of studies on work injuries, which frequently perform limited statistical analyses based on small sample sizes and often rely on self-reported surveys within specific industries, we use official microdata on occupational injuries obtained from the Ministry of Labor, which enables us to utilize a substantial amount of reliably sourced data, comprising more than 2.2 million observations.

Third, a variety of methodologies, such as econometric analysis, stochastic frontier analysis, survival analysis, cluster analysis, and other techniques, are applied to generate reliable and robust results. The innovative use of stochastic frontier estimation techniques is noteworthy as they make it possible to estimate the excess number of sick leave days and its associated costs as well as the propensity for presenteeism of certain groups of employees.

The main methodology employed in this thesis is stochastic frontier analysis, a powerful tool that not only enables the identification of determinants influencing the standard recovery time after a workplace injury but also helps uncover factors that may encourage injured workers to extend their incapacity period without valid health reasons. This approach further allows us to compute over-duration rates, indicating the percentage of days employees prolong their absence due to opportunistic behavior.

In addition to this methodology, various other techniques are incorporated to strengthen our results and provide evidence-based findings. A contemporary and widely used method for exploring associations among variables is cluster analysis. In our case, this technique identifies patterns among different groups based on personal, organizational, and employment characteristics, associating them with the duration of sick leave.

Moreover, given that the central focus is on the duration of sick leave, a survival analysis is applied to model the time until the occurrence of an event (the end of the sick leave period) and to identify factors influencing this duration. Furthermore, we employ a generalized ordered logistic regression and correspondence analysis, adapting our

dependent variable to five distinct groups representing varying durations of the incapacity period. This alternative approach enhances the validity of our results by recognizing significant variables influencing the incapacity period. This diverse range of methodologies employed across the chapters not only ensures the robustness of our empirical findings but also contributes to the generation of more solid and comprehensive results.

Finally, this study derives several managerial and policy implications. Thus, the findings provide valuable information for policymakers, insurance providers, and other stakeholders involved in managing occupational injuries to develop strategies aimed at improving the management of work-related accidents as well as mitigating opportunistic behavior and, hence, the economic burden on the public insurance system. In this regard, the investigation of this topic appears to be relevant since there is a need for evidence-based policies and interventions at the level of the worker (training, information, personal protective equipment, etc.), the company (organizational changes, tool design, risk prevention system, control, etc.), and the government (regulation, labor inspection, social rights, etc.) that lead to the creation of optimal working conditions and carry out an efficient and effective prevention policy.

The thesis is organized into five chapters. Each represents a distinct study with its own set of gaps, theories, data sources, and methodologies, offering distinct theoretical implications, practical recommendations, and limitations. Even so, the common thread across all chapters is the analysis of sick leave duration.

The first chapter sets up a synthetic conceptual framework to explain the duration of injury-related sick leave, providing a detailed discussion of the sources of involuntary absence and the drivers of moral hazard in the context of occupational accidents. The analysis highlights the complex, multifaceted nature of sick leave due to accidents at work. The outcomes of the chapter summarize the idea that absenteeism encompasses both involuntary and voluntary behaviors. An ex-post duration hazard exists where injured workers exploit informational asymmetry to mislead doctors, prolonging sick leave and delaying their return to work. This framework serves as a foundation for the subsequent four chapters, which scrutinize an array of variables to measure their potential impact on sick leave duration across different sectors of the Spanish economy.

Chapter 2 investigates the relationship between the sector of the firm and the length of sick leave, revealing compelling evidence that public employees tend to experience lengthier periods of absence compared to their counterparts in the private

sector. The main results of this section are related to the evidence that public-sector employees exhibit lengthier sick leave periods than their private-sector counterparts, and the extent of subsidy is positively correlated with prolonged absences.

Chapter 3 focuses on the behavior of teachers in the education sector. Levels of teacher absenteeism have been the subject of many studies from a variety of perspectives and disciplines. This chapter provides a comprehensive systematic literature review of teacher absenteeism followed by an empirical analysis of the sick leave duration of teachers at different education levels. The results of the systematic literature review indicate that addressing teacher absenteeism requires a multi-perspective approach, given substantial heterogeneity in measuring and approaching the issue, and there is no absolute consensus on predictors, but an increase in teacher absenteeism negatively impacts student achievement. The empirical analysis findings suggest that public school teachers tend to return later than their private school counterparts. Preschool and special education teachers have lower over-duration rates with shorter return periods compared to teachers at other educational levels.

Chapter 4 delves into the impact of firm size on the length of sick leave following a workplace injury within manufacturing industries. The chapter argues that the level of control and supervision, as well as employees' attendance motivation, vary across firm sizes, thereby configuring work contexts either more or less prone to the emergence of opportunistic behavior. The results show evidence that larger manufacturing firms witness prolonged absence periods after work-related accidents.

Chapter 5 focuses on the employees who return to work despite not having fully recovered, a behavior commonly known as presenteeism that is also rooted in moral hazard contexts. A specific stochastic frontier model is applied to analyze the most common hard-to-diagnose injuries among a sample of construction sector workers. The findings propose that immigrant and temporary employees are more likely to return before sick leave ends due to job insecurity. Conversely, workers in larger firms lean toward presenteeism due to deadline pressure, while higher disability benefits may encourage malingering and extended sick leave.

Table 1 summarizes the organization and main content of this doctoral dissertation, illustrating the alignment among objectives, data sources, methodologies, and outcomes across the five chapters.

Table 1. Structure and contents of the thesis

Chapter	Main Objective	Sample	Research	Methodology	Main results
1. The sources and determinants of the duration of sick leave due to work accidents: Conceptual framework	Develop a conceptual framework of sick leave duration after workplace injuries and describe the general context of occupational injuries in Spain	–	Theoretical	–	Presence of both involuntary and voluntary absence behaviors. Existence of an ex-post duration hazard in which the injured workers could take advantage of the informational asymmetry to mislead the doctor to prolong the duration of the sick leave and delay their return to work.
2. Examining disparities in sick leave duration following occupational injuries: A comparative analysis of public- and private-sector employees	Analyze the influence of the firm sector (public versus private) on the duration of sick leave post occupational injuries and quantify the excess days away from work and the extra costs involved	1.7 million observations of all non-fatal injuries that cause an absence of at least one working day in the service sectors in Spain from 2015 to 2021	Empirical	SFA/K-means clustering analysis	Public-sector employees take longer periods of sick leave compared to private-sector employees. Higher amounts of subsidy lead to longer periods of absence.
3. Return to school after an occupational injury: differences in teacher absence behavior across educational level	Analyze the drivers of teacher absenteeism	89 papers that study teachers' absences at work	Theoretical	Systematic literature review	A conceptual model of the predictors of teacher absenteeism is derived as a multilevel issue considering factors at the teacher, work, school, and contextual levels.
	Investigate the duration of sick leave after an occupational accident in the education sector in Spain and determine which individual, contextual, and center-level factors influence the length of the absence period	22,185 observations of all non-fatal injuries that cause an absence of at least one working day in the education sector in Spain from 2015 to 2021	Empirical	SFA/survival analysis	Teachers in public schools tend to return to work later than their counterparts in private schools. Preschool and special education teachers exhibit lower over-duration rates, as their return to work is typically shorter compared to teachers at other educational levels.
4. The role of firm size in sick leave duration after occupational accidents: evidence from Spain's manufacturing sector	Examine the effect of company size on sick leave duration following work-related accidents	548,000 observations of all non-fatal injuries that cause an absence of at least one working day in the manufacturing sector in Spain from 2015 to 2021	Empirical	SFA/generalized ordered logistic regression/ correspondence analysis	Workers in larger manufacturing firms tend to experience lengthier periods of absence after an accident at work.
5. Employees presenteeism and malingering on return to work after an occupational accident: a two-tiered stochastic frontier model	Study the length of sick leave after work-related accidents in the construction sector through the utilization of a two-tiered stochastic frontier model and estimate the inclination of workers to extend or abbreviate their time away from work after occupational injuries	24,288 observations of all non-fatal injuries that cause an absence of at least one working day in the construction sector in Spain from 2020 to 2021	Empirical	Two-tiered SFA	Immigrant and temporary employees are more likely to return to work before the end of their sick leave period due to job insecurity. Likewise, workers in big firms are more inclined toward presenteeism due to pressure to meet deadlines and participate in tenders. In contrast, higher disability benefits may increase malingering behavior and prolong the duration of sick leave.

Furthermore, Table 2 provides a comprehensive list of variables utilized in this thesis, accompanied by a concise explanation for each variable sourced from the Statistics of Work Accidents (Estadística de Accidentes de Trabajo, EAT), published by the Ministry of Labor and Social Security of Spain. The use of each variable is explained and justified in the methods section of each chapter.

It is noteworthy that an ideal exploration of opportunistic behavior in sick leave duration necessitates a holistic research approach. This entails not only access to detailed sick leave records, including information on the start and conclusion of each sick leave period, but also the incorporation of broader factors, such as employee demographics, injury characteristics, and work-related variables (such as job type, work schedule, and company size). Additionally, the inclusion of control variables, such as the region or the sector in which the accident occurs, is crucial for a nuanced investigation. All of the control variables are encompassed by the variables outlined in Table 2. This comprehensive dataset allows for a thorough examination of this complex issue.

However, it is essential to acknowledge that a more comprehensive analysis, beyond the scope of this thesis, would involve specific variables related to injured workers, such as comorbidities or previous injury records. Furthermore, detailed characteristics of the company, including the presence of health and prevention systems or initiatives to manage occupational accidents, could significantly contribute to a more nuanced analysis and understanding of sick leave behavior following a workplace injury. Nevertheless, those variables are beyond the scope of our study.

Incorporating qualitative insights, such as employee interviews or surveys, would provide a deeper understanding of the motivations influencing decisions regarding sick leave. While these aspects extend beyond the current thesis, they represent valuable avenues for future research into the dynamics of sick leave behavior and the broader context of workplace injury management.

Table 2. List of the variables used in the thesis

Variable	Description	Category	Use (chapters)
Injury severity	1= Serious injury, 0 = Minor injury	Injury characteristics	2,3,4
Hospitalization	1= Hospital care, 0 = Ambulatory care	Injury characteristics	2,3,4,5
Injury Type	Drowning and suffocation Traumatic amputations (loss of body parts) Dislocations, sprains, and strains Effects of extreme temperatures, light, and radiation Effects of noise, vibration, and pressure Poisonings and infections Bone fractures Superficial wounds and injuries Heart attacks, strokes, and other non-traumatic pathologies Multiple injuries Burns, scalds, and frostbite Psychic trauma, traumatic shock	Injury characteristics	2,3,4
Injured body part	Head Neck Back, including spine and thoracolumbar vertebrae Trunk and organs Upper extremities Lower extremities Whole body and multiple parts	Injury characteristics	2,3,4
Gender	1= Female, 0 = Male	Personal attributes	2,3,4,5
Age	Number of years the worker has lived	Personal attributes	2,3,4,5
Foreign	1= Immigrant worker , 0 = National worker	Personal attributes	2,3,4,5
Occupation dummies	Directors and managers Accounting, administrative, and other office employees Elementary occupations Plant and machinery operators and assemblers Scientific and intellectual technicians and professionals Technicians; support professionals Catering, personal, protection, and sales service workers	Personal attributes	2,4,5
Temporary contract	1= Temporary contract, 0 = Fixed-term contract	Work-related factors	2,3,4,5
Subsidy	Disability benefit in euros	Work-related factors	2,3,4,5
Firm size	Number of employees	Work-related factors	3,4,5
Weekend	1= Weekend shift, 0 = Week shift	Work-related factors	4
Night	1= Night shift, 0 = Day shift	Work-related factors	4
Public	1= Public sector, 0 = Private sector	Work-related factors	2,3,5
Part-time	1= Part-time job, 0 = Full-time job	Work-related factors	3
Educational level	Post-secondary Secondary Primary Preschool Special	Work-related factors	3
Sectoral dummies (services)	Administrative activities and auxiliary services Artistic, recreational, and entertainment activities Financial and insurance activities Real estate activities Professional, scientific, and technical activities Health and social services activities Public administration and defense; compulsory Social Security Wholesale and retail; motor vehicle and motorcycle repair Education Hostelry Information and communications Transport and storage	Control variables	2
Sectoral dummies (manufacturing)	Food, beverages, and tobacco Rubber and plastic Manufacture of furniture and others Manufacture of transport equipment Manufacture of electronic/electrical material, equipment Wood and cork Paper and graphic arts Metallic product Pharmaceutical products Non-metallic products Chemical products Machinery repair	Control variables	4
Autonomous community	Dummy variables for the 17 Spanish autonomous communities	Control variables	2,3,4,5
Time	t = 1…7 with year 1 corresponding to 2015	Control variables	2,3,4,5

Chapter 1. The sources and determinants of the duration of sick leave due to work accidents: Conceptual framework

Abstract

This chapter constructs a conceptual framework that aims to illuminate the complex landscape of sick leave duration following workplace injuries. The analysis marks the presence of both involuntary and voluntary absence behaviors. In particular, voluntary absence emerges from a moral hazard scenario, with three key factors converging: the presence of imperfect and asymmetric information regarding the employee's return-to-work capability, the employee's motivation to attend work, and the organizational measures to control potential opportunistic conduct. Furthermore, this chapter presents an exploration of the Spanish context regarding occupational accidents. This entails an exploration of the procedural aspects and the various stakeholders involved when workplace injuries occur. These insights lay the foundation for comprehending sick leave duration after occupational accidents as well as the nuanced analysis of the contextual dynamics that might tempt individuals to extend their absence from work opportunistically.

Chapter 1. The sources and determinants of the duration of sick leave due to work accidents: Conceptual framework

1.1 Introduction

Following an occupational injury, the number of days that the injured employee needs to recover is primarily based on medical criteria. However, the medical assessment of the injured worker's recovery is far from being completely accurate, as the process is surrounded by significant levels of uncertainty and the presence of imperfect and asymmetric information. For example, the doctor often does not have enough time to make all the necessary explorations to verify the reality of the symptoms. Similarly, delays in carrying out diagnostic tests are common, which can lead to evaluating the real condition of the patient without total certainty.

Determining the actual level of recovery of an injured worker's health and whether the worker is fit to safely perform tasks required by the job is often difficult and costly to verify accurately by an outside observer, even a physician. The presence of such imperfect and asymmetric information creates a situation of moral hazard, which facilitates the worker's ability to extend the time off work beyond the natural recovery time. In this context, there may be personal, organizational, or economic circumstances that motivate the employees to persuade the physician to extend the duration of sick leave beyond the standard period, even though they have already recovered and are able to return to work. Consequently, it is argued that the observed duration of sick leave is determined not only by medical and health factors that motivate a "legitimate" absence as a result of work-related ill health but also by factors that motivate an "illegitimate" absence from work. Understanding the drivers of both types of factors is crucial to taking appropriate management measures to reduce the duration of sick leave and its associated costs.

1.2 Sick leave duration: Between health recovery and moral hazard

As stated above, the duration of sick leave due to an injury at work is the result of two types of absence—involuntary and voluntary—each having different origins. The distinction between voluntary and involuntary absence behavior goes back to Steers and Rhodes (1978), whose model of employee attendance has guided much of the research on absenteeism in the human resources field. Figure 1 provides a schematic diagram of

the determinants of sick leave duration and their sources, each of which is discussed below.

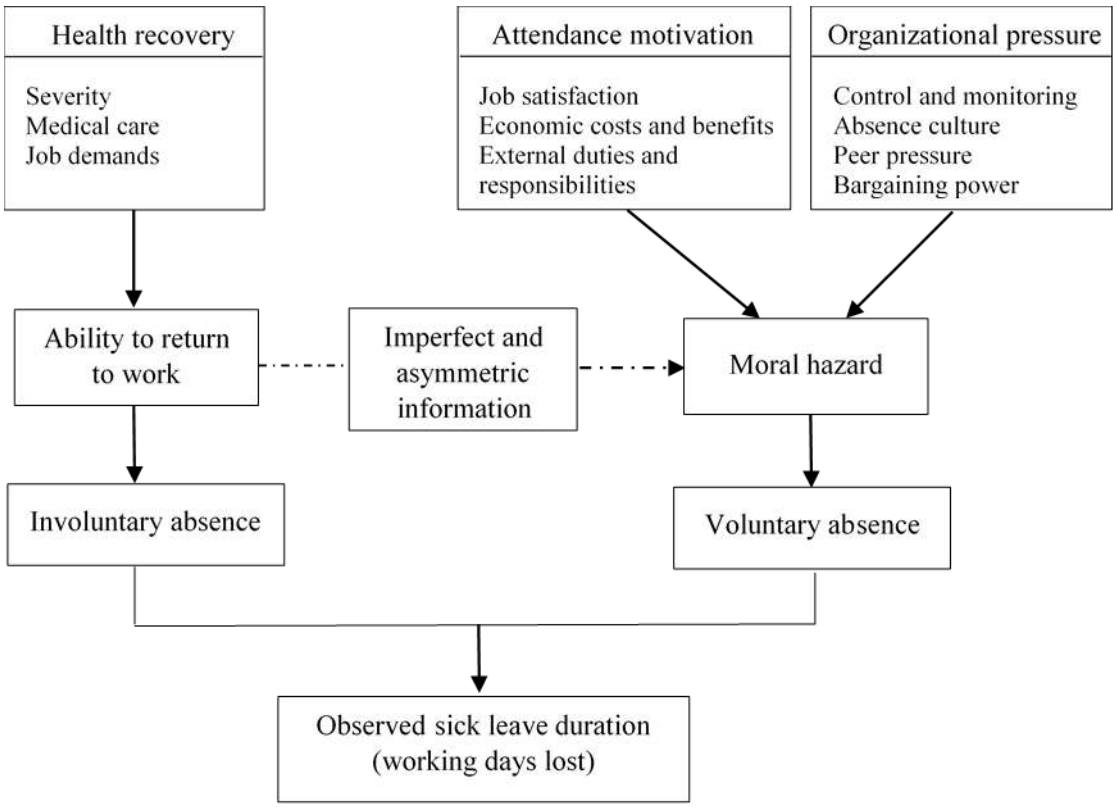


Figure 1. Conceptual framework of the determinants of sick leave duration

In Figure 1, involuntary absence appears related to the time the worker needs to be able to return to work. In principle, the duration of an injury-related sick leave should be determined by the worker's natural medical recovery time, that is, the time that the injured worker needs to complete healing after the injury. In this sense, the number of days a person needs to fully recover from a work injury depends on three factors: (i) severity of the injuries; (ii) medical care received; and (iii) job demands.

The degree of severity is determined primarily by the type of injury suffered by the worker. Thus, it is obvious that a finger sprain or a superficial wound is less serious than a fracture of the tibia and fibula. However, for a given injury, the severity of its consequences is also conditioned by the age and general health of the injured worker. Older workers may have lower functional and health abilities, which commonly implies a longer time of incapacity. That is, for the same type of injury, the natural recovery time of an older worker is expected to be longer than that of a younger worker. Moreover, the ability to return to work is directly influenced by the quality of medical care received by the injured person at different stages: first aid and initial assessment, diagnosis and

subsequent treatment, follow-up, and rehabilitation. Finally, job demands refer to the physical and mental effort and skills required to properly perform the tasks that characterize the worker's occupation. The more demanding the job, the longer and more rigorous the healing process before the injured worker is able to return to work.

On the other hand, as shown in Figure 1, voluntary absence has its origin in a situation of moral hazard. Voluntary absence constitutes a deliberate choice by the employee to avoid attending work, driven by factors within their control. In essence, the decision to attend work becomes a matter of the employer's discretion or personal choice, categorizing it as a non-medical behavior. In the context of injured workers, this specifically refers to instances in which individuals choose to be absent from work for personal or organizational reasons as opposed to being medically incapacitated. This distinction emphasizes that the absence is driven by factors unrelated to health conditions that would hinder the ability to work. Three variables converge in this situation: the presence of imperfect and asymmetric information about the extent to which the employee is able to return to work, the employee's attendance motivation, and the level of effort exerted by the organization to deter potential opportunistic behavior by the employee.

In general, a moral hazard is a situation that arises when individuals decide to take a risk because they will not bear the consequences of their actions. In other words, they may be motivated to think about changing or not changing their behavior, as it is unlikely that they will suffer the penalties or the costs of the risk. The lack of complete and symmetric information between the two parties of a transaction causes economic imbalances, as one party behaves in a riskier manner because that party knows that the consequences of such behavior will be borne by the other party. In the context of workplace injuries, Fortin and Lanoie (2000) identify four different types of moral hazard problems related to the use of informational asymmetries for personal gain. Two types define ex-ante moral hazard situations, which arise before the injury occurs. The first one is the injury hazard, which arises when insurance makes the worker less careful in preventing injuries. The second is the ex-ante causality hazard, which arises because it is sometimes difficult to identify which injuries have actually occurred at work.

The other two types of moral hazard problems are cases of ex-post moral hazard, in which the worker has reduced incentives to minimize the cost of the injury after it has happened. Within this category, Fortin and Lanoie (2000) include the insurance substitution hazard and the duration hazard. The former occurs when workers have

incentives to substitute less generous unemployment or health insurance for more generous work injury insurance. The latter refers to the situation in which the worker acts to prolong the duration of the absence period over which benefits are paid out. More precisely, the ex-post duration hazard reflects situations in which injured workers have better knowledge about the real progress in their recovery and ultimately about whether they are truly able to return to work. This information is not readily observable by the physician, let alone by the employer. In such a context, the injured worker can take advantage of the informational asymmetry to mislead the doctor in order to prolong the duration of the sick leave and thus delay returning to work.

Moral hazard is a latent threat, which raises the question of when opportunistic behavior is most likely to materialize. In other words, we are particularly interested in identifying the context and circumstances under which an individual might be more tempted to extend the absence from work. In this sense, two kinds of factors may trigger opportunistic behavior: (i) those that increase the worker's satisfaction and gains from extending the time off from work and (ii) those that reduce the probability of being discovered if one behaves opportunistically.

The first group of drivers is related to employees' valuations of their jobs and to the pressures coming from their private and work environments, which together determine employees' so-called attendance motivation (Nicholson, 1977; Steers & Rhodes, 1978; Warr & Yearta, 1995). In essence, they refer to non-health factors that influence people's level of motivation to attend work, which determines their response to an occupational injury causing sick leave. From an economic viewpoint, once employees have healed or recovered from an injury, they will seek to prolong their time off from work if the utility that they obtain at work is lower than that obtained during the period of sick leave or, alternatively, if ending the sick leave causes a cost to the employees that is greater than the utility they obtain at work. Such cost/benefit balance depends on a variety of motivational factors. For example, job (dis)satisfaction has been traditionally highlighted as a key explanatory factor of individuals' voluntary absence decisions (e.g., Steers & Rhodes, 1978; Brooke, 1986; Drakopoulos & Grimani, 2013).

Other attendance motivation sources are based on extrinsic rewards and external pressures. For instance, a worker who enjoys a higher insurance benefit and better social protection is likely to be more tempted to exhibit opportunistic behavior and prolong the duration of absence. In the same vein, a worker who has time-consuming obligations outside work (e.g., care of children or elderly relatives) might be more motivated to delay

the return to work. Conversely, if economic and market conditions are especially adverse for an employee in a particularly vulnerable situation, one would expect less incentive to extend sick leave for fear of losing a job.

The second group of drivers in Figure 1 refers to contextual factors that may exacerbate the moral hazard situation. In particular, to reduce the likelihood of opportunistic behavior and the voluntary absence it causes, the employer must exert, either directly or indirectly, closer control of employees to overcome the problem of information asymmetry. Such control is costly and becomes more difficult when the information relevant to a transaction is incomplete, asymmetric, and unverifiable. In environments where absence control is looser, opportunism has much more room to operate, as it is easier to cheat and go undetected. Likewise, peer pressure to return to work is weaker in work environments where determining individual performance is more diffuse, absent workers are easier to replace, and workers are easily interchangeable. Such organizations tend to have a more permissive absence culture.

In addition to the previously described scenario, there is another way in which employees might be tempted to engage in misconduct. This involves taking advantage of the imbalance in information and making the decision to shorten their sick leave and return to work prematurely, even if they have not fully recovered. This phenomenon is commonly referred to as presenteeism, and it manifests when employees choose to be physically present at their workplace despite not being in the optimal condition to perform at their best due to illness.

According to Ramsay and Oguledo (2015), presenteeism imposes a significantly higher cost on businesses than absenteeism, potentially resulting in up to three times the loss of productivity due to health-related issues. In essence, presenteeism can be viewed as a classic example of a moral hazard problem as the company lacks full visibility into the actions of its employees.

As highlighted by Ollo-López and Núñez (2023), employees respond to a combination of implicit incentives such as motivation, empowerment, and recognition, as well as explicit incentives like wages, training, and career opportunities when deciding to work while still unwell. Therefore, it is crucial to incorporate an examination of this phenomenon into our analysis. This entails gaining an understanding of the factors that influence employees' choices regarding their return to work before the designated period of incapacity concludes.

For instance, organizational policies related to sick leave, employment contract types, and the level of supervision exerted by the company may promote presenteeism. Following Johns (2010), it might be assumed that individuals with higher salaries would be more likely to take sick leave and avoid the challenges of presenteeism. The research of Aronsson et al. (2000) indicates that permanent employees tend to engage in presenteeism more frequently than temporary staff. Furthermore, exercising direct supervision and control over workers' tasks represents a straightforward and immediate solution for addressing moral hazards, as suggested by Alchian and Demsetz (1972). Consequently, the various work environments in which employees operate may contribute to the decision to show up at work even when feeling unwell.

Employees act as self-interested individuals who consistently explore their surroundings to identify opportunities that enhance their well-being. Opportunistic behavior is a potential avenue for employees to increase their satisfaction at the expense of the employer (Nagin et al., 2002). While opportunistic behavior is often associated with individualism for personal gains, its impact extends to collective interests. Therefore, it is imperative to limit and study this behavior from multidisciplinary perspectives. In the context of employment relationships, Akerlof (1982) contends that offering higher wages can discourage employees from engaging in opportunistic actions. Kreps (1997) suggests that the introduction of monetary incentives and close supervision enhances intrinsic motivation to perform well, while Encinosa et al. (2000) explore the significance of peer pressure in determining levels of work effort.

From a human resource perspective, Livingston (1969) emphasizes the role of supervision in shaping employee behavior. Additionally, the organizational structure of a firm is expected to consider monitoring costs as a necessary investment to mitigate opportunism (Alchian & Demsetz, 1972).

Within the occupational health framework, it becomes challenging to objectively verify the informational advantage that patients may possess regarding certain health conditions, creating a potential space for moral hazard situations. A case in point is the study by Markussen et al. (2011), which highlights substantial variations in certification practices among physicians. The findings suggest that there is considerable room for subjective judgment in the certification process, emphasizing the inherent challenges in objectively assessing certain health conditions.

The comprehensive and multidisciplinary concepts surrounding the analysis of opportunistic behavior are captured in Figure 1. This representation highlights the

presence of asymmetric information regarding the severity of injuries, providing an advantage to the worker who possesses more information than the employer. This asymmetry introduces subjective elements in defining sick leave durations, creating moral hazard situations that can be influenced by incentives.

As a result, a thorough analysis of this phenomenon necessitates the simultaneous consideration of economic, organizational, human, and health perspectives. These perspectives suggest strategies aimed at promoting incentives to diminish opportunities for voluntary worker misbehavior. This involves enhancing attendance motivation and elevating the levels of control and monitoring, thereby mitigating the potential for opportunistic actions.

Linking the variables outlined in Table 2 to the conceptual framework illustrated in Figure 1 reveals direct correlations. For instance, certain database variables, such as the severity or type of injury, and demographic factors, like gender, age, or occupation, are related to the ability to return to work after an occupational accident. Conversely, other variables, including contract type, immigrant status, working conditions (such as weekends or night shifts), or subsidy levels, may influence the employee's motivation to attend work. This could potentially lead to situations where individuals attempt to prolong sick leave without valid reasons.

Furthermore, organizational variables, such as firm size or sector, play a role in determining the level of control and monitoring, impacting the worker's decision to opportunistically extend the incapacity period beyond the standard recovery time. Hence, the conceptual framework provides a foundation for bridging the theory of determinants of sick leave duration and their origins with empirical analysis, utilizing the available information on occupational injuries in Spain.

With this perspective in mind, this thesis aims to offer a comprehensive exploration of the factors that influence the duration of sick leave after an occupational injury. It goes beyond merely examining health-related variables that affect the return to work. Instead, it explores the multifaceted aspects of a worker's decision-making process when faced with the choice of extending or shortening their incapacity period within the framework of moral hazard.

1.3 Background on occupational injuries in Spain

In Spain, three key organizations play a crucial role in promoting occupational health in the country. First, the Social Security System, established under the 1966

General Social Security Law, recognizes work-related injuries, professional illnesses, and temporary or permanent disabilities. Second, the National Health System, mandated by the 1986 General Health Law, is responsible for safeguarding the overall health of all individuals, including workers. Last, the Occupational Risk Prevention System, established in 1995 through the Law of Prevention of Occupational Risks, aims to protect employees and efficiently promote safety and health in the workplace. These three systems intersect to emphasize the importance of connecting social protection with public health policies. This integration contributes to best practices in the workplace, generates mechanisms for risk prevention, and reduces health inequalities within society.

According to Articles 156 and 157 of the General Social Security Law and Royal Decree 8/2015 (Ministerio de Empleo y Seguridad Social, 2015), a work accident in Spain is defined as an injury that occurs in relation to work activities, including the location and timing of the incident. This definition encompasses commuting to and from work (in itinere) as well as travel for work-related purposes (on mission). It's important to note that an incident is not considered a work accident unless it results in an injury.

Another significant concept is incapacity, which refers to a worker's inability to perform a job temporarily or permanently due to a common illness or work-related accident. In such cases, the worker receives healthcare coverage from the Social Security System. The maximum duration of incapacity is 365 days, with an additional 180-day extension when there are indications that the worker's condition may be medically cured during that time. The determination of when a worker is fully recovered and capable of resuming regular job responsibilities rests with medical professionals and is based solely on medical criteria.

Temporary and permanent incapacity for work is accompanied by an economic benefit provided through the Social Security System. This financial support includes a daily allowance calculated using the worker's regulatory base, primarily earnings from the previous months, and the cause of the disability. In the case of occupational diseases or work-related accidents, 75% of the regulatory base is granted starting the day following the sick leave.

Workplace accidents are a matter of great concern in Spain. According to Instituto Nacional de Seguridad e Higiene en el Trabajo (2022), the estimated cost of occupational accidents in Spain is around 3% of the gross domestic product (GDP), equivalent to approximately 12 billion euros. These figures are nearly three times higher than those of other European Union countries. Another alarming statistic, as presented by

Confederación Sindical de Comisiones Obrera (2022), relates to the incidence rate of workplace accidents resulting in absence. It increased by 6.8% from 2021 to 2022. This marks the second consecutive year of rising accident rates since the onset of the pandemic in 2020, resulting in a cumulative increase of 16.2% over two years.

The official data from occupational injuries in Spain indicates that the average duration of incapacity for work increased from 30 days in 2015 to 33 days in 2021, as illustrated in Figure 2. Interestingly, during the same period, the number of serious injuries decreased by approximately 9%. This overall trend suggests that despite the reduction in the average rate of severe accidents, the average number of days lost due to work-related accidents has risen. There is no definitive argument that explains the increase in the duration of sick leaves in recent years. However, according to information provided by insurers, the widespread aging of the population has resulted in more and longer sick leaves. It is also recognized that the COVID-19 pandemic caused a backlog in public healthcare, leading to long waiting lists for medical attention. This excessive delay in diagnosis and treatment has consequently resulted in longer periods of incapacity. According to Social Security sources, there is an observed increase in both the number of sick leaves and their duration, especially leaves related to orthopedic issues and mental health. Significantly more cases of anxiety and depression are being reported; they have gained prominence in the overall numbers of temporary incapacities: from 5.6% in 2016 to 6.5% in 2023. Experts point to new work circumstances, telecommuting, workplace pressure, and labor market uncertainty as the main causes of this increase in sick leaves due to mental health. This underscores the significance that mental health holds over quality of life and well-being in both the workplace and personal spheres. In summary, the figure emphasizes the importance of understanding the factors influencing sick leave duration, including the potential role of opportunistic behavior.

In addition to the human impact and the high economic costs associated with workplace accidents, there are indirect costs, such as loss of productivity and personnel replacement, making the study of this issue highly relevant. Specifically, in Spain, as highlighted in Informe PRESME (2023), there is a need to develop regulations for labor relations through the establishment of a new labor statute. This statute should promote dignified work and fair employment by introducing reforms or new legal measures to address employment and working conditions, including aspects such as contract types and duration, working hours, maximum working hours reduction, effective guarantee of breaks, restrictions on irregular scheduling, and limits against wage devaluation.

The current poor working conditions experienced by many workers in Spain may potentially exacerbate the inclination to engage in opportunistic behavior, influencing individuals to either extend or minimize their time away from work based on personal motivations. Furthermore, as emphasized by Gérvas et al. (2006), there are accessibility issues in accessing diagnostic tests and consultations with specialists in Spain, along with limited time for reviewing medical history and conducting physical examinations. Delays in diagnostic and therapeutic measures further complicate the process of determining sick leaves, increasing the likelihood that workers may attempt to take advantage of these system flaws for opportunistic actions, seeking personal benefits. In the same analysis, it is emphasized that there is still a need for training to instill a logical flexibility among physicians in defining work incapacities. This involves seeking the optimal duration of sick leave to prevent abuses, whether excessive or insufficient, that could be detrimental to the health of the worker. The framework outlined above substantiates and justifies the significance of this study.

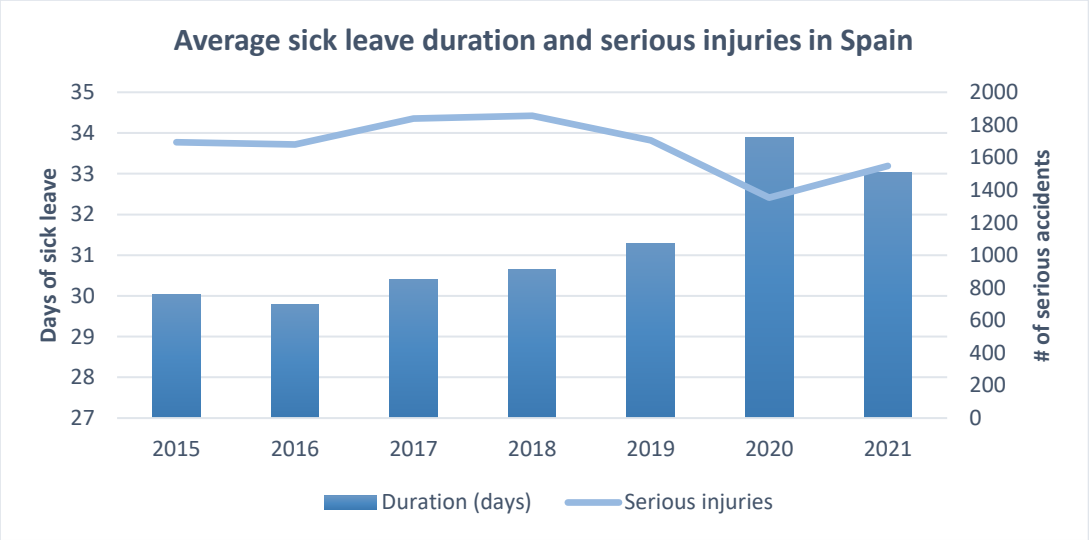


Figure 2. Average sick leave duration and serious injuries by year in Spain

When an injury occurs at the workplace, the process typically involves a series of potential actions, as illustrated in Figure 3. Occupational accidents can occur unexpectedly, resulting in injuries while individuals are carrying out their work responsibilities. In such situations, immediate medical assistance is vital to address the injuries and ensure the well-being of the affected individual. If medical assistance is required, it can be provided by either mutual insurance companies[1] or the Social Security

[1] Workers' mutual insurance companies are nonprofit business associations whose purpose is to collaborate with the Social Security System in managing various coverage, such as sick leave or temporary disabilities of employees.

System. These institutions offer coverage and compensation for occupational accidents, enabling individuals to receive the necessary medical treatment. In more severe cases, the injury may necessitate a temporary leave from work, commonly known as sick leave, to facilitate the recovery process. Medical professionals assess the extent of the injury and determine the duration of this leave, referred to as the "temporary disability period." Their evaluation serves as a basis for recommendations on when it is safe for the individual to return to work. In the scenario in which the employees believe they need additional time off for recovery, they should request a medical review. The doctor decides whether to extend the sick leave period or not. It is important to note that in the database used in this thesis, the extension of incapacity is treated as a new observation. In other words, it is not possible to track workers for whom sick leave has been extended due to a work-related accident.

The duration of an incapacity period is directly related to the natural progression of the pathological process, the body's recovery capacity, and the sequence of medical, diagnostic, and therapeutic interventions leading to the improvement or recovery of the worker's health. In Spain, the Royal Decree 575/1997 of April 18, which regulates certain aspects of the management and control of the Social Security (SS) economic benefit for Temporary Incapacity, establishes in its article 3.2 that to ensure that medical control actions for Temporary Incapacity have the greatest technical support, tables of average durations will be made available to the physicians responsible for such actions. These tables are standardized for various pathological processes that may lead to incapacities.

In support of the above, there may be factors dependent on the patient or the type of work activity performed that condition the functional recovery time to be shorter or longer than the defined standard time. These factors, which can affect the duration of the process and distort and increase the standard time, are known as correction factors (CF). These factors directly influence the duration of temporary incapacity. Among the correction factors, age, gender, comorbidity, and occupations are particularly noteworthy.

For this purpose, an Optimal Temporary Incapacity Time Manual is provided as a technical support tool to guide the medical estimation of the duration of temporary incapacity processes. It is grounded in the analysis of extensive databases and the expertise of professionals in the field. This tool is intended for all medical practitioners who need to estimate the duration of a temporary incapacity resulting from an illness affecting a worker. The manual aims to be an updated working tool to standardize criteria in medical actions for the follow-up and control of temporary incapacity. It serves as a

guide and technical reference to assist the prescribing physician in making decisions regarding sick leave.

However, it is important to note that there may be instances where injured workers, due to asymmetric information about their condition, may attempt to influence the physician to prolong the incapacity period. This opportunistic behavior can be driven by various factors, including personal motivations and pressures exerted by the organization to resume work.

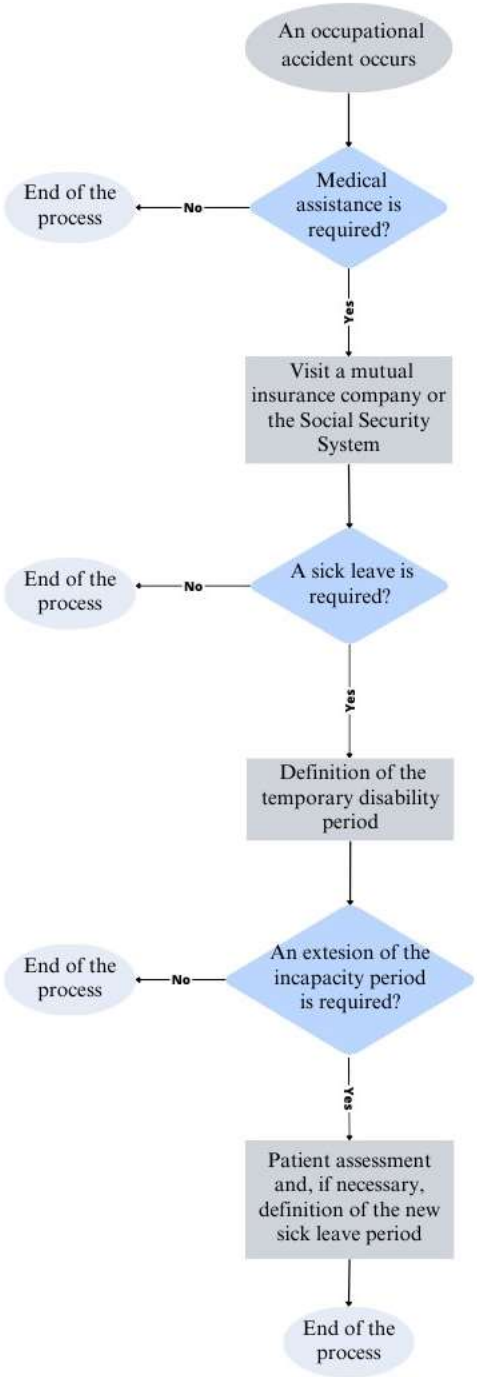


Figure 3. Process of sick leave after a workplace injury in Spain

With all this context as a reference, it becomes crucial to establish certain assumptions that will be taken into account throughout this thesis. First, the focus will be exclusively on the ex-post moral hazard situation that arises when workers intentionally prolong their sick leave without a valid health reason after sustaining an injury.

Second, as outlined in the process depicted in Figure 3, the initial determination of the duration of time off from work rests with the physician, who assesses the worker's condition and prescribes an appropriate recovery period. However, in the presence of asymmetric information, the injured worker may be tempted to exploit this situation and persuade the doctor to extend the incapacity period.

Furthermore, it is important to note that our study focuses on a homogeneous and comparable sample, excluding injuries resulting in worker fatalities, accidents during commuting (in itinere), and injuries sustained by self-employed individuals. These specific cases possess unique characteristics that warrant a distinct analysis. For instance, accident coverage, as well as the conditions pertaining to the Social Security System and healthcare system, differ significantly for self-employed individuals compared to dependent employees. By limiting our scope to dependent employees, we can ensure a more coherent and standardized analysis of the factors influencing sick leave duration.

With all this in mind, our overarching objective is to analyze the factors that drive workers to voluntarily choose to extend the duration of their sick leave beyond the standard recovery time following a work-related injury while also examining the broader effects of this misconduct. With the conceptual framework firmly established and the understanding of the background on occupational accidents in Spain, we can apply the theoretical basis to the forthcoming empirical analysis described in the subsequent four chapters. This comprehensive approach enables us to undertake a thorough investigation into the duration of sick leave following a workplace injury, resulting in a comprehensive and complete study of the subject matter.

Chapter 2. Examining disparities in sick leave duration following occupational injuries: A comparative analysis of public- and private-sector employees

Abstract

This chapter investigates the potential impact of the firm sector (public versus private) on sick leave duration after occupational injuries. We empirically analyze non-fatal occupational injuries within Spain's service sectors from 2015 to 2021. Applying a stochastic frontier approach, we regress sick leave duration on multiple variables for expected medical recovery time. This method produces individual performance measures, estimating extended sick leave duration percentages. We quantify excess days away and subsidy costs for both sectors. Our results reveal that public-sector employees take longer sick leaves compared to their private counterparts. Moreover, higher subsidies correlate with extended absence, and sick leave duration has increased over the study period. Notably, this pioneering research employs stochastic frontier analysis to determine incapacity period discrepancies between public- and private-sector employees.

Chapter 2. Examining disparities in sick leave duration following occupational injuries: A comparative analysis of public- and private-sector employees

2.1 Introduction

In this chapter, we argue that public organizations are more exposed to moral hazard situations than private ones, which may lead public-sector employees to take more time off work following a workplace injury. This view is based on two premises. First, public employees are perceived to have higher job security but weaker organizational commitment compared to their counterparts in the private sector. Second, there are fewer organizational incentives for control in the public sector, as government regulations, bureaucracy, and political frameworks often dictate operational practices. In contrast, the private sector is subject to more external pressure and incentives from market competition than the public sector, where a lack of competition and weak explicit incentives are more common (e.g., Dixit, 2002). Additionally, political pressure often constrains the actions of the public sector, making it challenging for public managers to supervise and monitor their employees.

We examine whether public-sector employees take longer to return to work following an occupational injury than their private-sector counterparts. We empirically test such contention on a dataset of non-fatal occupational injuries that occurred in the service sectors in Spain from 2015 to 2021, using a stochastic frontier approach in which the duration of sick leave is regressed on multiple explanatory variables for the expected time of medical recovery. This model allows us to calculate a performance measure for each individual that estimates the percentage of sick leave duration that is extended beyond the normal recovery time. We use individual performance measures to estimate the excess days away from work and the extra costs entailed in terms of subsidies for both public and private workers.

While it is true that through stochastic frontier methodology, it is possible to recognize the factors influencing the normal recovery time of a worker after a workplace accident, the main objective of this chapter is to identify the variables associated with the opportunistic behavior of extending sick leave time. Special emphasis is placed on determining whether the sector (public or private) influences a longer duration of incapacity once controlled for all relevant variables. This is achieved through the

stochastic frontier methodology, which allows the inclusion of a term associated with the prolongation of sick leave beyond the standard recovery time in order to identify the variables that explain it.

In this context, this methodology facilitates the analysis of variables influencing the standard medical recovery time and assists in delving into the over-duration rate. The inclusion of the sector as an explanatory variable of prolonged durations aims to assess whether significant disparities exist in the duration of sick leave following a workplace injury between the public and private sectors. This expanded approach allows for a more comprehensive exploration of the factors affecting both the typical recovery period and the potential for extended durations, with a particular focus on the role of the sector in shaping these outcomes.

After appropriately controlling for the intrinsic characteristics of the accident and the severity of the workers' injuries, the findings reveal a significant positive association between sick leave duration and public sector employees. We also find evidence that higher amounts of subsidies lead to longer periods of absence and that the duration of sick leave increased over the years of analysis. To our knowledge, this study is the first to provide robust and significant empirical evidence on this issue.

2.2 Moral hazard exposure in public versus private sector organizations

There are contextual and managerial differences between public and private organizations that can exacerbate moral hazard problems in the public sector.[2] These differences may increase the likelihood that injured public employees will take a longer sick leave following an occupational accident.

2.2.1 Attendance motivation of public sector employees

Public sector employees are commonly thought to have lower work attendance motivation and weaker organizational commitment than those in the private sector. Some authors argue that the scarcity of performance awards and incentive systems reduces attendance motivation in the public sector (Baldwin, 1990). Mastekaasa (2019) noted that the public sector attracts not only individuals with stronger prosocial motivations but also individuals with relatively low attendance motivation because of the weak work

[2] Núñez (2017) examines this issue from the perspective of ex-ante moral hazard problems, i.e., false reporting of illnesses by workers as a means to avoid work.

attendance incentives in public organizations. Moreover, Lyons et al. (2006) found that private-sector employees exhibit higher organizational commitment than their public-sector counterparts. Likewise, public jobs tend to be stable and repetitive and have standardized employment practices (Bellante & Link, 1981; Boyne et al., 1999; Liu & Tang, 2011), which imply job security and permanent work for life. In this regard, Hansen (2014) argued that public jobs are more attractive to people who prefer job security. Jensen et al. (2019) highlighted that the structural limitations and restricted resources that characterize the public sector can make employees frustrated with their organizations. Stiglitz (2000) argued that public companies lack incentive-based remuneration and have excessive red tape, high levels of risk aversion, a lack of competition, and high relevance of political objectives, which increase the likelihood of misbehavior by managers and employees.

A second explanation of the low attendance motivation of public sector employees is that public organizations offer better employment protection (Pfeifer, 2013). Public employees are rarely fired for poor performance and are less afraid of losing their jobs than private sector employees (Ichino & Riphahn, 2004). Additionally, the orientation of industrial relations in the public sector is typically more collective, resulting in a higher prevalence of union representation and employee participation (Schnabel, 2020). Accordingly, Chaudhury and Ng (1992) suggested that unionization is associated with more days off work, and Allen (1984) argued that union members tend to exhibit higher absenteeism rates.

Third, management styles differ significantly between public and private entities, as the nature of the owner tends to influence the preferences of an entity's directors. The context in which managers operate may generate distinct actions, behaviors, and choices that significantly affect employee commitment (Zeffane, 1994). The supervisor's leadership, reliability, and commitment may affect employee motivation and absenteeism (Hassan et al., 2014). Compared to their counterparts in the private sector, public managers tend to have lower levels of job involvement (Buchanan, 1974, 1975). Public directors are typically limited to implementing political decisions and adhering to rules, which reduces their autonomy (Desmarais & Abord de Chatillon, 2010). Perry and Porter (1982) argued that public organizations face challenges in instilling a sense of personal significance in employees due to deficiencies in motivation and the supervision of workers' activities and behaviors.

The literature on public management points out that several drawbacks of management in public organizations may contribute to higher levels of absenteeism in the workplace. Buchanan (1974) noted that the diffuse and often hard-to-follow goals of public organizations may make it difficult to link employees' efforts with the institution's effectiveness, thereby increasing the possibility of dissatisfaction at work. Leaders in government organizations generally have limited capacity to provide incentives to employees compared to their counterparts in business firms (Rainey & Bozeman, 2000). Tomo (2018) concluded that the culture of public organizations should focus more on employees' interests. Moreover, public administrators face more challenges than their private sector counterparts in creating a secure, comfortable internal climate that makes workers feel fulfilled in their jobs (Bysted & Jespersen, 2014). According to Turner (2020), one of the biggest demands in public management is for mechanisms and strategies for motivating public employees, increasing innovation, and reducing absenteeism.

Additional concepts in public administration literature include the notion that evaluating performance faces greater challenges in the public sector compared to the private sector (Burgess & Ratto, 2003). This difficulty in measurement makes the task of designing an optimal employment contract more complex, potentially leading to decreased employee motivation. Furthermore, the objectives of the public sector are often characterized as more ambiguous and indefinite when compared to those of the private sector (Kumari & Pandey, 2011). This lack of clarity in goals and objectives can impact employee motivation and job satisfaction. Additionally, employees in the public sector typically have lower levels of job autonomy and independence, while their counterparts in the private sector benefit from higher levels of freedom due to a reduced level of organizational constraint (Rashid & Rashid, 2012)

Finally, according to the theory of public incentives, the effectiveness of monetary incentives plays a crucial role in shaping employees' attitudes toward success, particularly within the public sector (Al-Belushi & Khan, 2017). Crewsen (2010) highlights the impact of rewards on motivation and behavior in the public sector, a phenomenon that may not hold in the private sector. Additionally, Ritz et al. (2016) observe that various institutional values and extrinsic incentives within public organizations create conditions that maximize individual utility. This includes factors such as offering comparatively high job security, protection against dismissal, promising career prospects, and salary stability overall (Buelens & Van den Broeck, 2007; Perry &

Hondeghem, 2008; French & Emerson, 2014). This interplay of incentives could contribute to the complexity of factors that may influence the decision of public workers in managing their absences at work; specifically, these factors may create an environment where employees may be inclined to extend their time off work opportunistically.

2.2.2 Monitoring and supervision levels in the public sector

Absence behavior is more likely to appear when control and supervision are weak (De Paola et al., 2014). In public organizations, the level and quality of supervision are often lower than in private organizations (Perry & Porter, 1982). This difference may be attributable to diffuse authority, as public personnel often answer to legislative or political superiors rather than a single, formal authority figure, as noted by Harel and Tzafrir (2001). In addition, public employees are less likely to face disciplinary penalties for unacceptable levels of absence (Paton, 2005). Moreover, public organizations invest less in training and hiring supervisors to control the actions of their workers than do private companies.

In public administrations, bureaucratic structures, multiple or diffuse lines of authority, and political decision-making act as barriers to implementing and promoting strategies for safety and security at work. Moreover, public managers have limited resources to invest in occupational safety and health and information systems for managing and monitoring records (Mitchell, 1998). These restrictions and the prioritization of specific public policies could result in non-optimal outcomes in terms of workplace safety and prevention practices. Schmidt et al. (2017) found that in Sweden, a lack of interaction with safety committees limited information flow on occupational health issues, and deficiencies or ambiguities in occupational health and safety management programs are common problems in the public sector.

Another important consideration is that the perception of a powerful ethical culture in the organization is related to fewer sickness absences. The supervisor's ethical behavior modeling can significantly reduce the possibility of employees misbehaving and taking more time off work. Kangas et al. (2017) argue that managers in the private sector have higher corporate ethical values and lower unethical behavior intentions. This factor may influence the decisions of public employees to extend their incapacity period after an occupational injury (Sardžoska & Tang, 2009).

As discussed in the references cited earlier, the literature has predominantly focused on researching and presenting evidence regarding the prevalence of moral hazard

situations leading to extended sick leave durations in the public sector when compared to the private sector. However, it is essential to consider alternative hypotheses that could elucidate reasons for longer periods of absence in the public sector without necessarily attributing them to opportunistic behavior.

For instance, demographic distinctions between the two sectors may contribute to varying sick leave patterns. The public sector typically employs a higher proportion of women and older individuals, potentially leading to increased health issues or longer recovery times. Additionally, the public sector's higher unionization rates can significantly influence leave policies and practices.

Furthermore, specific occupational hazards may elevate the risk of illness or injury among public-sector workers, particularly in roles related to health or education, where exposure to stress and burnout is more prevalent. Improved recording practices in the public sector may also provide a more accurate representation of absenteeism levels, reinforcing the contrast with the private sector, where recording standards can be notably inconsistent, especially among smaller firms. Last, the pressure to compensate for lost hours may be more pronounced in smaller workforces, which are more prevalent in the private sector. This dynamic could contribute to the apparent lower recorded levels of absence, highlighting the importance of considering various factors when analyzing and comparing sick leave durations between public and private sectors.

2.3 Methods

2.3.1. Data

The data used in this chapter come from the official records of occupational accidents provided by the Statistics of Work Accidents (Estadística de Accidentes de Trabajo, EAT), published by the Ministry of Labor and Social Security of Spain. It is important to highlight a notable advantage of our study: the use of a high-quality database comprising official data obtained from a reputable institutional source. This reinforces the rigor and quality of our analysis, offering a robust foundation for our research findings and conclusions. It is essential to emphasize that our observations are conducted at the level of individual injured workers, and thus, we utilize cross-sectional data rather than panel data. The final dataset contains more than 1.7 million observations corresponding to all non-fatal injuries that caused an absence of at least one working day in the service

sectors in Spain from 2015 to 2021. We took this frame because, in 2015, there was a modification in the law[3] relating to the responsibility of offering the services of external prevention, which, in some sense, could bias the occupational risk prevention activities and therefore the incident rate or the level of injuries. So, in the last six years, the behavior regarding occupational accidents in Spain has happened under the same legislative and economic conditions.

An occupational accident is defined as any bodily injury suffered by a person on the occasion of or as a consequence of work performed as an employee during the time of work and at the workplace. Injuries on the way to/from work and those suffered by self-employed workers and freelancers are not included in our dataset. Note also that sick leaves due to common diseases and COVID-19 are not considered.

The EAT provides information on several characteristics of the workers who have suffered accidents, their jobs, and the injuries themselves (type and severity). Specifically, the files record characteristics of the place and the firm where the accident occurred, the personal and professional characteristics of the employees, information on the environment, and the way the injury happened.

Our dependent variable is the duration of the incapacity, measured as the number of days an individual is absent from work due to an accident at work. Data shows that 16% of the injured in our sample are public sector employees, whose sick leave accounted for 20% of the total number of days lost. As shown in Table 3, the average duration of sick leave is 30.01 and 36.96 days in the private and public sectors, respectively. The main variables of our study differ between the sectors. Women account for 43% and 55% of injured workers in the private and public sectors, respectively. The incidence of workers requiring hospitalization following a workplace accident is notably higher in the public sector, standing at 13%, in contrast to the private sector, where this figure is 7%. A significant divergence between the sectors relates to the immigration status of employees, with only 2% of public sector workers being foreign, compared to 12% in the private sector. Moreover, the average age of public-sector employees is higher, at 47 years, compared to 40 years in the private sector. Additionally, the prevalence of temporary employment is greater in the public sector, accounting for 46%, compared to 38% in the private sector. Likewise, a substantial difference exists in the average size of companies with injured workers between the two sectors (482 and 2,112 employees in

[3] Royal Decree 899/2015, of October 9, which modifies Royal Decree 39/1997, of January 17, which approves the Regulation of Prevention Services. https://boe.es/buscar/doc.php?id=BOE-A-2015-10926

the private and public sectors, respectively). Finally, the average benefit received by injured workers is higher in the public sector (54.39 euros per day) than in the private sector (36.81 euros per day). These descriptive statistics provide insights into the inherent characteristics of each sector, contributing to a better understanding of the distinctions between them.

Table 3. Descriptive statistics of main variables in private and public service sectors

	Private			Public		
	Median	Mean	s.d.	Median	Mean	s.d.
Duration (days)	14	30	47.3	17	36.9	56
Hospital	-	7%	-	-	13%	-
Serious injury	-	0.4%	-	-	0.7%	-
Female	-	43%	-	-	55%	-
Age (years)	40	40.3	11.3	48	46.8	10.3
Foreign	-	12%	-	-	2%	-
Temporary contract	-	38%	-	-	46%	-
Size (# employees)	58	482	1,669	638	2,112	4,263
Subsidy (euros)	34.4	36.8	19.7	49.8	54.3	22.3

Table 4 lists the covariates used to control for accident severity, injury type, worker occupations, and other environmental variables that can influence the expected recovery time of an injured worker. The medical diagnostic level of the injury (minor, serious), the type of care required (inpatient versus outpatient care), and the part of the body injured are direct indicators of the accident severity, which, critically, determines the recovery time after the accident.

As noted above, the objective is to study whether the public nature of the company has a significant effect in explaining longer periods of incapacity due to an occupational accident after controlling for all the factors that may influence the normal recovery time. Within the dataset utilized for our analysis, a variable named “professional situation” serves the purpose of distinguishing between individuals belonging to the public sector and those in the private sector. The public sector is defined as the set of administrative bodies (institutions, corporations, and offices) of the state, so public employment includes all salaried individuals working for public enterprises and the central and territorial administrations.

Table 4. Description of control variables

Variable	Description
Severity	1= Serious injury, 0 = Minor injury
Hospitalization	1= Hospital care, 0 = Ambulatory care
Injury type	Drowning and suffocation Traumatic amputations (loss of body parts) Dislocations, sprains, and strains Effects of extreme temperatures, light, and radiation Effects of noise, vibration, and pressure Poisonings and infections Bone fractures Superficial wounds and injuries Heart attacks, strokes, and other non-traumatic pathologies Multiple injuries Burns, scalds, and frostbite Psychic trauma, traumatic shock Other
Injured body part	Head Neck Back, including spine and thoracolumbar vertebrae Trunk and organs Upper extremities Lower extremities Whole body and multiple parts
Occupation	Directors and managers Accounting, administrative, and other office employees Elementary occupations Plant and machinery operators and assemblers Scientific and intellectual technicians and professionals Technicians and support professionals Catering, personal, protection, and sales service workers
Subsector	Administrative activities and auxiliary services Artistic, recreational, and entertainment activities Financial and insurance activities Real estate activities Professional, scientific, and technical activities Health and social services activities Public administration and defense; compulsory Social Security Wholesale and retail; motor vehicle and motorcycle repair Education Hostelry Information and communications Transport and storage
Autonomous community	Dummy variables for the 17 Spanish autonomous communities
Time	t = 1…7 with year 1 corresponding to 2015

The fact that some workers take more time on sick leave than others can be influenced by personal characteristics, job factors, or employment conditions (Sloan, 2012). For example, the age of the employee is related to the worker's physical condition. In this sense, a positive relationship is expected between age and our dependent variable as older workers typically have lower functional and health abilities, which commonly implies a longer time of incapacity. That is, for the same type of injury, the natural recovery time of an older worker may be longer than that of a younger worker. Previous studies show that the consequences of an accident are more serious for mature than for younger workers (Blanch et al., 2009), resulting in more days absent from work

(Lipscomb et al., 2013). Bande and López-Mourelo (2015) confirm that in Spain, the probability of suffering a severe or fatal accident and the duration of sick leave increase with an employee's age.

Previous studies have shown that, on average, the number of workdays lost due to injury is greater for women than for men (e.g., Cheadle et al., 1994; Fontaneda et al., 2019; Johnson & Ondrich, 1990; Moral de Blas et al., 2012). Likewise, women tend to present higher levels of labor absenteeism than men (Ichino & Moretti, 2009; Mumford & Bridges, 2001).

Temporary and permanent incapacity for work is protected by an economic benefit within Spain's Social Security System. The financial benefit consists of a daily allowance calculated on the regulatory base (mainly the wage earned in the previous months) and the origin of the disability. For accidents at work, a minimum of 75% of the regulatory base is recognized from the first day after the work accident. This allowance is paid either by a mutual insurance company or the National Social Security Institute.

As insurance coverage increases, injured workers may be more tempted to prolong the duration of their period of recovery. If the subsidy covers 100% of the worker's salary, there is no monetary cost or penalty for being off work. Furthermore, the higher the compensation, the greater the monetary incentive for the employee to prolong the period of sick leave and continue receiving the subsidy without working. In this sense, evidence shows that sickness benefits and paybacks could increase absence rates and duration of absences (e.g., Henrekson & Persson, 2004; Ménard, 2017).

In certain social and economic contexts, a group of workers is particularly vulnerable. Consequently, those workers experience heightened apprehension regarding the possibility of job loss, coupled with significant difficulties in securing alternative employment. Immigrant and temporary workers can be considered emblematic of this group of highly susceptible workers. It is plausible to anticipate that individuals facing such vulnerability are less likely to engage in opportunistic behavior as they possess stronger motivations to avoid repercussions, such as termination, from their employers due to absenteeism.

Specifically, supporting this notion, Martín and Moral de Blas (2014) document that foreign workers, especially those originating from less developed nations, have access to a limited number of paid sick leave days. Furthermore, Agudelo-Suárez et al. (2010) demonstrate that immigrant workers exhibit a higher prevalence of sickness

presenteeism compared to their Spanish-born counterparts, potentially attributable to the precarious nature of their work and employment conditions.

According to Johns (2010), a number of studies have indicated that temporary employees exhibit lower rates of sickness absence compared to their permanent counterparts. This observation has been linked to the concept of job insecurity, suggesting that temporary employees are more inclined to attend work despite being unwell. In contrast, workers with permanent contracts may have a greater propensity to prolong their absence due to their perceived job security, coupled with the reduced exertion stemming from employment protection measures (Engellandt & Riphahn, 2005).

Thirteen injury dummy variables control for differences in scope and consequences associated with different types of injuries. Moreover, eight dichotomous variables consider the body part injured. The regional dummies account for additional unobserved characteristics that may influence recovery time, like medical assistance protocols and inspection activity by regional health authorities.

The occupation and industry dummies control for specific features associated with the worker's activity. When analyzing the most prominent industries by sector, in the private sector, administrative activities, retail, and hostelry hold the highest representation. In the public sector, on the other hand, the most prominent industries are public administration and healthcare. In terms of occupations, the distribution is similar between the two sectors, emphasizing that elementary occupations, administrative roles, workers in restaurant services, and technicians see the most recurrences in terms of accidents. Regarding the average durations of work-related absences, the public sector stands out for longer periods among workers in healthcare, education, and financial activities. In contrast, in the private sector, the average durations are very similar across different industries, with no significant differences among them. This characterization underscores the importance of controlling for these variables when conducting the analysis, ensuring that all relevant factors are considered in the study of the duration of disabilities following a workplace accident.

2.3.2 Methodology

2.3.2.1 Stochastic frontier analysis (SFA)

Farrell (1957) is credited as the pioneer in introducing a method for measuring efficiency by establishing the best practices observed within a study sample as the

benchmark for efficiency. This method involves calculating efficiency indices relative to observations that exhibit the optimal behavior, thereby generating a comparison between an observed production point and the ideal point, resulting in an efficient frontier. The efficient frontier allows for a comparison of the extent to which each observation deviates from the optimal behavior.

In the context of this specific study, the objective is to estimate the efficient frontier in terms of the duration of sick leave taken by employees after an occupational accident and measure the extent to which each individual deviates from the optimal duration. The length of absence considers variables related to the expected time for medical recovery as well as environmental variables associated with worker and firm characteristics that may influence the injured worker's opportunistic behavior in prolonging the period of absence from work.

Efficiency models can be broadly categorized into two groups: parametric and non-parametric models. Parametric models rely on statistical procedures, wherein a production or cost function is established, and account for the presence of random noise. These models assume a specific functional form for the underlying function and the distribution of the error term. On the other hand, non-parametric models do not specify any particular functional form for the underlying function and attribute all deviations from the efficient frontier solely to inefficiency without considering random fluctuations (Bogetoft & Otto, 2011). Among parametric models, the most well-known is stochastic frontier analysis (SFA), while data envelopment analysis (DEA) is a popular non-parametric model. There is no consensus in the literature regarding the strict preference for either approach, as both parametric and non-parametric models have their advantages and disadvantages. The choice between these models entails various tradeoffs (Hjalmarsson et al., 1996).

This study uses the SFA technique as it allows for the inclusion and explanation of inefficiency in the duration of sick leave, which we denominate as the over-duration term. This recognition is based on the understanding that the period of incapacity is influenced by medical and health factors, but it may also be affected by opportunistic behavior exhibited by workers who have the motivation to extend their sick leave without a genuine medical reason.

Therefore, our analytical framework is based on stochastic frontier analysis (Aigner et al., 1977; Meeusen & van den Broeck, 1977). This is a methodology widely used in the efficiency measurement literature to estimate production, cost, or profit

functions (e.g., Kumbhakar & Lovell, 2000; Kumbhakar et al., 2015). Here, we rely on the stochastic frontier methodology from the efficiency literature to estimate excess sick leave days for each injured worker.

Stochastic frontier analysis has conventionally found its application in the production or cost efficiency analysis, traditionally being away from the exploration of "duration functions" as commonly understood. Nevertheless, a distinctive contribution of this thesis lies in its innovative utilization of SFA to model and analyze the observed duration of work-related sick leave. In this context, the duration of sick leave represents the time required for an individual to recuperate from a work-related injury and return to regular work activities. This modeling approach incorporates explanatory variables that influence the standard recovery process, an inefficiency term, and an element of random noise.

Unlike conventional econometric techniques that analyze duration functions through regression models, wherein deviations from optimal choices are often considered mere statistical noise, SFA introduces a more nuanced perspective. It recognizes that not all individuals, even those who possess similar injury characteristics, personal attributes, and control variables, adhere strictly to the optimal recovery time. Some individuals exhibit longer sick leave durations, even when accounting for the standard elements involved in the recuperation process after an occupational accident.

SFA's strength lies in its ability to discern between two crucial factors contributing to the observed deviations from optimal recovery choices: inefficiency and random shocks. Inefficiency, in this context, reflects the failure to optimize the recovery process, acknowledging that individuals may not always choose the optimal time for returning to work. It means that there could be personal, organizational, or economic reasons for employees to try to prolong the incapacity period beyond the standard recovery time.

Consequently, this thesis aims to uncover significant variables contributing to extended sick leave durations, even after accounting for all elements intrinsic to a normal recovery process following an occupational accident. This approach allows for a more comprehensive understanding of the complex phenomenon of the duration of sick leave and the factors that determine it. Furthermore, the distinctive advantage and novelty inherent in employing stochastic frontier analysis (SFA) as a methodology for studying the duration of sick leave is the capacity not only to identify the presence of prolonged

periods of absence but also to recognize the significant sources that contribute to these extended durations.

Formally, a stochastic duration frontier model can be specified as:

$$lnd_i = lnd_i^* + u_i \quad (1)$$

$$lnd_i^* = f(x_i; \beta) + v_i \quad (2)$$

where the subscript i denotes individuals, d_i is the observed sick leave duration of individual i, x_i are the explanatory variables of the recovery time derived from the injury suffered by individual i (i.e., gender, age, the severity of the injury, etc.); β are unknown parameters, and u_i is the number of days above the recovery time (the inefficiency term in standard SFA applications). Given that $u_i \geq 0$, the observed duration (d_i) is bounded below by the frontier (optimal) recovery days (d_i^*). Given x_i, the frontier estimates the minimum duration of sick leave, and it is stochastic because v_i is a zero-mean random error.

The model can then be written as:

$$lnd_i = f(x_i; \beta) + \varepsilon_i \quad (3)$$

$$\varepsilon_i = u_i + v_i \quad (4)$$

In equation 3, the error term is composed of the two-sided random disturbance (v_i) and the one-sided term ($u_i \geq 0$), with v_i independent of u_i. The stochastic frontier approach uses the maximum likelihood method, which is based on distributional assumptions on the error components. Thus, while for $v \sim N(0, \sigma_v^2)$, u is assumed to be a random variable truncated at zero from below with a specific distribution (e.g., half-normal or exponential).

Rearranging (1):

$$\exp(-u_i) = \frac{d_i^*}{d_i} = D_i \quad (5)$$

The measure D_i in (5) is the ratio of the minimum duration (d_i^*) to observed duration (d_i), so it is bounded between 0 and 1, and it has an intuitive interpretation: a value lower than one indicates the deviation of worker i from recovery time, i.e., a delay in returning to work once recovered from injuries. Specifically, it indicates what

percentage of the sick leave days taken by the worker would have been sufficient to return to work. Therefore, if an injured worker does not extend the return to work beyond the recovery time, $u_i = 0$ and the deviations from the frontier are due only to random shocks. Conversely, if $u_i > 0$, it indicates the presence of slack days on the part of the worker. Consequently, $1 - D_i$ refers to the over-duration rate of individual *i* or, in other words, the percentage of sick leave duration that is extended beyond the normal recovery time, and it can be expressed as:

$$1 - D_i = 1 - \exp(-u_i) = 1 - \frac{d_i^*}{d_i} = \frac{d_i - d_i^*}{d_i} \quad (6)$$

The stochastic frontier approach allows not only for estimating the over-duration rate for each individual but also for analyzing the factors that can explain it. Thus, the over-duration term u_i can be specified as:

$$u_i = z_i\delta + W_i \quad (7)$$

In equation 7, the over-duration term u_i is determined by a set of variables z_i that explains over-duration, and W_i is a random variable that follows the distribution chosen for u_i. Following Meeusen and van den Broeck (1977), we assume an exponential distribution for u_i. We also estimate the model following a truncated normal distribution for u_i, obtaining the same results in terms of signs of the coefficients and their significance (Table 6), confirming the robustness of the results.

Then, equations 3 and 7 are simultaneously estimated in a one-step by maximum likelihood (Battese & Coelli, 1995). The single-step procedure accounts for the exogenous influences on the over-duration rate by parameterizing the distribution function of u_i as a function of exogenous variables z_i that are likely to affect it. The estimation in two stages generates two big problems that have been debated and documented in the literature (e.g., Battese & Coelli, 1995; Wang, 2002; Wang & Schmidt, 2002). The first is that it cannot be assumed that there is a correlation between the variables of the stochastic frontier and the explanatory variables of inefficiency; if so, the estimators of β and inefficiency would be biased by the omission of relevant variables so that the second stage does not contribute to explaining the level of inefficiency because it is considering the wrong inefficiency level. The second drawback is associated with the contradiction in the assumptions made about the inefficiency estimator in each of the

stages: in the first phase, it is assumed that the inefficiencies of each individual and at each moment are identically distributed, while in the second phase, each inefficiency is distributed according to the prediction of the explanatory variables.

Following this approach, the specification of the frontier is of the form:

$$lnd_i = \beta_0 + \beta_1 InjurySeverity_i + \beta_2 InjuryType_i + \beta_3 Hospitalization_i + \beta_4 Injuredbodypart_i + \beta_5 Gender_i + \beta_6 Age_i + \beta_7 Occupation_i + \beta_8 Subsector_i + \beta_9 AutonomousCommunity_i + u_i + v_i \quad (8)$$

The listed variables are described in Table 4.

Hence, the over-duration term is related to a set of specific variables, z_i, for each individual, as:

$$u_i = \delta_0 + \delta_1 Public_i + \delta_2 Gender_i + \delta_3 Foreign_i + \delta_4 Temporarycontract_i + \delta_5 Subsidy_i + \delta_6 Time_i + W_i \quad (9)$$

The decision to include specific variables in the stochastic frontier model while assigning others as determinants of the over-duration term depends on whether a variable influences the standard recovery time after a workplace injury or, conversely, is linked to opportunistic behavior, prolonging the period of incapacity. Therefore, variables that influence a physician's determination of sick leave duration, such as injury characteristics, gender, age, occupation, and relevant control variables, are included in the frontier. Essentially, the frontier considers the essential variables for calculating a normal timeframe for returning to work.

As previously noted, certain factors may motivate employees to act contrary to optimal behavior by attempting to extend the duration of sick leave. These factors could be associated with personal attributes or organizational characteristics that influence the worker's decision to remain absent from work for a longer period. Consequently, the variables incorporated into the model for the over-duration term are those thought to be associated with such opportunistic behavior.

The rationale behind this methodology is that, once we account for all the essential elements in a standard recovery process following a workplace accident using the stochastic frontier, significant differences still exist in the duration of sick leave among workers. Consequently, the objective is to investigate whether these variations are attributable to the influence of additional factors that might be motivations for employees

to prolong their absence from work. As we have described in the data section, we expound on the rationale for the inclusion of each variable based on the existing literature. By examining the arguments within the literature, we aim to provide a comprehensive understanding of the considerations surrounding the utilization of each variable in the context of our analysis.

2.3.2.2 Cluster analysis

To complement the analysis, we conducted a K-means clustering analysis using an unsupervised classification algorithm to identify different types of sick leave duration based on various personal aspects of the injured worker, organizational and contextual factors, and accident characteristics. This method groups objects into clusters based on their characteristics, with the aim of maximizing the variation among clusters and minimizing the variation within clusters. The clustering is performed by minimizing the sum of distances between each object and the centroid of its cluster. One of the advantages of this partitioning method is that it can be used to identify structures and relationships already present in the data and also to find similar characteristics between objects in the same cluster (Kaufman & Rousseeuw, 1990).

To determine the optimal number of clusters, we used the Caliński and Harabasz (1974) pseudo-F index as the stopping rule. We started with a two-cluster solution and successively increased the number of clusters up to five, computing the pseudo-F index for each cluster solution. Larger values of the F-index indicate more distinct clustering. We stopped the estimation when the first local maximum was reached, selecting the number of clusters that had a comparatively fast increase in the F-index.

Our analysis includes variables related to the personal conditions of the injured worker, such as sex, age, and occupation, as well as variables related to the accident characteristics, such as the type of injury and the environment in which the accident occurred. Overall, the non-hierarchical cluster analysis allowed us to identify different types of sick leave duration based on a variety of factors.

2.4 Results

2.4.1 Stochastic frontier analysis (SFA)

Some diagnostic checks are evaluated to assess the accuracy of the estimation of the stochastic frontier model. The statistical significance of the parameters in the model (in the stochastic frontier and the over-duration term) indicates that the selected variables contribute significantly to explaining the variation in the dependent variable.

Furthermore, the significance of the estimated variance parameters justifies the application of stochastic frontier analysis. The rejection of the null hypothesis through the generalized likelihood-ratio test, asserting the absence of the over-duration effect, strongly supports the appropriateness of employing this methodology.

We conduct a robustness check by varying model specifications, such as the distributional assumption of the over-duration term (from the exponential distribution to the normal-truncated distribution), finding that the results are robust across different specifications. Last, we compare what we found using stochastic frontier analysis with a different method called the "cluster technique." The similar results we get from both methods confirm that our findings are trustworthy and that the model works well with our data. Table *5* presents the simultaneous estimation of the parameters in the frontier and the determinants of the over-duration term. Before starting with the analysis of our key variables, we note that the variables related to medical factors behave as expected (equation 7). Thus, the coefficients for the diagnosis of the severity of the injury, the type of medical care received, and the age and gender of the injured worker show the expected positive signs and are statistically significant. In this regard, as expected, more severe accidents or those involving the hospitalization of the worker result in longer sick leave durations. Likewise, the notion that older workers and women experience longer durations of medical incapacities after a workplace accident is confirmed. Among injuries with longer durations are heart attacks, strokes, bone fractures, psychological traumas, and multiple injuries. The body parts affected in accidents with longer durations are the thoracic region, shoulder, and legs. Extended-duration injuries are associated with occupations including facility and machinery operators as well as technicians and support professionals. Finally, industries reflecting the longest injury durations include transportation and storage, artistic and recreational activities, and healthcare.

All occupation, injury type, industry, and regional dummy variables listed in Table 4 are included in the estimates, although their coefficients are not shown in Table 5. Among injuries with longer durations are heart attacks, strokes, bone fractures, psychological traumas, and multiple injuries. The body parts affected in accidents with longer durations are the thoracic region, shoulder, and legs. Occupations with extended durations are associated with facility and machinery operators as well as technicians and support professionals. Finally, industries reflecting the longest durations include transportation and storage, artistic and recreational activities, and healthcare.

Let us now focus on the estimated coefficients for the over-duration term (equation 9). A positive coefficient means an over-duration inducing factor. Therefore, the positive and highly significant coefficient for PUBLIC provides strong evidence that public-sector employees have a longer duration of absence following an occupational accident than do those in the private sector. Moreover, the positive sign for GENDER indicates that women face longer sick leave periods than men. Likewise, the coefficient of SUBSIDY also reflects a positive and statistically significant sign. In other words, as hypothesized above, the higher the level of subsidy received, the longer the worker's sick leave. On the other side, the negative and highly significant coefficient for FOREIGN and TEMPORARY CONTRACT suggests that more vulnerable positions, such as immigrant workers and employees holding a temporary contract, present shorter time off work after an occupation injury compared to their counterparts. Finally, the positive and statistically significant coefficient of TIME implies that the duration of sick leave has increased over the period analyzed. By introducing the trend variable as a determinant of the over-duration term, we are acknowledging the potential evolution of the factors contributing to extended durations beyond the standard recovery time over the examined seven-year period. Therefore, the positive coefficient for TIME suggests that the over-duration rate tends to rise throughout the seven-year period. This points out a pattern where the over-duration rate is increasing as time progresses, an important insight to consider for policy recommendations. Understanding that the over-duration rate is not static but exhibits an upward trajectory provides valuable insights for providing effective policies.

Table 5. Coefficient estimates: Stochastic frontier analysis (public sector), exponential distribution

Frontier	**Coefficient**
Hospital	0.15718 (0.00275)***
Serious	0.8015 (0.01645)***
Female	0.02407 (0.00509)***
Age	0.00953 (0.00007)***
Injury dummies	yes
Injured body part	yes
Occupation dummies	yes
Sectoral dummies	yes
Region dummies	yes
Constant	1.68915 (0.01666)***
Equation of inefficiency	**Coefficient**
Public	0.74086 (0.0418)***
Gender	0.30242 (0.07125)***
Foreign	-0.36868 (0.04147)***
Temporary contract	-0.10258 (0.02161)***
Subsidy	0.04529 (0.02512)*
Time	0.03397 (0.00501)***
Constant	-4.39035 (0.12358)***
Wald chi2(58)	233,503.04
Prob > chi2	0
No. of observations	1,703,500
Sigma_U	0.1424938***
Sigma_V	0.9111548***

Robust standard errors are in parentheses.
*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6. Coefficient estimates: Stochastic frontier analysis (public sector), normal-truncated distribution

Frontier	**Coefficient**
Hospital	0.14606 (0.00261)***
Serious	0.6494 (0.01476)***
Female	0.03883 (0.00158)***
Age	0.00879 (0.00006)***
Injury dummies	yes
Injured body part	yes
Occupation dummies	yes
Sectoral dummies	yes
Region dummies	yes
Constant	-0.22795 (0.01505)***
Equation of inefficiency	**Coefficient**
Public	0.07729 (0.00402)***
Gender	0.0393 (0.0028)***
Foreign	-0.11197 (0.00434)***
Temporary contract	-0.0439 (0.00285)***
Subsidy	0.07557 (0.00291)***
Time	0.02445 (0.0007)***
Constant	-0.51296 (0.0112)***
Wald chi2(58)	186930.12
Prob > chi2	0
No. of observations	1703500
Sigma_U	0.9289009***
Sigma_V	0.2445642***

Robust standard errors are in parentheses.
*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The numerical value alone does not provide any insight into the extent to which each variable affects the over-duration term (Kumbhakar et al., 2015). To gain a more comprehensive interpretation, we need to compute the over-duration measures for all the individuals. Table 7 shows the mean and the standard deviation of the complement of the over-duration rate (D_i) by sector, indicating that, on average, 81% of the sick leave days taken by the public workers would have been sufficient for a return to work, while 85% of the sick leave days taken by the private workers would have been sufficient for a return to work. In other words, public workers have an over-duration rate of 19% while private employees have an over-duration rate of 15%. These results might be interpreted as public workers reaching higher levels of over-duration rate, which means they are more prone to the opportunistic behavior of prolonging the absence period after an injury in the workplace compared to employees in the private sector.

Table 7. Estimates of the complement of the over-duration rate (Di) by sector

Sector	Mean	Std. Dev.	Min	Max
Private	85%	9%	2%	100.0%
Public	81%	5%	7%	99.7%

In addition, the estimation of the over-duration rate allows us to calculate the excess of absent days in an incapacity period for each worker as follows:

$$Total\ Exceed\ Days_i = (1 - D_i) * d_i \tag{10}$$

This excess of absent days represents the number of days the employee is absent beyond the standard recovery time, in a situation of moral hazard of trying to extend time off work motivated by individual and contextual factors.

Moreover, using the over-duration rate estimated by each individual, the duration of the sick leave, and the person's daily value of incapacity subsidy, the additional subsidy cost for prolonging the duration of the absence without an objective justification is computed as follows:

$$Subsidy\ Cost_i = Total\ Exceed\ Days_i * Daily\ Subsidy_i \tag{11}$$

where $Subsidy\ Cost_i$ denotes the cost of the opportunistic behavior for the *i*th worker. This amount of money represents the costs that firms and the National Institute of Social

Security incur for paying employees a subsidy (a percentage of their salary) when they are in condition to return to work but they misbehave, extending their absence period.

The results of the excess of absent days and the costs by sector are described in Table 8. The available evidence shows that while accidents registered in the public sector represent only 17% of the total number of injuries, the total excess days of absence of public workers represent 27% of the total excess absence days, and the total subsidy cost derived from this over-duration rate in the public sector represents 37% of the total subsidy cost. These findings suggest that the opportunistic behavior of extending time away from work is more pronounced in public sector workers. This is supported by the average number of days of excess absence, which is around nine days for the public sector and five days for the private sector. Additionally, the average subsidy cost of over-duration is estimated at approximately 500 euros for public workers and 200 euros for private-sector workers.

The total exceeding subsidy costs for the period under study rise to 411 million euros, which represents the savings that companies and the health system could gain if managers and authorities make efforts and create strategies to control the duration of sick leave after an accident at work by considering the characteristics of their workforce. It is relevant to highlight that these savings are attributed only to the exceeded subsidy payment to the workers who can return to work, but they present an opportunistic behavior. Nevertheless, the savings could be higher, considering the productivity lost and the cost of replacing an employee.

Table 8. Exceeding absence days and exceeding subsidy costs by sector

Sector	Mean exceeding absence days per worker	Total exceeding absence days	Mean exceeding subsidy cost per worker	Total exceeding subsidy costs
Private	5.55	7,074,174	209 €	267,000,000 €
Public	9.46	2,645,540	513 €	144,000,000 €

Regarding the evolution of the over-duration through the years, the findings suggest that the mean of excess days of absence has been increasing over the last seven years, specifically in the public sector, from eight days in 2015 to 10.30 days in 2021, while in the private sector, the mean of the excess days of absence has been constant during the period under study at around five days.

Furthermore, the results by region demonstrate that the average excess days of absence in the private sector is similar across the autonomous communities (around 5.4

days), while in the public sector, the average number of excess days of absence varies significantly, from Galicia with 14 days to the Balearic Islands with seven days of over-duration. Variations in sick leave durations among autonomous communities in Spain can be attributed to various factors. While there is no scientific evidence and no studies directly confirming these differences among regions, there are hypotheses that can explain them. The first is associated with disparities in working conditions, such as the nature of predominant industries, the proportion of employment in high-risk sectors, and the presence of specific working conditions that can influence rates and durations of sick leave. For example, in the Balearic Islands, the predominant productive activity is in the services, hospitality, and tourism sectors rather than in industrial activities. This difference may have an impact on shorter sick leave durations.

Differences in the culture of health and occupational safety, along with the implementation of preventive measures, can contribute to variations in sick leave durations. Autonomous communities with more proactive approaches to accident prevention may experience shorter sick leave durations. The availability and accessibility of healthcare services can influence how quickly workers receive medical attention and rehabilitation. Disparities in the quality and availability of healthcare services among regions can impact sick leave durations. Socioeconomic variables, such as income levels, access to programs supporting injured workers, and the social safety net, may vary among autonomous communities and affect sick leave durations. Regional labor and Social Security policies can have significant impacts on the management of sick leave. Differences in the laws and political approaches can contribute to variations in sick leave durations.

Finally, population characteristics are also a key factor that can explain differences in the duration of sick leaves. According to the Basque Observatory on Harassment and Discrimination (2015), the regions of Galicia and Castilla y León are the most affected by the accelerated aging of their inhabitants. This aligns with the autonomous communities that show a longer duration of work-related incapacities. These results confirm the idea that the context in which the injury occurs impacts the worker's decision to extend the sick leave due to a work accident and suggest an in-depth investigation of the reasons that influence employees to postpone their return to work, depending on multiple contextual variables.

Concerning the economic sectors in which accidents occur, the results suggest that the mean excess days of absence in the private sector are relatively consistent across the

different subsectors. However, a noticeable disparity is observed among subsectors within the public sector. Specifically, there is a substantial difference, ranging from 10 to 12 days for the financial and insurance activities, education, and health subsectors to five and six days for real estate activities, hostelry, and administrative services. These findings highlight the importance of including the specific characteristics of the economic sector in developing policies aimed at reducing absenteeism and increasing efficiency. Moreover, this emphasizes the need for tailored interventions that reflect the unique features of each subsector in the public sector to effectively address the issue of prolonged absence due to work-related injuries.

2.3.3 Cluster analysis

Finally, Table 9 shows the results of the *K*-means clustering analysis. We defined three clusters after verifying that the pseudo-F-index value does not significantly increase for the four- and five-group solutions. Table 9 shows the mean values of our key variables in each cluster.

The first group shows the longest average duration of sick leave (40 days); it also has the highest percentage of public workers and female workers (25% and 52%, respectively) and the employees with the highest average age (55 years). This is the group labeled as "Long" in Table 9. On the contrary, a second cluster, referred to as "Short" in Table 9, shows the shortest average time of incapacity (23 days), the lowest percentage of public workers and women (7% and 39%, respectively), and the lowest average age (28 years). Finally, a third group (referred to as "Medium" in Table 9) reflects an intermediate situation: 31 days of sick leave, 15% public employees, 42% women, and an average employee age of 42 years.

Table 9. K-means clustering analysis

Cluster	Mean duration	% Public	% Female	Age	N
1–Long	39.95	0.257	0.523	54.93	541,901
2–Medium	30.91	0.150	0.421	41.97	669,353
3–Short	23.44	0.069	0.393	28.18	583,435

The results of the cluster analysis indicate that, after controlling for the characteristics of the worker, the accident, and its context, the formed groups reflect a positive association between the duration of the period of incapacity and the public/private nature of the sector. Likewise, being female and being older are also factors

related to longer periods of sick leave after an occupational accident. Therefore, the results are fully consistent with those obtained in the stochastic frontier model.

2.5 Discussion and conclusions

Overall, the findings indicate that public-sector employees have longer absences after an injury in the workplace than those in the private sector. Furthermore, certain personal characteristics, such as being a woman or an older employee, contribute to longer periods of absence after an occupational accident. Therefore, the context wherein the accident occurs influences the duration of sick leave, precisely, how the characteristics of the public sector may contribute to longer periods of absence due to more job security, less monitoring and supervision, the organizational framework, and the legal context in which the organization operates. These findings underscore the need for policies that consider the specific context in which the injury occurred and the personal characteristics of the affected employee to effectively tackle the concern of prolonged absence due to work-related injuries.

The results suggest that public management efforts should be made to increase the well-being of workers through implementing best practices at work, improving working conditions, adopting strict regulations, and creating a proper workplace atmosphere. Likewise, public managers should be aware of the relevance of supervision, monitoring, and controlling the time off from work, specifically depending on some particular characteristics of the employee that could increase the probability of extending the sick leave beyond the normal period. The increase in the flow of information between public managers and employees minimizes the presence of incomplete and asymmetric information that facilitates an opportunistic injured worker's ability to extend time off work beyond the natural recovery time.

Communication about absenteeism policies is a key element in public administration, along with effective strategies to improve employee engagement, increase job satisfaction, encourage worker participation, and promote empowerment. Specific policies that public managers may consider are related to enhancing the working environment, offering incentives to outstanding employees, making available career opportunities, promoting dialogue between workers and their superiors, encouraging employee participation, providing autonomy and spaces to innovate, and, in general, generating wellness programs that minimize the possibility of opportunistic behavior related to being off work without a justified reason.

There should be labor, management, and government initiatives focused on improving occupational health and safety, promoting the utilization of preventive services, controlling the incidence and the time of employee absences, and providing workers a way to meet and balance the demands of modern working life.

Nowadays, Spain has multiple laws and regulations for managing the incapacity period after an accident at work, which can contribute to misunderstandings and situations of opportunistic behavior from the worker side. Furthermore, the presence of many actors involved in the process of sick leave (mutual insurance companies, National Social Security Institute, public organizations), who are not always coordinated, enables the possibility of losing or missing complete information about the process.

Consequently, it would be necessary to generate an easier procedure that clarifies and facilitates the method of managing sick leave and supervising its correct application. Furthermore, the best assessment of the situation of incapacity for work requires a unique and optimal channel to share the complete information on the process and its evolution, and also interrelating data referring to the employee's functional limitations, age, sex, job, position, and company sector, among other variables.

Based on the aforementioned information, we will now discuss the theoretical and practical contributions of this chapter, as well as the study's limitations, in the following manner.

Theoretical implications

To our best knowledge, this is one of the first studies to specifically analyze the understanding of factors that motivate public sector employees to extend their sick leave duration after an occupational injury without a valid health justification. Based on the conceptual framework developed in Chapter 1, our findings reveal two main reasons why public employees might prolong their incapacity period beyond the normal recovery time.

First, we identify lower levels of attendance motivation among public-sector employees compared to their private sector counterparts. This indicates that public employees may have fewer incentives and less enthusiasm to return to work promptly. Second, we observe lower levels of supervision and monitoring in public firms, where control is weaker compared to private organizations. This weaker control environment may contribute to the voluntary extension of sick leave duration after an occupational accident. While the existing literature acknowledges higher absence rates among public-sector workers compared to private firms, this study demonstrates, for the first time, the

existence of voluntary reasons for extending sick leave duration in the context of occupational accidents.

Furthermore, our research contributes to the literature by utilizing a novel methodology to test these ideas. We adopt an efficiency-focused methodology within the framework of work-related injuries. This approach allows us not only to estimate the variables that influence the incapacity period but also to calculate measures of over-duration, such as the number of days of absence exceeding the standard recovery time and the associated costs. Consequently, our methodology enables a decomposition of the classical regression model into one that explains both the variables affecting the standard recovery time and those influencing the voluntary extension of sick leave duration. Last, we are leveraging the official data on occupational accidents in Spain, which provides us with a substantial number of observations, thereby ensuring the accuracy and credibility of our findings. By utilizing this comprehensive dataset, we can obtain robust and reliable results that shed light on the analysis of workplace accidents in the country.

Through this analysis, it is possible to recognize the importance of investigating not only the variables related to longer absences from the workplace but also the factors that could influence higher presenteeism, meaning the return to work before being fully recovered and able to do so. Therefore, in Chapter 5 of this document, this extension is incorporated and the variables associated with presenteeism are considered. This is crucial for providing a comprehensive analysis of the subject matter.

Practical implications

Regarding practical implications, this chapter provides insights into enhancing public sector management. These implications can be divided into two categories.

The first category aims to improve the motivation of public workers through various approaches:

- Establish structured and supportive programs that facilitate a smooth transition for employees returning to work after a medical leave. These programs should include gradual reintroduction to work, accommodations tailored to individual needs, and ongoing support to ensure successful reintegration.
- Implement communication channels among supervisors, employees, and healthcare professionals to ensure a timely and accurate exchange of information regarding medical leaves. This enhances coordination and

sharing of relevant information between employers and healthcare providers to effectively manage medical leaves.

- Evaluate existing policies about medical leaves in the public sector and consider constant revisions. This may include clarifying guidelines for medical certifications and providing clear expectations and responsibilities for both workers and supervisors.

The second category of practical implications focuses on improving control and monitoring measures:

- Establish robust monitoring mechanisms to ensure compliance with medical leave policies and procedures. This can include regular audits, spot checks, or the utilization of technology solutions to effectively track and manage employee absences.
- Provide training programs for supervisors to enhance their understanding of medical leave policies and their role in managing employee absences.
- Introduce a peer review system where administrators periodically review medical leave cases. This can help identify patterns or discrepancies in the approval or duration of medical leaves, providing an opportunity for corrective measures and improving the overall fairness and effectiveness of the system.
- Cultivate an organizational culture that values accountability and responsible use of medical leaves. This can be accomplished through communications campaigns, training sessions, and recognition programs that highlight the importance of responsible absence management and its impact on the organization and its employees.

Limitations

Despite the significant insights provided by this study, some limitations should be acknowledged. Our dataset consists of cross-sectional data, which means we cannot track the progress of individual workers over time and uncover additional analysis and results. Additionally, our dataset lacks information about civil servants, which could broaden the scope of the research and help confirm the findings. In terms of methodology, we employ a parametric approach and assume a distribution for over-duration and error terms. Conducting a non-parametric analysis could be beneficial in enhancing the findings.

Finally, it is important to acknowledge that the analysis conducted in this study is focused on a specific country, which imposes limitations on the generalizability of the results to other contexts or environments with potentially distinct public-sector dynamics. While the findings provide valuable insights into the situation within the public sector of Spain, caution should be exercised when applying these results to different settings. Variations in legislation, governance structures, administrative practices, organizational culture, and resource allocation among countries can significantly influence the dynamics of the public sector and subsequently impact management approaches and outcomes. In the concluding chapter, we propose future research directions based on the limitations highlighted in each section.

Chapter 3: Return to school after an occupational injury: Differences in teacher absence behavior across educational levels

Abstract

This chapter explores a two-part analysis, incorporating both theoretical and empirical perspectives. The first section provides a systematic literature review of studies analyzing teacher absenteeism and develops a conceptual model of the predictors of teacher nonattendance at school. The findings provide a nuanced and overarching approach to analyzing teacher nonattendance at work, revealing the most significant correlates to absenteeism, exposing the consequences of educator absences on student achievement, and discussing several concrete policy implications. The second section analyzes the determinants of teachers' duration of sick leave due to occupational accidents. A stochastic frontier model is formulated where the duration of sick leave is regressed on multiple explanatory variables related to injury type and accident severity, individual characteristics, and contextual factors. The one-sided component of the error term in the stochastic frontier specification indicates the excess of days beyond the estimated maximum recovery time. Using a dataset with all occupational accidents causing sick leave in the education sector in Spain from 2015 to 2021, the results show significant differences in absence duration across teachers. Specifically, teachers in public schools return to work significantly later than those in private. Moreover, preschool and special education teachers show lower over-duration rates, indicating their return to work is shorter than teachers at other educational levels.

Chapter 3. Return to school after an occupational injury: Differences in teacher absence behavior across educational levels

This chapter represents a distinctive contribution to the study of occupational accidents within the education sector. First, it undertakes a systematic literature review on teacher absenteeism, examining various factors associated with teacher nonattendance and identifying relevant predictors linked to time off work. Furthermore, it presents a conceptual model outlining the predictors of teacher absenteeism, acknowledging the challenges inherent in addressing this complex issue within educational institutions and proposing evidence-based strategies to address it.

The initial section of this chapter establishes the theoretical foundation by synthesizing existing knowledge. Based on the first part, we conduct an empirical investigation into the factors influencing the duration of sick leave for teachers following occupational accidents. The findings from this analysis align with the insights found from the literature, highlighting factors such as the school sector (private/public), gender, and the level of education taught as significant contributors to prolonged absences.

This holistic analysis provides a deep understanding of absenteeism within the education sector, shedding light on the empirical drivers behind extended periods of absence among injured educators. As a result, this two-part study provides valuable insights that can inform relevant recommendations and policies. By offering practical implications, it empowers managers within the education sector to implement diverse workplace practices aimed at reducing unjustified extensions of incapacity periods among injured teachers.

3.1 Teacher absenteeism: A conceptual model developed from a systematic literature review

3.1.1 Introduction

Teacher absenteeism affects pedagogical quality and continuity, resulting in significant individual and societal costs. Absenteeism causes high costs attributed to lost productivity, extra payments to cover absences, and administrative expenses for managing the absences. Beyond the costs, teacher absenteeism disrupts the student learning process, affects student motivation, and creates a negative perception of teachers

in the eyes of students and their parents (Green, 2014). Due to teacher shortages in many developed economies, absent teachers are increasingly more difficult to replace. An increased frequency of teacher absenteeism could be considered a barrier to educational progress and generate significant learning deficits (Gambi & De Witte, 2023), which have long-lasting individual and societal costs.

Teacher absenteeism cannot be completely eliminated, as unforeseen situations and unexpected circumstances may occur in the daily activities of an organization. However, to reduce teacher absenteeism, evidence-informed policymaking requires insights into the previously identified predictors of teacher absenteeism and the consequences of teacher nonattendance at the workplace. Using a systematic literature review, this research provides an overview of the literature on this complex phenomenon to provide a conceptual model of the predictors of teacher absenteeism.

Teacher absenteeism is a growing problem in many education systems. In the United States, in 2021–2022, 49% of schools had higher chronic teacher absenteeism than the prior school year. U.S. teachers have become more likely to miss 10% more days since the COVID-19 pandemic began (National Center for Education Statistics [NCES], 2022). In England, the number of days lost to teacher sickness absence counted for more than 2 million during 2018–2019 (Explore Education Statistics, 2021). In the Flemish region of Belgium, the annual cost of sick leave accounts for about 72 million euros, and teacher absenteeism has increased by 40% since the pandemic. Moreover, due to the general teacher shortages, absent teachers are increasingly difficult to replace (Gambi & De Witte, 2023), resulting in lower educational attainments at the end of primary education. Similarly, Benhenda (2022) mentions that in France, around 25% of absent teachers are not replaced as there are insufficient substitute teachers. In Germany, Halász et al. (2004) observe that 26% of 15-year-old pupils attend schools whose managers think student learning is affected by teacher absenteeism. In survey evidence from Indonesia, Usman et al. (2007) find a national teacher absence rate of 19% and discover that about half of these absences are unexcused. In India, teacher nonattendance at work is associated with a fiscal cost of US$1.5 billion yearly (Muralidharan et al., 2017). Likewise, Játiva et al. (2022) report that in eastern and southern Africa, 15% of interviewed primary school teachers were recorded as absent at least once a week.

This analysis builds on earlier literature reviews on teacher absenteeism. Jacobson (1990) represents a framework for teacher nonattendance at school, recognizing that absenteeism is a function of job designs, interdependence between workers, work-unit

size, and organizational policies. Norton (1998) reviews the impact of incentive programs on teacher absences. Bowers (2001) uses information from Europe and North America to examine the definition, measurement, and cost of absenteeism and the relationship between teacher absenteeism and student attendance. Likewise, in a systematic literature review, Guerrero et al. (2013) give an overview of the interventions that work to increase teacher attendance in developing countries, while Lee et al. (2015) focus on the Pacific region. Similarly, Rogers and Vegas (2009) analyze the results of World Bank reports and other studies on teacher absenteeism and incentives for performance, while Uehara (1999) constructs a policy report on teacher attendance in the Pacific region, reviewing the existing literature and finding that complementary policies and their correct implementation are critically needed. In sum, these previous papers have recognized the relevance of studying teacher nonattendance at work and have identified multiple factors correlated to educators' absenteeism.

Despite the existing reviews, there are limitations in how the earlier work structures and synthesizes the current knowledge and consolidates the dispersed ideas presented on this subject. First, the literature reviews have focused on specific contexts and regions, which can limit the scope of the analysis. Second, more recent studies (with improved methodologies, data, and more present contexts) have not been included. Third, earlier reviews do not focus on the factors related to absenteeism or develop a conceptual framework to consider this urgent issue. Fourth, these previous studies provide mixed evidence without a clear consensus in the literature about the significant predictors of teacher absenteeism.

The present section contributes to the literature by systematically reviewing the studied factors related to teacher nonattendance and the relevant predictors correlated to being off work. In addition, we present a conceptual model of the predictors of teacher absenteeism, recognizing the challenges to mitigate this difficult situation in schools and developing strategies based on evidenced results. As such, this segment produces a nuanced and overarching approach to analyzing teacher nonattendance at work, aims to provide proactive plans for preventing absenteeism, and builds a path for future research.

3.1.2 Methods

This review applies a systematic approach to collecting, organizing, and summarizing studies on teacher absenteeism. The research synthesis is conducted in

different phases, following the guideline for reporting systematic reviews suggested by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). The flowchart of articles reviewed is presented in Figure 4.

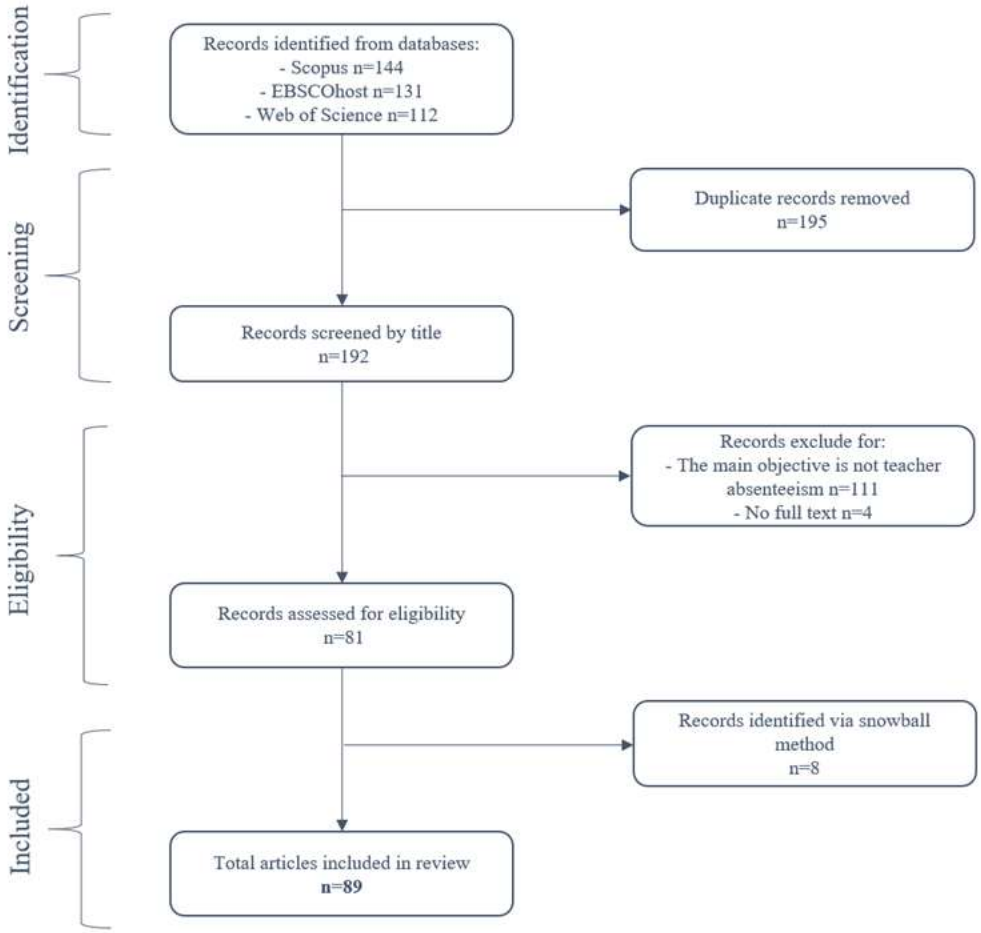


Figure 4. Article search and selection process

Research strategy

As eligibility criteria, we include only the articles in which the main objective is to study the absence of teachers at work. We consider all types of teacher absences: authorized absences such as appointments, training, and holidays; unplanned absences such as sickness, exceptional circumstances, and bereavement; and no authorized absences. As such, we provide a complete picture for analyzing the time-off-work phenomenon. Moreover, we are not limiting the search to studies that use an exclusive way of measuring teacher absences. Therefore, absenteeism could be expressed as a frequency, duration, or rate. Any restriction is imposed regarding the methodology used and the educational level considered.

Academic papers are deduced from Scopus, EBSCOhost, and Web of Science (WOS), which are three main academic libraries that contain a wide set of databases and include articles from multiple fields, producing comprehensive coverage, interdisciplinary results, and reliable outcomes. Our search strategy includes the following combinations of words: "teacher absen*" or "teacher attendance" or "teacher sick leave." The search is limited to studies published from 1990 to September 2022, an extensive period of more than 30 years. Publications on the topic before 1990 are scarce, resulting in a good starting point to produce trustworthy conclusions. Furthermore, we restrict the search to English-language papers in peer-reviewed journals to guarantee the relevance of the studies included in the sample and avoid investigations that are extremely specific to a country in order to produce more global and applicable results.

Study selection

After reviewing the initial results, 650 articles mention teacher absenteeism in the abstract, but their main objective is to study other topics, such as student absenteeism, job satisfaction, and burnout, rather than teacher nonattendance at school. For that reason, we have to delimit the search conditions exclusively to the title, which is in line with our inclusion criteria of selecting papers mainly focused on analyzing the absence of teachers in the workplace. This search retrieves 387 records (144 from Scopus, 131 from EBSCOhost, and 112 from Web of Science). Subsequently, duplicates are removed, resulting in a database of 192 articles.

Afterward, a more detailed analysis of the full texts is conducted, excluding records for not focusing the analysis on teacher absenteeism or not having the full text available, narrowing the database to 81 articles. Finally, we add eight studies using the snowball method to ensure all relevant studies are included. This technique refers to extending a systematic literature study, considering relevant articles as a reference point, and then identifying additional papers to include (Wohlin, 2014). The final database of this systematic literature review includes 89 papers. Overall, the selected papers aim to study teachers' absences at work. The articles analyze absenteeism from diverse perspectives. Most focus on understanding the predictors of time off work, while others address the consequences of nonattendance or the possible solutions for overcoming this problem.

Data analysis

We explore the papers in three main steps. In the first stage, we examine the applied method for studying teacher absenteeism and identify whether the study addresses the factors related to absences or the consequences of nonattendance. The next phase filters the papers by their topic (predictors, consequences, other approaches) and analyzes them separately. In the final step, we focus on the research approach and collect information on sample size, methods (descriptive, regression analysis, etc.), and results (coefficients, significance). A summary of the process is provided in Figure 5. After extracting the information from the full dataset, we observed that 74 papers study the predictors of teacher absenteeism, 21 papers consider its consequences, and 11 papers use other approaches to tackle this problem, such as prediction of the absences, their time tendency, or the solutions to this issue.

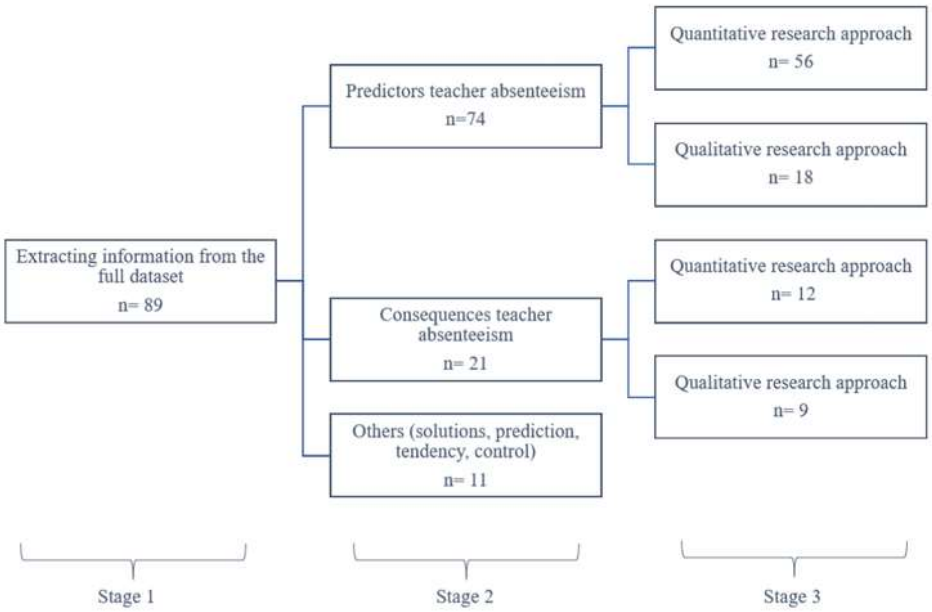


Figure 5. Data analysis process

*Note: One paper could address more than one topic.

3.1.3 Results

3.1.3.1 Overview reviewed literature

The systematic review allows us to analyze 89 articles focused on teacher absenteeism. The number of available papers related to the topic has increased during the last few years, which illustrates the growing attention to teacher attendance in student outcomes and education quality. An average of five articles on the topic have been

published per year during the last 12 years compared to an average of two articles published per year before 2010.

Fifty-eight percent of the papers are published in education journals, followed by 15% in health journals and 6% in economics journals. This illustrates the multidisciplinary nature of the topic. The studies use data from 30 different countries, predominantly the United States (19), Israel (9), Finland (6), Indonesia (6), and Brazil (5). Only six articles include in their sample more than one country (e.g., Bennell, 2022; Chaudhury et al., 2006; Guerrero et al., 2013). This could be explained by the difficulties in collecting data on absenteeism at the macro level, the diverse forms of measuring absenteeism, and the fact that the specific context and education system in each country complicates comparing the results. Also, the scope of the studies drastically differs depending on the funding, the research capacity, and the faculty available to conduct interviews, surveys, and visits, among other mechanisms to capture information.

Regarding educational level, 34% of the articles analyze teacher absenteeism exclusively in primary/elementary schools, 18% exclusively in secondary/high schools, and the remaining include at least two educational levels in their research. The majority of the countries in the European Union consider the statutory teaching time (mandatory attendance time) in primary education more important than in secondary education, and a minority of countries in the EU control the compulsory attendance time for teachers in secondary education (Farrugia et al., 2020). Likewise, as the learning process of primary education students might be severely interrupted by teacher absences, research might have been putting more effort into this educational level. Finally, according to the data analysis process, the reviewed articles mainly aim to comprehend the correlates of teacher absenteeism (83%), which means identifying the possible predictors of educators' time off work. Twenty-one articles address the consequences of teacher nonattendance. In the next subsections, we describe the findings of our review.

3.1.3.2 A conceptual model: Predictors of teacher absenteeism

Fifty-six articles report empirical results about the correlates of teacher absenteeism employing a quantitative methodology. Most papers use descriptive analysis (proportions, correlations, t-test) or linear regression models (n = 28) to study the relationship between absenteeism and the predictors. Other common methodologies refer to Poisson/negative binomial (n = 12) and logistic regressions (n = 10). The sample size of the studies varies from 50 to 500,000 observations. Nevertheless, most samples range

from 500 to 5,000 registers (n = 27), and only two studies use more than 100,000 observations for the analysis (Clotfelter et al., 2009; Ost & Schiman, 2017). Moreover, only one paper includes sample information from more than one country (Chaudhury et al., 2006). The United States (n = 15), Israel (n = 10), and Finland (n = 6) are the most frequently studied countries.

Through the analysis, we find evidence of 40 different variables used to understand the nonattendance of educators at school. The broad range of variables related to absenteeism includes individual, school, work, and environmental levels. Using these insights, we construct a conceptual model that represents in a structured and comprehensible mode the predictors found in the literature related to teacher absence at school. Creating this framework allows us to categorize the multiple variables into levels and identify the most frequent associations described in teacher time-off-work investigations.

The process to generate the conceptual model consists of collecting all the variables included in the literature as predictors of teacher absenteeism and counting the number of articles related to each. The next stage implies the identification of different categories to group all the variables according to the level of measurement (individual, school, job, context) and the type of information provided. The categorization created relies on the analysis of all the variables identified in this systematic review and follows the model of Steers and Rhodes (1978), which recognizes attendance at work is influenced by the employee's ability to attend and the motivation to come to work. On the one hand, the inability to attend, also called "involuntary absence," is mostly related to personal factors (e.g., gender, age, seniority), family composition (e.g., married, children), and health conditions affecting the capacity to be at work. On the other hand, job satisfaction, growth opportunities, relationships with workmates, workgroup rules, and incentives, among other organizational and contextual variables, influence employee attendance motivation (voluntary absence). Moreover, considering the prior literature analyzed in this study, predictors of teacher absenteeism typically include variables at the teacher, job, school, and environmental level, which guided the construction of the conceptual model.

Therefore, the classes identified in this conceptual model are: (1) Teacher factors (sociodemographic and psychological), which are micro-level variables that incorporate the individual factors that might be associated with the ability and the motivation to attend work; (2) Working conditions, linked to job characteristics that could impact a teacher's

attendance; (3) School characteristics (organizational factors and physical characteristics), which are macro-level variables that may affect an educator's behavior within the school; and (4) Environmental factors, the most general category related to external characteristics that could indirectly influence the motivation to attend to work.

Subsequently, in each group, the variables are organized according to the number of times they have been studied in the articles and their importance in understanding the absence of teachers at school. The resulting conceptual model of teacher absenteeism's predictors is described in Figure 6. As shown in the figure, each of the circles embodies a level. The levels closest to the center represent greater relevance for comprehending teacher absenteeism. Based on the analysis of the reviewed articles, the most important predictors of teacher absenteeism are recognized. Norton (1998) identifies that teachers' characteristics, such as gender, age, and personality attributes, are the most frequent variables in absenteeism studies. Moreover, Bowers (2001) remarks that educators' factors highly influence the experience at work. Absenteeism is definitely linked to job satisfaction, employment conditions, and the workplace's physical environment (Jacobson, 1990). Likewise, monitoring processes and supervision interventions significantly affect teacher attendance (Guerrero et al., 2013).

Notably, all these variables may influence teacher absenteeism depending on country-specific education systems, which regulate, organize, and structure the general conditions for the functioning of the schools. Each education system creates a framework to coordinate individuals (teachers, administrators, students), processes, and infrastructure. Thus, it is necessary to include this variable in the conceptual model as a contextual factor that involves the whole system. Furthermore, this divergent context could explain the possible causes of heterogeneity among the results of the articles. Following, emphasis will be placed on each of the levels and categories defined within the conceptual model to recognize the most important variables related to teacher absenteeism and the types of relationships found in the literature. Figure 7 summarizes the type of relationship found for each of the variables; a positive relationship implies more absence at work.

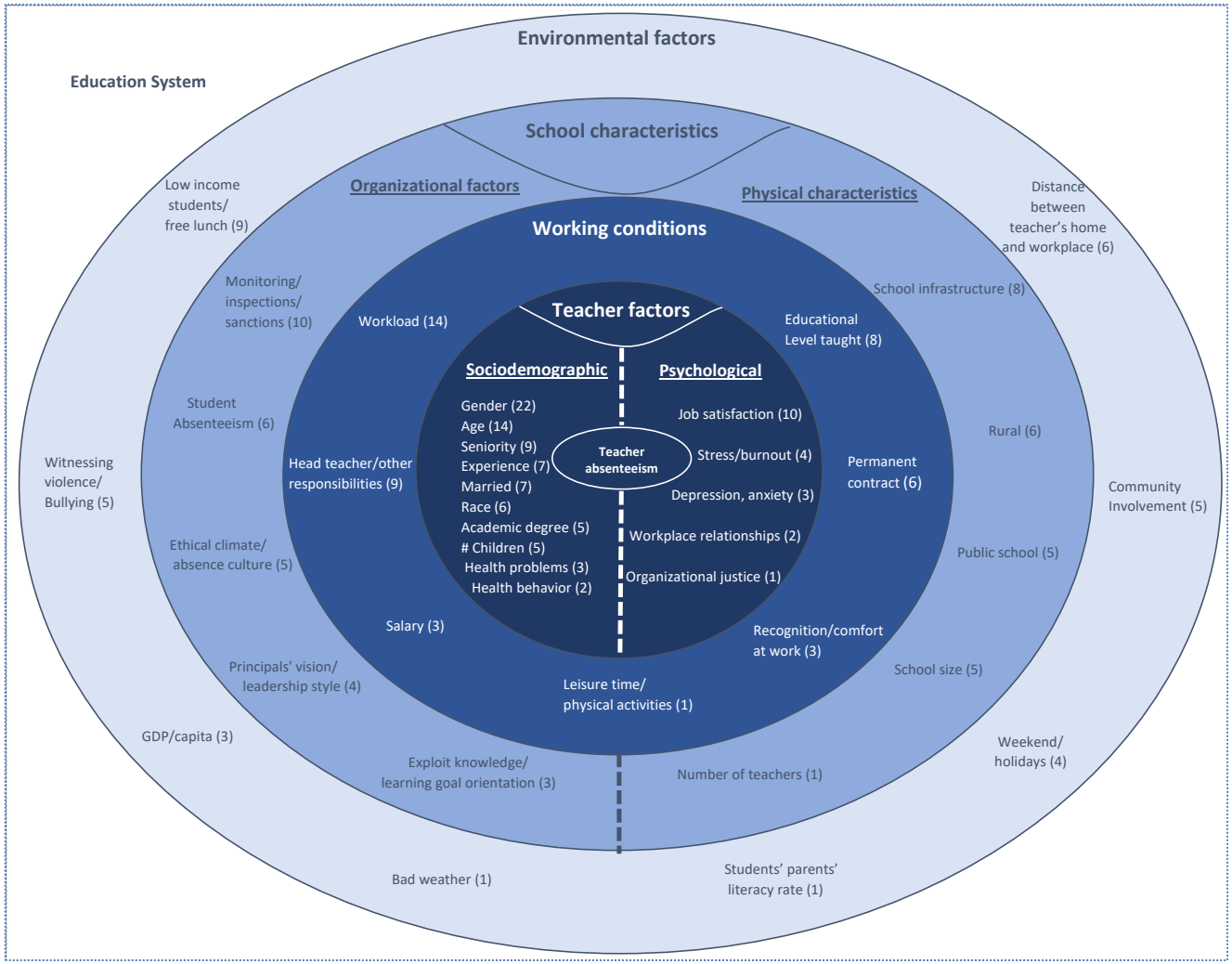
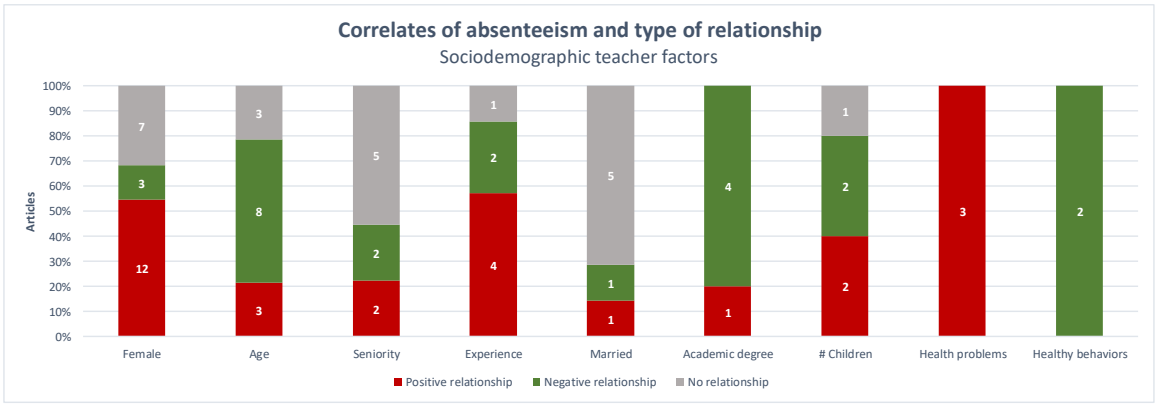
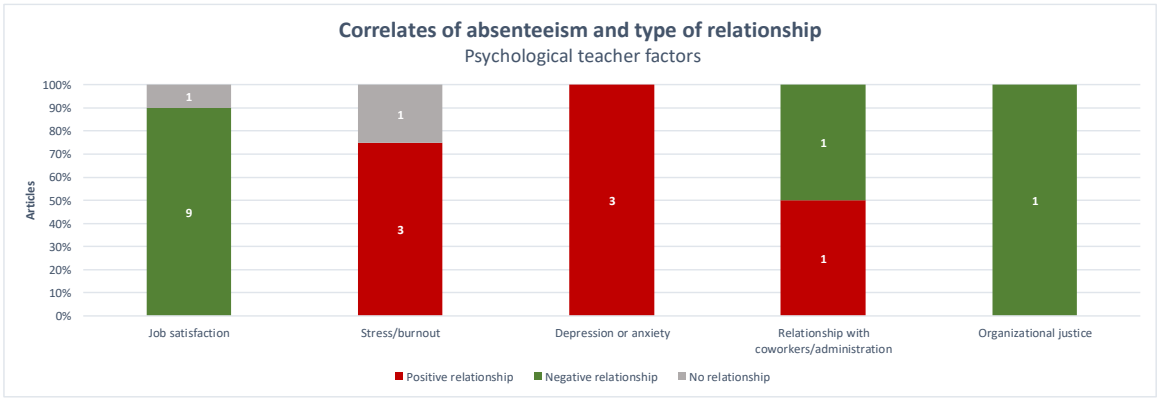
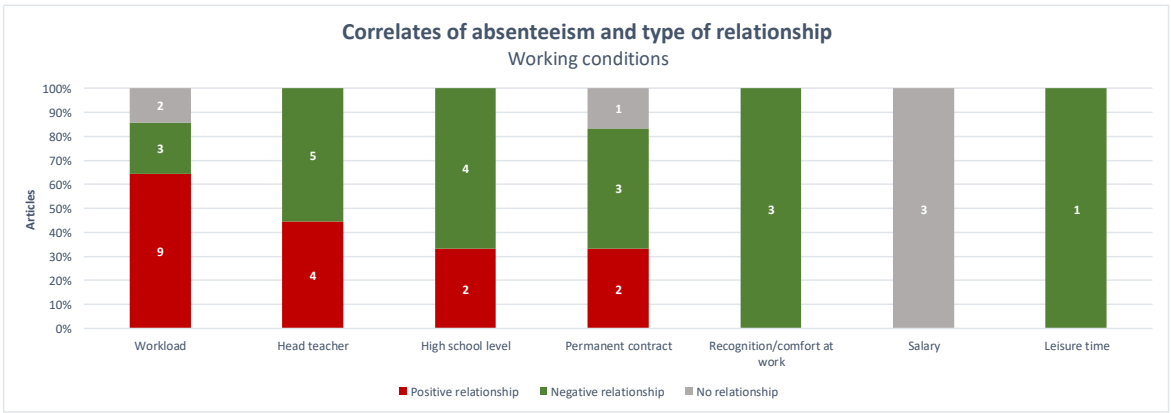


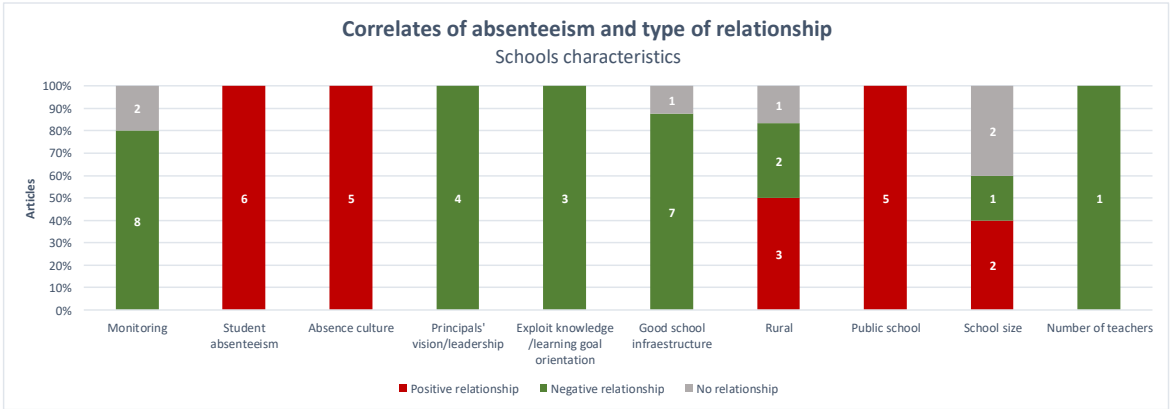
Figure 6. Conceptual model predictors of teacher absenteeism

*Note: The numbers in brackets represent the number of reviewed articles in which the variable has been included


Correlates of absenteeism and type of relationship
Sociodemographic teacher factors
Articles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Female
Age
Seniority
Experience
Married
Academic degree
Children
Health problems
Healthy behaviors
Positive relationship
Negative relationship
No relationship


Correlates of absenteeism and type of relationship
Psychological teacher factors
Articles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Job satisfaction
Stress/burnout
Depression or anxiety
Relationship with coworkers/administration
Organizational justice
Positive relationship
Negative relationship
No relationship


Correlates of absenteeism and type of relationship
Working conditions
Articles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Workload
Head teacher
High school level
Permanent contract
Recognition/comfort at work
Salary
Leisure time
Positive relationship
Negative relationship
No relationship


Correlates of absenteeism and type of relationship
Schools characteristics
Articles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Monitoring
Student absenteeism
Absence culture
Principals' vision/leadership
Exploit knowledge /learning goal orientation
Good school infraestructure
Rural
Public school
School size
Number of teachers
Positive relationship
Negative relationship
No relationship

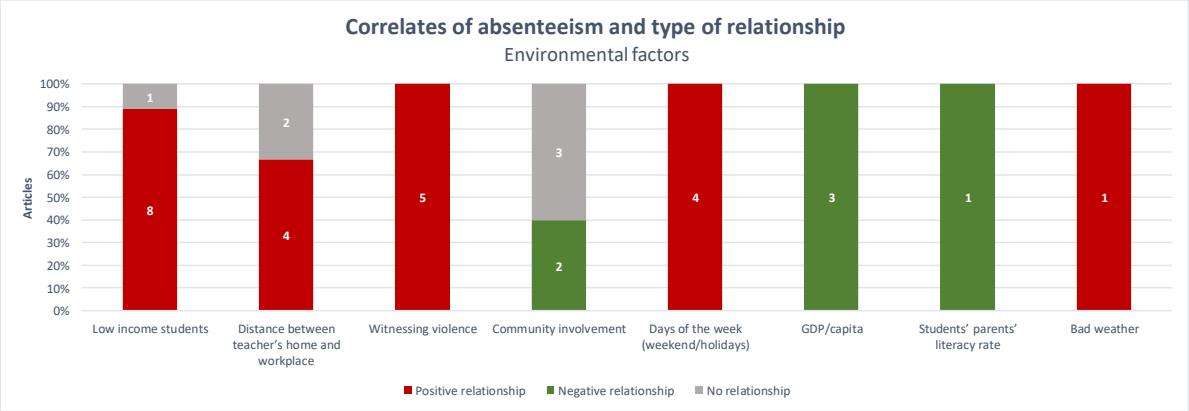


Figure 7. Variables by category and their relationship with teacher absenteeism

Sociodemographic teacher factors

This category includes 10 variables associated with the teacher characteristics defined in the literature as correlates of time off from work. The most studied variable refers to educators' gender; 22 papers include it in their empirical analysis as a predictor of teacher absenteeism. A vast amount of literature suggests women tend to have higher levels of absenteeism compared to men (Allen, 1984; Leigh, 1983), and further empirical research in labor absenteeism has found evidence of this matter (Ichino & Moretti, 2009; Mumford & Bridges, 2001; Paringer, 1983; Vandenheuvel & Wooden, 1995; Vistnes, 1997). One of the main reasons for this divergence is associated with the "double role" of women participating in the labor market and assuming responsibilities at home, such as taking care of their children, supporting other family needs, and assuming domestic tasks (Douthitt, 1989; Drago & Wooden, 1992; Gjesdal & Bratberg, 2002).

Evidently, women are more affected by mental health problems than men (Arocena & Núñez, 2014), and a stronger association between perceived stress and risk of sickness absence among women vs. men is noted (Thorsen et al., 2019), which may influence women's time out of work. Moreover, Bekker et al. (2009) describe several factors that might influence the higher absence rates in women compared to men. Reasons such as pregnancy- and menstruation-related health problems, perception of lack of opportunities, low levels of social support, frequent feeling of multiple roles, and perceived job inequity, among other aspects, are considered significant determinants of being more absent at work.

Specifically, from this systematic review of the education sector, 12 of the papers examining the role of gender (55%) find a positive relationship between female teachers and nonattendance at school (e.g., Ervasti et al., 2011; Rodríguez-Loureiro et al., 2019;

Scott & Wimbush, 1991). In general, family responsibilities and job settings differ among genders and create conditions that likely increase women's absenteeism. On the other hand, only a minority of papers (n = 3) describe in their studies a negative relationship between female teachers and absence at work (Chaudhury et al., 2006; Kremer et al., 2005; Usman et al., 2007). No gender differences are found in seven studies (e.g., Alcázar et al., 2006; Bermejo-Toro & Prieto-Ursúa, 2014; Rogers et al., 2004), which demonstrates there is not a conclusive relationship between gender of educators and their time off work. Regarding the magnitude of the relationship, two papers show female teachers are absent between one and two days more than male teachers (Balwant, 2016; Miller et al., 2008). Likewise, using a sample from Finland, two papers find females have an increased risk of absence compared to males (e.g., Ervasti, Kivimäki, Kawachi, Subramanian, Pentti, Oksanen, & Virtanen, 2012), and three other papers from the United States and Israel report that female teachers have about 11% to 20% higher frequency of absence days than male teachers (Herrmann & Rockoff, 2012; Howard & Howard, 2020; Rosenblatt et al., 2010). Conversely, two articles that use data from India find that men are about two percentage points more likely to be absent than women (Chaudhury et al., 2006; Kremer et al., 2005).

Teacher characteristics such as age, seniority (length of time that teachers have served a school), and experience (years of working) are also regularly included in the research. On the one hand, it is expected that long experience and job tenure imply higher age and therefore more probability of getting ill or facing longer recovery time. There is evidence that high levels of job monotony are significantly associated with longer organizational tenure and greater absenteeism (Kass et al., 2001). Also, seniority is linked with greater job security and, consequently, higher periods of absence (Dionne & Dostie, 2007). Furthermore, D'Errico and Costa (2012) remark that there is an association between tenure and job security, which, besides illness, is the most important determinant of sickness absence. On the other hand, some studies report a negative relationship between absenteeism and age (Kristensen, 1991), justified by higher job commitment in older age, more organizational fit, and extra responsibilities at work.

According to the analysis of the reviewed articles, the results have not been consistent as age seems to be negatively related to absenteeism, experience is positively related to absenteeism, and seniority has an insignificant relationship with absence (e.g., Shapira-Lishchinsky & Raftar-Ozery, 2018). This mixture of findings could be associated with the heterogeneity among the reviewed articles caused by different ways of measuring

absenteeism, multiple methodologies to address the topic, dissimilar sample sizes, country-specific situations, varied contextual factors, and divergent dynamics in each education system. For example, the papers studying the situation in Israel find similar results in terms of a significant and negative relationship between age and teacher absenteeism (Rosenblatt et al., 2010), while the studies in developed countries such as Australia and Finland (Bradley et al., 2007; Ervasti et al., 2011) report the relationship between these two variables is significant and positive. This confirms the idea of different results according to specific country circumstances and external factors, which could vary the findings among studies. Seniority is not a relevant predictor of teacher absenteeism, as five of nine papers find no significant relationships. However, dynamics among age, seniority, and experience need to be explored as the results are inconclusive, and interactions among these variables should be considered in the analysis.

Similarly, five to seven articles show an insignificant correlation between being married and teacher absenteeism. Likewise, the findings suggest an ambivalent relationship regarding the number of children of the teachers. Having a higher academic degree might contribute significantly to lower teacher absenteeism. This could be related to the idea that more education implies more professionalism, higher levels of commitment at work, and more self-consciousness about the importance of attending school. Finally, as expected, having health problems such as upper respiratory issues, musculoskeletal disorders, chronic diseases (Coledam & da Silva, 2020), or unhealthy behaviors (few hours of sleep, poor nutrition, higher levels of alcohol consumption, and cigarette smoking) are significant and positively related to teacher absenteeism. Nevertheless, few studies include these variables in the research, so further investigation should be addressed in this line.

Psychological teacher factors

This category includes five variables associated with the individual elements of teachers' personalities that drive their actions to seek satisfaction and determine their way of thinking. In this category, the results are conclusive. Higher levels of job satisfaction and commitment are negatively correlated to teacher absenteeism (e.g., Utami et al., 2021). When educators are satisfied at work, they feel involved in the job, they identify with the institution, and they exert their best effort to attend. On the contrary, teachers with lower job satisfaction are at greater risk of taking sick leave or being absent from work without a justified reason. For example, Derycke et al. (2013), using a sample of

beginning teachers in Flanders (Belgium), find that an imbalance between high levels of effort at work and poor compensation is related to more absenteeism. In this vein, different studies evidence that more workplace stress or feeling depressed and anxious related positively to being absent from work (e.g., Moriana & Herruzo, 2006). Howard and Howard (2020), using a sample of public-school teachers in the United States, find that for each unit increase in perceived stress, there is an increase of 2.5% in the frequency of days of sick leave. In addition, Peele and Wolf (2021) analyze childhood education teachers in Ghana, finding that one standard deviation rise in depressive symptoms increased by 4% (around nine days) the days of absence in a year.

Only one article investigates the relationship between organizational justice (understood as the perception of fairness at work) and teacher absenteeism (Shapira-Lishchinsky & Ishan, 2013). The results suggest that higher teacher perception of organizational justice relates to a lower attitude toward taking time off work. Relationships with coworkers and administration staff need further investigation as a predictor of teacher absenteeism, as the results are inconclusive. Furthermore, educators who feel involved in the school learning process could exploit their knowledge and perceive their job as easier, which impacts the decision to attend work (Da'as & Qadach, 2018). In summary, although the number of articles studying psychological factors is limited, the results are consistent on the importance of including teachers' cognitive and emotional behaviors to understand their attendance at work.

Working conditions

This category includes seven variables associated with all the elements in the workplace to provide teachers with the optimal conditions to perform their jobs. Several studies show a positive relationship between workload, measured as the pupil/teacher ratio, and the absence of educators at work. It is expected that teachers with work overload are most likely to take sick leave or face burnout and exhaustion, contributing to an increase in absenteeism. For example, one research study on teacher absence in Finland (Ervasti et al., 2012) finds that long-term absences are 15% higher for teachers with more classroom students than those with fewer students. Furthermore, a study in Germany (Nitsche et al., 2013) shows evidence that an increase of one unit in work avoidance (reducing their workload) is linked to a rise in absence days by 17.4%.

Holding a management position at school or having been assigned responsibilities other than teaching are frequently studied variables in the literature on absenteeism. The

results are mixed, as four articles mention the idea that head teachers are more likely to be absent than regular teachers (e.g., Kremer et al., 2005; Usman et al., 2007), while five other papers remark that the higher the position, the lower the absenteeism due to more responsibilities and more motivation to come to school (Banerjee at al., 2012; Bradley et al., 2007). Therefore, there is evidence of a significant relationship between a teacher's position at school and time off work, but the type of relationship is questionable, and additional research is needed on this aspect. Regarding the educational level taught, evidence from the reviewed articles supports the idea that high school teachers have lower levels of absence compared to elementary teachers; however, this result is based on only four studies (e.g., Clotfelter et al., 2009; Miller, 2012; Rosenblatt & Shirom, 2006). Likewise, two studies from the United States point out the opposite relationship, showing evidence that teaching at the high/middle school level presents more illness days than the elementary level (Eagle & Glenn, 2018; Howard & Howard, 2020).

Concerning the type of contract (permanent or temporary), the findings are inconclusive. On the one hand, temporary teachers have fewer incentives for effort, few commitments to work, lower levels of responsibility, and less attachment to the school, all of which increase the possibility of being absent. On the other hand, contract teachers could enjoy higher job security and feel less pressure about holding a perfect attendance record. For example, a study in Australia found that temporary workers take around 22% to 24% fewer days of absence than permanent workers (Bradley et al., 2007). The existence of job benefits such as recognition at work, feedback, award programs, presence of a "sick leave bank," and leisure time (Carson et al., 2010), among other aids, are associated with significantly lower teacher absences. Last, among the working conditions variables, salary does not contribute significantly to teacher absenteeism.

School characteristics

This category includes 10 variables associated with the physical characteristics of the schools and organizational factors that determine their operation, processes, resources, and, in general, their structure. Regarding the relationship between the organizational factors of the schools and teacher absenteeism, the results are clearly conclusive. Monitoring actions and frequent school inspections discourage absenteeism. The evidence from four different papers shows that increased supervision and monitoring initiatives reduce teacher absence by around 6 to 8 percentage points (e.g., Muralidharan et al., 2017; Rogers et al., 2004). Moreover, the findings support the idea that principal

supportive behavior (Da'as, 2021), directive leadership style (Imants & Zoelen, 1995), and the school's learning goal orientation are relevant to increasing teacher attendance. Additionally, positive correlations between student absenteeism or student dissatisfaction at school (e.g., Ervasti, Kivimäki, Puusniekka, Luopa, Pentti, Suominen, Ahola, Vahtera, & Virtanen, 2012; Ehrenberg et al., 1991) and institution absence culture (e.g., Gaziel, 2004) with teacher nonattendance are steadily confirmed.

Regarding the physical characteristics of the schools, the results confirmed that teacher attendance is considerably higher in schools with better infrastructure (measured by functioning toilets, presence of a staff room, indoor air quality, and availability of electricity, lighting, and library facilities, among others). In particular, moving from a school with the lowest infrastructure score to one with the highest score reduces the probability of teacher absences by 5 to 7.5 percentage points (Kremer et al., 2005). The school location (rural or urban) does not reveal consistent results, as three studies find that teachers working in rural communities have significantly higher mean absence rates (e.g., Chaudhury et al., 2006; Nugroho & Karamperidou, 2021), while two reviewed articles indicate that educators in rural areas take fewer absences than in urban places (e.g., Bradley et al., 2007; Rogers et al., 2004). At first instance, it is argued that teachers from remote schools must travel longer and may face problems commuting to work, so they could have greater incentives to be absent. Alternatively, other papers point out that rural schoolteachers tend to live close to work and might have a greater sense of community involvement, making it easier to attend work.

There is an evident tendency for teachers in public schools to have higher levels of absence compared to teachers in private institutions (e.g., Ghuman & Lloyd, 2010). This argument is related to the idea that public employees have higher job security and show weaker organizational commitment than private ones. Perry and Porter (1982) point out the difficulties of public agencies in instilling in employees a sense of personal significance, which can be derived from the deficiency of motivation and supervision of the activities and behaviors of the workers. Likewise, in the public sector, there are fewer organizational incentives to control, the way of operating depends on the laws that come from the government, there is much bureaucracy, and in most cases the political framework establishes the rules for action. By contrast, the private sector faces more external pressure and incentives from market competition. In contrast, in the public sector, a lack of competition and a paucity of explicit incentives is common (e.g., Dixit, 2002). Moreover, it is usually the presence of political pressure that constrains the actions of

public firms, which may complicate the process for public managers to supervise and monitor. Finally, there seems to be a negative relationship between the number of teachers in the school and absenteeism; however, only one study specifically included this variable (Banerjee et al., 2012). The results of school size reveal differences, so an absolute consensus on the relationship with attendance at work is not identified.

Environmental factors

This category includes eight variables associated with external conditions relating to teacher attendance at work, including contextual, economic, and social factors. The findings show significant agreement that teachers working in schools located in low-income neighborhoods (commonly measured by eligibility for free lunch) have higher levels of absence than those working in high-income neighborhoods. In other words, absenteeism seems to be more pronounced in schools where the district poverty rate is high. For example, Alcázar et al. (2006) find that an increase in the district poverty rate from 0 to 100 percent raises teacher absence by 12 percentage points. In this line, the prevalence of violence, vandalism, and bullying at school is positively related to teacher nonattendance at work, based on the idea that these behaviors are significant stressors and determinants for being absent. Ervasti, Kivimäki, Puusniekka, Luopa, Pentti, Suominen, Vahtera, and Virtanen (2012) show evidence that teachers in schools with a prevalence of more than 15% of vandalism, bullying, and truancy are at a 1.7-fold greater risk of absences than their counterparts.

Additionally, higher levels of GDP per capita are linked to lower levels of teacher absence at work since development and progress drive better quality of education (Muralidharan et al., 2017). Likewise, commuting distance from teachers' homes and workplaces is positively associated with teacher time off work. In contrast, the evidence appears to be not conclusive about the correlation between community involvement and the presence of a school parent-teacher association with teacher attendance. According to Chaudhury et al. (2006), the literacy rate of parents seems to be negatively related to absenteeism. Last, results reveal that absence rates are significantly higher on days next to holidays or weekends and on days with bad weather.

In line with the quantitative studies, the reviewed articles that use a qualitative approach mention similar ideas regarding the predictors of teacher absenteeism. Werang et al. (2017) find that teachers' demographic characteristics, working conditions, and local authorities' teacher assignment policies are the main variables that influence teacher

absenteeism in Indonesia. According to Carlsen (2012), the management, the colleagues, and the absence culture are the principal factors teachers in Norway believe could impact the level of sickness absence. In agreement with that, Bristol (2017) finds that teacher absenteeism in Guyana could be attributed to poor working conditions and weak administrative leadership. Likewise, a study in South Africa exposes that low absence rates might be related to the type of school, the management style, and the consequences of abusing the time off work (Bipath et al., 2019). Another study on teacher absenteeism in South Africa confirms the significant and positive relationship between the geographic isolation of rural schools and the absences of educators at work (Moletsane et al., 2015). Additionally, Tao (2013) recognizes that educators' absenteeism could be generated by constraints on being able to live in a good home, as this situation causes stress and affects teachers' behavior at school. A study in Cameroon describes poor health conditions and lack of control mechanisms as inducing factors for educators' absences (Ngwé, 2013). Finally, inadequate school infrastructure and lack of disciplinary sanctions are also revealed as determinant factors of absenteeism (Ramadhan, 2013).

3.1.3.3 Consequences and other approaches to teacher absenteeism

Considering the quantitative studies, the main consequence of teacher absenteeism, reported in the literature, is associated with the idea that teacher nonattendance at work has a statistically significant negative relationship with student achievement (e.g., Roby, 2013; Tingle et al., 2012). Specifically, eight different studies from the United States (5), France (1), India (1), and Ghana (1) find that 10 additional days of teacher absence reduce student test scores by about 1.7% to 3.3% of standard deviation (e.g., Benhenda, 2022; Gershenson, 2016; Obeng-Denteh et al., 2011). Generally, the papers analyze pupil test scores in math, reading, or English subjects. Regarding the methodology, the investigations highlight the problem that emerges from using a simple regression model causing biased coefficients. It occurs as teacher absences could be correlated with unobserved teacher and student characteristics and unmeasured factors of teacher abilities and effort. Moreover, absences at work could be influenced by students' performance because educators of pupils with low grades and academic difficulties may be less motivated to attend school. This possible causal link between the independent and dependent variables in the model leads to endogeneity. To address this endogeneity challenge, the studies apply an alternative specification using teacher fixed effects models and including pupil and teacher characteristics controls.

The findings suggest that a teacher who takes 10 additional days of absence in a year would be associated with around a 2% standard deviation reduction in student test scores, with all other factors remaining constant. In other words, a drop of 10 days in teacher absences is related to a 2% standard deviation test score gain, confirming the theory that teacher nonattendance obstructs students' academic progress and performance. Similarly, Herrmann and Rockoff (2012) use a sample of educators in the United States to demonstrate that substituting a regular teacher with an auxiliary is, on average, comparable to replacing an average teacher with one at the 20th percentile of productivity. In other words, employing a substitute educator is equivalent to replacing a regular teacher of average productivity with one at one-fifth productivity. Therefore, this study advises the existence of a loss in productivity when regular teachers are absent from work and it is necessary to appeal to temporary replacements.

Qualitative analyses of the consequences of teacher absenteeism focus on the implications of bringing in substitute teachers. Foremost, substitutes are hardly as effective as regular teachers (Jacobson, 1990), which could disrupt the teaching and learning process of the students (e.g., Al Marboui, 2018; Pitkoff, 2003; Patrinos, 2013). Furthermore, additional costs and administrative expenses are generated due to the necessity of contracting auxiliary teachers (Bowers, 2001). Other consequences of teacher nonattendance at work, less investigated but also mentioned in some reviewed articles, are related to poorer student attendance, higher student dropout rates, and more conflict among teachers as other educators may complain when they have to take over their colleagues' classes (Gørtz & Andersson, 2014).

3.1.4 Discussion and conclusions

This systematic literature review provides a comprehensible overview of studies investigating teacher absenteeism, recognizing it as a relevant and current concern in the education context. Furthermore, this review contributes to existing research on teacher nonattendance by examining the correlates of teacher absenteeism and developing a conceptual model to for understanding the main factors related to teacher absence at school. Multiple insights are derived from this analysis.

First, teacher absenteeism should be addressed from several points of view as it is a multi-perspective problem that involves different levels (teacher, work, school, and context), so it requires targeting from diverse sides. For example, initiatives at the national

level related to remuneration or incentives for teachers should be complemented with actions at the school level to increase the monitoring capacity (Cilliers et al., 2018), the regulation of educators' workload, and the provision of learning materials, and at the same time, plans at the teacher level that promote teachers' health and well-being in the workplace (Guidorzi & Karamperidou, 2020).

Second, the reviewed articles reveal substantial heterogeneity in measuring and approaching the problem of teacher absenteeism. Different ways of computing absenteeism (frequency, rate, duration), several methodologies used (quantitative and qualitative), diverse contexts, and specific educational systems in each country complicate a common and direct understanding of teacher time off work and make it difficult to compare the findings from the analyzed studies. Hence, a systematic literature review of the topic is necessary to consolidate, structure, and analyze the research results to find patterns, identify recurrent outcomes, and provide a comprehensible framework of how educators' nonattendance should be approached.

Third, most of the literature is focused on analyzing the underlying reasons for teacher absenteeism. The conceptual model illustrates that teacher absenteeism is a function of educator characteristics (sociodemographic and psychological), working conditions, school factors, and contextual aspects. While teachers' sociodemographic factors are the most frequent determinant of being absent from work, various studies highlight other factors, such as inadequate school infrastructure, high workload (pupil/teacher ratio), few inspections in the workplace both on the side of school administrators and on the side of national education inspectorate, and low job satisfaction as significant aspects that increase the risk of being absent from work. These results demonstrate that teacher absenteeism involves various factors that should be considered in encouraging educators to attend school. Moreover, the conceptual model acts as a framework to group multiple variables into overall categories, which may facilitate the interpretation and the proposal of strategies to mitigate this relevant issue.

Fourth, the systematic literature review exposes the inexistence of an absolute consensus on the predictors of teacher absenteeism, as educators increasingly face greater challenges derived from the dynamics of current education. Furthermore, many correlates show positive and negative relations with absenteeism, depending on the sample, the methodology, and the variables included in the model. In that sense, further research is crucial to provide evidence-informed results and to suggest strategic methods to minimize the absence of teachers. In addition, many of the reviewed articles base their analysis on

surveys, interviews, or experiences exclusive to teachers, leading to subjective results. Additionally, in some cases, the samples are carefully chosen (e.g., self-reported data on teacher absences) or not big enough, which can bias the findings, make statistical inferences harder, and make it more difficult to validate the results. Therefore, it is necessary to put more effort into increasing the sample size and not selecting it based only on convenience or specific criteria. Research on teacher absenteeism needs to be strengthened, as the costs of longer periods off from work are high in both monetary and academic terms. For example, more resources could be put into collecting teacher absence data, extending the sample size (or considering more than one country), and using more robust methodologies (not only correlational but casual). Furthermore, based on the systematic literature review, greater empirical evidence is needed that looks at variables at the teacher, school, job, and contextual levels to analyze teacher absenteeism. In line with this analysis, the second section of this chapter relates to empirical work conducted to study the factors determining teachers' sick leave duration using the available database.

Concerning the consequences of teacher nonattendance at work, the empirical evidence suggests that the increase in teacher absenteeism results in a reduction in student achievement of about 0.02 SD for 10 days of absenteeism. However, the evidence is limited, and more research is needed on the impact of teacher absenteeism (e.g., effect on student dropout rates, substitute teachers, relationship with coworkers, quality of education, and costs of replacement).

This systematic literature review notes that many lines of research are pending. First, the present literature has a mainly correlational focus. However, investigations should move toward exploring causal effects to understand the influence by which each of the factors contributes to teachers being off from work, using the appropriate and robust methodologies for this and considering the endogeneity problem. Second, some factors are overlooked among the multiple variables included in the reviewed articles as predictors of teacher absenteeism. We propose to include three different categories in analyzing teacher nonattendance at work. The first group of variables should be related to specific situations of the teaching profession that can influence the decision to attend work, such as availability of materials and resources along with the possibility of professional development initiatives. Subsequently, variables of labor relations should be accounted for, including, for example, communication among colleagues, teamwork atmosphere, participation in joint projects, democratic decision-making, and general factors measuring the interaction and collaboration among the educator staff. In addition,

the teaching profession is conditioned by the educational context. Thus, detailed variables of the framework in which the education system operates, such as organizational culture, resources allocated to education, implementation of new information technologies, presence of support systems, and teaching models, could be relevant in the analysis of teacher absenteeism.

As a third stream of future research, we suggest more focus on studying the effectiveness of interventions to reduce teacher absenteeism. Investigations aiming to evaluate the benefit and success of teacher attendance programs are needed for awareness of the practices that work in one country and could be adapted to other contexts and produce significant results.

3.1.5 Policy implications

Using the insights of the literature review, this section provides some policy implications. First, the findings indicate the importance of focusing on teachers' physical and emotional well-being. Examples are programs to promote good health, encourage actions to increase job satisfaction and develop activities to reduce the level of stress and anxiety among teachers. Furthermore, the literature review suggests that it is crucial to stimulate teachers to find a balance between personal, family, and work responsibilities so they can balance their professional careers with their home duties and leisure time.

Second, schools have a responsibility to improve working conditions (fair workload, autonomy, recognition at work, proper contract conditions), provide a better working atmosphere, guarantee constructive and positive relationships among teachers, and advocate for the use of non-monetary incentives (Pohl, 2001) such as training, rewards, work flexibility, and promotion opportunities, increase job responsibilities, and offer guidance and support through leadership style.

Third, a critical point recognized in this review is the weakness in gathering administrative records of teacher attendance, as a platform or a program scarcely regulates the registration of absences. Consequently, to learn from other schools and benchmark schools against each other, a procedure to capture more and better data on teacher absences needs to be developed. Schools should have a formal system for reporting absences with information about the frequency, duration, and reasons for nonattending to measure the problem dimension and create strategies to confront it.

Fourth, to improve educational continuity, an action protocol should be implemented to ensure the necessary resources (e.g., substitute teachers) and to prevent lasting teacher shortages. Furthermore, increasing teacher opportunities for professional development seems important for reducing absenteeism (Bristol, 2017). In that line, efforts should focus on marketing the teaching profession as a valuable and essential occupation, promoting educators' recognition and prestige, providing career paths, supporting continuous learning through career training, and empowering teachers to participate actively in different school projects and to be involved in the decision-making process.

Finally, our findings indicate that teacher absences occur more often in low-income schools (e.g., Bruno, 2002; Pitkoff, 1993; Virtanen et al., 2010), as the lack of resources, poor environmental conditions, and economic problems of students and their parents affect educators' health. Hence, a dedicated focus is required for these disadvantaged contexts. A single initiative does not result in a significant decrease in absenteeism. Interventions with diverse coordinated initiatives are needed and should be aligned to the specific conditions of each educational system.

3.2 Differences in teachers' sick leave duration across educational levels

3.2.1 Introduction

Building upon the literature review conducted on teacher absenteeism, this section describes an empirical analysis conducted to investigate the absence of teachers specifically after experiencing occupational injuries. By doing so, a comprehensive understanding of this phenomenon in the education sector is achieved, and the factors that empirically motivate injured educators to be absent for extended periods from their workplaces are identified.

Throughout their professional duties, teachers may face conditions that have the potential to impact their physical and mental well-being. Teaching not only involves imparting knowledge to students but also encompasses tasks such as lesson preparation, student assessment, and active participation in extracurricular activities, including sports and school committees. The multifaceted nature of a teacher's role, as highlighted by Erick and Smith (2011), can expose teachers to a range of responsibilities, leading to potential adverse effects on both mental and physical health.

In the teaching profession, specific occupational hazards contribute to physical discomfort and injuries. Repetitive postures, such as writing on a blackboard or sustained periods of “head down” reading and writing, are identified as common causes of pain and injuries among teachers (Rey-Merchán & López-Arquillos, 2022).

The literature review conducted by Erick and Smith (2011) emphasizes that teachers are at an elevated risk for developing musculoskeletal disorders (MSD), a prevalent occupational injury within this profession. Additionally, Chong and Chan (2010) highlight a spectrum of frequently reported injuries among teachers, including tiredness, eyestrain, anxiety, sleep problems, voice disorders, neck pain, shoulder pain, headaches, and lower back pain. Falls, slips, strains, sprains, ruptures, and injuries to the upper extremities are recurrent occurrences in the teaching profession, as noted by Schofield et al. (2022). These physical incidents contribute to the overall occupational health challenges faced by teachers.

Moreover, the teaching profession is uniquely characterized by factors that contribute to elevated stress levels during the school day. Cooper and Travers (2012) identify the constant workload, limited or no breaks in timetables, the high level of alertness and vigilance required, relationships with colleagues, and the role ambiguity associated with job relocations and constant changes in working methods as stress-inducing elements. Therefore, the multifaceted nature of teaching, associated with specific occupational hazards, underlines the importance of recognizing and addressing the study of occupational accidents in the education sector.

Moreover, the deterioration in education quality and efficiency is one of the main challenges that government and society have faced during the last decades (Chapman, 1994). Within the analysis of efficiency in the education sector, the time that employees are off from work is a key element to consider. The information about occupational accidents in Spain during the last six years shows that the average duration of sick leave after an injury at work in the education sector is one of the longest among the service sectors (followed by the health and public sectors). This implies an average of three days more of absence compared to the other sectors.

The absence of an employee causes a loss of productivity, excessive extra costs, and other administrative issues associated with recruiting and replacing the absent worker. Nevertheless, in the field of education, the nonattendance of the teaching staff also has important repercussions, such as disruption in the learning process of the

students, the effect on the student motivation, and the negative perception of teachers in the eyes of students and their parents.

In that sense, longer periods of absence among education personnel could be considered barriers to educational progress and generate significant learning-loss costs that should be accounted for. Therefore, this research aims to analyze the duration of sick leave after an occupational accident in the education sector in Spain and determine which individual, contextual, and center-level factors influence the length of the absence period. Moreover, through this research, it is possible to recognize whether there are significant differences in the duration of the incapacity period between public- and private-sector employees and among the educational levels (preschool, primary, secondary, and post-secondary). To develop this empirical research, we formulate a stochastic frontier approach in which the duration of sick leave is regressed on multiple explanatory variables for the expected time of medical recovery. Furthermore, we estimate the over-duration rate of the duration of sick leave, defined as the excess of days beyond the expected medical recovery time. This term is explained by environmental variables related to worker and school characteristics that would trigger the injured worker's opportunistic behavior.

This research provides a better understanding of the factors that can motivate an opportunistic behavior of extending sick leave duration after an accident at work in the education sector and, consequently, identifies strategies to minimize the risk of irregular actions from the teachers' side. Moreover, the study gives insights into different workplace practices that managers in the education sector could apply to reduce the possibility that injured teachers extend their incapacity period without a valid justification. The findings are useful for enlightening directors about the reasons for longer time off work. There is no earlier evidence on this, as no previous studies of the factors that influence teachers' duration on sick leave due to occupational accidents have been found.

This investigation fills a gap in the literature analyzing possible determinants of longer periods of absence after an injury at work in the education sector. In that sense, the study provides lessons and new empirical knowledge about strategies and policies to be adopted by managers in terms of health and occupational safety in the workplace.

In summary, to guarantee education quality and ensure the continuity of the learning process for students, absenteeism should be addressed as a priority in the education system. The costs of longer periods off from work are high not only in monetary

but in academic terms. There is a big challenge in education in designing policies to reduce the abuse of sick leaves and to promote optimal conditions at work, which contribute to quality education for learners. Specific interventions in education should be oriented to encourage teaching staff to give the right example to the students on taking work attendance seriously.

3.2.2 Methods

3.2.2.1 Data

Using the data described in the previous section from the official records of the work-related accidents offered by the Statistics of Work Accidents (Estadística de Accidentes de Trabajo, EAT), published by the Ministry of Labor and Social Security, we use a dataset with the occupational accidents that caused sick leave and occurred in the education sector in Spain from 2015 to 2021. As has been described in Chapter 2, the dataset used in this thesis lacks information about civil servants; for that reason, this specific group of teachers is not considered in the analysis. In the study, we consider the most frequent type of injuries, such as dislocations, sprains, and strains (59%), superficial wounds and injuries (20%), bone fractures (10%), and traumatic amputations/loss of body parts (5%), that represent more than 95% of the total of the accidents that occur in the education sector. After removing the injuries leading to worker fatalities, leaving only the accidents that occur in the workplace, and carrying out data cleaning, our final dataset contains 22,185 observations.

Our explanatory variable is the duration of the incapacity, and it represents the number of days an individual was absent from work due to an accident at work. The duration of sick leave is influenced by various factors, including injury characteristics and personal attributes of the injured worker, such as gender, age, and occupation. These factors play a significant role in determining the expected recovery period based on medical and health considerations. As uncovered in the comprehensive literature review detailed in the initial segment of this section, teacher absenteeism is influenced by a multitude of factors. The conceptual model exposed in Figure 6 encapsulates all the categories and variables that have been extensively studied as predictors of teacher nonattendance. However, for this empirical investigation, we have incorporated only those variables that are present in our dataset, as outlined below. Thus, the systematic literature review conducted earlier serves as a foundational framework for integrating

variables into our empirical model. This approach ensures that our analysis is grounded in existing research while also accounting for the specific data constraints of our study.

It is important to recognize that the health conditions of employees differ based on their age. Occupational accidents among older workers tend to result in more severe injuries, thereby requiring a longer natural recovery time. The type and medical assessment of the injury, whether minor or serious, as well as the required assistance (hospital care versus outpatient care), directly indicate the severity of the accident, which critically influences the recovery time following the incident.

In addition to considering individual and injury characteristics, it is crucial to incorporate contextual elements associated with the accident. Control variables such as the location (autonomous communities) and the year of the accident should be included to provide a comprehensive understanding of the context in which the injury occurred. For instance, regional dummies account for unobserved factors that may influence the duration of absence, such as medical assistance protocols and inspection activities conducted by regional health authorities.

However, some variables that affect the length of the absence period are not necessarily related to medical reasons. Therefore, the presence of an over-duration term can be explained by specific features of the employee that attempt to capture the effect of extending the duration of incapacity beyond the standard recovery time. These variables may encompass non-medical factors that contribute to prolonged absence. By considering these various factors and incorporating them into the analysis, we can achieve a more comprehensive understanding of the determinants of sick leave duration, accounting for both medical and non-medical influences on the length of absence.

Certain workers find themselves in circumstances characterized by higher levels of social and economic vulnerability. Consequently, they experience increased apprehension regarding the potential loss of their job and encounter greater challenges in securing alternative employment opportunities. Immigrant, temporary, and part-time workers exemplify segments of the workforce that are particularly susceptible to these vulnerabilities. The systematic literature review described earlier highlights the presence of these variables as predictors of teacher absenteeism, as has been conceptualized in Figure 6. It is plausible to anticipate that individuals facing such vulnerabilities would be less inclined to engage in opportunistic behavior as they possess stronger motivation to mitigate the fear of employer retaliation, which could result in termination for absenteeism.

An expansion in sickness benefits may create a temptation for injured workers to intentionally prolong their recovery period. As is described through the conceptual model in Figure 6, the salary is a clear predictor of teacher absenteeism. When the subsidy covers 100% of a worker's salary, there are no financial costs or penalties associated with being absent from work. Consequently, as the compensation level increases, employees may have greater monetary incentives to extend their sick leave and continue receiving the subsidy without actively participating in work-related activities. Generally, sickness benefits are recognized as a potential source of moral hazard, whereby individuals may alter their behavior due to the existence of such benefits. Based on these considerations, it is reasonable to expect a positive association between the value of the temporary disability subsidy and the duration of sick leave.

When examining environmental variables that may contribute to an extended duration of sick leave, it is worth considering certain firm-level factors, such as public sector employment and school size, while adequately accounting for the intrinsic characteristics of the accident and the severity of the worker's injuries. These factors are also recognized in the literature review as predictors of teacher absenteeism, confirming the idea of including them in our model. Employees in larger schools or the public sector often experience higher levels of employment protection, which has been identified as one of the key determinants of sickness absence (D'Errico & Costa, 2012).

Public-sector employees tend to feel more job security and may have fewer incentives to return to work promptly, whereas private-sector employees typically exhibit stronger organizational commitment and higher levels of effort. In the public sector, there may be fewer organizational incentives for absenteeism control, as operational guidelines are often dictated by government laws, bureaucratic processes are prevalent, and the political framework sets the rules of operation.

Regarding school size (defined as the number of employees in the education center), as companies grow larger, relationships can become more impersonal, and control mechanisms may weaken. This provides employees with more opportunities to potentially exploit the situation and prolong their absence. In larger companies, individual absences may go unnoticed due to the difficulty of identifying specific workers, and there may be a greater likelihood of colleagues being able to cover their tasks. Consequently, employees may perceive a diminished sense of involvement within the organization. Thus, the intensity of the supervision process may exhibit an inverse relationship with the size of the organization.

The education level taught by teachers is important when examining the factors influencing their absenteeism. Various studies have highlighted specific characteristics associated with each level of education that could contribute to the decision to take more time off work. For example, secondary school teachers tend to exhibit lower job satisfaction and are less satisfied with their working conditions compared to primary and preschool teachers. They also express a stronger desire to retire or switch professions (Markow et al., 2013; Mertler, 2002; Perie & Baker, 1997; Murnane & Olsen, 1989).

Moreover, occupational stress and strain are significantly higher among secondary school teachers compared to primary school teachers (Wang et al., 2001). Some factors that contribute to lower levels of job satisfaction and higher stress levels among secondary teachers could be the relationships with parents and co-workers, time constraints, student attitudes, recognition and support, and a lack of resources compared to primary school teachers (Kavita & Hassan, 2018).

Table 10 provides a concise summary of the sample characteristics. On average, injured teachers have a duration of sick leave of approximately 34 days. Just 1% of the teachers' injuries were categorized as severe, and 10% required hospitalization. The majority of injured educators in the sample are women, accounting for 80% of participants, and their average age is 43 years. In terms of employment status, 44% of the sample consists of public teachers, 41% have temporary contracts, and only 7% are part-time workers. The distribution across educational levels reveals that preschool teachers constitute approximately 30% of the sample, followed by primary teachers at 27%, secondary teachers at 19%, special education teachers at 18%, and post-secondary teachers representing only 6% of the total. The prevalent types of injuries are predominantly linked to dislocations, sprains, strains, and superficial wounds. Notably, the body parts most frequently affected include the back, upper extremities, and lower extremities.

Additionally, Figure 8 presents the average duration of sick leave according to the education level taught. Post-secondary and secondary education teachers have an average incapacity period of 40 days following an occupational injury, while preschool and special education teachers experience an average sick leave duration of around 30 days. This discrepancy of 10 days highlights the variation in absenteeism across different education levels, emphasizing the importance of addressing this issue.

Table 10. Main descriptive statistics of the sample (Education sector)

Variable	Mean	s.d.
Sick leave duration (days)	34.51	48.80
Serious injury	1%	-
Hospital	10%	-
Female	80%	-
Age (years)	43.52	10.49
Temporary contract	41%	-
Part-time	7%	-
Size (# employees)	1655.22	5043.55
Public sector	44%	-
Post-secondary	6%	-
Secondary	19%	-
Primary	27%	-
Preschool	31%	-
Special	18%	-

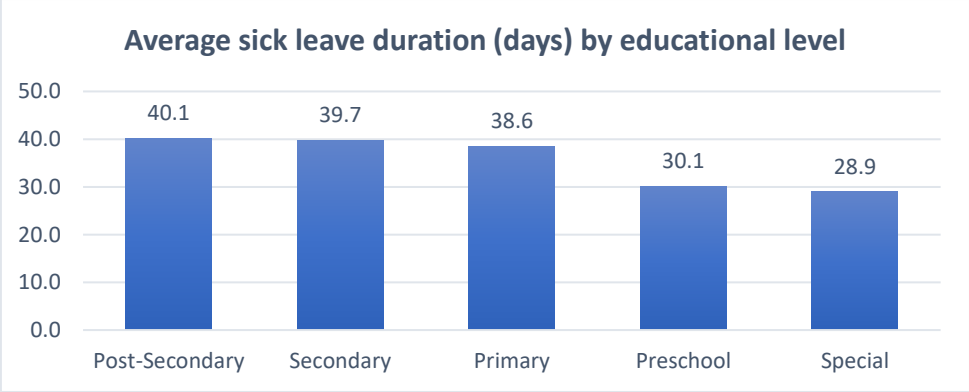


Figure 8. Average duration of sick leave by educational level taught

3.2.2.2 Methodology

3.2.2.2.1 Stochastic frontier analysis (SFA)

Building upon the methodology detailed in Chapter 2, we choose stochastic frontier analysis (SFA) as our approach. Through this analysis, we aim to explore the factors influencing the duration of sick leave by regressing it on the variables typically associated with the standard recovery process. Additionally, we simultaneously estimate the term representing over-duration, which captures the extended time taken due to opportunistic behavior unrelated to legitimate medical necessity. By employing SFA, we can effectively account for both the standard recovery process and the potential impact of opportunistic behavior on the duration of sick leave.

Throughout the preceding chapters, an important contribution of this thesis lies in the adoption of stochastic frontier analysis (SFA) as a methodological framework. This choice is significant as it enables the identification of variables impacting the standard recovery time following a workplace injury. Furthermore, it facilitates the recognition of variables that might influence opportunistic behaviors associated with extending sick leave durations. In this specific context, SFA allows for the detection of factors motivating injured teachers to prolong their incapacity period.

By applying this methodology, we can effectively identify the factors influencing the duration of sick leave in the education sector. The intrinsic characteristics of this sector are taken into careful consideration, allowing for a more sector-specific analysis. This approach ensures not only the detection of key variables affecting recovery times but also the understanding of the complex interplay of factors that motivate injured teachers to extend their sick leave. This is crucial for formulating concrete and contextually relevant recommendations as it offers practical insights that can be implemented in the education sector to optimize the management of sick leave. For example, with the existing data, it becomes feasible to identify whether personal attributes of teachers (such as gender and foreign status), features of their employment (including part-time status, contract type, subsidies, and the level of education taught), or aspects related to the school environment (such as size and sector) play a role in incentivizing injured educators to extend their absences from work after an occupational injury.

It is crucial to note that longer sick leave durations should not always be automatically attributed to opportunistic behavior. Numerous factors can contribute to extended periods of sick leave; the severity of the health condition, necessary recovery time, and the nature of the work-related injury play significant roles in determining the duration of sick leave. Opportunistic behavior implies a deliberate prolongation of sick leave without actual health reasons. However, individuals may legitimately require extended sick leave due to the complexity and seriousness of their injury. Consequently, in our analysis, we opted to incorporate variables into the frontier that influence the standard recovery time for injured teachers. Subsequently, the over-duration term within the model captures these individual attributes or workplace factors that could impact the decisions of injured educators to take extended periods of sick leave. This approach ensures a comprehensive and complete examination of the diverse factors influencing sick leave duration.

The specification of the frontier takes this form:

$$lnd_i = \beta_0 + \beta_1 InjurySeverity_i + \beta_2 InjuryType_i + \beta_3 Hospitalization_i + \beta_4 Injuredbodypart_i + \beta_5 Gender_i + \beta_6 Age_i + \beta_7 AutonomousCommunity_i + u_i + v_i \quad (12)$$

Hence, the over-duration term is related to a set of specific variables, z_i, for each individual, as:

$$u_i = \delta_0 + \delta_1 Public_i + \delta_2 Gender_i + \delta_3 Foreign_i + \delta_4 Temporarycontract_i + \delta_5 Subsidy_i + \delta_6 PartTime_i + \delta_7 EducationalLevel_i + \delta_8 FirmSize_i + \delta_9 Time_i + W_i \quad (13)$$

In the case where an injured worker adheres to the expected recovery time and does not prolong their absence from work, denoted by $u_i = 0$, any deviations from the frontier can be attributed solely to random shocks. Conversely, a positive value of u_i (> 0) suggests the presence of additional days of absence beyond the required recovery period, indicating the existence of slack days on the part of the worker. As such, the over-duration rate for each individual *i* represents the proportion of the sick leave duration that exceeds the normal recovery time. Calculating this rate for each individual is crucial to complete the analysis and yield valuable insights.

As is distinguished in the specifications of the model, the variables related to the medical and health factors that explain the sick leave durations of injured teachers are included in the frontier part, while factors associated with the employment conditions, school characteristics, and personal attributes are included as determinants of the over-duration rate, specifically linked to opportunistic behavior. This approach ensures a careful examination of the distinct sets of variables impacting the standard recovery time and those associated with potential opportunistic extensions of sick leave.

3.2.2.2.2 Survival Analysis

To complement the analysis, we conducted a survival analysis as a robustness test. The reason for including another methodology is to contribute to the robustness of the findings by validating results, enhancing generalizability, and building a more comprehensive understanding of our research question. It supports the reliability of the

findings, strengthens confidence in the accuracy of the results, can contribute to building a stronger theoretical framework by providing converging evidence, and helps to comprehend the complexity of the sick leave phenomenon. Moreover, survival analysis is one of the most common approaches when studying a variable that reflects duration. This methodology is particularly useful where the focus is on the time until the occurrence of a specific event of interest. Since our variable of interest is the duration of the sick leave, the survival analysis approach could be an appropriate statistical technique to model the expected duration of time until the end of the incapacity period occurs. Specifically, in this case, the survival model describes the length of time from the origin of the sick leave to its endpoint. We are interested in using this technique as a robustness check to confirm the results obtained from the stochastic frontier approach.

The survival function, usually denoted *S*, is defined as:

$$S(t) = P(T > t) \tag{14}$$

where *t* is some time, *T* is a random variable denoting the time of an event, and *P* denotes the probability of occurrence. That is, the survival function represents the probability that the event has not occurred by a given time. Then, the hazard function $h(t)$ represents the instantaneous rate of the event occurring at a specific time, given that the individual has survived up to that point. It signifies how quickly the event is likely to happen at that specific moment and is derived from the survival function.

$$h(t) = -\frac{S'(t)}{S(t)} \tag{15}$$

where S' is the derivative of the survival function. The accelerated failure-time (AFT) model and the multiplicative or proportional hazards (PH) model are commonly employed for adjusting survivor functions based on covariate effects. The most common survival model is the Cox proportional hazard model, in which it is possible to estimate the hazard function that describes how the risk of the event changes over time and also to analyze how the hazard is influenced by some explanatory variables (Kumar & Klefsjö, 1994). Even if this approach does not require strong assumptions and can be used to determine the characteristics that affect survival, it is required that the hazard ratio is constant over time, which means that the relative risk when each variable increases by one unit is always constant.

There are different tests for proving the proportional hazard assumption. In one of the most common, proposed by Grambsch and Therneau (1994), the null hypothesis indicates the log hazard ratio function is constant over time, which means zero slopes for individual covariates and the global model. If this hypothesis is rejected, there are diverse parametric models where the hazard function is specified. Some studies have shown that under some circumstances, the parametric models are good alternatives to Cox's model (Adelian et al., 2015). If the parametric model better fits the data, the parameter's estimation will be more precise and the model will provide more relevant interpretations (Cox & Oakes, 1984).

In the AFT model, the logarithm of the survival time $\log(t)$ is modeled as a linear function of covariates. It is expressed as:

$$\log(t) = \beta X_j + \epsilon \tag{16}$$

where $\log(t)$ represents the natural logarithm of the survival time, β represents the coefficients associated with covariates X_j, and ϵ is an error term. The AFT model assumes that the effect of covariates is to either accelerate or decelerate the survival time. The coefficients β provide information about the magnitude and direction of the covariate effects on the survival time. The distributional form of the error term determines the regression model. The most suitable distributions to model our outcome variable are the lognormal or the log-logistic distributions that are used for data that exhibit nonmonotonic hazard rates and accelerated failure time (Cleves et al., 2016), as happens in this case, precisely at first with increased and then decreased rates.

3.2.3 Results

3.2.3.1 Stochastic frontier analysis (SFA)

Table 11 provides the simultaneous estimation of parameters in the frontier and examines the determinants of the over-duration term. Prior to delving into the analysis of our primary variables, we note that the variables associated with medical factors exhibit anticipated behavior. Specifically, the coefficients corresponding to the severity of injury diagnosis, type of medical care received, and age display the expected positive signs and attain statistical significance. Furthermore, significant differences exist in the duration of sick leave across different regions. Specifically, Madrid, Cataluña, Pais Vasco, and

Baleares exhibit the shortest duration of incapacity periods following occupational accidents. The variation in the duration of sick leave across the autonomous communities could be attributed to a multitude of factors, reflecting the complex interplay of regional, economic, social, and organizational dynamics. For example, disparities in healthcare infrastructure and access to medical facilities among autonomous communities may contribute to variations in the speed and quality of medical care, influencing the duration of sick leave. Differences in demographic factors, such as age distribution, workforce composition, or the prevalence of chronic health conditions, could contribute to differences in sick leave duration. Educational programs, awareness campaigns on health and safety, and legal frameworks may affect how employers and employees approach sick leave policies and practices.

An intriguing finding emerges in relation to the coefficient of gender, which shows a negative and statistically significant effect. This suggests that injured female teachers experience shorter durations of sick leave following occupational injuries compared to their male counterparts. This result can potentially be attributed to the higher proportion of females within our sample and the levels of commitment and responsibility that women often associate with their profession, such as teaching. Other hypotheses associated with this result could be the idea that female teachers are engaged in activities with shorter recovery times due to less severe injuries or injuries of a different nature (e.g., physical education teachers, who frequently are men, might have more serious injuries and longer periods of recovery). Moreover, cultural norms and societal expectations regarding gender roles and health may play a role in how male and female teachers approach sick leave.

In the analysis of the estimated coefficients for the over-duration term, a positive coefficient indicates the presence of factors that contribute to an extended duration of sick leave. In line with the findings in Chapter 2, the positive and highly significant coefficient for the variable PUBLIC provides compelling evidence that teachers in the public sector tend to experience longer absences following occupational accidents compared to their counterparts in the private sector. This outcome underscores the previously established results. Some specific reasons for this result could be related to the idea that teachers in the public sector are frequently part of unions or associations that negotiate employment terms and return-to-work policies, which could contribute to longer absences due to established protocols. The availability of resources, including substitute teachers and support staff, may differ between public and private sectors. Decision-making processes

in public sector organizations can be more complex, which could contribute to delays in implementing return-to-work plans for teachers recovering from occupational accidents. Additionally, public-sector organizations, including schools, may be subject to budget constraints, affecting the availability of resources for efficient management of occupational accidents.

Table 11. Coefficient estimates: Stochastic frontier analysis (Education sector)

Frontier	**Coefficient**
Hospital	0.32039 (0.02589)***
Severity	1.20881 (0.10532)***
Gender	-0.09535 (0.03642)***
Age	0.01387 (0.00078)***
Regional dummies	Yes
Injury type	Yes
Injured body part	Yes
Constant	0.02615 (0.1099786)
Equation of inefficiency	**Coefficient**
Public	0.84768 (0.1886644)***
Gender	0.05211 (0.2324052)
Foreign	-1.41468 (0.9269862)
Temporary contract	0.18765 (0.1234826)
Subsidy	0.00532 (0.0034904)
Part-time	-0.07426 (0.2870972)
Secondary	0.20506 (0.2229587)
Primary	0.30804 (0.2199237)
Preschool	-0.3953 (0.2420767)*
Special	-0.58008 (0.2678922)**
School size	0.00001 (0.0000068)
Trend	0.12919 (0.0277789)***
Constant	-3.89122 (0.5334641)***
Wald chi2(27)	1853.99
Prob > chi2	0
No. of observations	22185
Sigma_U	0.2752139***
Sigma_V	1.080151***

Robust standard errors are in parentheses.
*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Furthermore, the negative and highly significant coefficients for the variables SPECIAL and PRESCHOOL education suggest that teachers at these education levels generally have shorter periods of absence after occupational injuries compared to teachers in post-secondary education. Some theories about this result could be linked to the notion that teachers in special and preschool education may engage in more direct interactions with students. The nature of their work may involve closer supervision, smaller class sizes, and a more intimate teaching environment, which could contribute to a quicker return to work after an occupational injury. In special and preschool education, students

often require more individualized attention and care. Teachers in these settings may feel a greater sense of responsibility toward their students, influencing their motivation to return to work sooner. Teachers in post-secondary education often handle larger class sizes, grading responsibilities, and research demands that can contribute to lower levels of job satisfaction and, therefore, more motivation to try to extend their time of absence. These results shed light on the differential patterns of sick leave duration across various education levels within the teaching profession.

Additionally, the positive and statistically significant coefficient for the variable TIME indicates that the duration of teachers' sick leave has increased over the analyzed period. This finding implies a temporal trend of longer absences for teachers following occupational accidents. Increasing workloads, common in recent times, may contribute to higher stress levels among teachers, generating more frequent and prolonged sick leave. In addition, there is a growing awareness of mental health issues among educators. Teachers may be more inclined to take sick leave for mental health reasons due to pressure, anxiety, or tension in the workplace. Increased administrative demands, larger class sizes, and constant changes in the work environment could impact teacher well-being and, consequently, higher sick leave rates and longer durations. The global COVID-19 pandemic has significantly impacted education systems. Teachers have faced challenges related to remote teaching and adapting to new technologies along with concerns about their health and safety, all of which may contribute to increased sick leave durations.

On the other hand, the remaining variables, including immigrant status, type of contract, level of subsidy, and school size, do not exhibit statistical significance. As a result, there is insufficient evidence to draw inferences regarding their influence on the length of absence periods within the education sector.

Merely considering the numerical values of the coefficients does not provide a comprehensive understanding of the impact of each variable on the over-duration term. To gain deeper insights, we must calculate the over-duration measures for all individuals. By examining these measures, we can obtain a more nuanced interpretation of the results.

The results, analyzed by sector of employment, indicate that injured public-sector teachers exhibit higher levels of over-duration rates. This suggests that they are more inclined to engage in opportunistic behavior, prolonging their absence period after sustaining a workplace injury compared to their counterparts in the private sector. Specifically, on average, approximately 70% of the sick leave days taken by injured

public teachers would have been sufficient for their return to work, whereas the corresponding figure for injured private teachers stands at approximately 80%. These findings underscore the importance of considering sector-specific differences in the behavior of teachers when it comes to extending their sick leave beyond what is medically necessary.

Moreover, when calculating the over-duration rate according to educational level, as shown in Table 12, the findings reveal that injured special education and preschool teachers have an average over-duration rate of 20%, while injured teachers in other education levels have an average over-duration rate of 27%. This indicates a significant difference of 7% between these categories, suggesting that teachers in special education and early childhood education tend to have shorter periods of absence.

Table 12. Over-duration rate by educational level

Educational level	Over-duration rate
Post-secondary	25%
Secondary	28%
Primary	29%
Preschool	20%
Special	20%

This discrepancy in over-duration rates across educational levels could potentially be attributed to various factors. Teachers in special education and preschool settings may perceive a greater sense of purpose and value in their work, leading to a stronger commitment to timely returns. Additionally, they may experience higher levels of recognition and appreciation for the quality of their professional actions from students and parents. The nature of their work in these settings may also offer more diverse and engaging activities, which could contribute to a reduced tendency for prolonged absences. Furthermore, it is plausible that teachers in special education and preschool settings shoulder greater responsibility for the well-being and care of their students, prompting them to prioritize their return to work.

Regarding the trend of the over-duration rate over the years, the results demonstrate a concerning pattern of increasing incapacity periods following workplace injuries. Specifically, the over-duration rate has risen from 22% in 2015 to 28% in 2021. This trend indicates a worrisome escalation in the extended duration of sick leave, which calls for urgent attention and intervention.

Continuing the analysis, we can not only estimate the percentage of sick leave duration extended due to opportunistic behavior but also quantify the number of days involved and their associated costs. Consistent with the methodology outlined in Chapter 2, Table 13 presents the outcomes of the excess of absent days and their corresponding costs categorized by sector. During the studied period, the total exceeding subsidy costs amounted to 13 million euros. Remarkably, 67% of this total corresponds to the public sector. This finding highlights the potential savings that schools and the healthcare system could achieve by exerting efforts and implementing strategies to effectively manage and control the duration of sick leave after workplace accidents, taking into account the specific characteristics of their workforce.

Table 13. Exceeding absence days and exceeding subsidy costs (Education sector)

Sector	Total exceeding absence days	Total exceeding subsidy costs	Mean exceeding subsidy cost per worker
Private	78,140	4,524,953 €	391 €
Public	146,966	9,464,100 €	963 €

Moreover, the total excess absent days accumulated to over 225,000 days over the six-year duration of the study. This figure represents the number of days that injured teachers could have been actively engaged in their duties but instead exhibited behavior prolonging the period of incapacity without a valid health justification. These findings underscore the economic implications of extended sick leave resulting from opportunistic behavior. By proactively addressing this issue through managerial interventions and strategic measures, significant cost savings can be realized, and educators can be encouraged to adhere to appropriate and justified durations of sick leave.

3.2.3.2 Survival analysis

To determine the independent predictors for the duration of sick leave and confirm the previous results, we decided to use survival analysis techniques. As the Cox model assumes proportional hazards for each variable, we apply the test of proportional hazards, which is rejected for the global model (p-value 0.000), so in our circumstances, the assumption that restricts $\beta(i) = \beta$ is not suitable for all variables. Consequently, the hazard function is modeled through a log-logistic distribution, which presents the lowest AIC and BIC values among other distributions and is consistent with the shape and behavior of our dependent variable.

The results obtained from the model are summarized in Table 14. Since the log-logistic model employs an accelerated failure-time parameterization, a positive coefficient signifies an increase in the time to failure, indicating a longer recovery period or extended duration of absence. Conversely, a negative coefficient suggests a shortened survival time or absence duration at work. Overall, the findings align with expectations and corroborate the previous results obtained through the SFA approach.

Table 14. Results from the survival analysis (log-logistic model)

Variable	Coefficient
Hospital	0.3246 (0.02685)***
Severity	1.30133 (0.10146)***
Gender	-0.09012 (0.02019)***
Age	0.01457 (0.00082)***
Public	0.15997 (0.01952)***
Foreign	-0.13608 (0.05139)***
Temporary contract	0.03741 (0.19504)
Subsidy	0.00018 (0.0005)
Part-time	-0.01653 (0.03184)
Secondary	0.05642 (0.03652)
Primary	0.07063 (0.0355)**
Pre-school	-0.04622 (0.00366)**
Special	-0.06087 (0.0374)*
School size	4.4100E-06 (1.64E-06)***
Trend	0.01875 (0.00393)***
Regional dummies	Yes
Injury type	Yes
Injured body part	Yes
Constant	1.60568 (0.11938)***
LR chi2(38)	2440.87
Prob > chi2	0

*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

The results confirm the influence of certain personal factors and accident characteristics on the duration of sick leave. Variables such as gender (male), age, being a national (rather than foreign), the severity of the injury, and the need for hospitalization contribute to longer periods of absence. However, in the context of the education sector, it is revealed that holding a fixed contract, being a part-time worker, and receiving higher levels of subsidy do not have a significant impact on the duration of teachers' absences from work.

Furthermore, the analysis provides evidence that in environments with more relaxed employee controls, such as the public sector and larger schools, the duration of the incapacity period tends to be longer. This observation stems from opportunistic

behavior on the part of workers who take advantage of the lower levels of supervision to extend their absence without a justifiable reason. Moreover, the results of the survival analysis affirm the notion of shorter sick leave durations for injured educators in special and preschool education settings.

Figure 9 presents the survival functions' curves at specific values of selected variables to facilitate a comparison of survival experiences under distinct circumstances. Specifically, the plot contrasts the survival curve for a female immigrant worker in a private school (profile 1) with that of a male national worker in a public school (profile 2). The figure reveals notable differences in survival experiences between the two profiles. The plots also indicate that the most pronounced divergence between the two lines occurs when the sick leave duration ranges from approximately 20 to 60 days. This discrepancy may be attributed to employees with severe injuries that require an extended recovery period and who are less inclined to engage in opportunistic behavior to prolong their absence compared to workers with a moderate duration of incapacity, who may be more susceptible to improper actions. Additionally, Figure 9 highlights that Profile 1 carries a lower risk of experiencing longer durations compared to Profile 2. For instance, the probability of surviving beyond 30 days for Profile 1 is approximately 20%, while for Profile 2, it stands at around 35%.

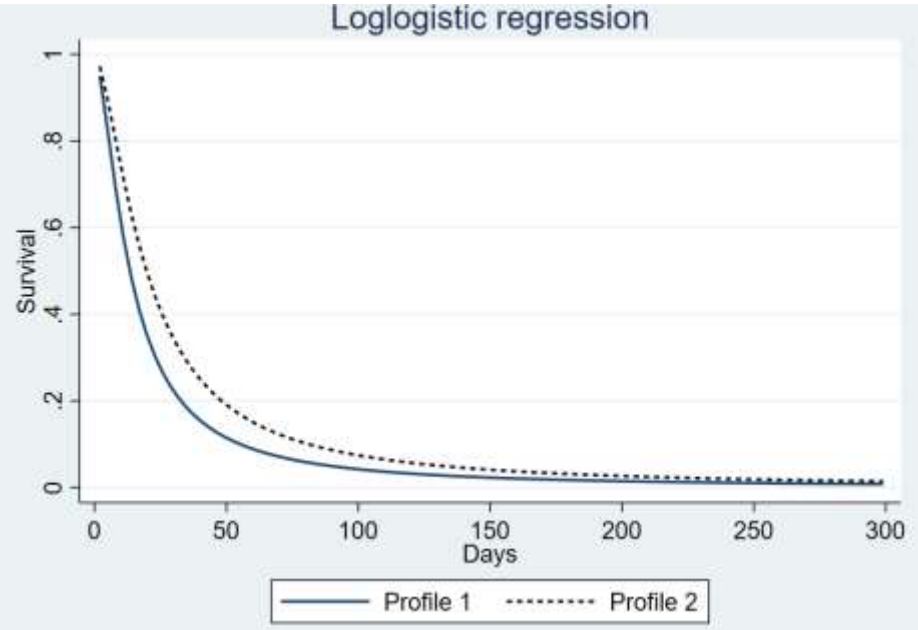


Figure 9. Survival curves by profile

Last, Figure 11 compares the survival curves by educational level taught, confirming the findings obtained from the two previously described methodologies. It clearly demonstrates that injured special education and preschool educators exhibit shorter survival times compared to injured secondary and post-secondary teachers.

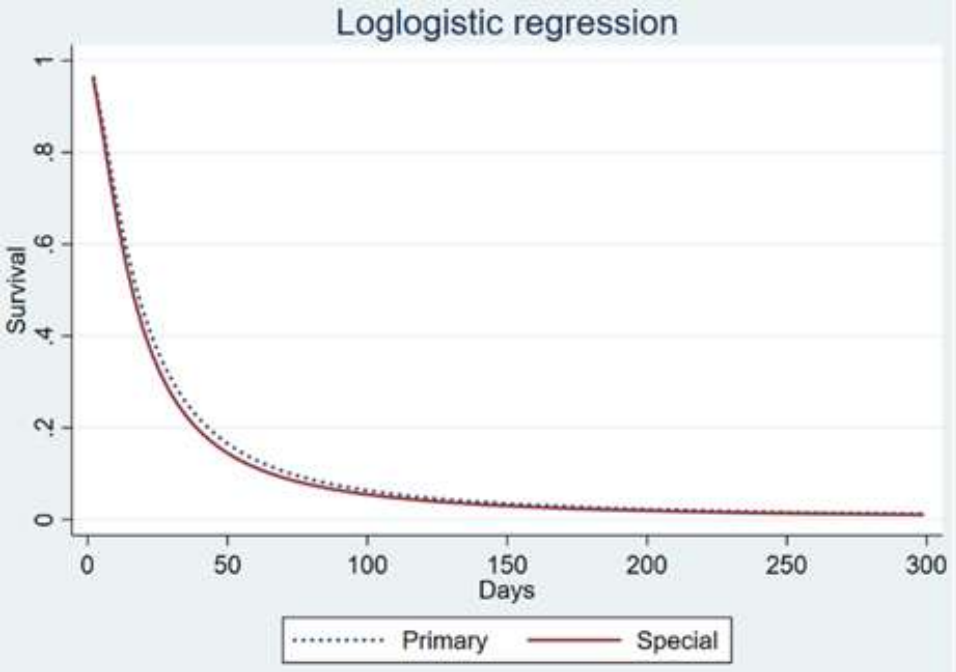


Figure 10a. Survival curves by educational level

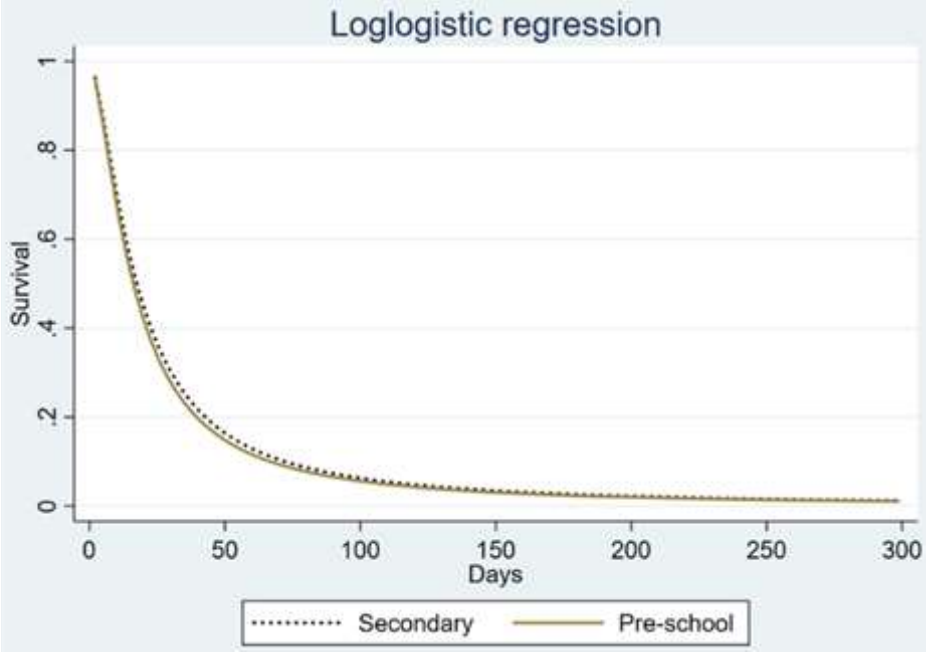


Figure 11b. Survival curves by educational level

3.2.4 Discussion and conclusions

By applying a new methodology, this study aims to shed light on the sources of prolonged absences from work without justified reasons and gain a better understanding of sick leave duration in the education sector. Addressing absenteeism is critical for ensuring educational quality and maintaining the continuity of the learning process. Using a dataset encompassing occupational accidents resulting in sick leave within the education sector in Spain from 2015 to 2021, this chapter examines individual characteristics, contextual factors, and center-level variables to investigate the determinants of sick leave duration and the presence of an over-duration term, defined as the excess days beyond the expected recovery time.

Employing a stochastic frontier approach, the study regresses the duration of sick leave on various explanatory variables related to the expected time of medical recovery. Additionally, the over-duration term of sick leave duration is estimated and linked to environmental variables reflecting teachers and school characteristics that may trigger opportunistic behavior by the injured worker.

Overall, the findings closely align with the systematic literature review conducted on the predictors of teacher absenteeism outlined in the initial section. This congruence strengthens the analysis of nonattendance within the education sector, contributing to a comprehensive understanding of the phenomenon. The correlation between our empirical findings and the insights derived from existing research underscores the robustness of our investigation and its relevance in addressing the complexities of teacher absenteeism. The research reveals significant variations in the duration of absences among injured teachers, particularly between those working in public and private schools. Injured teachers in public schools tend to return to work later than their counterparts in private schools. It supports the hypothesis that environments characterized by lax control and weak monitoring facilitate the prolongation of sick leave. Additionally, injured preschool and special education teachers exhibit lower over-duration rates, as their return to work is typically shorter compared to injured teachers at other educational levels. This outcome suggests a possible greater commitment to their job, increased responsibilities in caring for their students, and potential difficulties in finding suitable replacements for teachers at special and preschool education levels.

The findings that injured teachers in public schools tend to return to work later than their counterparts in private schools and that preschool and special education

teachers have shorter return-to-work durations have several implications for both educators and educational systems. The observed difference in return-to-work durations may suggest variations in teaching management, workforce planning, and administrative processes. Adequate support and resources for these specific groups of more vulnerable teachers who misbehave by extending their sick leave period should be in place as a priority to accommodate their unique needs. Our results may indicate potential challenges in the public education system, such as heavier workloads, bureaucratic processes, or stressors affecting teacher well-being. Addressing these issues can contribute to a healthier and more productive workforce. Ensuring appropriate training, improving work conditions, and enhancing support systems might contribute to a more satisfied and stable teaching group and increase educator retention.

These findings contribute to our understanding of the factors influencing sick leave duration within the education sector. They highlight the importance of monitoring and control mechanisms to mitigate moral hazard situations and reduce the extension of sick leave beyond the necessary recovery period. The results also emphasize the unique dynamics within different levels of education, with preschool and special education teachers exhibiting shorter periods before their return to work.

Given the critical role of education in maintaining quality standards and ensuring a continuous learning process for students, it is crucial to prioritize efforts to address absenteeism within the education system. The costs associated with extended periods of absence extend beyond financial considerations and have academic implications as well. Consequently, designing effective policies to reduce the misuse of sick leave and promote optimal working conditions in education poses a significant challenge. It is essential to create an environment that fosters quality education for learners while minimizing the abuse of sick leave. Such policies will contribute to a more efficient and effective education system overall.

In light of these findings, we recommend three types of interventions to address the issue of excessive sick leave in the education sector. The first group of interventions focuses on control measures aimed at intensifying monitoring and supervision of sick leave duration, taking individual employee characteristics into consideration. This includes implementing disciplinary interventions, applying sanctions when necessary, and establishing stringent procedures and regulations to ensure compliance.

The second group of interventions should be oriented to motivational actions aimed at increasing job satisfaction and overall well-being. This can be achieved through

the implementation of wellness programs, empowering educators, and creating a better working atmosphere. Additionally, investments should be made in teachers' physical and emotional well-being with a focus on reducing stress and anxiety levels. Furthermore, developing programs to educate teachers about the impact of their absenteeism on student outcomes can also be beneficial.

The third group of suggestions involves implementing a combination of targeted strategies that address various factors contributing to teachers' decisions to extend their sick leave. For example:

- Establish mental health programs, counseling services, and stress management initiatives to support teachers' overall well-being.
- Try to implement flexible scheduling options or adjustable hours to accommodate teachers' personal needs and reduce burnout.
- Offer continuing professional development and training programs to keep teachers engaged and motivated in their roles.
- Ensure that teachers have manageable workloads by setting realistic expectations and providing adequate resources.
- Designate programs to recognize and appreciate teachers for their dedication and hard work, encouraging a positive and motivating atmosphere.

Overall, by implementing these targeted interventions, policymakers and stakeholders in the education sector can effectively reduce excessive sick leave, enhance productivity, and foster a healthier and more efficient work environment for educators. The insights from this chapter provide a solid foundation for developing strategies and initiatives to support the well-being of educators that translate into optimal learning conditions for students.

Having presented the aforementioned information, we will now explore the theoretical and practical contributions of this chapter while addressing the study's limitations.

Theoretical implications

This chapter makes a highly significant theoretical contribution by undertaking the first systematic literature review on teacher absenteeism. Through this review, we have developed a conceptual model that identifies the variables influencing

nonattendance at work. These variables have been categorized into different groups to enhance the understanding and analysis of the subject matter.

Building upon this comprehensive review, we have also conducted an empirical study, thereby contributing to the existing body of literature on understanding the sources of over-duration rates for educators. Moreover, our research sheds light on the individual and contextual factors that motivate injured teachers to extend their period of absence in situations involving moral hazard. By exploring these factors, we contribute to a deeper understanding of the complexities surrounding teacher absenteeism and its implications.

Our conceptual model and empirical findings offer valuable insights into the underlying mechanisms and dynamics of teacher absenteeism, advancing theoretical knowledge in this area. These contributions provide the way for further research and theoretical development, facilitating the formulation of more accurate and comprehensive models to explain and address the phenomenon of teacher absenteeism.

Practical implications

Based on these findings, we can suggest practical implications for addressing the issue of excessive sick leave in the education sector. These implications could be oriented to motivational actions or control measures.

One example is implementing initiatives to improve overall job satisfaction and well-being among educators through the development and implementation of wellness programs that focus on physical and mental health support. It is also relevant to provide opportunities for professional development, recognition, and involvement in decision-making processes. Empowering educators by giving them a sense of ownership and autonomy can enhance their motivation and commitment to their work, potentially reducing the likelihood of excessive sick leave.

An uncommon but necessary action is related to educating teachers on the impact of absenteeism and developing programs to raise awareness among teachers about the consequences of their absenteeism on students' outcomes. Providing information and training on the importance of regular attendance and the potential negative effects on student learning can help foster a greater sense of responsibility and commitment to their role.

Moreover, through the intensification of control measures, potential abuse or unnecessary prolongation of sick leave can be identified and addressed promptly. Establishing clear procedures and regulations regarding sick leave and applying

disciplinary actions or sanctions, when necessary, can reduce the misuse of sick leave and reinforce the importance of responsible absence management.

Limitations

It is essential to acknowledge the limitations of our study, which may impact the generalizability of the results. The specific context and sample characteristics considered in our research may restrict the applicability of our findings to other settings or populations. Therefore, caution should be exercised when extrapolating these results to different educational contexts or regions.

Additionally, it is important to note that our model incorporates only the variables that we were able to collect based on the available database. Other individual characteristics of teachers and environmental factors may also play a role in their decision to return to work. Consequently, the conclusions drawn from our study are limited by the availability of data and may not fully capture the entire spectrum of factors influencing sick leave behavior.

An inherent limitation in our analysis originates from the potential presence of selection bias. This arises from our exclusive focus on teachers who experienced occupational accidents and subsequently required sick leave. Consequently, our findings and recommendations are established on a specific sample of teachers who experienced an injury at work and were absent for a defined period. It is essential to acknowledge that teachers who present occupational injuries but did not take sick leave, as well as those absent for reasons unrelated to work-related incidents, remain unexplored in our study. Future research efforts should contain a wider scope of teacher experiences. The inclusion of data on teachers who either did not take sick leave after an occupational injury or were absent for reasons other than work-related incidents would contribute invaluable perspectives. Exploring these additional dimensions could provide more findings that contribute to the understanding of the factors influencing sick leave duration and potential opportunistic behavior.

The empirical results are based exclusively on quantitative analysis. Nevertheless, for this type of sector, conducting qualitative research, such as interviews or surveys, could provide deeper insights into the individual experiences and motivations of teachers regarding sick leave. To capture the perspectives of teachers themselves, we suggest exploring a mixed-method approach and gaining a more nuanced understanding of the contextual factors that influence sick leave behavior.

Chapter 4: The role of firm size in sick leave duration after occupational accidents: Evidence from Spain's manufacturing sector

Abstract

This chapter presents a focused investigation into the impact of firm size on sick leave duration following work-related accidents. With limited existing evidence in this area, we aim to analyze potential disparities in sick leave duration across firms of different sizes, using a sample exceeding 500,000 non-fatal work accidents in Spain's manufacturing industries from 2015 to 2021. We employ a stochastic frontier approach and an econometric model to provide a comprehensive empirical analysis of the key variables affecting the number of working days lost after occupational injuries in manufacturing industries. Our findings highlight a significant trend: workers in larger firms tend to face extended absence periods following work accidents. This phenomenon can be attributed to the relatively reduced control and supervision within larger organizations, potentially creating more opportunities and incentives for workers to extend their sick leave.

Chapter 4: The role of firm size in sick leave duration after occupational accidents: Evidence from Spain's manufacturing sector

4.1 Introduction

As it has been described throughout the thesis, the duration of sick leave following an occupational accident is influenced by various individual and accident-related factors. However, the characteristics of the company where the injured worker is employed may also play a role in determining the length of sick leave, including factors such as the sector or the firm's size.

Existing literature suggests that larger companies tend to have higher absence rates, possibly due to lower levels of supervision, reduced commitment, and challenges in monitoring larger staff (Allen, 1981; Barmby & Stephen, 2000; Ose, 2005). Nevertheless, there is a notable gap in research regarding the specific effect of firm size on the duration of sick leave after occupational accidents.

In this chapter, our primary aim is to investigate the influence of firm size on sick leave duration after work-related accidents. We seek to discern whether there is a significant difference in sick leave duration between firms of different sizes, as limited evidence currently exists on the impact of firm size in occupational accidents, particularly regarding sick leave duration.

Given the relevance of lost workday rates in manufacturing industries, which typically exceed those in the service sector, we consider it essential to analyze work-related injuries in the manufacturing sector extensively. Hence, we find it imperative to incorporate the study of work-related injuries in the manufacturing sector and expand our analysis to adopt a broader and more comprehensive approach. Therefore, our study provides a comprehensive empirical analysis of the key variables affecting the number of working days lost after occupational injuries in manufacturing industries.

Furthermore, the emergence of the COVID-19 pandemic has brought about additional challenges regarding occupational accidents in this sector. The pandemic may have an important impact on various aspects, introducing notable changes in work patterns, types of accidents, and related factors irrespective of firm size. The pandemic has accelerated the adoption of remote work, leading to a significant increase in telecommuting. With remote work becoming more prevalent, there has been a shift in the types of accidents. While traditional workplace accidents may decrease, new risks associated with home offices and virtual work environments may emerge. Moreover, the

pandemic has highlighted the importance of mental health in the workplace. Increased stress, anxiety, and burnout among employees may contribute to changes in accident rates and patterns.

In the manufacturing sector, the transition to remote work or the adoption of flexible schedules to accommodate social distancing measures could impact accident rates and sick leave durations. Supply chain disruptions caused by the pandemic could lead to delays, increased pressure on workers to meet production demands, and potential safety risks. Furthermore, economic challenges resulting from the pandemic may lead to a reduction in costs, affecting workplace safety initiatives and resources.

The surge in demand for consumer-packaged goods and medical equipment necessitated an intensified focus on increasing production. Consequently, manufacturers in these sectors were exposed to non-stop work to meet the global demand, resulting in an elevated risk of occupational accidents. These significant shifts have placed considerable pressure on manufacturing companies, especially in the planning of production processes. In response to the emerging conditions, these companies have had to experience revisions and adjustments to their production strategies (Ardolino et al., 2022). Therefore, the COVID-19 pandemic has brought about a transformation in manufacturing work dynamics, and its impact on accidents and related factors is multifaceted, justifying the study of occupational injuries in this sector.

To achieve this, we conducted analyses on a sample of over 500,000 non-fatal work accidents that occurred in Spain's manufacturing industries between 2015 and 2021. Employing a stochastic frontier approach and an econometric model, we examine various employee, work, firm, and environment characteristics associated with the number of days off work.

Our study's theoretical discussion and empirical findings hold implications for manufacturing company managers and policymakers. We aim to aid in mitigating both voluntary and involuntary absences due to work-related injuries by providing strategies and policies to enhance safety management, prevent occupational illnesses, develop targeted prevention programs, and suggest safety requirements based on firm size to protect workers. Additionally, we seek to offer recommendations for prioritizing precautionary measures and implementing effective educational programs for vulnerable enterprises.

Overall, our research aims to facilitate resource allocation for auditing, education, and safety programs, particularly targeting industries and firms with the greatest needs.

Moreover, it contributes to advancing knowledge in the field of occupational accidents in the manufacturing sector in Spain, offering insights for the development of future research approaches and strategies for policymakers, Social Security supervisors, government bodies, and labor or health institutions.

4.2 Theoretical background

Firm size emerges as a significant risk factor for workplace injuries and may play a crucial role in explaining the origins of most accidents (Sanmiquel et al., 2015). While several studies have explored the relationship between firm size and the incidence rate of occupational accidents, scant attention has been given to the duration of sick leave following work-related injuries.

Most of the literature has found higher incidence rates in small firms than in big ones (Sinclair & Cunningham, 2014). For example, López et al. (2011) found that accidents with ladders in smaller-sized firms in Spain were more serious and involved more fatalities than those in larger-sized firms. Sørensen et al. (2007) examine the status of the literature on the work environment in small firms, finding that in most of the research, there is evidence of more severe injuries and fatalities in small enterprises. Additionally, a study across all EU member states affirms the incidence of major injuries and fatalities is proportionally higher in smaller businesses than in larger ones (EU-OSHA, 2018).

Nevertheless, the importance of analyzing not only the number of accidents but the length of the incapacity period after workplace accidents and its connection to firm size becomes relevant due to the various additional costs incurred by different stakeholders. Employers bear the burden of productivity loss, expenses related to training new employees, potential reputational damage, and decreased efficiency upon extended employee absence as well as administrative and legal costs expenses (Soklaridis et al., 2012). Insurers also face administrative expenses associated with managing compensation cases, which tend to escalate when employees extend their sick leave period (Galizzi et al., 2016). On the workers' side, uncovered medical costs, the risk of unemployment, skill obsolescence, and loss of experience time are among the challenges they may confront (Galizzi & Boden, 2003). Moreover, family members of injured workers may experience less visible but equally impactful consequences, such as the need to provide additional income, the stress in family relationships caused by illness, and assuming all family responsibilities (Strunin & Boden, 2004). Thus, a prolonged absence

from work has not only economic implications but also profound social, organizational, and administrative repercussions.

In line with these considerations, Spanish laws have recognized the significance of firm size in the context of occupational accidents and workplace safety. The Occupational Risk Prevention System, established in 1995 by the Law of Prevention of Occupational Risks, aims to protect employees and promote safety and health at work. According to this system, the decision to provide prevention services internally or externally depends on the number of employees in the firm. Companies with up to 10 workers may personally handle prevention activities, whereas companies with over 500 workers are legally required to have an internal prevention service. For companies with 250 to 500 workers, the requirement for an internal service is contingent on specific occupational risks. An internal service denotes an in-house option, while an external service involves outsourcing the prevention activity to a specialized company accredited to advise, manage, and ensure compliance with legal requirements for occupational risk prevention.

There could be some reasons to assume that employees of larger firms have longer periods of sick leave than those of smaller firms. In general, the intensity of monitoring and control is inversely related to the size of the organization (Rutherford, 2016). In small companies with shorter and more direct hierarchical structures, absenteeism from work does not go unnoticed. In smaller organizations, interpersonal relationships are usually closer, which translates into a higher level of involvement and commitment to both the sustainability of the company and the repercussions of absenteeism for workmates. By contrast, larger companies have higher rates of job rotation and employee turnover (Zhu, 2016) and have more resources to replace employees on sick leave quickly, and workers at such companies have less of a direct perception of the consequences of their absenteeism.

Even if a firm possesses specific human capital, a sufficiently large company can establish a reserve of employees who know company policies and procedures well. Therefore, the cost of replacing absent workers tends to be notably high for small firms that lack the financial capacity to create such a reserve pool (Pauly et al., 2002). Moreover, the elevated productivity observed in larger firms allows such firms to incorporate a reserve capacity of skilled workers (Dupuy & de Grip, 2003). Besides, quickly finding temporary substitute workers may pose challenges, leading to organizational issues that impede overall productivity. This is particularly pertinent for

small- and medium-sized enterprises, where it may be more challenging for other employees to take on the tasks of those who are absent (Grinza & Rycx, 2020).

Furthermore, as the company grows, relationships become more impersonal and organizational control is weaker, so employees may feel more tempted to take advantage by trying to prolong sick leave duration. In this vein, several previous studies show that the size of the organization is positively correlated with absence rates (e.g., Barmby & Stephen, 2000; Heywood & Jirjahn, 2004; Dionne & Dostie, 2007).

In large companies, an impersonal atmosphere and the difficulty of closely supervising and tracking daily activities for the entire workforce can lead to certain workers taking advantage of the situation after an injury. Since tasks can often be easily replaced by other colleagues, absences may not be as noticeable, potentially leading some employees to take more days off due to injuries without facing immediate repercussions. Additionally, when an external company is responsible for the risk prevention system, as is common in larger firms, the involvement may be less personalized, resulting in standardized preventive activities and solutions that may not fully align with the specific characteristics of the company. The lack of detailed control and supervision in such cases can further contribute to workers seeking to extend the duration of their incapacity period.

On the other hand, in small enterprises, the close coordination between employees and employers, as well as the sharing and communication of information among colleagues (Holá, 2012), can create a more connected and transparent work environment. Peer group effects can play a crucial role in influencing decisions to be absent from work (De Paola, 2010). Moreover, workers in smaller companies often interact more directly with their supervisors, making it easier for their absences to be noticed (Anand & Dalmasso, 2020). Additionally, large firms usually present higher monitoring and evaluation costs (Ferrer & Lluis, 2008), leading employees to the possibility of being away from their jobs without being noticed.

Furthermore, the literature indicates that employers in larger firms typically pay higher wages due to greater productivity and workforce stability (Gibson & Stillman, 2009; Lallemand et al., 2005; Pull, 2003). Large enterprises, which are often more innovative and capital-intensive, may require highly qualified employees who demand higher salaries (Schmidt & Zimmermann, 1991). Lucifora and Origo (2015) found that the impact of performance-related pay on productivity varies by firm size, and Söderbom and Teal (2001) emphasized the role of human capital in determining productivity and earnings, suggesting that larger firms may have a more skilled workforce, which could

contribute to their higher productivity. Consequently, if workers perceive higher income, their paid sick leave may also be greater, providing them with more incentives to continue receiving compensation without returning to work. The opportunity cost of returning to work comes into play in this decision-making process, where the utility of staying at home and receiving compensation may outweigh the utility of returning to work.

Another potentially influential factor contributing to longer periods of absence in large firms is the perception of greater job security in these organizations compared to their smaller counterparts (Lin et al., 2021; Wagner, 1997). This association may originate from various factors, including economic stability, diversified operations, long-term planning strategies, and increased opportunities for internal mobility within larger firms. The notion is that employees in larger firms, who perceive their jobs as more secure, may feel less motivated to cut short their sick leave for fear of potential dismissal. This is in contrast to workers in smaller firms, where job insecurity might be more prevalent, potentially discouraging them from extending sick leave due to concerns about job retention. Research supports this idea, as evidenced by Ishimaru (2020), whose findings link job insecurity to presenteeism, where employees come to work despite being unwell. Additionally, Ichino and Riphahn (2005) highlight that employment protection, a form of job security, is associated with increased absenteeism.

Finally, extensive employee benefits and support programs, as frequently observed in larger firms (McGaughey et al., 2005; Brown et al., 1990), play a crucial role in influencing employee behavior regarding sick leave. These comprehensive programs not only provide the necessary support for employees to take the time needed for a full recovery but may also create an environment where individuals feel encouraged to extend their leave when required. Aligned with this perspective, Crawshaw et al. (2012) underscore the significance of career development opportunities and procedural fairness in shaping employee behavior. The presence of clear paths for career advancement and fair procedural practices within larger firms may contribute to a work environment in which employees feel more comfortable taking longer periods of sick leave without concerns about negative consequences.

Considering these factors, we see that firm size can act as a significant risk factor in the analysis of occupational accidents and the development of effective organizational safety strategies at work. The different dynamics and incentives at play in large and small companies highlight the importance of tailoring preventive measures and policies to the size and unique characteristics of each organization.

4.3 Methods

4.3.1 Data

The dataset used for this study is sourced from the Statistics of Accidents at Work (SAW), published by the Ministry of Labor and Social Security. It encompasses all work-related accidents in Spain that led to an absence of more than one day from the job during the years 2015 to 2021, resulting in approximately 548,000 observations. The dataset contains valuable information, including characteristics of the workers involved in the accidents, details of the injuries sustained (type, severity), and characteristics of the firms where the accidents occurred, offering insights into intriguing relationships.

Our main explanatory variable is the duration of incapacity, which represents the number of days individuals were absent from work due to work-related accidents. Analyzing this dependent variable in terms of firm size, we observe an interesting pattern: on average, larger companies tend to have longer durations of incapacity after work accidents. This trend becomes more pronounced when enterprises exceed 250 employees. Curiously, smaller businesses with fewer than 10 workers exhibit a longer duration of sick leave, comparable to firms with 200 employees. Additionally, the dataset reveals that the rate of serious accidents is considerably higher in the smallest organizations and gradually decreases as the firm size increases (Figure 12). The proportion of serious injuries is two times higher in the smallest enterprises than in the biggest ones. Some reasons for this could be associated with more possibilities to employ higher-risk workers, lack of expertise, difficulties in realizing economies of scale in the production of safety, and less probability of being inspected (Mendelof et al., 2006). This observed pattern underscores a concern that serves as a primary motivation for the study.

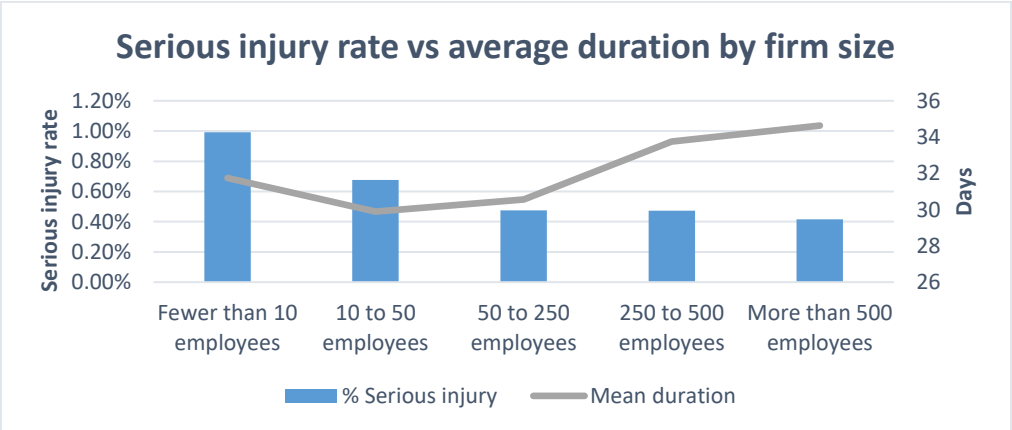


Figure 12. Serious injury rate and average duration of sick leave by firm size

To further explore the size of the firms in our sample, we classified them according to the definitions of small- and medium-sized enterprises set by the European Union (EU, 2012). We also considered the established rules in Spain concerning the risk prevention system that companies should adopt based on their number of employees. Consequently, we categorized the firms into four groups: fewer than 50 employees, 50 to 250 employees, 250 to 500 employees, and more than 500 employees.

Figure 13 reveals that a significant proportion of accidents occur in companies with fewer than 50 employees (50%) and 50 to 250 employees (33%). However, despite this distribution, the longest periods of absence are predominantly observed in the largest firms, which presents an intriguing result warranting further analysis.

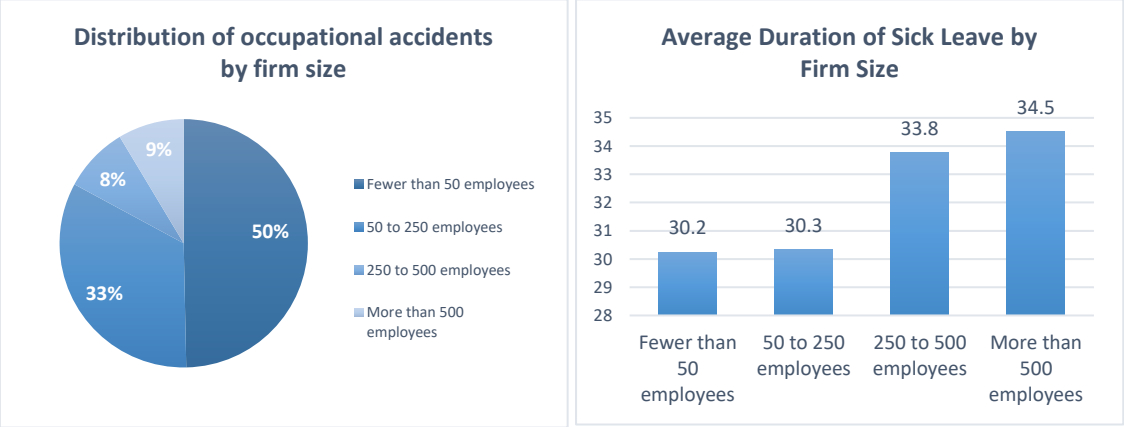


Figure 13. Proportion of accidents and mean of duration sick leave by firm size

Additionally, the Ministry of Labor and Social Security in Spain has classified sick leave duration into five distinct time intervals based on common determinants during the incapacity period. These categories are defined as follows: two to seven days, eight to 15 days, 16 to 30 days, one to three months, and more than three months. A compelling observation emerges when comparing the duration categories with firm-size categories: the highest proportion of accidents that result in sick leaves lasting more than three months is found in the largest companies (Figure 14). This data exploration underscores the significance of the study and the necessity of comprehending the relationships derived from it.

The independent variables in our study serve the purpose of controlling intrinsic factors related to the injury, the worker, and the company, all of which may impact the duration of sick leave following an accident. The initial set of variables pertains to worker characteristics that can influence the length of the recovery period, including gender, age,

and type of occupation. Remarkably, the National Institute of Social Security[4] in Spain utilizes these three variables to compute a measure that physicians employ as a correction factor to estimate the optimal healing time after a work-related injury.

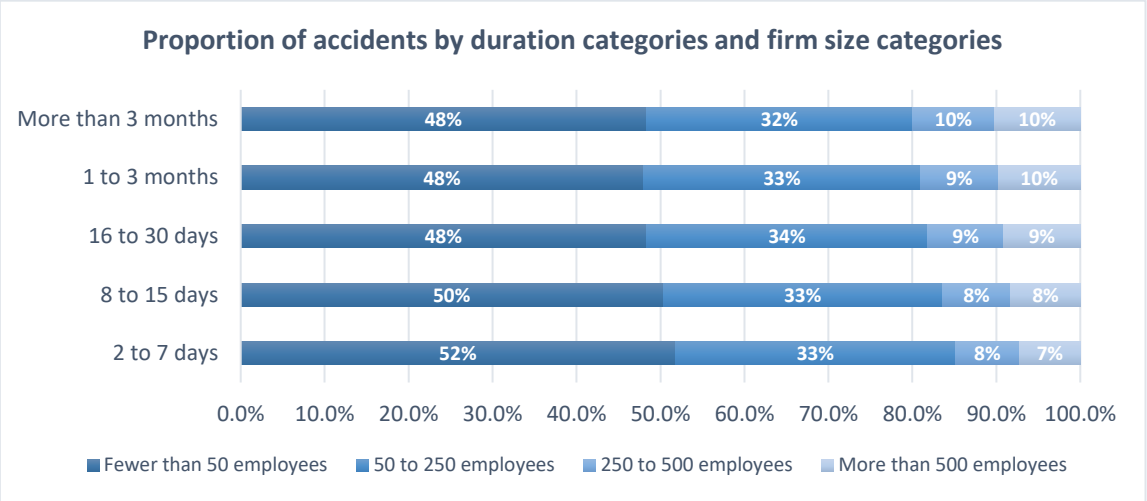


Figure 14. Percentage of accidents by duration of sick leave and firm size

The age of the employee is included to proxy the worker's health status and recovery capacity. Calzavara et al. (2020) and Di Pasquale et al. (2020) provide comprehensive surveys on the consequences of an aging workforce in manufacturing. As argued above, we expect a positive association between the variable age and our dependent variable; i.e., the consequences of an accident are more severe for mature workers than for younger workers, which usually translates into more days off work.

We use several proxies to control for the factors that influence the recovery time of an injured worker discussed above. First, the medical assessment of the seriousness of the injury, which is defined according to the doctor's criteria at the time of certifying the sick leave: broadly, a physician classifies an injury as serious if he or she considers that it may foreseeably cause the injured worker sequelae that may result in some degree of permanent disability. Second, the type of care required by the injured worker (inpatient or outpatient care) is a good control variable for injury severity. Logically, inpatient care is indicative of an injury with more far-reaching health consequences, requiring a longer recovery time than an injury requiring outpatient medical care.

Likewise, injury dummy variables control for differences in the extent and consequences associated with different types of injuries. More than 80% of the injuries fall into two broad categories: dislocations, sprains, and strains and superficial wounds

[4] National Institute of Social Security, 2017. https://www.seg-social.es/wps/wcm/connect/wss/d24cc76a-e1f4-49b6-b36f-fb8fc00a32a7/Manual+Tiempos+%C3%93ptimos+IT_Castellano_v4.0_+Accesibilidad.pdf?MOD=AJPERES

and injuries, which are the typical injuries that occur in manufacturing activities. The occupation and industry dummies control for specific features associated with the worker's activity. As might be expected, the data reveals that most accidents occur in blue-collar jobs. Regional dummies are included to account for additional unobserved characteristics that may influence the recovery time, such as differences in the effectiveness of medical assistance protocols and inspection activity among regional health authorities.

Finally, we note that weekend and night shifts are common in many manufacturing firms. There is ample evidence that night work and lack of sleep, as well as altered circadian rhythms, constitute a potentially dangerous combination of factors. Nightshift workers are often tired and sleepy due to their shift work schedule. Excessive fatigue reduces concentration, which increases the likelihood of making mistakes and the occurrence of more serious accidents. The night shift is considered to be more prone to unsafe work behaviors (Larson, 1998). Furthermore, shift work can be stressful and detrimental to workers' health conditions (Rosa & Colligan, 1997). The time the accident happens can also determine how quickly and accurately first aid is administered. For instance, in many companies and jobs, there are fewer staff members working during night shifts and weekends, and thus prevention and medical assistance services may not be fully operational, delaying and reducing the effectiveness of the first response to the accident. Therefore, the variables NIGHT and WEEKEND are included to account for their potential impact on the recovery time.

As discussed throughout this thesis, various variables influence the duration of the incapacity period, especially in situations of moral hazard, where workers might be tempted to extend their time off work beyond the standard recovery period due to personal or contextual reasons. It is, therefore, imperative to incorporate some of these influential variables into our analysis.[5]

The first variable is related to the employee's gender. The manufacturing sector is a male-dominated context. The traditional gender imbalance that prevails in manufacturing industries, with women being a minority, contributes to internalizing gender stereotypes and propagating discriminatory norms that negatively affect women at work (e.g., Kanter, 1977; King et al., 2010). Likewise, many empirical studies have found that in predominately male organizations, sexual harassment occurs relatively more

[5] While the variable TIME was initially incorporated into the model to maintain consistency with other chapters in the thesis, it did not exhibit significance. Consequently, it was excluded from the estimation of the final model.

often than in more gender-balanced workplaces (e.g., Gutek et al., 1990; Willness et al., 2007). Further, it is a fact that women are more involved in household and family care activities than men (e.g., Eurostat, 2019). Thus, working women face a double burden, i.e., a higher workload, because they spend significantly more time than men on household chores and caring work, such as childrearing or caring for sick family members. Such pressure may act as an incentive to extend the period of paid sick leave, as women are often unable to shirk their responsibility for domestic and family duties. Furthermore, women are affected not only by stressors common to both sexes but also by stressors unique to women, such as their lower social positions and their active role in private life (Casini et al., 2013). As a result, women usually face higher levels of work stress and lower well-being and morale, which increases the probability of wanting to be out of the workplace for more days.

The second variable is associated with the migration status of the worker. It is well known that immigrant workers are more exposed to adverse and unstable working conditions than native employees. As Porthé et al. (2010) argue, immigrants' employment is "characterized by high job instability, a lack of power for negotiating employment conditions, and defenselessness against labor demands." Furthermore, immigrants typically face greater difficulties in entering the labor market in the host country. They are relatively helpless as regards the threat of unemployment and are critically dependent on their jobs and incomes (Khanm & Rehnberg, 2009; Sterud et al., 2018). In short, immigrant workers are in situations of greater social and economic vulnerability than native workers, so they are more fearful of the possibility of losing their jobs as they face greater difficulties in finding new ones. Consequently, it seems reasonable to expect that an immigrant worker will feel more pressure to avoid the time it takes to return to work after an accident at work being perceived as excessive and thus minimize the risk of having his or her job threatened.

Another crucial factor linked to the vulnerability of workers within the organization is the type of contract they hold. The level of job security associated with different types of contracts can influence the duration of employee absence after a work-related accident. Employees on temporary contracts may have stronger incentives for job attendance due to the fear of layoff or the desire for contract renewal (Arai & Thoursie, 2005). This sense of job insecurity might lead to a shorter duration of absence in such cases. Conversely, employees with permanent contracts may experience a sense of job

security, which could potentially lead to a longer duration of absence after a work-related accident (García et al., 2015).

The findings of Reuter et al. (2019) suggest that temporary workers exhibit increased attendance behavior, likely due to their reduced access to social protection in the event of illness. Based on the above discussion, we anticipate that employees with temporary contracts will have a shorter duration of absence due to work accidents compared to employees with permanent contracts.

Continuing with the description of the variables, in the event of a work accident, the injured worker is entitled to receive a disability benefit during the sick leave period. Thus, the employee receives a daily allowance, which is calculated according to the worker's earnings. However, there is a monetary cost or penalty for being on sick leave, as the benefit is usually lower than the worker's base salary, and sometimes workers do not receive income during the first few days of their sick leave. The penalty is relative. For a worker with a low wage facing with a disability allowance that covers only part of it, each day on sick leave is clearly costlier than for a worker with a high salary who receives the full amount for the entire period of sick leave. In this regard, the level of the sickness benefit can be a source of moral hazard: a worker decides to prolong the period of sick leave when the increase in welfare associated with leisure offsets the reduction in income. Previous evidence suggests that increased sickness benefits can increase absence rates and the duration of absences (e.g., Johansson & Palme, 1996; Henrekson & Persson, 2004). Therefore, it is possible to expect that the value of the subsidy for temporary disability is positively associated with the sick leave duration.

Last, we include the size of the firm, expecting that employees of larger firms have longer periods of sick leave than those at smaller firms, as has been described in the introduction of this chapter.

Table 15 presents an overview of the average values for the key variables categorized by firm size. Small firms exhibit a lower percentage of female employees and a higher presence of foreign and temporary contract workers compared to large firms, where the proportion of females is higher and the number of immigrant and temporary workers is lower. Notably, sick leave subsidies are more substantial in larger firms, aligning with expectations. Furthermore, big firms tend to have a more frequent occurrence of accidents on weekend and night shifts compared to their smaller counterparts. The average age of injured workers remains consistent, regardless of firm size.

Table 15. Mean of the main variables by firm size

Size	Female	Age (years)	Foreign	Temporary Contract	Subsidy (euros)	Weekend	Night
Fewer than 50 employees	9%	41.0	10%	31%	41.2	3%	7%
50 to 250 employees	17%	41.6	8%	25%	50.1	6%	13%
250 to 500 employees	21%	41.6	6%	22%	54.4	8%	19%
More than 500 employees	24%	40.7	8%	23%	58.8	7%	18%

4.3.2 Methodology

4.3.2.1 Stochastic frontier analysis (SFA)

In the initial phase, we employ stochastic frontier analysis methodology, as utilized in the preceding chapters. This approach serves a dual purpose: first, to identify the variables influencing the standard recovery time after a work-related injury and, second, to determine the variables explaining the extension of the incapacity period due to moral hazard, achieved through the inclusion of the over-duration term.

In this case, the specification of the frontier is of the form:

$$lnd_i = \beta_0 + \beta_1 InjurySeverity_i + \beta_2 InjuryType_i + \beta_3 Hospitalization_i + \beta_4 Injuredbodypart_i + \beta_5 Gender_i + \beta_6 Age_i + \beta_7 Occupation_i + \beta_8 Subsector_i + \beta_9 AutonomousCommunity_i + \beta_{10} Weekend + \beta_{11} Night + u_i + v_i \quad (17)$$

Hence, the over-duration term is related to a set of specific variables, z_i, for each individual, as:

$$u_i = \delta_0 + \delta_1 Gender_i + \delta_2 Foreign_i + \delta_3 Temporarycontract_i + \delta_4 Subsidy_i + \delta_5 Size_i + W_i \quad (18)$$

Notably, we incorporate the firm size variable as a determinant of the over-duration term to investigate whether the size of the company significantly influences the worker's decision to prolong the duration of sick leave by capitalizing on the situation of asymmetric information.

Recognizing the multifaceted nature of analyzing sick leave duration, we have chosen to adopt a comprehensive approach by incorporating two additional methodologies. This strategic decision aims to enhance the depth of our investigation, complementing the insights derived from the SFA method. By employing these

supplementary methodologies, we hope to strengthen the robustness of our findings and provide a more complete understanding of the factors influencing sick leave duration in our study. Specifically, we are interested in using the duration categories mentioned earlier to analyze the probability of a worker falling into each of these groups after a work-related injury. Our aim is to establish whether these probabilities of shorter or longer periods of absence from work exhibit any significant relationship with firm size. Considering the nature of our data, we have chosen to implement the following models, which will be thoroughly described.

4.3.2.2 Generalized ordered logistic regression

In cases involving a discrete dependent variable with more than two outcomes, there are two types of approaches. The first approach is the multinomial model, which is suitable when the categories of the explanatory variable lack a natural ordering. The second approach is ordinal logit regression, which is used when the outcomes have a sequential order, with one category being higher than the previous one (Gelman & Hill, 2007).

In our case, the dependent variable comprises five different groups representing the duration of the incapacity period, ranging from the lowest duration (two to seven days) to the longest duration (more than three months). Importantly, this variable exhibits a strict order, where the highest category signifies an extended period of absence from work.

The ordered logit model can be described as:

$$P(Y_i > j) = g(X\beta) = \frac{\exp(\alpha_j + X_i\beta)}{1 + \{\exp(\alpha_j + X_i\beta)\}}, j = 1, 2, \dots, k-1 \qquad (19)$$

where k refers to the number of outcomes of the dependent variable.

The use of this model implies a strong assumption called “proportional odds” or the “parallel regression assumption.” It indicates that there is only one set of coefficients to be estimated, meaning that ordered regression assumes the βs are the same for all values of *j*, so the relationship between the lowest and all the other categories is the same as the relationship between the next category and all the other ones.

In that sense, it is necessary to run the Brant test, which provides evidence on whether the parallel regression assumption is violated or not (Brant, 1990). Therefore, the

null hypothesis is $\beta_j = \beta$ and the alternative is $\beta_j = \varphi_j \beta$—that is, a Wald-type test calculated based on differences in the estimated coefficients $\hat{\beta}_j$ and their variances. Consequently, a significant test statistic provides evidence that the parallel regression assumption has been violated.

If this strong assumption is violated, it is necessary to approach another model, as the ordered logit model might fail to accurately explain the influence of the variables. Specifically, the estimated coefficient underestimates the effect of the variable on moving from the lowest category to the next category and also overestimates the impact on moving to the highest category (Williams, 2016).

In this case, the generalized ordered logistic model is the most suitable option as it is less restrictive than the parallel line model but more interpretable than non-ordinal methods (e.g., multinomial logistic regression). Moreover, this partial proportional odds model allows that some of the estimated coefficients are the same for all the classes while others can be different.

In the partial proportional odds model, some of the β coefficients can be the same for all values of *j*, while others can differ. The generalized ordered logit model can be described as:

$$P(Y_i > j) = g(X\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + \{\exp(\alpha_j + X_i\beta_j)\}}, j = 1, 2, \ldots, k-1 \quad (20)$$

Here, both the intercepts and the slopes can vary across the different categories of the dependent variable.

It is necessary to ensure that, as the associated predictor variable increases, the predictions progressively move through the categories in the correct sequence. This poses a challenge in maintaining the appropriate order of outcomes when using a linear model. A conventional approach to address this issue is to utilize a cumulative link function (McElreath, 2018). Linking the linear model to cumulative probability could guarantee the correct ordering of the outcomes; consequently, the cumulative probability of a value represents the probability of that value or any smaller value.

Then, the probability that *Y* takes the value of each category is:

$$P(Y_i = 1) = 1 - g(X_i\beta_1) \quad (21)$$

$$P(Y_i = j) = g(X_i\beta_{j-1}) - g(X_i\beta_j) \;\; j = 2, \ldots, k-1 \quad (22)$$

$$P(Y_i = k) = g(X_i\beta_{k-1}) \quad (23)$$

This model becomes equivalent to a sequence of binary logistic regressions; therefore, if there are five categories, category number 1 is contrasted with groups 2, 3, 4, and 5; then, for category number 2, the contrast is between categories 1 and 2 versus groups 3, 4, and 5, and so on. This means that this model always compares the current category and all the lower classes to those categories greater than the current one. For that reason, positive coefficients imply that higher values of the explanatory variable make higher values on the outcome variable more likely. According to the levels of our dependent variable, four equations corresponding to the five groups of sick leave duration were fitted.

Once the probabilities of being in each duration category have been obtained, it becomes feasible to conduct tests to assess the differences between the mean probabilities for each firm size group. For instance, these tests allow us to compare whether the average probability of being in the longest duration sick leave group is statistically different between the smallest and largest companies.

4.3.2.3 Correspondence analysis

To complement and strengthen the findings from the previous model, we can utilize a correspondence analysis, particularly since our variables of interest, namely duration and firm size, can be categorized into different classes. Correspondence analysis is a powerful multivariate statistical technique employed to identify significant relationships between two categorical variables (Greenacre, 2007). One of its main advantages lies in its ability to visually represent the associations between the classes of these variables, offering a more intuitive understanding of their relationships.

For instance, in a study conducted by Altunkaynak (2018), correspondence analysis was used to examine the relationship between different types of accidents and the corresponding lost workdays for occupational accidents in the manufacturing industry in Turkey. This analysis revealed insightful patterns, such as the most frequent accident type being “pressing of the body or member between two objects,” leading to an incapacity to work of 30 to 59 days.

In our case, this graphical approach is highly suitable for detecting patterns of association between the classes of sick leave duration and the groups of firm size, potentially revealing hidden relationships that may not be apparent from a classical contingency table. Essentially, correspondence analysis is similar to principal component analysis for qualitative variables, as it generates factor scores for the rows and columns

of a contingency table. These scores are then visualized in a two-dimensional space, allowing for a comprehensive and easily interpretable overview of the data (Weller & Romney, 1990). By employing correspondence analysis, we can gain deeper insights into the interrelations between the different categories of sick leave duration and firm size, thereby enhancing the overall understanding of our dataset and confirming the results of the previous models.

4.4 Results

4.4.1 Stochastic frontier analysis (SFA)

Table 16 presents the parameter estimates of the frontier model and the over-duration term. Although not shown in the table, all occupation, injury type, injured body part, sector, and regional dummy variables are included in the estimates. Notably, all proxies for injury severity exhibit the expected behavior, demonstrating a positive association with the duration of sick leave. Additionally, accidents occurring during weekends and night shifts are associated with significantly longer periods of sick leave. Moreover, the positive coefficients for gender and age suggest that women and older workers experience longer absences.

The findings are particularly significant for manufacturing industries, where, compared to the service sector, on average, workers earn higher wages, have greater seniority in their jobs, and there is a higher percentage of large firms. Likewise, as Di Pasquale et al. (2020) note, there is a marked upward trend in the percentage of older workers employed in manufacturing and production environments. For example, according to the Economically Active Population Survey in Spain, between 2015 and 2019, the percentage of manufacturing workers over the age of 50 increased from 25.2% to 28.7%, and the percentage of plant and machine operators and assemblers over the age of 50 increased from 27.8% to 33.4%. In addition, 6.1% of employees work more than half of their working days on night shifts (5.2% in the case of employees over 55 years old), while around 20% of employees work at least one Sunday shift per month (17.6% in the case of those over 55 years old).[6]

Let us focus on the determinants of the over-duration term. The positive and highly significant coefficient for gender provides compelling evidence that women

[6] Data from the Economically Active Population Survey are available on the website of the Spanish National Statistics Institute: https://www.ine.es/

experience a longer duration of absence following work-related accidents compared to men. Similarly, the statistically significant positive sign for subsidy suggests that higher subsidy levels are associated with a longer duration of sick leave. In contrast, the negative signs for the variables FOREIGN and TEMPORARY CONTRACT indicate that the period of incapacity is shorter for immigrant workers and temporary employees than for national workers and those with a permanent contract, respectively.

Table 16. Coefficient estimates: Stochastic frontier analysis (Manufacturing sector)

Frontier	**Coefficient**
Female	0.04941 (0.00849)***
Type of assistance	0.24197 (0.0053)***
Level of injury	0.95274 (0.02618)***
Age	0.00932 (0.00013)***
Weekend	0.06857 (0.00594)***
Night	0.012 (0.00406)***
Injury dummies	yes
Injured body part	yes
Occupation dummies	yes
Sectoral dummies	yes
Region dummies	yes
Constant	1.79253 (0.03561)***
Equation of inefficiency	**Coefficient**
Gender	0.12336 (0.06598)*
Foreign	-0.24058 (0.04146)***
Temporary contract	-0.25371 (0.02801)***
Subsidy	0.48658 (0.04085)***
Firm size	0.07899 (0.00791)***
Constant	-5.07694 (0.17546)***
Wald chi2(61)	110891.71
Prob > chi2	0
No. of observations	548419
Sigma_U	0.22777***
Sigma_V	0.88818***

Robust standard errors are in parentheses.
*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Now, turning our attention to the primary variable of interest, the positive and highly significant coefficient for SIZE further supports the notion that extending sick leave is more prevalent in large organizations. These findings provide valuable insights into the factors influencing the length of absence after occupational accidents and highlight the significance of firm size as a contributing factor to the extended duration of sick leave. The utilization of stochastic frontier analysis (SFA) holds importance in this chapter in terms of the dynamics of sick leave duration by firm size. While conventional literature often emphasizes higher accident rates in small firms relative to their larger

counterparts, the results derived from SFA challenge this idea. Our findings suggest that as firm size increases, the duration of sick leave is longer. This revelation not only adds a distinctive perspective to the existing literature but also underscores the invaluable contribution of SFA in discovering new patterns that might challenge traditional analyses. With the aim of exploring this significant finding more deeply, we will now present and discuss the results of the other two methodologies.

4.4.2 Generalized ordered logistic regression

The Brant test statistic indicates a violation of the parallel regression assumption in the ordinal logistic regression model. As a result, a generalized ordered logistic regression is estimated where constraints for parallel lines are imposed on 26 variables, while the other 40 variables are allowed to vary across outcome classes. The insignificant Brant test result for the final model (Prob > chi2 = 0.1201) indicates that this model no longer violates the parallel lines assumption.

The results of the fitted partial proportional odds model are presented in Table 17. Most of the coefficients are significant, except for certain types of occupations, subsectors, and injuries. The signs of the coefficients tend to be consistent across the cumulative logits, with slight differences in magnitudes.

Positive coefficients indicate that higher values of the covariate are associated with a higher category level of the dependent variable, suggesting longer durations of the incapacity period. Conversely, negative coefficients suggest that higher values of the independent variable increase the probability of being in the current or a lower level of the outcome variable.

Most coefficients behave as expected, with more severe injuries resulting in longer periods of sick leave. Similarly, coefficients for women and older employees are positive and significant, indicating a longer recovery time for both after an occupational accident compared to men and younger workers. Moreover, a higher subsidy is associated with a longer duration of incapacity.

Regarding the main variables of interest, with the dummy variable associated with the biggest firms as the reference category, all other dummy variables of firm size exhibit negative and significant coefficients. This suggests that the longest duration of sick leave occurred in the biggest firms; in other words, moving from firms with more than 500 employees to firms with fewer than 50 employees decreases the duration of sick leave.

Table 17. Parameter estimates of the generalized ordered logistic regression

Variable	2 to 7 days	8 to 15 days	16 to 30 days	1 to 3 months
Female	0.12389 (0.01085)***	0.16664 (0.00947)***	0.12696 (0.01078)***	0.05869 (0.02003)***
Type of assistance	0.39023 (0.0156)***	0.48337 (0.01301)***	0.61016 (0.01355)***	0.755 (0.02128)***
Age	0.01755 (0.00035)***	0.01942 (0.00031)***	0.02191 (0.00036)***	0.02865 (0.00068)***
Weekend	0.08646 (0.01247)***	0.08646 (0.01247)***	0.08646 (0.01247)***	0.08646 (0.01247)***
Night	0.0394 (0.01117)***	0.02035 (0.0099)**	-0.01109 (0.01142)	-0.01553 (0.02123)
Foreign	-0.00705 (0.0012)*	-0.05125 (0.01115)***	-0.07537 (0.01358)***	-0.04236 (0.02645)
Temporary contract	-0.05803 (0.00816)***	-0.05912 (0.00749)***	-0.04961 (0.00888)***	0.00049 (0.01693)
Subsidy	0.00091 (0.00022)***	0.00218 (0.00022)***	0.00329 (0.00025)***	0.00378 (0.00042)***
Fewer than 50 employees	**-0.19473 (0.01101)*** **	**-0.19473 (0.01101)*** **	**-0.19473 (0.01101)*** **	**-0.19473 (0.01101)*** **
50 to 250 employees	**-0.2114 (0.01062)*** **	**-0.2114 (0.01062)*** **	**-0.2114 (0.01062)*** **	**-0.2114 (0.01062)*** **
250 to 500 employees	**-0.11573 (0.01289)*** **	**-0.11573 (0.01289)*** **	**-0.11573 (0.01289)*** **	**-0.11573 (0.01289)*** **
Injury dummies	yes	yes	yes	yes
Injured body part	yes	yes	yes	yes
Occupation dummies	yes	yes	yes	yes
Sectoral dummies	yes	yes	yes	yes
Region dummies	yes	yes	yes	yes
Constant	-0.08085 (0.07993)	-1.26224 (0.07835)***	-2.28582 (0.08248)***	-4.253 (0.10925)***
LR chi2(186)	95397.72	-	-	-
Prob > chi2	0	-	-	-
Pseudo R2	0.0655	-	-	-

Robust standard errors are in parentheses.
*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Furthermore, the model allows for predicting the probabilities of being in each category of the dependent variable, providing insight into the factors influencing each outcome occurrence. The probabilities vary considerably by enterprise size. Employees in companies with fewer than 50 employees have a 28.4% probability of taking the shortest duration category (two to seven days of sick leave) compared to 23% in firms with more than 500 employees. On the other hand, employees in companies with fewer than 50 employees have a 5.1% probability of taking more than three months of sick leave compared to 6.5% in firms with more than 500 employees. Figure 15 illustrates the relationship between the probability of being in the shortest and longest duration category of sick leave and firm size, confirming that employees in the largest companies tend to have longer periods of absence after an occupational injury.

To further support these findings, we conducted several tests for differences between the probability means. The tests revealed that the probability of being absent from work for more than three months after an occupational accident differed significantly depending on company size.

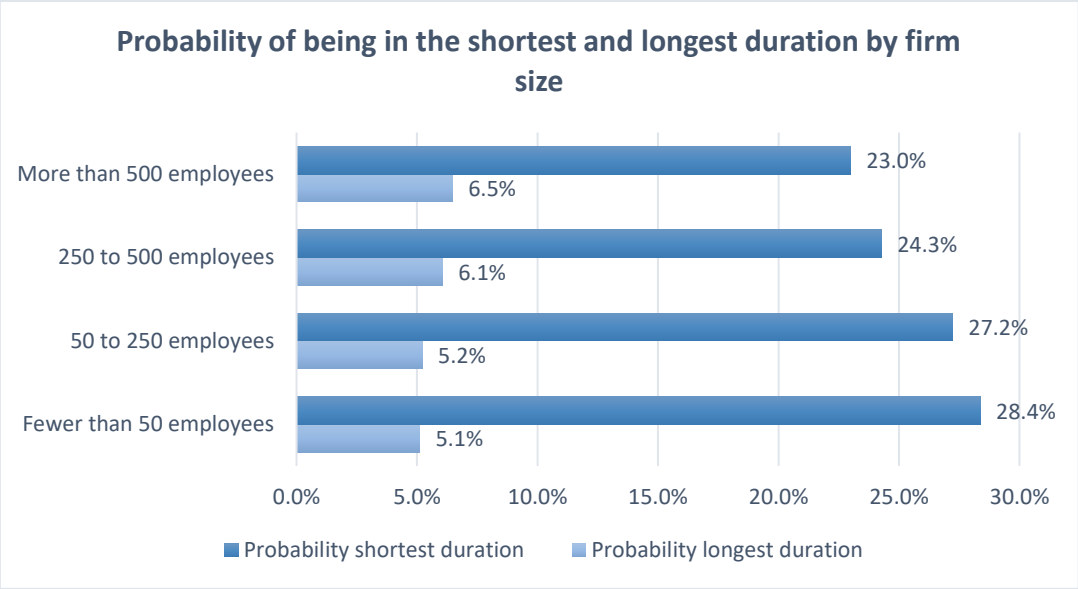


Figure 15. Probability of shortest and longest duration category by firm size

4.4.3 Correspondence analysis

The analysis continues with the estimation of the correspondence analysis between the categories of sick leave duration and firm size, as depicted in Table 18. This statistical method provides a representation of how the different values of rows and columns contribute to the total variance (inertia) in a table. The Pearson Chi-square test for the two-way table shows a significant association between the variables, rejecting the null hypothesis (p-value = 0.000).

The correspondence analysis results reveal that the first two dimensions explain 99% of the inertia, justifying a two-dimensional representation using a biplot of the two categorical variables under study. The panel displays the coordinates of each category, enabling the graphing of row and column coordinates with the origin of the plot for a geometric interpretation of the similarity among classes.

Table 18. Results of the correspondence analysis estimation

Pearson chi2(12)	1135.01
Prob > chi2	0
Number of dim.	2
Expl. inertia (%)	99.83

Dimension	Value	Inertia	chi2	Percent	Cumulative
Dimension 1	0.0480664	0.0023104	1114.91	98%	98%
Dimension 2	0.0061398	0.0000377	18.19	2%	100%
Dimension 3	0.0019887	0.00000396	1.91	0%	100%

In Figure 16, orange triangle points represent the different categories of sick leave duration, while blue circle points represent the firm-size categories. The plot illustrates that categories of the biggest firms and categories of the longest duration of the incapacity period are placed closely together, supporting the previous findings regarding the tendency of workers in large companies to take more time off work after an occupational accident.

Furthermore, the position of the smallest firm's category suggests a relationship with the shortest duration group, indicating a correlation between small firms and shorter sick leave durations. Additionally, a clear association is observed between medium-sized companies and an average duration of sick leave between 16 and 30 days.

This approach further confirms the results of the previous methodologies, providing additional evidence of a significant relationship between the duration of an incapacity period and the size of the firm in which the accident occurs. This complementary analysis reinforces the findings and supports the conclusion that firm size plays a crucial role in influencing the duration of sick leave after an occupational injury.

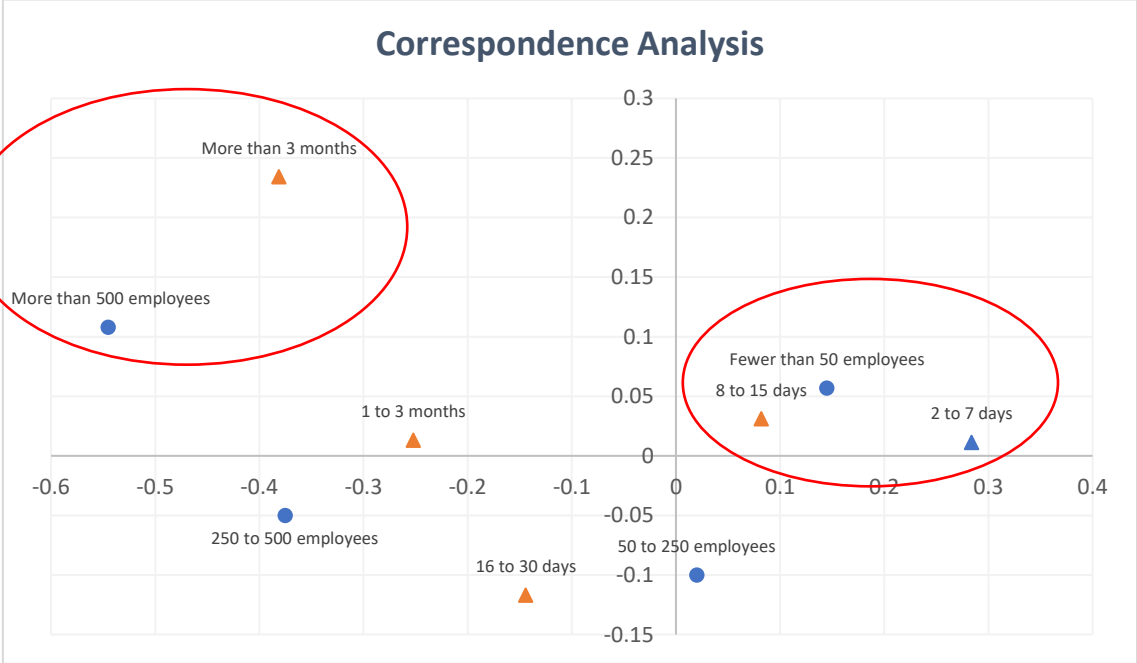


Figure 16. Graphical representation of the correspondence analysis estimation

4.5 Discussion and conclusions

This chapter presents a novel approach to studying occupational accidents in Spain, focusing on the duration of sick leave and its relationship with firm size. The

existing literature predominantly examines incident rates, leaving a significant knowledge gap regarding the impact of firm size on the length of sick leave. As such, our study contributes to the field by revealing longer durations of sick leave in the biggest firms, a previously unexplored idea. Additionally, we apply an econometric model that is not frequently used in this context, providing a fresh perspective on the subject. In this chapter, the application of stochastic frontier analysis (SFA) takes on significance, providing insights into the complexities of sick leave duration. Contrary to the conventional literature, which frequently emphasizes elevated accident rates in smaller firms compared to their larger counterparts, the innovative outcomes produced by SFA provide the intriguing finding that an increase in firm size correlates with an extended duration of sick leave. This revelation not only introduces a unique perspective to the ongoing discussion but also underscores the indispensable role played by SFA in revealing detailed patterns that conventional analyses could overlook.

The findings of our research indicate that workers in larger firms tend to experience lengthier periods of absence after an accident at work. This can be attributed to the lack of control and supervision in larger organizations, which may present more opportunities and temptations for workers to extend their sick leave. Addressing this issue highlights the importance of increasing the degree of control and keeping workers constantly motivated to align with the organizational objectives.

These results make it evident that occupational health strategy should be tailored to company size. Preventive plans and specific policies need to be formulated, and they must take into account various factors that differ between bigger and smaller enterprises, such as investment in technology and equipment, workforce skills, and implementation of preventive activities.

This research suggests the development of micro- and macro-level strategies, accounting for the size of the company, to ensure effective implementation and application of safety policies in the workplace. For instance, communications systems regarding occupational health objectives, emergency action plans, and the structure of occupational health committees should be tailored to suit the specific needs of each firm-size category.

From a safety perspective, understanding the influence of firm size on the duration-of-incapacity period after an accident at work can provide valuable insights for managers and those responsible for employee well-being. These results offer an alternative perspective for decision-making in designing and implementing safety

policies, potentially leading to improved workplace safety and better management of occupational accidents.

The findings of this chapter offer significant theoretical and practical implications in the dominion of occupational accidents, which will be discussed as follows.

Theoretical implications

By examining the factors influencing the duration of sick leave after an occupational injury, we gain a deeper understanding of the drivers behind the extension of recovery time for injured workers. Notably, we shed light on the crucial role of firm size as a motivating factor that may lead workers to take more or less time off work.

The incorporation of two novel methodologies, the generalized ordered logistic model and correspondence analysis, improves the analysis and strengthens the reliability of the results. These methods allow for a comprehensive examination of the data, controlling for various individual and company-related variables while also providing a visual representation of the associations among different categories of sick leave duration and firm size.

The revelation that larger firms may create a favorable environment for employee misconduct, potentially leading to the prolongation of sick leave after an injury, opens new avenues for research in the field of occupational injuries and workplace safety. The lack of control and supervision in bigger organizations could be a critical factor that needs to be addressed to ensure a safe and productive work environment for all employees.

Practical implications

As a first general implication, our analysis suggests that there are compelling reasons for many employers to more proactively manage absences due to workplace injuries in manufacturing industries. Moreover, the diverse explanatory sources of the duration of sick leave suggest different interventions at different levels, from company management to public administration, highlighting the need to adopt a holistic approach for effective management aimed at reducing lost work time and its associated private and public costs.

The first type of intervention concerns factors related to the attendance motivation of workers who are most prone to moral hazard in the manufacturing sector. We find positive associations between the duration of sick leave and female workers. Improving

the working conditions of these groups may facilitate their return to work after an appropriate medical recovery time. Various policies and actions to be considered may be related to personal, family, and work reconciliation so that all workers can maintain a full professional career while exercising their rights to care for their family, undergo training, or enjoy their leisure and free time. Concrete examples are the implementation of flexible working hours, working from home, and continuous working hours for childcare, among others.

The second type of general intervention is related to the improvement of control and supervision mechanisms in the recovery process of injured workers. Our analysis shows that the threat of moral hazard is more intense for native workers, who earn higher wages (and, consequently, higher disability benefits) and who are employed in larger companies. This suggests that the more favorable the worker's working conditions and context, the longer the delay in returning to work.

Third, several work-related circumstances that are largely manageable affect the severity of accidents and, therefore, the length of the medical recovery time. Clearly, better occupational health and safety prevention helps reduce the risk of serious injury. Likewise, enhancing the quality and speed of primary care after an accident improves diagnosis and promotes quicker medical recovery. In this sense, our results suggest that firm management should consider strengthening safety and medical assistance when organizing work on more dangerous shifts (e.g., night shifts, weekends) and assigning and designing jobs for more vulnerable workers (e.g., older workers). Depending on the characteristics of the company and its workers, the firm's management should establish different preventive processes, adopt specific safety education and training policies, improve supervision and inspection standards, and promote actions that help employees recover more quickly to reduce the duration and costs of sick leave. In line with Katiraee et al. (2021), our findings also highlight the need to integrate age differences among workers into the design and management of production systems in manufacturing companies.

Similarly, public policy interventions aimed at improving social and labor conditions, increasing labor inspection capacity, and creating an appropriate regulatory context to require companies to adopt a robust occupational risk prevention system should be considered. Such policies should not be seen as an expense but as an investment that generates benefits that are reflected in the improved health of workers, increased productivity of companies, and savings of resources for the public insurance system.

Limitations

Our analysis, while providing valuable insights, does have certain limitations that should be acknowledged. One notable limitation is the exclusion of some variables that could influence the regular recovery time after an injury at work. Factors such as differences in the level of care received, the presence of comorbidities in the injured worker, and a more detailed understanding of the specific tasks and operations the worker performs could have an impact on the duration of sick leave. Unfortunately, due to data constraints, we were unable to incorporate these variables into our empirical analysis.

Another limitation stems from the absence of firm identifiers in the dataset, which prevents us from including firm-specific fixed effects. This would have allowed us to account for unobservable firm-level characteristics that might influence sick leave duration. Furthermore, the dataset does not capture the perspectives of other stakeholders involved in the occupational injury process, such as physicians who determine the length of sick leave and supervisors who balance employee well-being and company productivity. The insights from these stakeholders could offer additional valuable information.

Moreover, the study's reliance on data from Spain may limit the generalizability of our findings to other countries with distinct cultural and organizational contexts. It is essential to consider the variations in workplace safety regulations, healthcare systems, and organizational practices across different countries when interpreting the results.

Chapter 5: Employee presenteeism and malingering on return to work after an occupational accident: A two-tiered stochastic frontier model

Abstract

This chapter explores sick leave duration analysis within the construction sector, utilizing a novel methodology as the two-tiered stochastic frontier model. This approach separates sick leave duration residuals into components representing excessive days beyond recovery time (malingering) and insufficient time for full recovery (presenteeism). Employing a dataset of occupational accidents causing sick leave in Spain's construction sector from 2015 to 2021, the model regresses the duration of sick leave with multiple explanatory variables for the expected medical recovery time. Additionally, error components relate to environmental variables, uncovering employee motivations for prolonging or shortening incapacity. Results show notable insights: immigrant and temporary workers exhibit presenteeism due to job vulnerability, while larger firm employees are inclined toward presenteeism due to project pressure and deadlines. In contrast, higher disability benefits incentivize malingering, extending sick leave periods for financial gain.

Chapter 5: Employee presenteeism and malingering on return to work after an occupational accident: A two-tiered stochastic frontier model

5.1 Introduction

According to the latest Annual National Accounts data published by the INE (Spanish National Statistics Institute), in 2021, the construction sector in Spain represented around 5.5% of its GDP. Similarly, in 2022, approximately 1.3 million workers were registered in the construction sector, which denotes around 6.5% of the total employed population (Instituto Nacional de Estadística INE, 2022). Beyond this, the construction sector exhibits the highest incidence and severity rates of accidents with sick leave in Spain over the last 10 years. For example, according to data provided by the Work Accidents Statistics in Spain (Estadística de Accidentes de Trabajo, EAT), the average incidence rate over the last five years is 1.5 times higher in the construction sector compared to the manufacturing sector, and three times higher compared to the service sector.

As indicated by Benavides et al. (2003), despite the adoption of legal norms to guarantee safer working conditions that do not put workers' health at risk, Spain presents a high incidence of work-related accidents and a growing trend mainly due to high temporality and subcontracting. Similarly, Fontaneda et al. (2005) point out that in the construction sector in Spain, physical conditions are worse than in industry, and workers have less training and recognition along with greater mobility among companies.

Furthermore, it should be noted that the mean duration of sick leave after a work-related injury has exhibited an upward trend, increasing from an average of 29 days in 2010 to 36 days in 2021. Consequently, the issue at hand is not only the high incidence rate of accidents in this particular sector but also the significant number of workdays lost to disability, resulting in mounting costs for companies and society as well as reduced productivity, impaired performance, weakened work capacity, and a decline in efficiency. These alarming figures reflect the importance of addressing occupational accidents in the construction sector, specifically analyzing workers' absence time due to an accident at work.

The time it takes for an injured worker to return to work after an occupational injury is mainly determined by the characteristics of the worker (age, sex, comorbidities), the severity of the injuries suffered, and the subsequent medical recovery process. However, the duration of sick leave may be extended as a result of the injured worker's

opportunistic behavior in a situation of moral hazard, or it may be reduced, with the worker returning to work despite illness as a consequence of job insecurity, limited job opportunities, and higher social and economic vulnerability. On the one hand, an employee's absence causes a loss of productivity, excessive extra costs, and other administrative issues associated with recruiting and replacing the absent worker. On the other hand, presenteeism limits efficiency at work, decreases job quality, increases work stress, and creates future sickness absence.

Therefore, this chapter aims to analyze the duration of sick leave after an accident at work in the construction sector using a two-tiered stochastic frontier model to estimate workers' propensity to prolong or shorten the time off work after an occupational injury. The model developed apportions the residual of the sick leave duration function into three components, one purely random and the other two corresponding to the excess of days beyond the expected medical recovery time and the lack of days to complete the recovery process. In other words, the two one-sided errors represent malingering and presenteeism at work, respectively.

The distinctive characteristic of our model lies in the consideration of both lower and upper bounds for the outcome variable (duration of sick leave). In the two-tier frontier model, these bounds are integral components of the estimation process. Neither of the previous approaches is complete, as each ignores one of the extremities relating to observed sick leave. Consequently, the adoption of the two-tier stochastic frontier technique appears well-suited for a comprehensive exploration of absenteeism and presenteeism within the occupational accidents framework.

The primary goal in employing a two-tier stochastic frontier function is to obtain observation-specific estimates of both presenteeism (represented by u_i) and absenteeism (represented by w_i) for each injured worker, encapsulated within the composed error term *ei*. This approach goes beyond mere parameter estimation, providing deeper insights into the impact of diverse personal, organizational, and employment variables on the duration of sick leave following a work-related injury.

The two-tier frontier technique enables not only the identification of variables influencing the decision to extend or shorten the incapacity period but also the extraction of net effects specific to each injured employee. In essence, our choice to utilize the two-tier stochastic frontier technique aims to estimate model parameters and derive observation-specific measures of the days by which sick leave is either extended or shortened for individual workers.

Using a dataset with the occupational accidents that caused sick leave and occurred in the construction sector in Spain from 2015 to 2021, we use the two-tier frontier technique to regress the duration of sick leave with multiple explanatory variables for the expected medical recovery time. Moreover, the two error components are explained by environmental variables related to worker and firm characteristics that would trigger the injured worker's motivation to extend or shorten the incapacity period. Previous research provides just a limited investigation of absenteeism and presenteeism in the construction sector, and the factors that could lead to such opportunistic behaviors remain unknown. The application of a two-tiered frontier model for estimation purposes represents a novel and valuable contribution to the field. This methodology has not been previously employed in this context, underscoring its potential for shedding light on factors influencing absenteeism and presenteeism in the construction sector.

The results show evidence that immigrant and temporary employees tend to show up at work before their sick leave is over owing to their vulnerable position, which makes them afraid of the possibility of losing their jobs and facing greater difficulty in finding a new one. Furthermore, our findings demonstrate that workers in big firms are inclined to presenteeism as they may have more pressure to finish and deliver the construction work on time, not only because of the penalty costs for delays but also because otherwise they cannot participate in new public tenders. That situation makes the control and supervision much greater in big companies than in small companies. On the contrary, our results suggest that the higher the worker's disability benefit, the greater the monetary incentive for the worker to prolong the period of sick leave and continue receiving the subsidy without working. In this sense, the evidence indicates that sickness compensation and paybacks might increase, prolonging the duration of an absence.

This research gives insights into different workplace practices that managers in the construction sector can apply to diminish the possibility that workers extend or reduce their incapacity period, both of which affect job productivity. Moreover, the findings raise the awareness of directors about employees' reasons for malingering or presenteeism and the importance of creating an environment that balances worker health with family and work responsibilities.

5.2 Absenteeism and presenteeism in the construction sector

5.2.1 Absenteeism

Absenteeism in the construction sector is a pervasive issue that has deleterious effects on the productivity and profitability of companies. To better understand this complex phenomenon, it is important to differentiate between two types of absences: involuntary absences, which occur when a worker is unable to work due to illness, injury, or domestic emergency, and voluntary absences, which occur when an employee chooses not to work, despite being able to do so, due to personal or external reasons. The latter type of absenteeism is of particular concern, as it is more difficult to monitor and control than the former.

In accordance with The Business Roundtable (1982), absenteeism in the construction industry may have a substantial and damaging impact. This results in reduced profits due to the failure to meet project schedules, disruptions to planned schemes, increased overtime requirements, underutilization of expensive capital, such as equipment and materials, and intensified workload and employee fatigue. The consequences of absenteeism also lead to project delays, decreased quality of work, and higher costs associated with the replacement of absent employees. These effects can be detrimental to companies operating within the construction industry.

The construction industry exhibits distinctive labor characteristics that may contribute to higher absenteeism rates. For instance, the prevalence of subcontracting practices is associated with elevated levels of absenteeism (Min et al., 2013). Additionally, employee turnover poses a significant challenge for the construction sector, as it hinders the retention of skilled workers and restricts the attainment of competitive advantage (Chih et al., 2016). Similarly, the construction industry is marked by high levels of job insecurity resulting from factors such as employment downsizing, financial instability, lack of education and training, and technological changes (Mathebula et al., 2015). Given the seasonal fluctuations in workload and the susceptibility to economic downturns, the construction industry is prone to higher levels of job uncertainty (Gallie et al., 2017). Moreover, the cyclical nature of the construction industry poses challenges in maintaining a stable and motivated workforce over time (Proverbs et al., 2000). Additionally, a major concern in the construction sector is the difficulty in the recruitment of supervisors (Lim & Alum, 1995) and, therefore, the lack of adequate resources to manage and supervise projects, which can incentivize absenteeism.

The study of Hinze et al. (1985) remarks on some of the worker characteristics reported as correlators to voluntary absence in the construction sector, such as gender, age, job satisfaction, tenure, and union affiliation. Nevertheless, no substantial consensus is found in the literature. Moreover, research has shown that absenteeism rates in the construction industry are attributed to a variety of contextual factors, including unsafe working conditions (Hanna et al., 2005), long working hours (Salehi et al., 2011), and a lack of recognition and opportunities for career development (Ibrahim et al., 2010).

Previous studies have posited that absenteeism exerts a stronger influence on public organizations compared to private ones (Chun & Rainey, 2005; Miller, 2005; Núñez, 2017). This perspective is rooted in two key premises. First, it is argued that public employees enjoy greater job security and exhibit weaker organizational commitment relative to their private-sector counterparts. Second, fewer organizational incentives for control in the public sector exist, given that operational practices are subject to government regulations, bureaucratic processes are prevalent, and rules for action are largely dictated by the political framework. In contrast, the private sector is subject to greater external pressure and incentives stemming from market competition, as opposed to the public sector, where weak explicit incentives and a lack of competition are more common (e.g., Dixit, 2002). Additionally, political pressure often constrains the actions of public firms, thereby posing challenges for public managers to effectively supervise and monitor employees. Consequently, it is pertinent to explore whether the sector of the firm has an impact on sick leave duration, particularly in the construction sector, as such an investigation remains underexplored in the existing literature.

Likewise, the study of absenteeism in the workplace encompasses various factors, one of which is the disability benefit (or subsidy) received by injured workers during their sick leave. Past research has indicated that an increase in sickness benefits leads to higher rates and longer durations of absenteeism (Johansson & Palme, 1996; Henrekson & Persson, 2004), whereas a decrease in sick pay results in a corresponding decrease in absenteeism (Ziebarth & Karlsson, 2014). For workers with low wages who receive a disability allowance that covers only a portion of their salary, the cost of each day of sick leave is considerably higher than for workers with high salaries who receive the full amount for the entire period of sick leave. This discrepancy in sickness benefit levels may potentially incentive absenteeism, whereby a worker decides to prolong sick leave if the increased welfare associated with leisure outweighs the reduction in income.

Nevertheless, the evidence within the construction industry remains limited, and further analysis is necessary.

5.2.2 Presenteeism

Presenteeism is a widely recognized phenomenon in which employees attend work while experiencing sickness or health problems, resulting in decreased engagement and productivity. Unlike absenteeism, presenteeism has been relatively under-studied, likely due to the difficulties in identifying it (Hansen & Andersen, 2008) and the challenges in measuring it through consistent methods (Lohaus & Habermann, 2019). Jayaweera and Dayarathna (2019) note that while presenteeism is attracting growing attention from human resource management practitioners and scholars, there is a need for additional studies to further clarify its conceptualization and its consequences. Moreover, Lapierre and Cooper (2023) remark that despite substantial research in this domain, there is still a need to acquire a more profound understanding of the factors influencing employees' choices to continue working while unwell.

Recent studies suggest that the cost of presenteeism exceeds that of absenteeism and has a significant impact on productivity (Collins et al., 2005). However, the consequences of presenteeism are not only in economic terms but also may have future negative physical and mental health and well-being consequences for an individual (Skagen & Collins, 2016). Like absenteeism, presenteeism also reflects a decision by the employee to take advantage of information asymmetry to behave irregularly and shorten a sick leave, driven by various factors such as personal, workplace, and contextual characteristics. Therefore, presenteeism could be viewed as a situational attendance decision that needs careful examination (Van Waeyenberg, 2023).

Predictors of presenteeism are commonly classified into negative attributes linked to personal characteristics, work-related elements, organizational factors, and the broader socioeconomic environment (Van Waeyenberg, 2023). Lack (2011) identifies two primary reasons for presenteeism: health-related issues and job-related concerns. Health-related issues contain both physical and mental well-being, incorporating factors such as health risks, the aging workforce, and dependent care issues. On the other hand, job-related concerns involve perceived work pressure and the apprehension of potential income or employment loss. Economic pressures, coupled with excessive workloads, could also be motivators of presenteeism (Prater & Smith, 2011). Merrill et al. (2012) discovered that work-related factors exert the most significant influence on presenteeism.

Additionally, personal problems and financial stress/concerns make substantial contributions to the occurrence of this phenomenon.

Using the variables at our disposal for this study, we analyze the existing literature to examine the impact of each of these variables on presenteeism. Several studies have examined the relationship between immigrant status and presenteeism, highlighting the unique challenges that immigrants face in the workplace. Soler-Gonzalez et al. (2008) find that immigrants have shorter sick leave periods compared to natives, which may be due to job insecurity and their adverse socioeconomic situation, which motivates them to work while ill. Similarly, Agudelo-Suárez et al. (2010) show that immigrant workers in Spain report more sickness presenteeism than native workers, which could be related to precarious work and poor employment conditions. Martín and Moral de Blas (2014) also report that foreign workers, particularly those from less developed countries, enjoy fewer economic sick leave days. Overall, immigrants often face unique challenges in the workplace, such as higher social and economic vulnerability and the risk of losing their jobs and facing greater difficulty in finding new ones, which may contribute to their tendency to be present at work while sick.

Research has shown diverse variables correlated with presenteeism, including employment contract type. Johns (2010) refers to several studies that have found that temporary employees have lower rates of sickness absence than their permanent counterparts. This phenomenon has been attributed to job insecurity, which may make temporary employees more likely to attend work even when they are sick. A study conducted by Reuter et al. (2019) shows that non-permanent workers, such as those on fixed-term contracts or temporary agency workers, are more likely to exhibit attendance behavior when unwell due to limited access to social protection. Additionally, Virtanen et al. (2003) find that changing a fixed-term contract to a permanent employment contract could increase sickness absence rates explained by a reduction in presenteeism, as permanent employees may feel more secure in their jobs and therefore more likely to take time off when they are unwell.

The relationship between company size and presenteeism remains a topic of limited research. Arjona-Fuentes et al. (2019) note that few studies have explored this relationship, with most finding no significant effect of company size on presenteeism (Arnold, 2016; Doki et al., 2015; Lohaus & Habermann, 2019). However, Hansen and Andersen (2008) find an inverse relationship between presenteeism and company size

across various sectors in Denmark. They suggest that in smaller organizations, employees are more dependent on each other, making it harder to replace absent workers.

In the construction industry, however, the situation may be different. Large construction companies face considerable pressure to maintain productivity levels so that projects can be completed on time. Employees may feel obligated to attend work even when they are not feeling their best due to the potential consequences of their absence for project delivery and the company's reputation. These companies are subject to greater scrutiny and pressure to meet deadlines and maintain eligibility for future public tenders, leading to a heightened emphasis on productivity compared to smaller firms.

The construction industry, characterized by its dynamic and frequently unregulated nature owing to the complexity of projects, poses challenges in implementing human resource management (HRM) functions compared to more structured economic sectors. This challenge is particularly pronounced in places that heavily depend on a migrant, casual, and transient workforce (Srour et al., 2017). While a transient workforce provides flexibility, it also introduces the potential for unpredictable absenteeism/presenteeism rates and suboptimal productivity.

In the specific context of the construction sector, limited evidence exists regarding the phenomenon of presenteeism in this industry (Emily, 2022). Drake et al. (2020) identify two primary reasons for attendance at work while ill in the United Kingdom construction sector: fear of financial consequences or loss of income and the need to complete an excessive workload. In addition, a report from the University of East Anglia's Norwich Business School highlights the issue of employees in the construction context continuing to work even when sick in order to avoid losing wages. This practice has been demonstrated to be counterproductive, dangerous, and potentially life-threatening for both the individual and the firm's other workers (Paton, 2016).

Furthermore, Galon et al. (2014) acknowledge that the construction sector is particularly susceptible to economic crises and high unemployment rates, which could lead to increased levels of presenteeism among employees. According to Fapohunda (2016), occupations characterized by heavy workloads, tight deadlines, and minimal backup support are associated with elevated levels of presenteeism. Such conditions are common in the construction industry, where workers may feel compelled to show up for work despite experiencing illness. Moreover, Böckerman and Laukkanen (2009) highlight that existing literature frequently links sickness presenteeism to factors such as

working-time arrangements, attendance pressure, and replacement practices, all of which are concerns within the construction sector.

Overall, job demands, job insecurity, worker replacement conditions, and high levels of pressure may increase the likelihood of presenteeism among construction workers. Long-term consequences of presenteeism within this industry may include decreased productivity, increased risk of accidents, and negative impacts on workers' physical and mental health. Therefore, construction organizations must identify and address the underlying causes of presenteeism to promote a safe and productive work environment for their employees.

5.3 Methods

5.3.1 Data

In this chapter, we continue utilizing data from the official records of occupational injuries provided by the Statistics of Work Accidents (Estadística de Accidentes de Trabajo, EAT), published by the Ministry of Labor and Social Security of Spain. The EAT data are drawn from occupational injury reports, the official documents by which the employer notifies the government of the occurrence of an occupational injury, the manner in which it occurred, the place, and the consequences of the injury. The dataset contains anonymized data for injuries occurring over a one-year period and records data on the firm where the injury occurred, personal and professional characteristics of the injured employees, and the type and medical diagnosis of the injuries. It is important to note that the observations in each year do not necessarily refer to the same employee; therefore, it is pooled data and not panel data. Therefore, the sample utilized in this section includes data for all non-fatal injuries that occurred in the construction sector in Spain during 2020–2021 and resulted in an absence of more than one day from work. Sick leave due to work-related disease, injuries on the way to/from work, and those suffered by self-employed workers are not included in the dataset. The study focuses on minor injuries to the back (including spine and thoracolumbar vertebrae) and upper extremities (shoulder and arm) in order to obtain a more homogeneous sample.[7]

[7] Given the innovative methodology at the core of our analysis, where convergence necessitates a restricted number of observations, we opt for a meticulously chosen, homogenous, and consistent sample. Our decision is based on the intention to enhance the robustness and reliability of our findings. Therefore, we incorporate the most recent information from the last two study years, focusing specifically on the most prevalent injuries within the construction sector. This deliberate selection of data, prioritizing recent and relevant information, enables us to provide an appropriate analysis of the duration of sick leave following occupational accidents in the construction sector.

The construction industry experiences major threats in terms of occupational health, in particular regarding work-related musculoskeletal disorders (Valero et al., 2016; Biswas et al., 2017). For example, Schneider (2001) finds evidence that construction workers are at significant risk of musculoskeletal injuries, with about 50% at higher risk than all other workers. Reddy et al. (2016) point out that musculoskeletal disorder is the single largest cause of work-related illness in construction workers, accounting for 77% of all reported occupational illnesses in India for this sector. Furthermore, musculoskeletal diseases, mainly lumbar problems, are the most frequent health problems associated with presenteeism (Galon et al., 2014). A study in Switzerland found the highest rates of presenteeism among workers with back pain (Aronsson et al., 2000). Based on the evidence presented, the study covers the most frequent and relevant injuries to be studied in the construction sector.

During the examined period, a total of 24,288 occupational injuries were documented (62% of the observations correspond to injuries in the back and the rest to injuries in the upper extremities), which led to over 580,000 lost workdays. As a consequence, the expenditure on disability benefits amounted to 1.07 million euros, calculated as the sum of the allowances received by the affected workers while on sick leave.

Table 19 presents the main descriptive statistics related to the study. The average duration of a work-related injury varies between 18 days for back injuries and 34 days for upper limb injuries. The remaining characteristics are very similar for both groups of injured body parts. The percentage of foreign workers in the construction sector is approximately 18%. The majority of the workers (60%) hold temporary contracts, while only 1% of the employees are women and 1.5% work in the public sector. The average age of the workers under study is 43 years, and they receive an average disability subsidy of 44 euros per day. Finally, the average company size in our sample is around 41 employees.

Table 19. Main descriptive statistics of the sample by injured body part

Injured body part	Mean duration (days)	Foreign (%)	Temporary contract (%)	Gender (%)	Public (%)	Mean age (years)	Mean subsidy (Euros)	Mean firm size (employees)
Back	17.71	19%	60%	1.0%	1.4%	42.65	44.01	39.37
Upper extremities	34.46	17%	59%	1.1%	1.6%	43.34	44.25	42.99

It is worth noting that the level of women's employment in the construction sector in Spain is significantly lower than that of men (Infante et al., 2012). This is due to various factors, including the perception of the sector as being associated with physical strength, leading to the allocation of social roles and spaces based on the supposed natural abilities of each gender. Additionally, the construction industry workforce is becoming increasingly older in many countries, and it is becoming more challenging to recruit and retain young workers (Kines et al., 2007).

5.3.2 Methodology

In this chapter, we employ a stochastic frontier approach as the analytical framework to investigate the duration of sick leave for injured workers. Specifically, the duration function of an individual *i* is represented in equation 21, where d_i refers to the observed duration of sick leave for worker *i*, *xi* represents a set of variables that define the standard time required for recovery after an accident, such as gender, age, and severity of the injury, and β denotes unknown parameters.

$$lnd_i = f(x_i|\beta) + \varepsilon_i \tag{24}$$

The duration of sick leave is influenced by injury characteristics as well as personal factors of the injured worker, such as gender, age, and occupation, which affect the expected recovery period based on medical and health-related factors. The severity of the accident, as indicated by the type of assistance required (hospital care versus outpatient care), is a direct predictor of the recovery time after the accident. In addition, occupation and regional dummies capture specific features associated with the worker's activity and unobserved characteristics that may influence the absence period, such as medical assistance protocols and inspection activity by regional health authorities. Moreover, older workers tend to have more serious injuries from occupational accidents, which may require longer recovery times. Hence, the resulting model can be expressed as follows:

$$lnd_i = \beta_0 + \beta_1 InjuryType_i + \beta_2 Hospitalization_i + \beta_3 Gender_i + \beta_4 Age_i + \beta_5 Occupation_i + \beta_6 AutonomousCommunity_i + \varepsilon_i \tag{25}$$

However, some variables that affect the duration of the absence period are not related to medical reasons. Thus, the error term could capture specific features of the

employee that extend or shorten the incapacity duration beyond the standard recovery time. In the classical stochastic frontier model, the error term is comprised of two components, namely the random disturbance (v_i) and the inefficiency term (u_i). In this model, if an individual is completely efficient, then $u_i = 0$, and the deviations from the frontier are attributed solely to random shocks. However, in situations where workers exhibit opportunistic behavior, the inefficiency component can arise due to environmental variables related to worker and firm characteristics. Such opportunistic behavior may manifest as extending the sick leave period beyond the normal recovery time (absenteeism) or as returning to work before fully recovering from the injury (presenteeism).

To account for both upper and lower levels of the duration of sick leave and estimate their effects, the classic stochastic frontier model is extended in this study using a two-tiered stochastic frontier model. Drawing on the model of Polachek and Yoon (1987), we introduce a composite error term that captures the presence of both positive and negative deviations from the frontier. The two-error components model allows for the possibility of aspiration biases or inefficiencies that are not accounted for in the classical model.

$$\varepsilon_i = v_i - u_i + w_i \tag{26}$$

Equation 26 embodies a three-component error model that accommodates the potential for systematically positive and negative components within the error structure in addition to the conventional random error component (Kumbhakar & Parmeter, 2009). This model implies that workers may behave opportunistically by abbreviating the incapacity period following a work-related accident, represented by *u*, or prolonging the period off work, represented by *w*. Thus, the parameter μ_u denotes the negative deviation in the duration of sick leave and can be interpreted as the impact of presenteeism, while μ_w represents the positive deviation in the duration of sick leave and can be regarded as a measure of absenteeism. Furthermore, since the presence of the noise term is likely to influence the boundaries, the parameter v_i captures the effects of random shocks.

The model was estimated using the maximum likelihood (ML) method, based on certain distributional assumptions of the error components. Specifically, it was assumed that the error components v_i, u_i, and w_i were independently distributed with $v_i \sim \mathrm{N}(0, {\sigma_v}^2)$, $u_i \sim \exp(\sigma_u)$, $w_i \sim \exp(\sigma_w)$ distributions, respectively. Moreover, they

were assumed to be independent of the regressors. To capture additional information and following Tomini et al. (2012), we decided to parameterize the negative and positive stochastic deviations, allowing these parameters to vary with observable characteristics as follows:

$$\mu_{ui} = \alpha_{u0} + \alpha_{u1} Foreign_i + \alpha_{u2} TemporaryContract_i + \alpha_{u3} Size_i \quad (27)$$

$$\mu_{wi} = \alpha_{w0} + \alpha_{w1} Public_i + \alpha_{w2} Subsidy_i \quad (28)$$

Equation 27 intends to explain presenteeism and comprises some worker-specific characteristics, such as immigration status and type of contract, while the final variable pertains to the firm size. On the other hand, equation 28 aims to explain absenteeism and incorporates environmental factors, including the sector and the amount paid as a sickness subsidy. As discussed in the previous section, these variables have been recognized in the literature as correlators with presenteeism and absenteeism, respectively. Thus, the idea is to establish the statistical significance of these variables and their association with the negative and positive stochastic deviations.

As emphasized throughout our thesis, our analysis is based on the available information on occupational injuries in Spain. In this context, the frontier segment of our model contains variables that we can effectively capture to determine the standard recovery time. These variables include the severity of the injury, the necessity for hospitalization, and the gender, age, and occupation of the injured worker, with the autonomous community where the accident occurred serving as a control variable.

Moving beyond an exploration of the factors influencing the extension of the incapacity period, as discussed in previous chapters, our focus extends to comprehending the reasons that may drive workers to shorten their absence and return to work before the designed end of sick leave. Considering the available information and taking into account the literature background for the construction sector shown in the second section of this chapter, we introduce the sector (public/private) and the level of subsidy received by each worker during a period of incapacity as determinants of absenteeism.

As clarified in earlier chapters, the sector emerges as a significant factor, particularly in the public sector, where lower levels of control and supervision may allow absences to go unnoticed, job security is higher, and work attendance motivation is lower. As anticipated, a higher subsidy level is associated with an increased motivation for

absenteeism, creating an incentive for individuals to be absent and continue receiving benefits without actively working.

Contrarily, variables potentially linked to presenteeism include the immigration status of the injured worker, the type of contract, and the size of the firm. In the thesis, we have highlighted how more vulnerable positions, such as being foreign or holding a temporary contract, may act as motivators for steady attendance to secure their position and demonstrate commitment. In contrast to the previous chapters, the size of the firm, particularly in the construction sector, is associated with presenteeism. Larger firms face intensified pressure to complete construction projects, thereby increasing the urgency for employees to be present at work.

In summary, this chosen technique offers a robust medium for exploring the complexities of absenteeism and presenteeism in the context of occupational accidents. The observation-specific measures obtained allow for a secondary analysis, facilitating an in-depth examination of potential sources of absenteeism and presenteeism. Moreover, this secondary analysis serves to discern whether certain groups of workers exhibit a greater propensity to extend or shorten their incapacity period following a work-related injury.

5.4 Results

Table 20 presents the results of the simultaneous estimation of parameters for each injured body part, the two terms of the negative and positive stochastic deviations that represent presenteeism and absenteeism, and their determinants. The two-tiered method enables the breakdown of observed outcomes into three components, including a random error term and an inefficiency term that is divided into positive and negative deviations. The former represents factors beyond the control of the individual, while the latter captures deviations above or below the optimal expected recovery time.

Based on the estimation outcomes, we find that a majority of the variables are highly significant and demonstrate the expected sign for both models. Specifically, hospital care and older workers are found to increase the duration of work-related sick leave. Our findings underscore the significant influence of variables used to control for different environmental factors associated with the occurrence of accidents, including the occupation and community autonomy where the injury takes place.

For the model focusing on back injuries, the gender variable is found to be significant with a positive sign, indicating longer periods of sick leave for women than

for men. By contrast, for the model analyzing upper extremity injuries, the gender variable is not significant, possibly due to the low representation of women in the sample.

Considering the context of the construction sector, the variables explaining the standard recovery time after a work-related injury align with expectations. Female workers and older employees exhibit longer durations of sick leave, attributed to their inherent characteristics and the increased time required for recovery. Notably, injuries characterized by traumatic amputations, bone fractures, dislocations, sprains, and strains are associated with the lengthiest recovery periods. Furthermore, when examining occupations within the sector, we observe that individuals employed in elementary occupations and those working as plant and machinery operators and assemblers typically experience extended periods of sick leave. These results highlight the occupational groups within the construction sector that may require additional support and attention to mitigate absenteeism and facilitate return-to-work initiatives.

The lower section of Table 20 presents the parameterized specification estimates of μ_{ui} and μ_{wi}. A significant proportion of the variables are statistically significant, indicating that a worker's decision to shorten or extend the duration of sick leave following a work-related injury is influenced by various characteristics examined in the analysis.

Focusing on the variables that explain negative deviations from the expected duration of recovery time, a positive coefficient suggests the presence of presenteeism-inducing factors. The positive sign for the variable FOREIGN in both models suggests that the incapacity period for immigrant workers is lower than that of their national counterparts. Additionally, the positive and statistically significant coefficient for the variable SIZE provides support for the idea that workers in larger construction firms have shorter absence periods, possibly due to higher levels of pressure and the need to complete large projects as quickly as possible, even when feeling unwell. In terms of the type of contract, the coefficient for the back-injury model is not statistically significant, whereas, for upper extremity injuries, the TEMPORARY coefficient is positive and significant, suggesting that temporary workers have shorter sick leave periods, likely due to their vulnerable position and risk of job loss. In summary, foreign and temporary workers in the construction sector may exhibit higher levels of presenteeism due to job insecurity, and the fear of not having their contracts renewed may lead them to prioritize attendance at work, even when unwell, to demonstrate commitment and retain their positions. In addition, temporary and foreign workers may fear repercussions for taking time off. As a

result, they may choose to work through illness to avoid financial hardship or job loss. Larger construction projects often have significant scale that impacts on project timelines. Employees may fear that their absence could result in project delays or increased workloads for colleagues, leading them to choose presenteeism over taking sick leave. Moreover, workers could believe that their absence may have a more significant impact on project progress, influencing them to prioritize attendance to maintain project continuity. Furthermore, larger construction firms may promote a competitive work environment where employees look for recognition and advancement. In such environments, workers might be hesitant to take sick leave, fearing it could be perceived as a lack of commitment or competitiveness.

With regard to the variables that account for positive deviations from the anticipated duration of recovery time, a positive coefficient indicates the presence of absenteeism-inducing factors. Specifically, the significant and positive coefficient for the variable SUBSIDY in both models suggests that greater levels of sickness benefit are associated with more extended periods of incapacity following a work-related injury. Conversely, the coefficient for the variable PUBLIC is not statistically significant in either model, indicating that there is no evidence to suggest that workers in public construction firms experience more prolonged periods of absence. This finding could be attributed to our sample's lower percentage of public employees.

Table 20. Parameter estimates two-tiered stochastic frontier model

Frontier		
	Upper extremities	**Back**
Hospital	0.48677 (0.11297)***	0.56654 (0.08939)***
Gender	0.07903 (0.11217)	0.26636 (0.07823)***
Age	0.0137 (0.0011)***	0.00977 (0.00077)***
Type of injury dummies	Yes	Yes
Occupation dummies	Yes	Yes
Regional dummies	Yes	Yes
Constant	2.43754 (0.27508)***	1.9886 (0.2832)***
Random error term (SigmaV)	0.04108 (0.01174)***	-0.28384 (0.01452)***
Coefficient of the one-sided error term (u)		
Foreign	0.41372 (0.17583)**	0.79569 (0.45383)*
Temporary contract	0.46054 (0.2228)**	-0.06936 (0.16342)
Size	0.20559 (0.05497)***	0.21255 (0.06621)***
Constant	-2.88428 (0.53179)***	-2.95054 (0.40808)***
Coefficient of the one-sided error term (w)		
Public	0.5411 (0.39235)	-0.01166 (0.10993)
Subsidy	0.45499 (0.09394)***	0.09226 (0.05086)*
Constant	-3.64061 (0.01148)***	-0.91331 (0.19605)***
Log likelihood	-13484.787	-20487.088

Robust standard errors are in parentheses.
*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Interpreting the one-sided terms is an essential part of two-tier stochastic analysis. The relative measures of one-sided terms measure the result of information asymmetry. Therefore, continuing with the analysis, the expected values of the one-sided error terms in the analysis are calculated. Since the dependent variable enters the regression in logarithmic form, we need to consider the expected values of the exponentiated variables. The expected value of u and w could be interpreted as the percentage reduction and increase, respectively, in the duration of sick leave due to information asymmetry that may motivate the injured employees to have less or more time absent from work. To get an exact percentage measure of the duration of sick leave reduction or increase, we need to obtain the conditional expectation. Following Lian et al. (2021), the percentage of days that can be shortened or extended beyond the normal recovery time can be estimated as $1 - E(e^{-u_i}|\varepsilon_i)$ and $1 - E(e^{-w_i}|\varepsilon_i)$, respectively. These values represent the average level of presenteeism and absenteeism among the workers in the sample. For the upper extremity injury model, we find that the levels of presenteeism and absenteeism are very similar at around 12%. However, for the back-injury model, the level of presenteeism is only about 8%, which is much lower than the level of absenteeism, which oscillates around 36%.

In computing these measures, we derive the percentage of days that can be either shortened or extended beyond the normal recovery time. As elucidated earlier, this involves calculating observation-specific measures of the conditional expectations of u (representing presenteeism) and w (representing absenteeism). Subsequently, we incorporate the actual duration of sick leave observed for each worker. By multiplying this observed duration by the calculated percentage of days extended or shortened, we can precisely determine the number of days employees are inclined to be absent or present beyond the standard recovery time (equations 29 and 30). In this particular context, as our main interest lies not in the absolute value of each error term but rather in the propensity of each worker to prolong or shorten the duration of sick leave after a work-related injury, we calculate the number of days of presenteeism and absenteeism for each individual and then take the difference between these values to determine the tendency of each worker to be absent for more or less time off work. In essence, this propensity measure serves as a valuable metric, providing the net effect of each injured worker's decision regarding the duration of their sick leave after experiencing a work-related injury. Furthermore, this metric can be calculated for various subgroups of injured workers, producing valuable insights into specific areas that require attention for

understanding and managing the challenges associated with absenteeism and presenteeism in the construction sector. With this, targeted strategies and interventions can be suggested, promoting a more effective approach. This approach allows for a valuable assessment of the extent to which individual workers deviate from the typical recovery period, providing new understandings of the dynamics of absenteeism and presenteeism in the context of work-related injuries.

$$PresenteeismDays_i = \left(1 - E(e^{-u_i}|\varepsilon_i)\right) * d_i \quad (29)$$

$$AbsenteeismDays_i = \left(1 - E(e^{-w_i}|\varepsilon_i)\right) * d_i \quad (30)$$

$$Propensity_i = AbsenteeismDays_i - PresenteeismDays_i \quad (31)$$

Where d_i is the observed duration of sick leave for the *i*th worker.

Table 21 presents the findings of the propensity days for each of the injured body parts analyzed in this study. The results reveal that workers tend to extend their incapacity period after an occupational injury rather than shorten it. Construction work is often physically demanding and involves potential exposure to risky conditions. Severe injuries may necessitate a more extended recovery period, prompting workers to extend their incapacity to ensure a complete and safe recovery. Also, workers may face financial pressures, and an extended incapacity period may be seen as a way to continue receiving financial support through sick leave benefits.

For the upper-extremities model, the extension of the sick leave duration is only around one day beyond the normal recovery time, while for the back-injury model, the inclination to prolong the absent time is much more pronounced, with around eight additional days of absence. The literature has suggested that moral hazard tends to be more prevalent in cases of hard-to-diagnose injuries, such as low-back injuries (e.g., Bolduc et al., 2002; Fortin et al., 1996; Martin-Roman & Moral, 2008). The underlying cause of this phenomenon can be attributed to the diagnostic process being subject to a certain degree of uncertainty, which complicates the determination of appropriate treatment (Moral de Blas et al., 2012). The moral hazard of extending sick leave tends to be more prevalent in cases of hard-to-diagnose injuries due to factors such as subjectivity in symptoms, limited verifiability, ambiguity in recovery timelines, and the perceived lower risk of detection. Consequently, workers may be inclined to exert some level of control over the recovery period, leading to its extension beyond what may be necessary.

Table 21. Presenteeism, absenteeism, and propensity days by injured body part

Mean	Upper extremities injury	Back injury
Presenteeism days	3.8	1.3
Absenteeism days	5.0	9.5
Propensity days	1.1	8.2

Upon analyzing the outcomes by groups of workers, we find that the foreign population shows interesting results, as depicted in Figure 17. The propensity days for immigrant workers are significantly lower compared to their national counterparts, substantiating the idea that foreign employees in the construction industry have a propensity to return to work sooner, even if they have not entirely recovered, as they perceive themselves to be in a vulnerable position and fear losing their jobs. As a result, they need to demonstrate their commitment to the company by showing up for work. Specifically, for the case of the upper extremity injury model, the propensity days for immigrant workers are negative, indicating that presenteeism is more apparent in these situations. Following the results for this model, in which the coefficient of the type of contract is significant, the results reveal that the propensity days for temporary workers are only about 0.5 days, compared to two days for employees with a fixed contract, confirming the higher levels of presenteeism for this group of individuals who are more susceptible to job loss and, therefore, endeavor to attend work as much as possible.

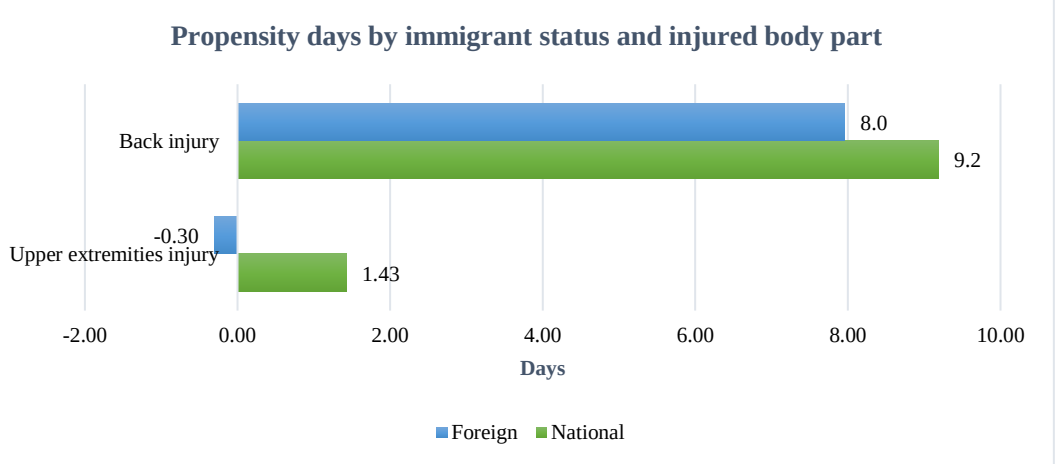


Figure 17. Propensity days by immigrant status and injured body part

The ability to quantify not just the count of absent days but also the duration of reduced workdays among injured workers in the construction sector following occupational accidents constitutes a unique and substantial contribution to this thesis.

This quantitative approach represents a significant and meaningful contribution to the overall research, providing a novel investigation for understanding and analyzing the prevalence and impact of presenteeism in the studied context. Furthermore, the inclusion of quantitative estimates enhances the thesis's empirical value, advancing our understanding of the complexities of presenteeism.

5.5 Discussion and conclusions

To better understand the factors influencing the duration of sick leave in the construction sector, we used a two-tiered stochastic frontier model to estimate the propensity of workers to prolong or shorten the incapacity period. The model breaks down the residual of the sick leave duration function into three components, one purely random and the other two corresponding to malingering and presenteeism at work. Overall, this research provides valuable insights into the factors influencing absenteeism and presenteeism in the construction sector, and the methodology used represents a novel contribution to the field and provides insights into factors influencing the duration of sick leave following work-related injuries.

Using a dataset of occupational accidents in the construction sector in Spain from 2020 to 2021, the study found that immigrant and temporary employees are more likely to return to work before the end of their sick leave period due to job insecurity. Likewise, workers in big firms are more inclined towards presenteeism due to pressure to meet deadlines and participate in tenders. In contrast, the study found that higher disability benefits may increase malingering behavior and prolong the duration of sick leave.

It is worth noting that the consequences of work-related accidents go beyond the economic impact, as they also have a significant social and human cost. Work-related accidents often lead to physical and emotional trauma for the worker and their families and can result in long-term disabilities that may affect their quality of life. As such, it is crucial for employers to prioritize the safety and well-being of their workers and take the necessary measures to prevent work-related accidents and injuries. To mitigate this issue, employers must create a positive work environment and provide opportunities for training and career advancement to promote job satisfaction and reduce absenteeism.

Another important step is to improve job security measures for immigrant and temporary employees. The vulnerable position of immigrant and temporary employees increases their fear of losing their jobs, and hence, they may return to work before their sick leave period ends. To address this issue, policymakers can consider implementing

job security measures for these employees, such as longer notice periods for termination or legal protections against discriminatory practices.

Encouraging better working conditions in big firms will also help address sick leave duration issues. Workers in big firms may experience greater pressure to meet deadlines and participate in tenders, which may lead to presenteeism. Policymakers can encourage big firms to provide better working conditions and more support to their workers, such as flexible work arrangements and adequate staffing levels, to reduce this pressure and improve worker health.

Revising disability benefit policies should also be considered. The study found that higher disability benefits may increase malingering behavior and prolong the duration of sick leave. Policymakers can consider revising disability benefit policies to prevent such behavior, such as setting a limit on the duration of benefits or implementing stricter eligibility criteria. By implementing these policy changes, policymakers can address the issues of opportunistic behavior in the construction sector and improve the health and well-being of workers.

Based on the information presented, we will now discuss the theoretical and practical contributions of this chapter while also addressing the limitations of the study.

Theoretical implications

This chapter introduces a significant theoretical contribution by applying the two-tiered stochastic frontier model to the context of occupational injuries, which has not been extensively studied in the literature. This model allows us to identify the variables that influence workers to prolong their incapacity period along with factors that encourage opportunistic behavior, leading to a shorter duration of sick leave and an early return to work. By recognizing the characteristics of employees that contribute to presenteeism, this research expands the existing literature on the topic and plays a valuable role in developing strategies and policies to mitigate the impact of the emerging issue of presenteeism. This aspect is particularly relevant considering the increasing necessity for workers to be present at work despite being sick.

Furthermore, this chapter provides insights specific to the construction sector, which is significantly affected by occupational accidents. The study reveals novel findings not previously documented in the literature, such as the impact of firm size on the decision to return to work as soon as possible. Additionally, the research highlights

the highly significant influence of factors such as the immigration status of workers and their type of contract, which generate substantial pressure to be present at work.

Practical implications

The practical implications of this chapter are noteworthy, particularly for the construction sector and industries dealing with the challenge of occupational injuries and presenteeism. The identification of variables influencing the duration of sick leave and factors driving presenteeism can inform the development of targeted strategies and policies to improve workplace safety and employee well-being. Specifically, these practical implications should include implementing programs and initiatives that promote a healthier work culture, discourage presenteeism, and encourage employees to prioritize their well-being and take adequate sick leave when necessary. This can involve raising awareness about the risks and consequences of working while unwell.

Moreover, measures to improve occupational safety in the construction sector must be prioritized, considering the sector's high rate of accidents. This can involve strengthening safety protocols, providing adequate training, ensuring compliance with safety regulations, and implementing effective risk management strategies.

One of the most relevant actions should be oriented to ensure equal treatment and opportunities for all workers regardless of their nationality or their contractual arrangements. Therefore, support mechanisms may be developed that provide, for example, language assistance or facilitating access to healthcare services.

Limitations

We must recognize our study's constraints, which can affect the extent to which the findings can be applied more broadly. The particular context and characteristics of the sample in our research may limit the relevance of the results to other sectors or countries. Consequently, it is important to be cautious in extrapolating these findings to industries beyond construction.

It is crucial to recognize the innovative nature of the methodology employed in this chapter, particularly its implementation in statistical software, which is relatively recent. Consequently, the results are sensitive to both the model specification and the characteristics of the sample used. Additionally, it is important to note that due to

convergence issues with larger sample sizes, the analysis in this study is based on a limited dataset comprising only two years and two types of injuries.

To strengthen the robustness of the analysis and validate the findings, we recommend considering alternative approaches. This could involve employing different statistical software packages to construct the model or exploring alternative methodologies as a robustness test. By conducting these additional analyses, the reliability and validity of the results could be reinforced.

General conclusions of the thesis, limitations, and future research

Occupational injuries and work-related accidents have significant economic and social implications at personal, organizational, and governmental levels. The costs associated with sick leave, such as decreased productivity, organizational disruption, and government expenditures, highlight the need for effective strategies to reduce the duration of sick leave following work-related accidents.

As has been shown, the duration of sick leave is primarily influenced by accident characteristics, injury severity, medical assistance received, and the employee's ability to recover. However, the medical assessment of an injured worker's recovery is often surrounded by imperfect information, which can lead to opportunistic behavior and unjustified extensions of sick leave. For example, the thesis findings highlight the influence of weak control, lax supervision, and monitoring in the public sector on longer durations of absence following an occupational injury (Chapter 2).

Additionally, the findings indicate that there are contextual factors that may motivate opportunistic behavior from the worker side; for instance, the study in the education sector reveals that injured educators at higher levels, like post-secondary and secondary, experience lengthier incapacity periods compared to other educational levels (Chapter 3). Similarly, the findings indicate that firm size has an impact on sick leave duration within the manufacturing sector. The inherent attributes of these companies could potentially create an environment where workers might be inclined to opportunistically extend their time off work without genuine health-related reasons (Chapter 4). Moreover, the research not only examines variables related to absenteeism but also recognizes factors influencing presenteeism. For example, it identifies that immigrant workers and temporary employees in the construction sector tend to have shorter sick leave durations (Chapter 5).

Consequently, reducing opportunistic behavior is crucial for minimizing the economic burden derived from occupational accidents. By accurately reflecting the worker's natural recovery time, the duration of sick leave can be aligned with the actual health condition of the employee, thereby reducing unnecessary costs for companies and preserving resources within the public insurance system.

This research project provides a unique contribution by investigating the duration of sick leave and its implications, filling a gap in the existing literature that has predominantly focused on the incidence and consequences of work-related accidents. The

findings serve as a valuable resource for policymakers, insurance providers, and other stakeholders involved in managing occupational accidents, enabling them to develop strategies to reduce opportunistic behavior and mitigate the economic costs for companies, the health system, and society in general. This thesis makes valuable contributions in terms of significant results and their policy implications and also in research methodology, as we employed econometric tools and efficiency models that enhance the reliability and significance of the findings.

However, it is imperative to acknowledge significant limitations inherent in this thesis that provide a comprehensive overview of the next steps to improve the analysis and inform future critical advancements. First, our dependence on cross-sectional data restricts our ability to track individual worker trajectories over time, potentially limiting the depth of analysis and insights that could be derived. Second, the study's focus on a specific country introduces constraints on the applicability of findings to other contexts with distinct dynamics. While this research employs parametric approaches and econometric models, it is important to recognize the potential benefit of incorporating other types of methodologies to strengthen the robustness of the results. Additionally, the conclusions drawn from our study are inevitably formed by the available data, potentially missing crucial variables that influence sick leave behavior.

Another significant limitation to highlight is that our dataset lacks input from other stakeholders in the occupational injury process. Perspectives of physicians, who determine sick leave lengths, and supervisors, who balance employee well-being and productivity, remain unaccounted for. These absent viewpoints could enrich our understanding and provide invaluable insights into sick leave behavior.

Consequently, several areas within the field of occupational accidents require further research and attention. The following ideas outline potential avenues for future work:

- Further exploration of the factors that motivate and facilitate opportunistic behavior among injured workers is needed. Understanding the underlying motivations and circumstances that lead to unjustified extensions of sick leave can help inform the development of interventions and policies aimed at reducing the lost time from work and related costs.
- Investigating the role of worker-level interventions, such as training, information, and personal protective equipment, in reducing the duration of sick leave can provide valuable insights for improving workplace health and safety practices.

Similarly, exploring organizational changes, risk prevention systems, and control measures can help identify effective strategies to minimize the impact of occupational accidents on productivity and performance.

- In-depth sector-specific investigations, similar to the ones conducted in this research project, can be extended to other sectors beyond public employees, educators, and construction workers. Exploring sick leave duration patterns in different sectors can provide sector-specific insights and facilitate the formulation of targeted interventions and policies.
- Introducing information about more countries to compare the current findings or including new variables about characteristics of the workers, the jobs, and the firms and distinguishing by the different types of accidents could be interesting next steps. Likewise, it would be valuable to understand how the economic cycle and variables like inflation, GDP, or unemployment rate affect the duration of work absences.
- Further research on presenteeism, the decision of workers to attend work despite being unwell, is necessary to understand the factors influencing this behavior. Exploring the variables that contribute to presenteeism can help in developing strategies to encourage employees to take appropriate sick leave when needed, promoting better overall health and productivity.
- Longitudinal studies tracking the recovery and return-to-work processes of injured workers can provide valuable insights into the dynamics of sick leave duration over time. Understanding how various factors evolve and interact throughout the recovery process can inform decision-making regarding health and safety at the workplace and the prevention of occupational injuries.
- New methodologies could also be proven in the context of injuries at the workplace, such as transient and persistent efficiency models, productivity analysis, and non-parametric efficiency models to extend the scope of the study.

By addressing these areas of future research, policymakers, managers, and other stakeholders can gain a more comprehensive understanding of the determinants of sick leave duration and work toward evidence-based policies and interventions that improve workplace health, safety, and employee wellness.

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