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## ESTIMATING ACCIDENTS AT WORK IN EUROPEAN UNION

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**Abstract:** *This paper describes safety at work as an issue to be addressed in terms of legislation, with due statistical knowledge of the phenomenon. Through the application of multiple indicators while investigating the rate of homogeneity and non-homogeneity of available data, especially at international level, the concept at study can be analyzed using specific scientific methods.*

*The Total Frequency Rate of accidents could be influenced by a country's industrial structure. The standardization of industrial structures into NACE divisions or sub-divisions (and not only on an aggregate activity level), has proved very useful as an integral part of the statistical infrastructure used within the European statistical system for producing comparable statistics. Looking at the distribution of the Total Frequency Rates (TFR) of accidents in different world regions, the picture is quite different, as the phenomenon is by no means evenly spread across the globe. Fatalities are proportionately much higher in some regions than in others. Carrying out a country-by-country analysis would in no doubt reveal greater variations. Occupational accidents and work-related diseases in some European countries are twice as high as in some others.*

*We show that the shadow economy has an important impact in outlining an "effective frequency rate of accidents". In Italy, the impact of an excessive economy and the influence of organized crime in the South, which could alter the basis for reporting work-related accidents and occupational safety performance indicators, has led to the consideration of the actual rate of accidents in Italy slightly higher than the European average.*

**Keywords:** *Effective accident rate, ESAW (European Statistics on Accidents at Work), underground economy.*

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## 1. Introduction

In 1990 the Eurostat harmonization project of European statistics was initiated on accidents at work (European Statistics on Accidents at Work - ESAW) to develop methodologies for the collection of comparable and significant data within the European Union. With the 2002-2006 European Strategy for Health and Safety at Work, member countries were invited to promote real well-being at work, in terms of physical, psychological and social well-being.

Occupational accidents and work-related diseases in some European countries are twice as high as in some others, while in the Middle East and Asia, these phenomena are the biggest component as fatality rates rise four times higher than those in the safest industrialized countries.

Among the objectives of work are:

- to briefly picture the phenomenon of safety at work in the world, Europe and among immigrants in Italy (through Eurostat, ILO, INAIL);
- to consider the statistical phenomenon of accidents in the Euro zone looking at the total indicators available (rates of irregularities, standardized and non-standardized accident rates, territorial variabilities). There are some areas to be understood in greater detail, areas particularly represented by the underground economy of Greece, Hungary, Lithuania, Romania, Southern Italy, Spain and the need to make Eurostat indicators more comparable (as required by project ESAW);
- to delineate the relationship between underground economy and accidents at work. To this end, official ISTAT data on non-registered labour (see [6], [7], and [8]) and their dynamic sector are essential.
- to outline some elements in the collection of statistics that could improve the European statistics.

Safety on the work is one of the main ingredients to avoid that job becomes precarious.

## 2. Data and Sources

The phenomenon of Total Frequency Rate of accidents seen among workers is a matter of "variable geometry," an ethical code practiced by the media where intermittent media attention is high in the presence of one or more tragic events, and low in the prolonged absence of the same [1]; a determining factor as to how the information is received.

In this paper, therefore, the phenomenon of work-related accidents and fatalities is approached from another angle, looking at reliable official data provided by the International Labour Organization (ILO) and Eurostat on health, safety and well-being of workers in Europe and the rest of the world.

The ILO provides particular data for the following variables: total employment, accidents in complex, fatalities. These indicators are disaggregated over the following geographic areas and interests: countries with market economies, former socialist countries, China, India, other Asian countries, Sub-Saharan Africa, Latin America, the Caribbean, Middle-east, and the world as a whole.

In Italy, Insurance to cover occupational accident, health and illness is handled through the National Insurance Institute for Employment Injuries (INAIL). This government agency, designed to monitor occupational illness and injury, focusing in particular on emerging

multifactor illnesses, provides periodic statistics from reports it receives. This information is grouped into provincial, regional and national levels and includes: insured activities, claims declared, claims compensated and the type of risk. The Institute of Prevention and Safety at Work (ISPESL), on the other hand, through data retrieved from INAIL database, produces an annual historical series on injuries and fatalities.

Regarding the role of Eurostat, it is shown that in 1990 the harmonization project of European statistics was initiated on accidents at work (European Statistics on Accidents at Work - ESAW) to develop methodologies for the collection of comparable and significant data within the European Union. With the 2002-2006 European Strategy for Health and Safety at Work, member countries were invited to promote real well-being at work, in terms of physical, psychological and social well-being.

An ad hoc module, included in the Labour Force survey by EU Member States in the second quarter of 2007, with descriptive purposes, was a useful tool for the evaluation of the Community's strategy, through the measurement of exposure to risk factors for the health of workers. The Italian Caritas, a Pastoral Body created by the Italian Episcopal Conference to promote charity commitment of the Italian ecclesiastical, through the Immigration Statistical Dossier, "Caritas / Migrantes," outlines the characteristics of immigrant employment each year and processes data on accidents as well: approximately 40% of workplace fatalities concerning foreigners in Italy involves, predominantly, citizens from Morocco, Romania, Albania.

Other than data and analyses provided by the above-mentioned institutions, there is no vast literature on the phenomenon of workplace injuries and fatalities. The subject is often treated within Commentaries to legislation on accidents [1],[3], and [10]. Safety at work is an issue that should be addressed not only from a legislative point of view, but also from a correct statistical perspective. By applying proper multiple indicators and investigating homogeneity and non-homogeneity levels of available data, especially at an international level, this phenomenon can be analyzed scientifically.

Among the most commonly used indicators for statistical and economic analysis (and which will be explained in the following paragraphs) are:

- attendance rates by countries standardized on the basis of the NACE industrial structure
- accident rates by region and country
- composition of indexes by geographical areas and nationalities
- relative rates on non-registered workers
- relative frequency of injuries based on the number of workers compensated
- relationship between compensation and reported accidents
- fatalities not reported compared to company size
- changes in commuting accidents

Legislation to protect safety and health at work in EU countries is represented mainly by EU directives; the Framework Directive No 391/89, specifically. This accident phenomenon, however, has a high degree of variability within the European Union, which is influenced by different social and legal practices.

### 3. Calculation methodologies of Eurostat data

Data cited in Table 1 below, based on occurrence rate of injuries per 100.000 employees, are "standardized" by Eurostat for various economies in order to integrate technical data submitted by member countries absolute. The EU countries provide their data not in the presence of a directive but a simple "gentlemen's agreement", i.e. an informal agreement.

Some member States, in fact, do not have a specific insurance system and, according to Eurostat, only a part of workplace accidents is actually declared. Even in cases where statistics do exist, they may be compiled in a different way. Thus, such a system merely the registration of an average level of declaration of only 30% -50% per the total number of sectors of economic activities [4].

**Table 1. Frequency rates standardized per every 100.000 employees in 2006<sup>(\*)</sup>.**

SECTORS	UE at 15	UE at 12	Italy
9 sectors common to NACE	3.013	3.469	2.812
Agriculture	3.879	4.145	<b>6.013</b>
Manufacturing Activities	3.463	3.890	3.488
Electricity, Gas, Water	1.577	1.763	2.288
Construction	5.974	7.049	4.539
Trade and Commerce	2.096	2.386	1.551
Hotels and Restaurants	2.909	3.294	2.133
Transport and Communication	3.674	4.447	4.562
Financial Intermediation and Real Estate Activities	1.464	1.760	1.184

<sup>(\*)</sup>Source: EUROSTAT

The ESAW methodology considers, essentially, two types of statistical indicators for the analysis of accidents at work: the number of accidents and their frequency. To define the frequency of accidents, it is necessary to define the relationship between the number of accidents and the population of employees referred to, calculated using the sample survey run by ISTAT Labour Force Survey in Italy.

It is important to note that this is a useful report that shows numerator data from administrative sources and denominator data from statistical source (the LFS). Therefore during their interpretation, the following should be considered:

- the non-homogeneity of the sources of provenance
- the probability to have data underestimated.

In fact, while data on employment (the denominator) includes most of the non-regular workers, the accident (the numerator) should include injuries of legal workers and partly, "serious injuries" of non-registered workers [5]. Eurostat statistics are compiled on the basis of reported injuries compensated by insurance benefit, and therefore require sufficient time for definition. Total Frequency Rate (TFR) is defined as the number of accidents per 100.000 employees:

$$\text{Frequency rate} = \frac{\text{Number of accidents (fatal and non fatal)}}{\text{Number of employees in the population}} * 100.000 \quad (1)$$

This rate can be based on the variables that classify the victims of an accident (e.g. economic activities, age, etc.), it could be calculated for the whole Euro Area aggregate, for a Member

State or any other subdivision of the population, and the type of injury ( injured body part, etc.). For an over-three-day injury which results in the injured person being away from work or unable to do their normal work for more than three days, Total Frequency Rates (TFR) are calculated separately.

Deaths caused by road accidents are a significant percentage of the total number of fatalities, but are not included when calculating the frequencies, because they are not recorded as workplace accidents. And, in the absence of proper correction, the comparison between incidence rates of deaths would introduce a significantly distorted national data. For each Member State, in fact, an adjusted frequency of fatal accidents is used.

In some States, accidents at work leading to absence from work for more than three days are declared only partially. Based on these declaration levels, Eurostat could rectify data on accidents and carry out their evaluation based on deduction.

It is known that the frequency of accidents is much higher in some areas than others. The industrial structure of a country influences the total incidence rate of accidents based on the percentage of sectors with higher risks (i.e. agriculture, construction , transport).

A country with a significant proportion of those employed in high-risk sectors, compared to another Member State which, by definition, has a frequency rate of accidents similar to each sector, will have a greater Total Frequency Rate (TFR) of accidents nationwide. To correct this distortion, standardized data of workplace accidents are shown in ESAW publications, attributing to every sector at the national level, the same relative total weighting as that of the European Union (Standardized Frequency Rate).

The following elements improving a comparison of European statistics could be delineated :

- standardization of the industrial structure by sector (NACE subsection or division) and not only on aggregate activities level;
- standardization based on work : part-time work, contracts, legal working time, flexibility of employment;
- standardization for age and sex;
- more complete data from member countries on occupational diseases.

#### **4. Injuries in the European Union**

Table 2 below, reproduced with data for year 2006 ( the latest made available by Eurostat) shows that Italy has, as per accidents at work, a "rate effect" of up to 2.812 accidents per 100.000 employees for the entire economy. Therefore, one injury every thirty-six employee. Below the average value calculated for the fifteen EU countries (3.013), and for the 12 Euro zone countries: (3.469). The existence of a significant under-ground economy in Italy leads to the conclusion that the actual standardized rates are slightly higher than those reported by Eurostat and thus similar to those of Germany (also a country with a manufacturing production structure ). As for Greece, the review of data on public debt, which occurred in 2009, could, perhaps in the future, lead to a reformulation of the statistics on Gross Domestic Product of this country, and consequently of under-ground economy and non-registered labour.

Based on data collected for year 2006, the rate of accidents at work Italy is in line with the European average, and rises slightly higher in the case of deaths. It is shown, however, that within the agricultural sector, the overall rate of accidents is well above European average.

**Table 2. Standardized accident rate per 100,000 employed.**

(Source: Elaboration on EUROSTAT data - Excludes injuries leading to absence from work for less than 4 days and commuting accidents.)

MEMBER STATES	2001	2002	2003	2004	2005	2006	Var. % 2006/2001
Spain	6.917	6.728	6.520	6.054	5.715	5.533	-20,0
Portugal	4.986	4.054	3.979	4.111	4.056	4.183	-16,1
France	4.819	4.887	4.689	4.434	4.448	4.022	-16,5
Luxemburg	4.585	5.131	5.033	4.439	3.414	3.685	-19,6
<b>Euro Area</b>	<b>4.426</b>	<b>4.035</b>	<b>3.783</b>	<b>3.638</b>	<b>3.545</b>	<b>3.469</b>	<b>-21,6</b>
Germany	4.380	4.082	3.674	3.618	3.233	3.276	-25,2
Belgium	4.242	3.685	3.456	3.306	3.167	3.077	-27,5
<b>UE – 15</b>	<b>3.841</b>	<b>3.529</b>	<b>3.329</b>	<b>3.176</b>	<b>3.098</b>	<b>3.013</b>	<b>-21,6</b>
Finland	2.973	2.914	2.847	2.864	3.031	3.008	1,2
Netherlands	3.588	1.442	1.188	1.070	2.653	2.831	-21,1
<b>Italia</b>	<b>3.779</b>	<b>3.387</b>	<b>3.267</b>	<b>3.098</b>	<b>2.900</b>	<b>2.812</b>	<b>-25,6</b>
Denmark	2.876	2.630	2.443	2.523	2.658	2.689	-6,5
Austria	2.763	2.788	2.629	2.731	2.564	2.394	-13,4
Greece	2.530	2.441	2.090	1.924	1.626	1.611	-36,3
Ireland	1.509	1.204	1.262	1.129	1.217	1.289	-14,6
UK	1.665	1.632	1.614	1.336	1.271	1.135	-31,8
Switzerland	1.500	1.347	1.252	1.148	1.130	1.088	-27,5

INAIL data indicate that in 2008 there were about 1.120 fatalities, i.e. 130 less than the 1.250 of 2007, showing, therefore, a decline rate close to 10%. In fact, since 1966, there has been slow and continuous decrease of white deaths in Italy. In that year, there were 3.744, while 1.120 cases were detected in 2008; a decrease in 32 years by 70%

**Table 3. Deaths: rates standardized incidence per every 100,000 employee in EU.**

(Source: Eurostat data)

MEMBER STATES	2001	2006
<b>Portugal</b>	<b>9,0</b>	<b>5,2</b>
<b>Austria</b>	<b>4,8</b>	<b>4,2</b>
Greece	2,9	3,8
Spain	4,4	3,5
France	3,2	3,4
<b>Italy</b>	<b>3,1</b>	<b>2,9</b>
<b>UE12</b>	<b>3,1</b>	<b>2,8</b>
Denmark	1,7	2,7
Belgium	3,8	2,6
<b>UE15</b>	<b>2,7</b>	<b>2,5</b>
Ireland	2,6	2,2
Germany	2,0	2,1
Luxemburg	1,7	1,7
The Netherlands	1,7	1,7
Finland	2,4	1,5
Switzerland	1,4	1,5
The United Kingdom	1,5	1,3

#### 4.1 Indicators to analyze Safety Performance

We consider the following indicators to analyze safety performance in European Union:

##### 1) Indicators based on the Added Value

Balance sheet indicators, generally used for the analysis of the economic management in an enterprise and to measure labour profitability, are often supported by per-capita indicators.

Through the comparison of the value added (VA) with the number of employees ((UL), it is possible to obtain the measures the contribution of each employees to the formation of the operating results.

In the same way the ratio between the sectoral added value and the number of sectoral accidents (AC), fatal and non fatal, is calculated in EU countries.

The ratio between VA (gross value added at basic price) and the number of accidents (AC) is a contribution of production to the security at work:

$$PAC = \frac{VA}{AC} \quad (2)$$

##### 2) Ratios based on Employment data

On the contrary, Total Frequency Rate (TFR) is defined as the number of accidents per 100.000 employees (see equation1). These rate must be standardized in order to integrate technical data submitted by member countries.

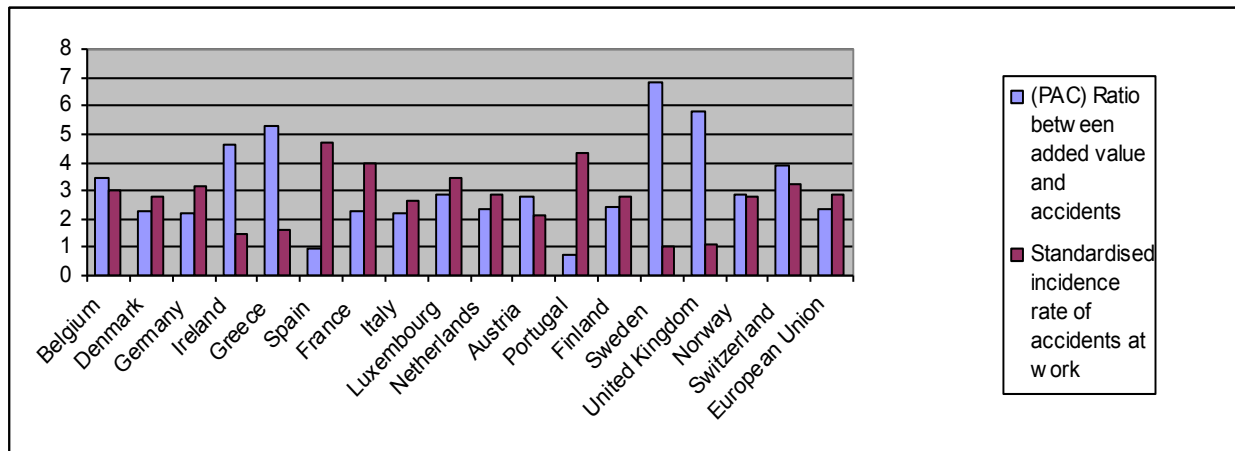


Figure 1. Comparing labour profitability and accidents at work.

##### Main results:

Through the ratios above outlines we define four clusters of countries with homogeneous characteristics:

1. Member States (MS) having an "universal Social Security system" that could strongly underestimate accidents: IE, SE (we observe a quite high PAC, see equation 2);
2. Member States having an "universal Social Security system" that don't underestimate accidents: DK, NL, NO. For Netherlands only survey data are available for the non-fatal accidents at work (a special module is included in the national labour force survey).
3. MS having "insurance based systems": in this case the declarations of accidents at work are made either to the public (Social Security) or to private specific insurance for accidents at

work or to other relevant national authority (Labour Inspection, etc.). The ones with value indicators near the to European average are: AT, BE, DE, IT, LU.

4. PT and Spain have an insurance based systems and high accident rates.

The following countries show some peculiar aspects:

- Greece (EL) has an "insurance based systems" and a large shares of self-employed workers; probably she overestimates GDP and/or underestimates accidents: in fact, data coverage of self-employed and family workers is limited because the first are excluded from the reporting and registration procedures;
- Italy has an high territorial variability;
- France shows both a quite high accident rate and an high value added production.

#### 4.2 *Delineating Sectorial Performance in the European Economy*

Total accident rate is influenced by sectorial breakdown of gross value added. Our goal is to eliminate the influence of industrial structure (manufacturing) from the total incidence rate of accidents for each country analyzed, to highlight "Service" contribution to accidents on the work. We calculate in table 4 that follows the relation between Total Accident Frequency rate (TFR) and Manufacturing Accident Frequency Rate (MFR):

$$contr^{(Serv)} = \frac{TFR}{MFR} \quad (3)$$

**TABLE 4. Relation between Total Accident Frequency rate and Manufacturing Accident Frequency Rate.**

<b>Countries</b>	<b>Contr(Serv)</b>
<b>Euro Area</b>	<b>0,90</b>
Belgium	0,93
Denmark	0,62
Germany	1,03
Spain	<b>0,64</b>
France	1,16
Ireland	0,62
Italy	0,81
Luxembourg	1,09
Netherlands	1,02
Austria	0,88
Portugal	<b>0,72</b>
Finland	0,86
Sweden	0,72
United Kingdom	1,25



In particular, we observe that:

- accidents at work is mainly a “Service sector problem” in UK; while in Ireland and Denmark, Manufacturing sector is more risky than the whole Economy. However, how it is explained in section 4.1, in Ireland accidents are underestimated.
- In Germany, Netherlands and Luxembourg we don't observe a particular difference in sectoral security at work
- For Greece it does not seem possible to analyze sectoral performance, since there is not enough coherence in these data
- For Italy, since we observe some great regional differences, we analyze the phenomenon more deeply in next section.

#### Some problems to underline

It is important to note that these useful indicators show data from administrative sources (accidents at work) and from statistical source concerning National Accounts (GDP and Employment). Therefore, during their interpretation, the following should be considered:

- the non-homogeneity of the sources of provenance
- the probability to have underestimated data regarding accidents at work, since they don't include underground economy: while data on employment (the denominator in the TFR indicator outlined above) includes most of the non-regular workers, the accidents (the numerator) should include injuries of legal workers and partly "serious injuries" of non-registered workers.

## **5. Risk of accidents and the underground economy**

The March 2004 Censis report titled: "The Value of Safety in Italy", stated that safety in Italy was not a social value yet. Indeed, Italian national data on injuries shows a certain variability at the regional level, explained through the following factors:

- different sectoral specialization (calculation problems outlined in the previous paragraphs can be extended to EU countries at national levels, as well as regional levels);
- the importance of underground economy and the presence of illegal migrant workers.

Regarding the latter, it is shown that available statistical data on accidents are influenced by the existence of an economy not directly observed<sup>1</sup>. It stems from an underground economy, illegal activities, informal activities and underground statistics.

Underground economy derives from the production of economic goods and services which, though legal, are not directly observable due to tax evasion phenomenon and lack of social security contributions. Informal economy is represented by the activities based on personal or family working relationships; casual jobs with no formal employment contract. While underground statistics relates activities not registered due to a lacking in the system of statistical data collection.

Thus, the concepts of legal and illegal employment are not necessarily related to those of registered and non-registered<sup>2</sup> productive activities. A statistical analysis of accidents caused by illegal employment concerns :

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<sup>1</sup> The national accounts (CN) follow Italian patterns and definitions of the European System of Accounts (ESA95), which requires that the economy not directly observed is accounted for in Gross Domestic Product.

- the continuation of operations carried out not according to current legislation;
- occasional work performed by students, retirees, housewives: a unit that is declared inactive
- non-resident and illegal aliens
- multiple activities not declared to Tax Office.

### 5.1 *A new approach to estimate accidents at work*

Estimates regarding shadow economy in each country of European Union can be used to calculate the "Effective Accident Rate" (EAR), that is equal to the accident rate shown in equation (1) increased by a percentage  $\alpha$  concerning the rate of shadow economy:

$$EAR = TFR + \alpha \cdot TFR^s \quad (4)$$

where TFR is calculated as in equation 1,  $TFR^s$  (the accident rate in the shadow economy) is obtained by an iterative procedure, considering TFR data from 2001 to 2006, for each country analyzed (and for every region when data are available): the algorithm stops when EAR is maximized. The underlying logic is that underground economy should have higher accident rates than the ones concerning the observed one.

If we consider the above algorithm and a sectoral disaggregation by  $n$  sectors, we can outline that:

$$TFR^s = \sum_{i=1}^n \omega_i \alpha_i TFR_i \quad (5)$$

The various sources of data concerning the rate  $\alpha$  of underground economy could also be weighted following a deterministic criteria concerning the reliability of the estimates;  $\omega_i$  is the weight of an economic sector on the total added value (alternatively, we could consider the weight of an economic sector in terms of employees).

Since the denominator of TFR in (1) also includes the employees in the shadow economy, while the numerator only considers accidents in regular economy, in calculating EAR we increase the standardized TFR by the component of accidents regarding underground economy.

In synthesis, the procedure can be structured as it follows, for each European country:

- Step 1. Definition of the historical series of TFR to use for the whole economy (all the economic sectors);
- Step 2. Definition of the different sources to use for the outlining of the underground economy (national official estimates, main literature references) and choosing of the weights to value the reliability for each source of data;
- Step 3. Calculation of the effective accident rate (EAR) for every economic sector;
- Step 4. Outlining of the EAR for the whole economy.

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<sup>2</sup> The Italian NA (National Accounts), at present, as well as other European countries, does not consider the illegal economy and therefore the non-registered workers are not related to illegal activities.

In table 5 that follows we highlight preliminary estimates from a synthetic experiment: the “Highest TFR” is outlined for each country considering data from 2001 to 2006; EAR (the effective accident rate that we estimate) and shadow economy data regard 2006.

**TABLE 5. The Effective Accident rate versus the Standardized Total Accident frequency Rate in 2006.**

<b>MEMBER STATES</b>	<b>TFR in 2006 (Official estimate)</b>	<b>HIGHEST TFR</b>	<b>SHADOW ECONOMY</b>	<b>EAR (Reviewed Estimate)</b>
SPAIN	5.533	6.691	20.2	6.885
PORTUGAL	4.183	4.498	20.3	5.096
FRANCE	4.022	4.887	13.2	4.667
LUXEMBOURG	3.685	5.131	9.4	4.167
GERMANY	3.276	4.380	15.4	3.951
BELGIUM	3.077	4.242	19.9	3.921
FINLAND	3.008	3.008	15.8	3.483
NETHERLANDS	2.831	3.588	11.2	3.233
ITALY	2.812	3.779	23.1	3.685
DENMARK	2.689	2.876	16.5	3.164
AUSTRIA	2.394	2.788	9.5	2.659
GREECE	1.611	2.530	26.0	2.269
IRELAND	1.289	1.509	14.5	1.508
UK	1.135	1.665	10.9	1.316
SWITZERLAND	1.088	1.500	8.3	1.213

We observe, in particular, that:

- Italian Effective Accident Rate is higher than the ones concerning Netherlands and Finland, while the official Eurostat data (not including underground economy) showed the contrary;
- Spain, Portugal, Belgium and Italy are the countries where underground economy increases very strongly the official accidents (we observe, by our *reviewed estimates*, about 1.000 accidents more than the *official estimate* for 100.000 employees for each of these countries).

The source for the estimation of the shadow economy is Schneider, Buehn (2009). We do the hypothesis, empirically confirmed by the Italian case below outlined, that there is a linear relation between the amplitude of the shadow economy and the accident rate regarding this black economy: the latter is directly proportional to the accident rate in the observed economy.

## 5.2 *The Italian case*

The rate of irregularity, calculated as percentage ratio between units of illegal labour of a territorial area and the total units of work employed in it, in Italy in 2009 was equal to 12.2% for the entire economy ( the highest level since 2003). Thus, the following breakdown by macro areas could be considered:

- 24.5% in agriculture (compared to 18.3% in 2003)
- 6.2% in industry (5.7% in 2003)
- 13.7% in the services sector (13.5% in 2003).

The South has rates well above the national average and other geographical areas, close to 18% of the total economy. The presence of economic phenomena developed, more or less, such as

underground economies surely alter the analysis of data taken from the archives of an administrative nature (see archives INAIL, INPS), for more details see [2].

Figures relating to accidents in the informal economy, as long as it has to do with an economy not directly observable, escapes the statistics of administrative bodies, (INPS, INAIL) and ad hoc surveys.

However, an attempt could be made for 2009 to give an assessment since ISTAT's estimates [8] for the said year sums up to 2.965.600 units of illegal work, approximately broken down to 2.653.800 in the industrial sector and 311.800 in the agricultural sector (on the basis of historical data available). Applying these Eurostat standardized frequency rates of accidents provided by INAIL (equivalent in 2006 to about 28 per every 1000 for the total economy, and 60 per every 1000 in agriculture) to the estimates, the accident that occurred in 2009 at irregular units should be approximately 74 million in the industrial and services sector, and 19 000 in the agricultural sector.

Therefore, in 2009, the last year with irregularities made available by ISTAT, about 93 000 accidents could be estimated with results of more than three days.

Eurostat statistics are compiled on the basis of reported injuries compensated by insurance benefits. Therefore, considering the relationship between reported and compensated cases (thus including those with absence from work for three days or more), and including commuting accidents (Table 6) that in 2007 amounted to 97.278 (and considering an autoregressive logic equal to more than 100.000 in 2009), that occurred from home to work and vice versa, a hypothetical rough estimate could be made of 135.000 for default accidents occurring among illegal workers in 2009 (without considering the values of the illegal economy).

There are no evidences that show that these estimates decreased significantly in 2010 due to the international economic crisis and the absence of a new legislation on the emergence of underground economy, such as those contained in the "Measures of 100 Days. It specifically refers to the Norms to encourage the emergence of underground economies, as contained in Chapter I of the 383 Law of 18 October 2001. The latter allowed, together with the Bossi-Fini amnesty law of 2002 on immigration, the reduction of illegal employment by 225.000 units between 2001 and 2002 and about 240.00 between 2002 and 2003, after it had risen by almost 63.000 work units per year between 1996 and 2001.

**Table 6. Types of accidents at work in Italy.**

Type of Occurrences	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006	Year 2007	Var% 2001-2007
Workplace	965.093	920.299	898.121	881.849	850.589	835.661	815.132	-15,5
Commuting	58.286	72.356	79.073	84.880	89.432	92.497	97.278	66,9
Total	1.023.379	992.665	977.184	966.729	940.021	928.158	912.410	-10,8

It is important to note that accidents involving illegal workers often go unreported, especially when they relate to minor events. Placed under the so-called principle of automatic compulsory social security benefits (Article 2116 Civil Code), even workers for whom the employer does not comply with insurance obligations have rights to the provision of the law. It is conceivable that accidents giving rise to the most serious and permanent disabilities are reported by the workers themselves or by the judicial police. It is therefore possible to synthesize the equation for calculating the dependent variable injuries of non-registered workers as follows:

$$Inf_{irr} = ULA_{irreg} * \alpha + commuting * \beta + \left(1 - \frac{Inf_{ind}}{Inf_{den}}\right) * Inf_{den} = 93.000 + 97.000 * 0,12 + 0,32 * 93.000 \approx 135.000 \quad (6)$$

Where  $ULA_{irreg}$  is the unit of illegal work,  $\alpha$  represents standardized frequency rates of accidents,  $commuting$  indicates accidents while traveling for work,  $\beta$  is the rate of national irregularities, and  $(Inf_{ind}/Inf_{den})$  shows relationship between compensation and reported injuries. The Italian underground economy issue is very interesting. In fact, it shows (Figure 2 below) a slightly negative correlation between the level of irregularities (Source: ISTAT) and the relative frequency of injuries<sup>3</sup> (Source: INAIL, calculated on the basis of accidents and workers compensation INAIL).

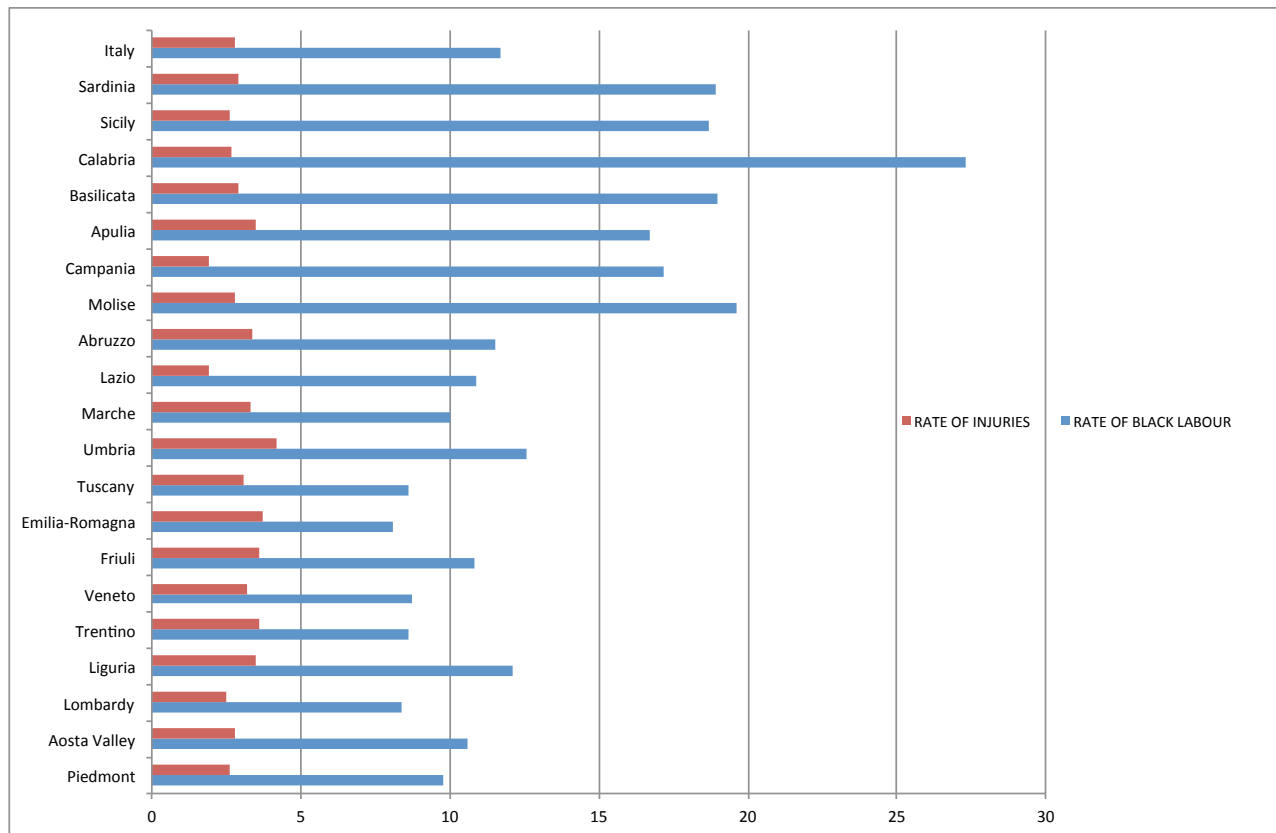


Figure 2. Unobserved Economy and Risks of Workplace Accidents in Italy.

Regions where underground economy is most prevalent tend to have a slightly lower percentage of workplace accidents and injuries than the total national index.

And since it is conceivable that resorting to illegality has beneficial effects on quality of work, thus reducing the number of accidents, it is entirely legitimate to say that, although higher,

<sup>3</sup> These rates are calculated by INAIL based on accident compensation rate compared to the "staff-year, annual work unit calculated on the basis of remuneration calculated by companies. This figure, unlike those of Eurostat, is not then compared to the population of the occupied and it is not standardized, but is very similar to them (2.8 against 2.9 injuries per 100 employees). The data presented for employees relate to the average 2005-2007, now available on the web pages of the INAIL database, and do not include commuting accidents. Rates of regional irregularities used in Diagram 1 concern year 2007.

accident rates in these areas of the country is lower due to failure to report the event to social security institutions and sometimes due to the influence of organized crime, particularly within the southern regions where there are large economic interests in underground economy. Figure 2 reproduced below makes it easier to understand this assumption.

In Table 7 below, it is relevant to analyze the relationship between the rate of black labour and the rate of injuries (B / A).

It is well above the national average (4.2) for all regions of the South (with a maximum of 10.1 in Calabria). Within the entire Central and Northern regions (with the exception of Lazio and Piedmont), it is below national average. Southern regions having a higher level of irregularity based on estimates by ISTAT, should, logically, have higher accident rates, or at least equal to that of the northern regions, which have with lower prevalence of underground economy.

**Table 7. Relationship between rate of black labour and injuries in 2007.**  
(Source: Elaboration on INAIL and ISTAT data)

REGIONS	Irregularity Rate in % (B)	Rate of Injuries per 100 employees (A)	B/A
Piedmont	9,8	2,6	4,8
Aosta Valley	10,6	2,8	3,8
Lombardy	8,4	2,5	3,4
Liguria	12,1	3,5	3,5
Trentino	8,6	3,6	2,4
Veneto	8,7	3,2	2,7
Friuli	10,8	3,6	3,0
Emilia-Romagna	8,1	3,7	2,2
Tuscany	8,6	3,1	2,8
Umbria	12,6	4,2	3,0
Marche	10,0	3,3	3,0
Lazio	10,9	1,9	5,7
Abruzzo	11,5	3,4	3,4
Molise	19,6	2,8	7,0
Campania	17,2	1,9	9,1
Apulia	16,7	3,5	4,8
Basilicata	19,0	2,9	6,6
Calabria	27,3	2,7	10,1
Sicily	18,7	2,6	7,2
Sardinia	18,9	2,9	6,5
<b>Italy</b>	<b>11,7</b>	<b>2,8</b>	<b>4,2</b>

Since the data show the opposite (and in fact the ratio B / A is higher in South ), the presence of a large number of accidents not reported could be easily identified in these abnormalities (and probably a little less, according to the previous survey), especially in Calabria, Sicily and Campania. All around the Southern regions, the percentage of injuries eligible for compensation not reported<sup>4</sup> could be estimated, most of which happened to illegal workers, alongside with accidents reported and compensated.

<sup>4</sup> Such value was obtained by hypothetically imposing, in the South (excluding Abruzzo), a ratio equal to the total injuries and irregularities in Italy (4.2%). It thus appears that approximately 78,000 injuries, as minimum estimate, in most cases "not very serious," are absolutely not reported to competent authorities.

It is therefore possible to use the following calculation method, which also takes into account unreported accidents, to synthesize the calculation of accidents in underground economy:

$$Inf_{irr} = ULA_{irreg} * \alpha + \beta * Itinere + \left(1 - \frac{Inf_{ind}}{Inf_{den}}\right) * Inf_{den} + Inf_{nonden} = 93.000 + 11.640 + 0,32 * 93.000 + 78.000 \approx 210.000 \quad (7)$$

These are estimates based on assumptions, that use variables sometimes measured through different methods and sometimes we must use deterministic imputation for missing data, in particular if we want to outline a sectoral analysis. Therefore, these figures should only be seen as approximate an measurement of the phenomenon. It is true, however, that more than 200.000 injuries, mostly involving illegal workers, represent almost 25% of the total injuries reported in 2008 by INAIL. Finally, we can estimate for Italy an “*effective accidents frequency rate*” that is near to 3.600 in 2006-2008, therefore similar to the Euro Area weighted average (see section 5.1 above).

## 6. Some conclusions

An international comparison of data shows Africa as the continent where there is more to be done to create environment for decent work. Asia increasingly shows a percentage of workplace accidents similar to those of the Western world, including progress within the world of work that is taking place in India and China. Asia remains the continent where most accidents happen because of its high rate of employment.

Italy, on the other hand, having shown constant improvement in the last years, accident levels have apparently fallen below the European average. However, this excessive underground economy issue and organized crime in the South (particularly in Calabria, Sicily and Campania), lead to failure to notify the enforcing authorities of accidents, or perhaps the altering of details of notification. As a consequence, the Italian actual rate of accidents could be considered slightly higher than the European average. It is also seen that in the agricultural sector, the overall frequency rate of accidents is well above the European average.

The presence of an economic phenomena like the underground economy, where massive, certainly affects the analysis of events taken from the archives of an administrative nature: a comparison between socio-economic surveys, and such files could provide a measurement of events not declared correctly.

A balanced statistical-economic analysis on the trend of the injuries cannot depend on the following considerations:

- the existence of economic structural peculiarities of each country (which recommends a detailed comparison of sector statistics, however);
- the need for consistent temporary comparisons to analyze the evolution of the phenomenon in every territory in question;

- computable statistical and economic indexes are clues and so should be considered together with appropriate qualitative and quantitative evaluations for the understanding of socio-economic phenomena.

The following elements could improve comparison of European statistics:

- higher completeness of data from member countries for occupational diseases;
- standardization of the industrial structures in NACE subsection or division (not solely on the level of NACE aggregate activities);
- standardization by sex and age and by working hours: part-time work, short-term contracts, hours of legal work, flexibility in work relationship.

Through some estimates based on assumptions, that use variables often measured using different methods or for different periods (but close), we observe, in particular, that:

Spain, Portugal, Belgium and Italy are the countries where underground economy strongly increases the official accident estimates: we observe, by these reviewed estimates, that illegal workers represent, for each of these countries, about a quarter of the total injuries reported in 2006 by Official Estimation.

Future developments of the work could be based on the sectoral estimation of accident rate at work for all the countries of UE, including Lithuania and Romania, where last available official statistics (OECD, 2003) show the presence of a large underground economy to investigate.

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