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Analysis

Estimating a meta-damage regression model for large accidental oil spills

Maria Alló, Maria L. Loureiro *

Department of Economic Theory, University of Santiago de Compostela, Santiago de Compostela, Spain

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ABSTRACT

Oil spills cause major damage to both a wide range of economic sectors and the environment. It is therefore important to anticipate the potential damage caused by these types of disasters, which can occur under many different and unpredictable circumstances. In this paper we study the main determining factors of the damage caused by oil spills, focusing in particular on the role played by the legislation applied in preventing these accidents. We find that more restrictive legislation reduces the economic damage caused by vessel oil spills. Based on the results of this international meta-regression, we are able to predict the marginal contributions to the damage function of the most relevant causing factors. These estimated damages can be used for rapid evaluations in the future, in cases where a direct damage assessment is not possible.

1. Introduction

There is a heavy dependency on oil consumption around the world. Data show that in the 36 years from 1973 to 2009, consumption increased by more than 53.93% (IEA, 2011). This increase in worldwide oil consumption also increased the overall likelihood of spillages (Jin and Kite-Powel, 1995). Vessel oil spills are incidents that cause a major impact on the environment and the economy of the affected areas. Often, these incidents affect fishing, tourism and other related sectors of the economy. The seriousness of this damage has been highlighted by various impact assessment studies conducted after catastrophic spills, such as those from the Amoco Cadiz (Grigalunas et al., 1986), Exxon Valdez (Carson et al., 1992), Erika (Bonnieux and Rainelli, 1993), Sea Empress (Moore et al., 1998), American Trader (Chapman and Hanemann, 2001) and Prestige (Loureiro et al., 2006), among others.

According to data from the International Tanker Owners Pollution Federation Limited (ITOPF, 2010a),[1] the total number of oil spills has decreased in the last 41 years worldwide. The ITOPF database contains data on spills since the 1970s, and has found a significant decrease in both the number of accidents and the total amount spilled over the years, although spills are still a frequent occurrence. However, according to the last ITOPF (2010a) report, a few very large incidents are responsible for a high percentage of the total oil spills worldwide. Since 2000, 182 major vessel oil spills have been registered worldwide, resulting in 212,000 tons of oil being lost. However, about thirty-five per cent of this amount was spilt in just 2 incidents (the Hebei Spirit and Prestige oil spills), not taking into account the recent Deepwater Horizon incident in the US.

Given this background information, it seems necessary to focus on the causes of these accidents, since they can have significant effects on the final oil spill size and on the total costs and damage caused. According to ITOPF (2010b), most oil spills result from routine operations such as loading, discharging and bunkering. The quantities spilt in these types of accidents are usually less than 7 tons per incident. In this particular analysis, we will focus on accidental vessel oil spills.

The geographical distribution of accidental oil spills is another factor to consider, given its importance due to the different liability regimes in place. As will be described later, there are two main liability regimes in place throughout the world: the liability-based American Oil Pollution Act (OPA) enacted in 1990, and the international protocols of the Internacional Maritime Organization (IMO) (2010), with limited compensation based mainly on a limited liability system. For this reason, one of the purposes of this paper is to make predictions available via a meta-damage regression for the total damage caused by vessel oil spills in different geographical areas. These estimates may be particularly relevant in situations in which a direct impact assessment study is not feasible (due to the lack of time or resources to carry it out). Studies such as those of Kontovas et al. (2010) conducted analyses of oil spill costs through the IOPCF data, providing results that can be used to estimate the benefits of regulations that deal with the protection of marine environment and oil pollution prevention. We extend their analysis in two main ways: a) by including not only the IOPCF dataset but also other sources of international data; and b) by modeling the damages not only as a function of the size of the spill, but also as a function of vessel, incident, and regulatory related variables. Thus, the present study departs from the previous literature, and sets out to analyze whether countries in which stricter laws are applied have less costly incidents than countries with more relaxed laws. A second objective is to assess the impact of the

* Corresponding author. Tel.: +34 881811674; fax: +34 981547134.
E-mail address: maria.loureiro@usc.es (M.L. Loureiro).

[1] The International Tanker Owners Pollution Fund is a not-for-profit organization involved in all aspects related to ship-source spills of oil, chemicals and other substances in the marine environment.

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various causes of spills on the total damage caused, so that prevention policies can be properly articulated.

Consequently, the following model contains a statistical analysis of a large collection of observations from individual vessel oil spills around the world, with the aim of drawing up some general findings about their causing factors (Glass et al., 1981), and the contribution of each of the factors to the total damage. The rest of the paper is organized as follows: Section 2 presents a review of the literature on the legal situation and the most substantial changes that have occurred over the last decades. Section 3 describes our data sources, while Section 4 presents the econometric models and the research hypotheses. Section 5 contains the results, and the paper concludes with the discussion presented in Section 6.

2. Legal Environment

Worldwide, it is possible to distinguish between two generic types of liability regimes widely applied in tort law: strict liability and negligence. Under strict liability, polluters must always compensate their victims for the total damage caused, regardless of the amount of care exercised. Under the negligence system, polluters must compensate victims for the damage caused only under the following circumstances (Shavell, 1984). First of all, if there is evidence that the polluters acted negligently; secondly, if the polluters did not use all means at their disposal to avoid the accident; and thirdly, if the polluters acted in bad faith. Therefore, the strict liability system should generate higher levels of environmental quality, since it is more severe with polluters. Strict regulation imposes the total costs of any harm on the injurer. It can therefore be compared to a price instrument, given that the injurer pays a price for conducting a particular activity, while the negligence rule is rather a quantity instrument, where the injurer pays a price for failure to comply with a given standard of conduct (Segerson, 2002).

The topic of strict liability has been explored and discussed in a large number of previous studies. It has been argued that liability can be considered as a potential policy tool for controlling environmental risks if firms internalize environmental costs (Opaluch and Grigalunas, 1984). In particular, Shavell (1984) uses an accident occurrence model to analyze the role of liability and safety regulations as means for controlling risks. He concludes that liability is not better than regulation, but that the joint use of both provides greater benefits, based on the fact that the regulator does not have perfect information about the risks. Alberini and Austin (2002) conclude that enforcing strict liability for the cost of cleaning up pollution sites raises the level of care taken by firms and thus reduces the frequency and severity of spillages. However, the effects of strict liability vary with the size of the firm, with smaller companies being associated with the occurrence of more incidents where stricter laws are applied. Therefore, in order to conduct an assessment of the liability regime on the occurrence of vessel oil spills, other factors must be taken into account, such as the assets of the shipping firm, its size, the chance of escaping liability, the time and place of occurrence, and the potential damage caused.

As previously stated, and specifically in terms of regulating oil spills, there are currently two different regimes to be considered: one is a common international regime applied by all members of the IMO and the other is the strict liability regime applied by the US and regulated by the Oil Pollution Act (OPA), 1990. The international regime emerged after the Torrey Canyon oil spill in 1967, while the US regime was established after the Exxon Valdez oil spill in 1989. Both incidents confirmed the need for new legislation on liability and financial responsibility in oil spill accidents and on compensation regimes (Kim, 2003). However, the US regime imposes unlimited liability and compensates damage to natural resources, while the international regime imposes a system of limited liability with characteristics similar to a negligence system, and excludes compensation for environmental damage. Table 1 presents a summary of the different conventions and dates of the various regulatory changes behind the international limited liability protocols in place in all IMO countries.

The approval of the OPA-90 has strengthened accountability for vessel oil spills in the US waters. It has also improved the nation's ability to prevent and respond to oil spills by establishing provisions that expand the government's ability and provide the money and resources necessary to respond to them. Moreover, the OPA-90 has increased penalties for polluters, broadened the response of the authorities and preserved state authority to establish law governing oil spill prevention and response (US Environmental Protection Agency, 2011).

Most other countries apply the international IMO regime. The IMO is a specialized agency of the United Nations which deals with marine affairs and pollution. This organization was set up in 1982 and has drawn up numerous conventions and restrictions in order to improve marine safety and reduce pollution. However, the IMO has no enforcement capacity over signatory states of the protocols, and the safety standards are voluntary for each nation. Currently, and after 1992, two protocols known as the Convention on Civil Liability for Oil Spill Damage (1992 CLC) and the International Fund for Compensation for Oil Pollution Damage (1992 Fund Convention) are being applied.

However, according to Loureiro (2008) the international conventions on civil liability (CLC) and their corresponding liability funds did not provide sufficient incentives to decrease the probability of oil spills occurring at international level. Thébaud et al. (2005) showed that there is a significant difference between the amounts claimed as damages and the payments received as compensation from the CLC funds. In particular, the maximum amount of compensation paid by the 1992 Fund Convention with respect to an incident that occurred prior to 1st of November 2003 was set at US$ 205.6 million. This amount increased up to US$ 309.1 million in November 2003.[2] However, due to a shortage of funds for compensation, and in the wake of the multiple complaints following the Prestige oil spill in Spain in November 2002, this Fund has been reinforced by an additional Supplementary Compensation Fund that increases the compensation of victims of oil pollution from oil tankers to US$ 1142 million. This Supplementary Fund covers accidents occurring after the entry into force of the Protocol on 3rd March 2005 (ITOPCF, 2011).

In the following analysis, we assess the marginal contribution of the various factors that cause accidental oil spills to the total damage, and we predict total damage with a meta-regression. These predictions can be used so that future compensation claims can be more concordant with the damage caused.

3. Data Description

We collected data on oil spill damages from different databases, including the International Tanker Oil Pollution Fund (ITOPF, 2010c), the French *Centre de Documentation de Recherche et d'Expérimentations sur les Pollutions accidentelles des eaux* (Cedre, 2011), and the Damage Assessment, Remediation and Restoration Program (2011) database. All spills that contained a damage assessment were included into the dataset. The ITOPF database contains information on incidents that have occurred in IMO member countries, providing information on claims filed by countries and individuals, as well as the final compensation paid by the ITOPF. A different database used was the Center for Tank Ship Excellence (CTX-4), from which we collected information on the technical characteristics of ships involved in oil spills since 1903. In order to complete missing information about the characteristics of the vessels or the accidents, we have also used information provided by Grey (1999), the OECD (2004), the National Oceanic and Atmospheric Administration (NOAA) (1992) and the web database of the GL Group (2012).[3]

[2] This information is available at: http://www.iopcfund.org/compensation.htm.

[3] Which provides assurance, consulting and classification for the maritime and energy industries http://www.gl-group.com/en/group/aboutGL-Group.php.