Influence of attitudes and perceptions on deprivation cost functions

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ABSTRACT

Appropriate objective function for post-disaster humanitarian logistics models must be a matter based on minimizing social costs. Such social costs require the estimation of proper Deprivation Cost Functions (DCFs). This paper estimates more explanatory DCFs by analyzing the role of psychosocial factors using hybrid Latent Variable – Discrete Choice Models with data from a stated choice survey applied in Colombia. The results demonstrate that risk perception, safety culture, and confidence in Emergency Response Systems play a major role in an individual's disaster preparedness and in capturing individuals' heterogeneity for the estimation of DCFs.

1. Introduction

Natural disasters have a severe negative impact on a population's quality of life and health. This impact is even higher in developing countries (Halgamuge and Nirmalathas, 2017) where the vulnerability is higher than in developed countries due to many people living in high-risk areas prone to natural disasters, exposed to extreme weather, or where poorly constructed buildings become rubble and cause massive loss of life. Frequently, urban and rural areas lack early warning programs or Emergency Response Systems (ERSs), further aggravating the vulnerability.

At the same time, major disasters (catastrophes) generate an impact on society that affects their responsiveness severely. Technically, a catastrophic event is one in which the role of local supplies in the response is minimal. They are mostly destroyed, creating scarcity, which means that those affected must cope with deprivation and suffering. Additionally, the response of the emergency organizations is delayed since their facilities and operational bases are themselves hit. Private sector supply chains cannot help in the response since they are often severed or destroyed (Holguín-Veras et al., 2012).

The absence of functioning markets preventing individuals from buying, selling or trading goods or services is one critical feature of catastrophes (Holguín-Veras et al., 2013). As a result, the demand for essential supplies increases rapidly as well as personal suffering, necessitating the most immediate response possible from relief agencies. This measure of suffering is known in scientific literature as Deprivation Costs (DC), which are externalities associated with delays in aid distribution after disasters (Cantillo et al., 2017b; Holguín-Veras et al., 2013; Pérez and Holguín-Veras, 2015). The more delayed the response, the lower the survivors' welfare and their ability to cope with the impact of the disaster (Cohen, 2008).

Usually, in post-catastrophe environments, the relief supplies available are frequently not sufficient to meet the needs of all those affected. Then, aid agencies must decide on how best to allocate the scarce resources available while, at the same time, account for their logistics costs. This trade-off between the impact on beneficiaries and logistics costs is, according to scientific literature, the best way to provide life-saving emergency assistance for persons in need. This balance allows for achieving a socially optimal level of distribution of the available resources (Cantillo et al., 2017b; Holguín-Veras et al., 2012; Holguín-Veras et al., 2013).

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In line with this idea, (Balza-Franco et al., 2017; Chapman and Mitchell, 2016; Khayal et al., 2015; Pérez and Holguín-Veras, 2015; Rivera-Royero et al., 2016) developed humanitarian logistics models based on social cost minimization. Those models include the logistics costs carried out by the relief groups and the deprivation costs perceived by individuals due to delays in relief distribution. The social cost is essential because the deprivation costs, which are higher than the logistics costs, are not reflected in the market price of goods. Such deprivation costs are the opportunity costs of the delivery strategy since the amount of distributed supplies do not meet all demands and they will increase exponentially as the affected wait for supplies increases (Cantillo et al., 2017a; Holguín-Veras et al., 2016; Holguín-Veras et al., 2013; Pérez and Holguín-Veras, 2015). Indeed, if the relief groups do not consider the deprivation costs in the decision-making process, the possibility of achieving effective outcomes diminishes as real needs created by the disaster are not satisfied, and supplies take a longer time to become available (Holguín-Veras et al., 2016; Holguín-Veras et al., 2013). Therefore, it is critical that humanitarian aid operations develop appropriate approaches for estimating these costs that can support the efficient allocation of resources.

The estimation process of these deprivation costs is not a trivial task since it was demonstrated that they depend not only on the deprivation time but also on the socioeconomic variables of individuals (Cantillo et al., 2017b). The current deprivation costs modeling efforts have allowed for estimation of Deprivation Cost Functions (DCFs) as a proxy of this externality, which have a monotonically increasing, nonlinear and convex structure with respect to the deprivation time (Cantillo et al., 2017a; Cantillo et al., 2017b; Holguín-Veras et al., 2016; Holguín-Veras et al., 2013; Pérez and Holguín-Veras, 2015). Holguín-Veras et al. (2016) estimated DCFs using the Contingent Valuation (CV) method while Cantillo et al. (2017a; 2017b) proposed a microeconomic approach based on the classical consumer theory to estimate DCFs. When using discrete choice techniques, DCFs are estimated from the economic valuation that individuals give to the elapsed time without access to particular types of supplies, estimated through the change in consumer surplus. An alternative approach for evaluating the degree of human suffering caused by the lack of access to a good or service is to estimate deprivation level functions using a numerical rating scale (Wang et al., 2017)

If deprivation costs are considered assuming a homogeneous population, the attention process of the affected will be inequitable since disasters have different consequences for specific social groups. Children, for example, are more exposed to risks due to their limited possibilities of surviving by themselves; the elderly face reduced mobility and physical limitations, while pregnancy is a biological aspect that increases the vulnerability of women. That is why some socioeconomic aspects of the affected have been considered in previous considerations of DCFs, such as age, gender, and the presence of multiple children at home (Cantillo et al., 2017b). However, some psychosocial factors, such as attitudes and perceptions have not been studied yet, which can play an essential role in capturing an individual's heterogeneity for the estimation of DCFs and explaining the behavior of those affected during a disaster situation.

As a result of these theoretical gaps, a novel approach to estimate more explanatory DCFs was proposed, including the influence of personal attitudes and perceptions on disaster preparedness, as well as the relationship between these latent factors and the socioeconomic characteristics of individuals. Using a stated preference survey, Hybrid Latent Variable – Discrete Choice Models (HLVDCMs) were estimated with different functional forms and used data collected in Colombia.

Attitudes and perceptions related to risk perception, safety culture, and confidence in ERSs were included as explanatory variables in the estimation of DCFs. As a result, two DCFs were estimated, which can be considered in models used in humanitarian logistics. This paper demonstrates that these latent factors play a significant role in an individual's disaster preparedness and capture an individuals' heterogeneity for the estimation of DCFs. The organization of the paper is as follows: the next section presents a theoretical framework for previously estimated DCFs and their relationship with HLVDCMs. Section 3 presents a description of the attitudinal and behavioral indicator variables studied. This section also describes the data collection process, placing particular emphasis on the experiment design used in this research as well as in the descriptive analysis of the sample. Section 4 presents the model specifications. Section 5 gives the estimation results and its analysis. The last section presents relevant conclusions.

2. Theoretical framework

This section provides an overview of the relevant literature associated with the estimation of DCFs and HLVDCMs.

2.1. Antecedents on deprivation costs functions

Deprivation cost (DC) is a topic that, in the context of disasters, has been studied for the last few years. Holguín-Veras et al. (2013) define DC as "*…the economic value of the human suffering caused by a lack of access to a good or service…*" which can be mathematically approximated by DCFs. Such DCFs have a monotonically increasing, nonlinear and convex shape with respect to deprivation time (*DT*). In essence, DCFs reflex the welfare loss that individuals perceive due to a period of time without consumption of essential supplies (Cantillo et al., 2017a; Holguín-Veras et al., 2016; Holguín-Veras et al., 2013; Pérez and Holguín-Veras, 2015).

From the humanitarian logistics point of view, persons affected by catastrophes experience cycles of deprivation caused by a lack of essential supplies for survival, such as water, medicine, and food. These critical supplies are scarce, difficult to get, and, in high demand in the short-term after the occurrence of a catastrophe, which leads to a progressive increase in human suffering (Holguín-Veras et al., 2016; Holguín-Veras et al., 2013; Pérez and Holguín-Veras, 2015). Consequently, when essential supplies or services are provided to those affected by disasters promptly, the level of suffering reduces.

As a result of the fact that in situations of catastrophes the tradeable market disappears, it is necessary to use economic valuation techniques, which are appropriated to estimate the value of non-market goods (Bateman et al., 2002). According to Holguín-Veras et al. (2016), an individual who is experiencing deprivation is willing to pay for an item is determined by their ability to pay and their