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Dengue endemic and its impact on the gross national product of BRAZILIAN'S economy

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ABSTRACT

In history disease has caused social and economic damage. Dengue is an illness typically found in the tropics that has affected more and more people. In Brazil, according to the Brazilian Institute of Geography and Statistics (IBGE), in 2013 at least 12.9% of the population (25.8 million) reported already having had dengue in their life. So, how wide are the economic impacts that dengue's contagion has on the gross national product? Using Leontief's method, it became possible to estimate the direct and indirect impact on the workforce and output by one country. Workforce absenteeism reduced the national productiveness and welfare state where we found maximum inoperability of 0.027% and a minimum of 0.002%. This paper develops a methodology for estimation of the impact dengue has incurred in each sector of an economy; designing a ranking with sectors that have been more affected and forecasting the propagation of the endemic throughout a region. This research measures the impact of dengue on economy, the result was that the total loss of the Brazilian economy in 2013 was around BRL 1,023,174,876.83; the importance of 0.02% of the Gross Domestic Product.

1. Introduction

Dengue is a mosquito-borne viral infection that causes flu-like illness. It's commonly said that a person has contracted dengue, but more correct is to say that he one was bitten by the dengue mosquito. Dengue is a virus and the dengue mosquito is the *Aedes Aegypti*. The clinical cases of serotype are cataloged in DEN 1,2,3,4; in Brazil it's possible to find all serotypes.

Dengue cases have grown rapidly. According to the WHO (World Health Organization) 40% of the world population is at risk of contracting dengue and it can cause a great impact on the global economy. Various studies have sought to estimate dengue impacts globally, mainly in Latin America and Asia, Shepard et al. (2011) and Suaya et al. (2009).

The natural or man-made disasters have various levels of impact, from simple absence to total elimination of productive factor. Workforce absenteeism as a result of dengue has a negative impact on the national product resulting in economic loss. This paper is not looking to estimate the risk of dengués perturbation of the national product, but to compute an approximation of workforce absenteeism in the Brazilian economy. In general, the academic investigations elaborate possible scenarios for disasters, and the numbers of scenarios depend on the complex level of perturbation, the number of impacted sectors, and the workforce involved. The failures of economic systems vary on a scale of normal to complete failure. So, in especial case of dengue, the recovery of the workforce is relatively fast.

The present study focuses on two contributions: a developed method of study of the impact of dengue on the workforce and to estimate the economic loss for 2013. The next section discusses the data set used in the research, the data harmonization, and the number of sectors analyzed. Section 3 has a brief discussion about the Leontief model, an inoperability method. The impact of dengue on workforce and economic loss are exposed in the Section 4. Finally, in the last section we describe the results obtained in the processing of models.

2. Material and methods

William Petty (1623–1687), Richard Cantillon (1697–1734), and Franc¸ois Quesnay (1694–1774) developed the fundamentals for input–output methodology. But was from Leontief's studies that input-output matrices gained popularity. Leontief's inverse was established as an efficient method of estimation of direct and indirect impacts of changes in economic variables.

Input-Output Tables (IOT) for Brazil are available from the National Statistic Department (IBGE). The last table was released by IBGE on its website in 2005 and shows 55 economic activities and 110 products.

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Nomenclature

c^*_i	Demand pertubation vector by sector
$\widetilde{w}_i$	Workforce impact-remuneration
$\tilde{x}_i$	Degraded output
$\hat{x}_i$	Diagonal matrix output
$¥_i$	Remuneration ($)-worked-year- sector i
h_i	Number of DEATHS reported sector i
r_i	Economic sector
Φ_i	Size of workforce-year- sector i
Ψ_i	Sector economic loss
Ω_i	Total national economic loss
A*	Interdependency matrix normalized with respect to the total input
$LAPI_i$	Local area persona income sector i
c_i	As-planned demand sector i
d_i	Degraded demand sector i
f_i	Number of DF reported sector i
s_i	Number of DHF/DSS reported sector i
t_i	Unavaliable sector i
t_i^h	Time no-work deaths cases sector i
t_i^f	Time no-work for DF cases sector i
t_i^s	Time no-work for DHF/DSS cases sector i
x_i	As-planned output

However, as our goal is to reach more current calculations we have use the input product matrices from 2013, provided by NEREUS Guilhoto and Sesso Filho (2010) and Guilhoto and Sesso Filho (2005) group. The tables contain 68 sectors, 128 products and are based on National Accounts published in 2015.

Regarding employee data on those infected by dengue, it was considered that the proportion of mothers whose absence from work to care for their sick children with dengue or DHF/DSS coincided with the percentage of children with dengue. At first we thought to exclude children from the calculation of the impact on the workforce but we consider that for each child infected a father or a mother wasn‘t working, this is just a model assumption. In relation to wage, the wage received per week by each sector of 52 weeks/year from national accounts was considerable.

Brazil is officially divided into five geographical regions and with different economic and climatic characteristics. There was uncertainty if the number of dengue cases recorded in each region, in relation to the total number of cases registered in Brazil, was different from the proportion of number of employees in each region in relation to the total number of jobs. To our surprise, the proportions found were very similar, which successfully facilitated the allocation of those affected by economic sector.

The reports of those infected by dengue doesńt include detailed information on profession, years of study, if the sick are employed or unemployed, in what sector they are working, or the individual time of absence. From an improved database, estimates of the impact on GDP may be more detailed and accurate. At the moment we are forced to make estimations with variables that are officially provided by official agencies.

Our starting point is a brief explanation about the basic input-output equations.

$$Z + Y = X \tag{1}$$

Where Z is a matrix which represents the coefficients of intra and intersector (intermediate goods), Y is a vector which are denoted final demand, finally, X is a vector where the elements represent the gross value of production. Eq. (1) can be represented in terms of technical coefficients (A), known as direct matrix coefficients, since A may be defined as:

$$A = Z(\hat{X})^{-1} \tag{2}$$

Where $\hat{X}$ is the diagonal matrix $\hat{X}$ (gross production) and each element of the direct coefficient matrix (A) is defined as follows:

$$a_{ij} = z_{ij}/X_j \tag{3}$$

Where a_{ij} is called input-output ratio, technical coefficient or direct application coefficient. Each a_{ij} element provides information about the direct effects of an exogenous change in final demand. By Eq. (4), you can see that the ratio of technical coefficients is a fixed relationship between the inputs used in production and the total produced by each sector.

Introducing the general equation between output and final demand (c) we have:

$$x = Ax + c \tag{4}$$

For estimation of coefficient matrix:

$$A = T < pb >^{-1} \tag{5}$$

Where A is defined as consequence of the T transactions matrix divided by the gross production column vector invested and diagonalized, Borges and Montibeler (2014). Manipulating expression 2 it's possible to find a new equation to determine the output:

$$x = (I - A)^{-1}c \tag{6}$$

Ramping up of production and complex interdependence among economic sectors has increased the importance of the Leontief inverse. This method is very efficient to calculate the direct and indirect impacts of production from endogenous or exogenous perturbation. For more details about previous development equations we suggest, Miller and Blair (2009).

But, the Leontief inverse is defined as:

$$L^I = (I - A)^{-1} \tag{7}$$

The Leontief inverse is an important concept and easy to handle. Their extension and applications provide important studies.

2.1. Inoperability input-output model

The study about Inoperability Input-Output has received special attention in the literature and more and more studies have applied this methodology in the measuring of natural or man-made disaster that damage the productive structure. A detailed search for the term “inoperability” in more important specialized journal in input-output models: Economic Systems Research, was found 13 results Lian and Haimes (2006) developed and applied to the concept of important work.

More recently Dietzenbacher and Miller (2015) published a paper making “reflections on the inoperability input-output model” and their conclusion was that this model is a straightforward application of standard input-output model. Others interesting work has been done, for example: study about “Northeast Blackout”, Anderson et al. (2007), “resilience measure”, Jonkeren and Giannopoulos (2014), “economic losses”, Okuyama and Santos (2014), “port shutdown”, Rose and Wei (2013), “global economic effects due to the disruptions in the automotive industry”, Arto et al. (2015), “pandemic scenario”, Orsi and Santos (2010), “Biofuel Subsidy”, Santos et al. (2008). Also can add other publications like “economic and natural disasters”, Dacy and Kunreuther (1969), “urban transportation”, Gordon et al. (2004). These studies are relevant to the estimation and projection of possible economic, and social, impacts of great disturbances.

The first step towards the construction of the model is to normalize the standard production equation: