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# The productive interdependence of tourist activities in Brazil

## A interdependência produtiva das atividades turísticas no Brasil

## La interdependencia productiva de las actividades turísticas en Brasil

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**Keywords:**

Tourism;
Input-Output;
Hypothetical Extraction;
Structural Decomposition Analysis.

**Abstract**

This paper examines the production linkages of Tourism Characteristic Activities in the Brazilian economy and breaks down the output variation of these activities into technological change and final demand effects. To do so, we use the hypothetical extraction and structural decomposition methods based on the Brazilian input-output matrices of 2010 and 2015. The main results show that the absence of tourist activities would cause a 0.83% reduction in the total output in Brazilian economy, and the impacts caused by the absence of the purchasing and selling structures of these activities were relatively low, which can be partially explained by the fact that tourist activities are oriented towards final demand. Furthermore, variations in the output of tourist activities are predominantly explained by the behavior of final demand, with a reduced impact of technical progress. Household consumption and exports are the ones that contributed the most to the variations in output.

**Palavras-chave:**

Turismo;
Insumo-Produto;
Extração Hipotética;
Análise de Decomposição Estrutural.

**Resumo**

Este artigo analisa os encadeamentos produtivos das Atividades Características do Turismo na economia brasileira e decompõe a variação do produto dessas atividades em mudanças tecnológicas e efeitos de demanda final. Para tanto, foram utilizados os métodos de extração hipotética e decomposição estrutural baseados nas matrizes brasileiras de insumo-produto de 2010 e 2015. Os principais resultados mostram que a ausência de atividades turísticas causaria uma redução de 0,83% na produção total da economia brasileira e os impactos causados pela retirada das estruturas de compra e venda destas atividades foram relativamente baixos, o que pode ser parcialmente explicado pelo fato das atividades turísticas estarem orientadas para a demanda final. Além disso, as variações na produção das atividades turísticas são predominantemente explicadas pelo comportamento da demanda final, com impacto reduzido do progresso técnico. O consumo das famílias e as exportações foram os que mais contribuíram para as variações do produto.

**Palabras clave:**

Turismo;
Entrada-Salida;
Extracción Hipotética;
Análisis de Descomposición Estructural.

**Resumen**

Este artículo examina los vínculos de producción de las actividades características del turismo en la economía brasileña y desglosa la variación de la producción de estas actividades en cambios tecnológicos y efectos de la demanda final. Para ello, utilizamos los métodos de extracción hipotética y descomposición estructural basados en las matrices input-output brasileñas de 2010 y 2015. Los principales resultados muestran que la ausencia de actividades turísticas causaría una reducción del 0,83% en la producción total de la economía brasileña. y los impactos causados por la ausencia de estructuras de compra y venta de estas actividades fueron relativamente bajos, lo que puede explicarse en parte por el hecho de que las actividades turísticas están orientadas a la demanda final. Además, las variaciones en la producción de las actividades turísticas se explican predominantemente por el comportamiento de la demanda final, con un reducido impacto del progreso técnico. El consumo de los hogares y las exportaciones son los que más contribuyeron a las variaciones del producto.

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## 1 INTRODUÇÃO

Tourism is an economic activity that has been gaining prominence in recent years. Since the 1990s, it has become one of the largest sectors of the global economy (Capobe & Boix, 2008). According to the World Travel and Tourism Council (WTTC, 2020), in 2019, the impact of tourism accounted for 10.3% of global GDP, generating 330 million jobs, which represents 10.4% of total employment worldwide. In the same year, tourism accounted for 7.7% of the Brazil's GDP.

The practice of tourism directly and indirectly propels various sectors of the economy, generating a multiplier effect that drives the economic development of the host locality. This occurs because tourists demand not only touristic services but also goods and services from other sectors (Ribeiro & Lopes, 2015), causing the income flow generated by tourism to circulate within the local economy (Santos et. al, 2018).

Faced to the chain reaction resulting from tourism, many countries, especially those in the developing stages, leverage their tourist attractions as an opportunity to, for instance, acquire foreign exchange, establish local business activities (Mosedale, 2006), and consequently stimulate the economic growth of their economies. Atan and Arslanturk (2012) emphasize that the expansion of marketing products and services to meet tourists' demand provides a clear rationale for acknowledging the increasingly relevant role of tourism in any economy.

Given the economic relevance of tourism, it is crucial to consider the impacts resulting from the practice of this activity in the development and planning of policies (Surugiu, 2009). There are several methods available to estimate and measure the impacts caused by tourism, among which the input-output model stands out. Widely employed in the literature to measure the tourism economic impacts (Archer, 1995; Archer & Fletcher, 1996; Casimiro Filho & Guilhoto, 2003; Surugiu, 2009; Haddad et al., 2013; Ribeiro et al., 2017; 2022), the input-output model is notably used. However, like any model, there are limitations in which, West and Gamage (2001) emphasize the overestimation of multiplier effects resulting from the strict linearity structure of the model. Therefore, the obtained results should be interpreted with caution.

Within this context, this article poses the following question: What is the importance of Tourism Characteristic Activities (TCAs) for the Brazilian economy from a structural perspective? The objectives are: i) to analyze the production linkages of TCAs in relation to the Brazilian economy; and ii) to breakdown the variation in the production of tourism-related activities into effects of technological change and final demand for the years 2010 and 2015. To accomplish this, hypothetical extraction and structural decomposition methods are employed using information from the official input-output matrices of Brazil for 2010 and 2015.

The tourism sector, according to Fletcher (1989), interfaces with various economic sectors, making it important to understand both the interdependence among the activities that constitute tourism and the economic impacts its expansion may cause. In this regard, Pedauga *et al*. (2022), employing a structural analysis through linkage indices and hypothetical extraction analysis to assess the potential of tourism in India, and concluded that the effects of the tourism sector's development, in addition to contributing to activities and job creation in sectors directly related to tourism, could also impact other economic activities. This impact may manifest in the generation of employment in other sectors or in the overall increase in the economy's production, owing to both direct and indirect connections with other sectors.

In the Brazilian literature, there are some studies that make use of the input-output model to analyze the impacts and interactions of TCAs with other sectors of the economy (Casimiro Filho & Guilhoto, 2003; Takasago & Mollo, 2010). However, none of these studies have used the hypothetical extraction and structural decomposition methods to evaluate TCAs in Brazil and the input-output matrices used to determine the model were estimated by the authors. In contrast, this article considers the more recent official input-output matrices released by the Brazilian Institute of Geography and Statistics (IBGE).

Therefore, this article contributes to the empirical literature by providing a more detailed analysis, from a structural perspective, of the relevance of tourism to the Brazilian economy, as well as highlighting the main components that have influenced the variation in the production of tourist services. More than that, our main contribution is disaggregating the weight of trade flows from tourist activities in the Brazilian input-output matrix. Thus, this paper offers an unprecedented database for Brazil by sectoral disaggregating tourist activities. The estimation method can be replicated for other countries, such as Brazil, do not have a Tourism Satellite Account. The disaggregation of the TCAs avoids overestimating the effects of tourism on the national economy.

This article is organized into five sections. In addition to this introduction, the second section presents a review of the empirical literature, including national and international studies that have used input-output models to analyze tourism. The third section describes the input-output model, the hypothetical extraction method, the structural decomposition method, and the data source. The fourth section discusses the results. Finally, the fifth section provides concluding remarks.

## 2 TOURISM AND INPUT-OUTPUT

In Brazil, Casimiro Filho and Guilhoto (2003) were pioneers in studying tourism using the input-output matrix. These authors constructed a model for the tourist economy based on the input-output matrix of the Brazilian economy estimated by Guilhoto *et al*. (2001), using information from the National Accounts of Brazil for the year 1999, with the purpose of measuring the intersectoral relationships of the activities that make up the tourism sector with respect to other sectors of the economy.

Takasago and Mollo (2010), on the other hand, using the input-output matrix from the Center for Excellence in Tourism (CET) at the University of Brasília, analyzed the potential for job creation and income generation in Brazilian tourism for the base year 2006. Based on the results, the authors observed that recreational and cultural activities stood out in the generation employment and income, indicating their strategic importance for investment, and contributing to local/regional development. In another study using information from the regionalized input-output matrix estimated by CET for the base year 2004, Takasago and Mollo (2011) analyzed the potential of tourist industry to promote production, income, and employment growth in the Federal District. The results indicated that tourism has a greater income-generation potential than employment generation in the Federal District compared to other sectors of the economy.

To analyze the consumption patterns of domestic tourism and its contributions to diminishing inequality in Brazil, Haddad *et al*. (2013) used data from the "Characterization and Sizing of Domestic Tourism in Brazil – 2007", survey conducted by the Institute of Economic Research Foundation (FIPE) and constructed an interregional input-output model for the base year 2007. According to the results, domestic tourism can be considered an important channel to increasing production and income throughout the country, positively contributing to the reduction of inequality among Brazilian regions. These findings are corroborated by Ribeiro *et al*. (2022), who used an interregional input-output matrix estimated from electronic invoices to evaluate the impacts of domestic tourism spending on regional income inequality.

Ribeiro *et al*. (2013) estimated an input-output matrix for Sergipe to measure the impact of investments from the National PRODETUR[1] on the state's production structure. According to the results, in terms of income and employment generation, PRODETUR investments had an impact equivalent to 0.75% of the state's GDP and create 3,212 new direct and indirect jobs.

To simulate the impacts of tourism expenditures in Sergipe, as well as their effects on the rest of Brazil, Ribeiro *et al*. (2014) used an interregional input-output system. The authors found that for every R$ 1.00 spent on tourist activities in Sergipe, the impact on the state's production would be R$ 0.86, while the impact on the rest of the country would be R$ 0.14.

Souza *et al*. (2015) estimated an interregional input-output model to analyze the participation and interaction of the tourism sector in the Northeast region, using the base year 2009. In addition to information from the National Household Sample Survey (PNAD) and the Household Budget Survey (POF), the model incorporates information on the distribution of labor income and tourist consumption by income bracket. The results showed a tourism contribution of 2.77% to the Northeast's GDP and 2.27% to Brazil's GDP. Furthermore, the authors identified that the tourism industry had relatively more importance in the Northeast region compared to the other regions of the country.

Ribeiro *et al*. (2017) estimated the economic impacts of tourism spending on the production structure of the Northeastern states using an interregional input-output model with the base year 2004. It was found that tourism expenditure contributed to a 3.9% increase in the Northeast's GDP and that among the tourism-related activities only road and water transportation contributed to income concentration in the region.

[1] The National Tourism Development Program is an initiative of the Ministry of Tourism aimed at contributing to the development of Brazilian tourist destinations and strengthening the National Tourism Policy.

In the international literature, there are several studies that use the input-output matrix to analyze the economic impacts of tourism. In their work, Archer (1995) compares the contribution of international tourism to exports, income, and employment in Bermuda in relation to other exporting sectors, based on the estimation of input-output models for the base years 1985, 1987 and 1992. The main results show that despite the relative decrease in the importance of international tourism in Bermuda's economy, it continues to be the main source of employment and income in the country. Archer and Fletcher (1996), in collaboration with the Management Information Services Division (MISD) of the Seychelles government, estimated an input-output model for the base year 1991 to analyze the impact of tourism expenditures on the economy of the Republic of Seychelles. It was found that European tourist expenditures contributed to about 77% of total revenue and jobs generated in the country.

Frechtling and Horváth (1999) used a regional input-output model to analyze the impacts of tourism expenditures in Washington, United States. The results showed that the employment multiplier for tourism activities was about three-quarters higher than that observed in the industrial sector.

The impacts of international tourism on the Chinese economy were analyzed by Oosterhaven and Fan (2006) using an input-output matrix along with a social accounting matrix for the year 1997. The findings led to the conclusion that 1.64% of the gross domestic product (GDP), 1.4% of household income, and 1.01% of Chinese employment rely on international tourism. Thus, although the effects of tourism remain relatively small in the Chinese economy, its greater impact on GDP (compared to income and employment) suggests its potential significance in the future of the Chinese economy.

Using a multiregional input-output model, Cai (2016) analyzed the impact of greenhouse gas emissions resulting from tourism activities in South Tyrol, a tourist region in northern Italy. The main results showed that in 2010, the production of goods and services consumed by tourists resulted in emissions of 1092 kt $CO_2e$, which corresponds to average emissions of 38 kg $CO_2e$ per night or 0.316 kg per euro spent on tourist products and services. In a broader perspective, Lenzen *et al*. (2018) estimated that between 2009 and 2013, the global tourism carbon footprint increased from 3.9 to 4.5 $GtCO^2$, accounting 8% of total global greenhouse gas emissions.

Khoshkhoo *et al*. (2017), using the matrix developed by the Statistics Center of Iran for the base year 2011, employed the input-output model to calculate income multipliers and employment multipliers to evaluate the impact of tourism activities on the Iranian economy. It was found that the income multiplier for the tourism sector was 0.839, higher than the average for the economy (0.788). This implies that for every unit of tourism expenditure in Iran, 0.839 would go towards residents' income.

Munjal (2018) and Pedauga *et al*. (2022) employed the hypothetical extraction method in an input-output framework to examine the tourism sector in India and the impact of sports tourism on the economic system, respectively.

Our article differs from the others in that it uses two input-output techniques (hypothetical extraction and structural decomposition) that have not yet been jointly used in the national literature to analyze tourist activities. Consequently, a structural and detailed analysis of TCAs in Brazil is provided.

## 3 METHOD AND DATA

This section presents the input-output model, describes the hypothetical extraction method and structural decomposition analysis (SDA), and presents the data used in the article.

### 3.1 Input-Output Model

The input-output model, developed by Leontief in the late 1930s, allows for the analysis of interdependence and interactions among productive sectors of a given economy. This model enables the examination of how sectors are directly or indirectly related and how some sectors become more or less dependent on others (Miller & Blair, 2009).

In matrix form, following Miller and Blair (2009), the input-output model can be presented as follows:

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f} \quad (1)$$

Where: **x** is the sectorial production vector of order *n x 1*; **A** is the technical coefficient matrix given by $A = a_{ij} = \frac{z_{ij}}{x_j}$ and $z_{ij}$ is the trade between sectors i and j; **f** is the final demand vector of order *n x 1*.

The solution of the Leontief model n can be described as follows:

$$\mathbf{x} = \mathbf{Bf} \tag{2}$$

Where **I** is an identity matrix and $(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{B}$ is the Leontief Inverse Matrix. Matrix **B** captures not only the direct effects but also the indirect relationships among economic sectors.

After this presentation of the basic input-output model, the following subsections describe the hypothetical extraction method and structural decomposition method, which are extensions of the input-output model.

### 3.2 Hypothetical Extraction Method

Initially proposed by Strasser (1968), the Hypothetical Extraction Method aims to quantify the reduction in the total production of an economy caused by the removal of a specific sector. This removal can occur in three ways: i) total sector extraction of the sector (total effect); ii) extraction of the input structure (backward effect); and iii) extraction of the output structure (forward effect) (Miller & Blair, 2009).

According to Miller and Blair (2009), when performing the extraction of the input structure of sector *j*, it is assumed that this sector does not purchase any intermediate goods from any other sector in the economy. Therefore, in this case, the information contained in the columns of matrix A (equation 2) related to tourism activities is replaced with zero, as represented in equation (3):

$$\bar{\mathbf{x}}_{(\mathrm{cj})} = [\mathbf{I} - \bar{\mathbf{A}}_{(\mathrm{cj})}]^{-1}\mathbf{f} \tag{3}$$

The subscript $_{\mathrm{cj}}$ indicates that the column related to sector *j* (tourist activity) has been extracted. By comparing equations (2) and (3), the impact on production caused by the backward effect can be obtained as $i'\mathbf{x} - i'\bar{\mathbf{x}}_{(\mathrm{cj})}$, which is the impact of removing the input structure of a specific sector, in this case, the removal of TCAs.

To identify the impact of the removal of the output structure, forward effect, the input-output model is used from the supply side:

$$\mathbf{x} = \bar{\mathbf{A}}X + \mathbf{v} \tag{4}$$

Where: $\bar{\mathbf{A}}$ is the technical coefficient matrix from the supply side; $\mathbf{v}$ is the value-added vector.

The resolution of equation (4) results in the following equation:

$$\mathbf{x} = \mathbf{v}(\mathbf{I} - \bar{\mathbf{A}})^{-1} \tag{5}$$

Where $(\mathbf{I} - \bar{\mathbf{A}})^{-1} = \mathbf{G}$ is the Ghosh Inverse Matrix.

To extract the output s structure of tourism activities, the rows corresponding to each of these activities are extracted from matrix $\bar{\mathbf{A}}$, as shown in equation (6):

$$\bar{\mathbf{x}}_{(rj)} = \mathbf{v}[\mathbf{I} - \bar{\mathbf{A}}_{(rj)}]^{-1} \tag{6}$$

By comparing equations (6) and (5), the forward effect can be calculated as $i'\mathbf{x} - i'\bar{\mathbf{x}}_{(rj)}$, a measure of total forward linkage of TCAs, caused by the removal of the output structure of tourism-related activities in total production.

In total extraction, both the input and output are removed, allowing the measurement of the reduction in production (**x**) caused by the absence of a specific sector. In this case, the hypothetical extraction of TCAs is considered (equation 7):

$$\bar{\mathbf{x}}_j = \left[\mathbf{I} - \bar{\mathbf{A}}_j\right]\mathbf{f} \tag{7}$$

By comparing equations (2) and (7), the total effect $\mathbf{T}_j = i'\mathbf{x} - i'\bar{\mathbf{x}}_j$ can be calculated, which is an aggregate measure of the decrease in production value caused by the extraction of sector *j* (TCAs) from the economy.

### 3.3 Structural Decomposition Method

The structural decomposition method, initially developed by Chenery *et al*. (1962) and Carter (1970), enables a detailed analysis of changes in the economic structure (Hoekstra & Van Den Bergh, 2002). It is a comparative-static technique that can be used to decompose changes in macroeconomic variables (Moreira & Ribeiro, 2013). It is observed that any change in production is partly due to changes in sectoral technology and partly due to variations in final demand (Chóliz & Duarte, 2006).

Considering the basic input-output model presented in subsection 3.1, equation (2) $\mathbf{x} = \mathbf{Bf}$, Miller and Blair (2009) highlight that for the application of the method, it is necessary to consider input-output matrices for different years, denoted with superscript 0 (the year 2010) and the most recent year with superscript 1 (the year 2015), forming the following system of equations:

$$\mathbf{x}^1 = \mathbf{B}^1.\mathbf{f}^1 \tag{8}$$

$$\mathbf{x}^0 = \mathbf{B}^0.\mathbf{f}^0 \tag{9}$$

Where: $\mathbf{f}^t$ Is the final demand vector in year t; and $\mathbf{B}^t = (\mathbf{I} - \mathbf{A}^t)^{-1}$

The change in the sectoral output observed over the period is represented by:

$$\Delta\mathbf{x} = \mathbf{x}^1 - \mathbf{x}^0 = \mathbf{B}^1.\mathbf{f}^1 - \mathbf{B}^0.\mathbf{f}^0 \tag{10}$$

The objective is to break down the total variation in output into two components: technological change ($\Delta\mathbf{B} = \mathbf{B}^1 - \mathbf{B}^0$) and variation in final demand ($\Delta\mathbf{f} = \mathbf{f}^1 - \mathbf{f}^0$).

Miller and Blair (2009) develop a series of algebraic decompositions to analyze the variation in the output decomposition in different ways based on equation (10). However, Dietzenbacher and Los (1998) present equation (11) as the most appropriate for the method structural decomposition.

$$\Delta\mathbf{x} = \frac{1}{2}\,(\Delta\mathbf{B})(\mathbf{f}^0 + \mathbf{f}^1) + \frac{1}{2}(\mathbf{B}^0 + \mathbf{B}^1)(\Delta\mathbf{f}) \tag{11}$$

Where: $\Delta\mathbf{B}(\mathbf{f}^0 + \mathbf{f}^1)$ corresponds to technological change, which implies a change in the Leontief inverse ($\Delta$**B**); and $\Delta\mathbf{f}\ (\mathbf{B}^0 + \mathbf{B}^1)$ is the variation in final demand.

If $\Delta\mathbf{f} = 0$, $\Delta\mathbf{x} = \frac{1}{2}\,(\Delta\mathbf{B})(\mathbf{f}^0 + \mathbf{f}^1)$, meaning that the variation in output is caused by technological changes.

To aggregate the final effects of the output variation ($\Delta$**x**), it is necessary to break it down into two or more elements. In this article, the following decomposition will be used:

$$\mathrm{i}'(\Delta\mathbf{x}) = \mathrm{i}'\left[\left(\frac{1}{2}\right)(\Delta\mathbf{B})(\mathbf{f}^0 + \mathbf{f}^1)\right] + \mathrm{i}'\left[\left(\frac{1}{2}\right)(\mathbf{B}^0 + \mathbf{B}^1)(\Delta\mathbf{f})\right] \tag{12}$$

Where: $i'\left[\left(\frac{1}{2}\right)(\Delta\mathbf{B})(\mathbf{f}^0 + \mathbf{f}^1)\right]$ represents the total effect of technological changes; and $i'\left[\left(\frac{1}{2}\right)(\mathbf{B}^0 + \mathbf{B}^1)(\Delta\mathbf{f})\right]$: represents the total effect of changes in final demand.

The effect of variations in final demand was also decomposed into its components. Therefore, according to Miller and Blair (2009), in an input-output model with *n* sectors and *p* categories of final demand, instead of a vector final demand $\mathbf{f}^{\mathrm{t}}(\mathrm{nx1})$, there is a matrix of final demand:

$$\mathbf{F}^t_{(nxP)} = [\mathbf{f}^t_1, \ldots, \mathbf{f}^t_p] \tag{13}$$

The components of final demand considered were exports, government expenditures, household consumption, and investment (gross fixed capital formation plus inventory variation).

Therefore, by applying this method, the variations that occurred in the production of TCAs during the period 2010-2015 can be measured.

### 3.4 Database

For the application of the hypothetical extraction method, the input-output matrix, sector by sector, for the Brazilian economy was chosen, with the base year of 2015. In this matrix, some sectors will be disaggregated to provide a higher level of detail regarding activities related to tourism. This matrix, calculated by the IBGE, is already in line with the new reference of the System of National Accounts (United Nations, 2008) and originally consists of 67 sectors. However, to estimate the participation of TCAs, certain activities were disaggregated, resulting in a matrix with 74 sectors.

According to Fletcher (1989), there are numerous difficulties in assessing the impacts of tourism because tourism is not typically defined as a singular activity. The definition of tourism activity varies among studies, particularly in terms of data collection methods and data availability, which can vary significantly across countries. For instance, in the study conducted by Surugiu (2009), the impact of tourism activity in Romania was estimated by considering only the hotel and restaurant sectors. In general, tourists consume various types of goods and services, which are

also accessible to residents. Hence, as mentioned by Romero and Tejada (2011), there are no specific sectors or products with entirely tourism-oriented characteristics.

In this study, tourism activity was defined as illustrated in Table 1. Initially, we considered the activities related to tourism available in the TACs 2010 and 2015, as disclosed by the Brazilian Institute of Geography and Statistics (IBGE). However, as these sectors are not exclusively tied to tourism and due to the absence of Tourism Satellite Accounts, we classified the sectors into tourist and non-tourist categories. This segregation was based on employment coefficients calculated by the Institute of Applied Economic Research (IPEA) within the scope of the Integrated System of Information on the Labor Market in the Tourism Sector (SIMT), as outlined in Sakowski (2013). The data provided in the SIMT survey were gathered via a telephone sample survey to ascertain the proportion of activities related to tourism within each considered TCA.

Table 1 displays the relationships between the activity's representative of tourism, as disclosed in the TCAs by IBGE, and the characteristic tourism activities according to the SIMT survey. Additionally, the coefficients calculated in the SIMT were utilized for this purpose. These coefficients were instrumental in categorizing the sectors within the input-output matrix into tourist and non-tourist sectors.

**Table 1:** Weights of TCAs in the sectors of the Economy act

| Tourist activities | | Years | |
|---|---|---|---|
| Sector TCAs – IBGE | Tourism Sector Labor Market Information System - SIMT | 2010 | 2015 |
| Passenger land transport | Passenger land transport | 0.28 | 0.27 |
| Water transportation | Water transportation | 0.10 | 0.09 |
| Air Transport | Air Transport | 0.86 | 0.83 |
| Accommodation services in hotels and similar | Accommodation services in hotels and similar | 0.74 | 0.78 |
| Food services | Food services | 0.28 | 0.26 |
| Other administrative activities and complementary services | Transport rental and travel agencies* | 0.026 | 0.025 |

**Source**: Authors.

According to Table 1, we observe that the activities of Travel Agencies and Car Rental, as defined in the TCAs within the SIMT, are not disaggregated in the TCAs disclosed by IBGE. To incorporate these activities, we utilized the weigh calculated in the study by Gonçalves *et al*. (2020), disaggregating the sector "other administrative activities and complementary services"[2].

After disaggregating the tourist and non-tourist activities, for the application of the structural decomposition method, the input-output matrices (sector by sector) for the years 2010 and 2015 were utilized, encompassing 74 sectors.

## 4 RESULTS AND DISCUSSIONS

This section presents the results and discussions generated from the application of the hypothetical extraction method. This measured the importance of TCAs for the Brazilian economy. The structural decomposition method enabled the analysis of production variations in TCAs between 2010 and 2015.

### 4.1 Hypothetical Extraction

To measure the importance of tourism for the Brazilian economy, the hypothetical extraction method was used to simulate the impact of the absence of TCAs on the total production of the Brazilian economy. The simulations considered an open input-output model, in which all components of final demand are considered exogenous in the model. The presented results are in terms of percentage losses of output.

To measure the total effect of tourism on the Brazilian economy, the weighted average of the participation of each TCAs in the total output of the economy was used as part of the calculation. This measured the impact of extraction of the "tourism sector" from the Brazilian economy. The absence of tourist activities would lead to a 0.83% reduction in the total production of the Brazilian economy. For India, based on the hypothetical extraction method, Munjal (2018) estimated a 7.2% decline in GDP resulting from the extraction of tourism. The absence of sports tourism

[2] Car rental and travel agencies activities are subclasses of the Administrative activities and complementary services class, according to CNAE 2.0.

would lead to a 9.31% reduction in the total production of Castile and Leon (Pedauga et al., 2022). Table 2 shows backward (demand), forward (supply) and total impacts according to each tourism activity in Brazil.

**Table 2 -** Impacts on Brazilian production caused by the extraction of tourism activities, 2015 (%)

| Tourism Activities | Impacts | | |
|---|---|---|---|
| | Backward Effect | Forward Effect | Total Effect |
| Land passenger transportation | -0.50 | -0.63 | -1.12 |
| Water transportation | -0.01 | -0.02 | -0.02 |
| Air Transportation | -0.21 | -0.30 | -0.40 |
| Accommodation services in hotels and similar establishments | -0.14 | -0.18 | -0.24 |
| Food services | -0.88 | -0.57 | -0.96 |
| Non-real estate rentals and intellectual property asset management | -0.02 | -0.05 | -0.06 |
| Arts, culture, sport, and recreation services | -0.02 | -0.01 | -0.02 |

**Source**: Author based on the IBGE input-output matrix, 2015.

The total effect reflects the impact of removing the buying and selling structure related to the presence of tourism. In this scenario, the absence of Land Passenger Transportation would result in a 1.12% reduction in the GVP of the economy. Food Services, with the second-largest total effect, would lead to a 0.96% reduction in GVP. These results corroborate the analyses on the Brazilian tourism sector conducted by Takasago and Mollo (2010), who also found a higher linkage level in Food Services and Land Passenger Transportation, indicating that these activities are strategic, and their development tends to stimulate growth in other sectors. On the other hand, according to Pedauga *et al*. (2022), due to the extraction of sports tourism in Castile and Leon, the accommodation sector would be the most affected, experiencing a 12.29% reduction in its level of activity. Casimiro Filho and Guilhoto (2003) have found that accommodation, and restaurants and other food service establishments was key sector in the Brazilian Economy, which means backward and forward linkages above the average. However, unlike our work, these authors did not carry out any statistical treatment regarding the weight of the TCAs.

Ribeiro *et al*. (2021), using the partial hypothetical extraction method in an input-output framework, estimated the economic impacts of the Covid-19 pandemic on tourist activity in Brazil. The results indicate that emergency aid mitigated the impact from 31% to 17% on tourism GDP. Moreover, in sectoral point of view, the greatest mitigation effect was in the road transport and food services.

However, the removal of the purchasing and selling structure of Air Transportation, a tourist activity with the second-largest share in the economy 0.48% (see Appendix 1), would reduce output by 0.40%. The absence of tourism would have a negative impact on the production of Accommodation Services in Hotels and Similar Establishments, resulting in a 0.24% reduction in output.

The forward effect reflects the interrelationships of activities from the supply side. Two activities showed the highest forward linkage: Land passengers transportation and Food services, which means that the hypothetical extraction of the sales structure of these activities reduces the production of the Brazilian economy by 0.63% and 0.54%, respectively. Arts, culture, sport, and recreation services (-0.01%) is the TCA that would generate the lowest impact on production if it no longer made sales to other economic sectors, followed by Water Transportation, which would cause a reduction in output of 0. 02%.

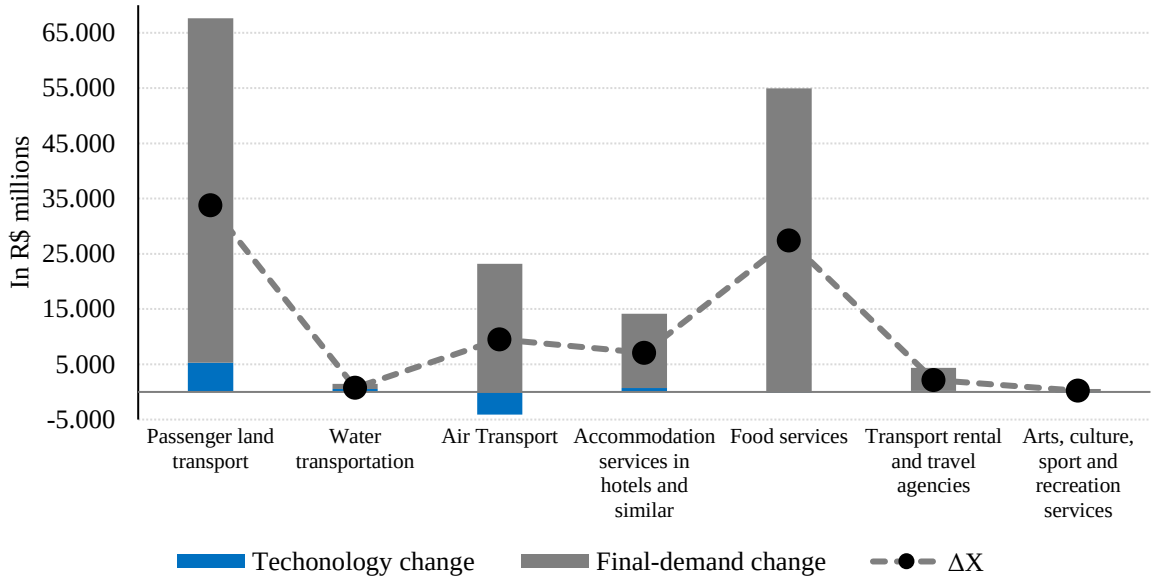
Finally, the backward effect represents the relationship of activities from the demand side. Among the TCAs, Food services showed the highest backward effect. The hypothetical extraction of the inputs purchased by this activity would result in a 0.88% reduction in Brazilian production. Therefore, it is the activity with the highest demand-side linkage, followed by Land passenger transportation (-0.50%) and Air transportation (-0.21%).

Overall, relatively low impacts are observed. This is partly because TCAs are more oriented towards final demand than intermediate demand, which minimizes multiplier effects in the economy.

## 4.2 Structural Decomposition

The variation in production during the analyzed period can come from changes in technical coefficients (technological changes) and/or variations in the components of final demand, as mentioned earlier. Based on Figure 1, it is possible to analyze the extent to which the total variation in output in each TCAs is due to changes in final demand and/or technological changes.

**Figure 1 -** Structural breakdown of tourist activities in the period 2010-2015




**Source**: Author based on IBGE input-output matrices, 2010 and 2015.

The total variation in the production of TCAs during the analyzed period was mainly influenced by changes in final demand. It can be observed that two of the seven TCAs, Land Passenger Transportation and Food services, showed the highest growth levels. This implies that if technology remained constant, these two activities would have a positive variation in production solely due to an increase in final demand.

For all TCAs, there was growth in production mainly influenced by variations in final demand. This demonstrates that the Brazilian tourism sector has a growth dynamic influenced by final demand, which is a relatively expected result because TCAs, for the most part, target the final demand of the economy. Moreira and Ribeiro (2013) and Sousa Filho *et al*. (2021) using the same methodology, observed a similar behavior for the Brazilian economy. These authors identified that the variation in Brazilian production during the periods of 2000-2005 and 1990-2015, respectively, was mostly explained by changes in the components of final demand. It is important to highlighted that these both studies, as our research, have used the official Brazilian input-output matrices.

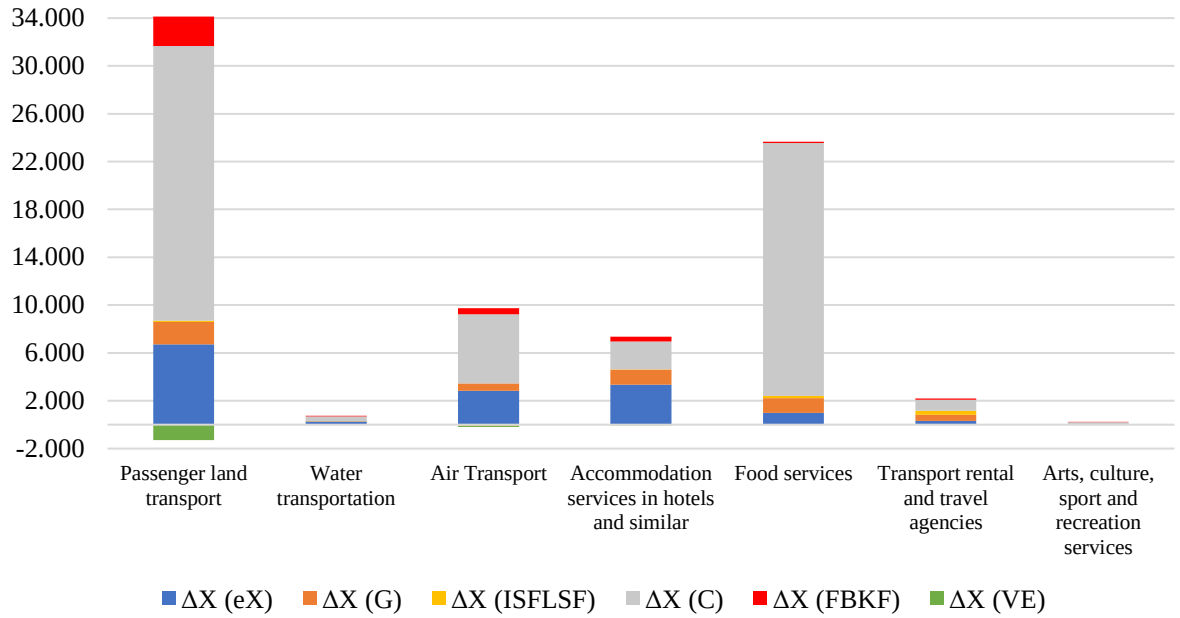
According to Moreira and Ribeiro (2013), alongside currency devaluation, the diminished performance of domestic demand, largely influenced by the implementation of the new macroeconomic policy model, has prompted certain sectors, like Oil and Natural Gas and Automotive Vehicles, to intensify their reliance on exports. Conversely, the expansion of production in sectors primarily oriented toward the domestic market, with potential significant effects on the productive chain, has been significantly hindered by the shifts in final demand, as seen in the cases of Trade and Construction. The findings of Sousa Filho *et al*. (2021) suggest that the Brazilian production structure remains vulnerable and reliant on demand fluctuations for its expansion. Additionally, the manufacturing industry continues to be the primary sector capable of instigating fundamental alterations in production.

Regarding technological changes, Viotti (2002) emphasizes that in developing countries, processes of technical changes are generally related to the absorption and improvement of innovations produced in developed countries.

Analyzing the technological performance, the TCAs that stood out with increased dynamism were Land transportation, non-real estate rentals and intellectual property assets management, and Water transportation. In the other TCAs, the impact of technological changes on variation in production was insignificant, meaning that they were not relevant in influencing changes in production. The fact that TCAs are more focused on final demand, which is at the final stage of the production chain, limits development and innovations in their activities. Therefore, in general, products and services related to tourism have low or no technological dynamism.

Figure 2 highlights variations in the production of TCAs resulting from changes in the components of final demand, which are: ΔX (eX) (exports); ΔX (G) (government spending); ΔX (C) (household consumption) and ΔX (I) (investment).

**Figure 2 -** Influence of final demand components on the variation in production of tourist activities in the period 2010-2015




**Source**: Author based on IBGE input-output matrices, 2010 and 2015.

The Land Transportation and Food services showed the highest variations in production during the analyzed period. The factor that contributed the most to this variation was the increase in final demand from household consumption.

Changes in household consumption levels influenced the production of almost all TCAs, which is an expected result. As mentioned earlier, the products and services generated by TCAs generally target final demand. According to Rabahy (2000), the domestic market is the driving force of Brazilian tourism. Domestic tourist consumption is about 9.9 times larger than international tourist consumption. The exception was the Accommodation sector, in which foreign demand had a greater influence on the variation in production than domestic consumption. The importance of domestic tourism in Brazil has also been discussed previously by Haddad *et al*. (2013) and Ribeiro *et al*. (2022).

These authors have found that domestic tourism contributes to reduce regional inequality in Brazil. Both studies have used input-output models and tourism expenditure data to simulate these effects.

Another component that positively contributed to the growth of TCAs production was government spending ΔX(G), which mainly influenced variations in the final demand for Land transportation services, Food services, and non-real estate rentals and intellectual property assets management. According to statistics released by the Ministry of Tourism, between 2010 and 2015, there was a considerable increase in the government expenditure on tourism, averaging of US$ 21,12,.33 million per year (Brazil, 2019). The hosting of the 2014 World Cup and the 2016 Olympics may have contributed to the increase in government spending during the analyzed period. The participation of ΔX(I) investments in production variation mainly contributed to the growth of the Land transportation sector.

Therefore, it can be inferred that even in the absence of technological changes in the Brazilian tourism sector, variations in final demand, especially variations in household consumption, would be sufficient to ensure growth in output of tourism activities. It is worth noting that with the expansion of international tourism in the coming years, it is expected that the export component will also play an important role in the sector's growth dynamics.

## 5 FINAL REMARKS

The objectives of this article were to measure Brazil's degree of dependence on TCAs and to decompose the variation in the production of these activities into effects of technological changes and final demand during the period 2010-2015. To achieve the proposed objectives, we used the methods of hypothetical extraction and structural decomposition using input-output matrices in Brazil, which constitutes a novel empirical contribution to the Brazilian economy.

The results of the hypothetical extraction revealed that among the TCAs, Food services and Land passenger transportation would have the greatest impact on the reduction of Brazilian production if their purchasing and selling

structures were extracted, meaning they are the activities with the highest level of relative importance. This result is corroborated by Takasago and Mollo (2010,) who identified these two activities as the most strategic.

In general, the backward, forward, and total effects of TCAs on the reduction of GVP were relatively insignificant. This can be explained by the fact that these activities produce goods and services with a greater focus on household consumption. It was also found that the hypothetical extraction of the Brazilian tourism sector would lead to a reduction of approximately 0.83% in GVP in 2015. This result should be interpreted with caution, as indirect data from the SIMT survey was used to obtain it. Thus, it may be underestimating the effects of tourist activity on the Brazilian economy.

The results of the structural decomposition showed that during the period from 2010 and 2015, the variations that occurred in the production of TCAs were mostly explained by changes in final demand, specifically changes in domestic household consumption. This result is in line with previous studies that applied decomposition techniques to the Brazilian economy.

Regarding the variation in technical coefficients, the results indicated a small contribution of technological changes to the variation in production of TCAs. The only tourism-related activities that showed significant technical advances were Land transportation, non-real estate rentals and intellectual property assets management and Water transportation. Therefore, it can be understood that in the absence of an expansion of final demand, there would be a sharp decline in the production of tourism activities.

Although an effort has been made to measure the size of tourism activities in the Brazilian economy, the main limitation of this research is the use of generic data to represent them. As mentioned earlier, the lack of a Satellite Account prevents us from obtaining more precise data and, therefore, hinders more efficient analyses of the true dimension of tourism in Brazil.

More specifically, when using weights from the SIMT survey to disaggregate the ACTs subsectors into touristic and non-touristic, structurally in the input-output model the results would be the same. On the other hand, this procedure allows us to resize the weight of tourism in the Brazilian economy. Furthermore, the limitations inherent to the hypotheses of the input-output model such as, constant returns to scale, non-substitution via prices between inputs and constant technical coefficients can influence the results.

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## APPENDIX

**Appendix 1** - Participation of tourist activities in the total output in 2015

| Tourism activities | Total Output (in BRL million) | Participation in total production (%) |
|---|---|---|
| Passenger land transport | 64,060 | 1.57 |
| Water transportation | 1,178 | 0.03 |
| Air Transport | 19,681 | 0.48 |
| Accommodation services in hotels and similar | 10,459 | 0.26 |
| Food services | 9,076 | 0.22 |
| Transport rental and travel agencies | 4,175 | 0.10 |
| Arts, culture, sport and recreation services | 328 | 0.01 |
| **Total Output** | **4,092,532** | - |

**Source:** Author based on data from the IBGE Input-Output Matrix, 2015.