



# Tsunami's Trail on Spending : Exploring Gender Differential Impact in the Aftermath of the 2004 Disaster

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## Abstract

This study delved into the aftermath of the 2004 tsunami, focusing on its gender-specific impact on consumption expenditure in India. The study used a Difference-in-Difference (DiD) approach, comparing expenditure patterns between the tsunami affected and unaffected districts of India for male-headed households, female-headed household and expenditure on male, female and adult goods. The data was drawn from the National Sample Survey Organisation (NSSO) Consumer Expenditure Survey, providing insights into Monthly Per Capita Consumption Expenditure (MPCE) and overall consumption expenditure across specific male and female goods. The results highlights a distinct gender-related dimension to the impact of the tsunami. Male headed households experienced a reduction in MPCE, revealing the vulnerability of their economic well-being in the face of such disasters. As a result, the study aims to find out if that led to gender-bias within households and had any impact on female goods. I find that there was a significant impact on women's clothing, personal care sanitary products and adult goods. Although there has been a rise in expenditure on women's clothing, but there has also been a decline in spending on sanitary products and adult goods, indicating mixed results. This nuanced perspective sheds light on the gender differentiated effects of natural calamities on consumption spending.

**KEYWORDS :** Natural Disaster, Gender Bias, Consumption Expenditure.

**JEL Classification :** J16; Q54; D12

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# List of Abbreviations

**INR** Indian Rupee . . . . . 2

**MPCE** Monthly Per Capita Consumption Expenditure . . . . . 1

**FDI** Foreign Direct Investment . . . . . 7

**NSSO** National Sample Survey Organisation . . . . . 1

**DiD** Difference-in-Difference . . . . . 1

**CPI** Consumer Price Index . . . . . 14

**OLS** Ordinary Least Squares . . . . . 3

# Introduction

The 2004 tsunami was an immensely destructive natural disaster caused by a powerful 9.0 magnitude earthquake near Sumatra, Indonesia. This catastrophic event took place on December 26, 2004, and led to massive tsunami waves that affected 18 countries in Southeast Asia and Southern Africa. The impact was devastating, resulting in the loss of more than 250,000 lives and leaving over 1.7 million people without homes. Entire communities were obliterated, creating a humanitarian crisis of unprecedented proportions.<sup>1</sup> As data on the horrendous death toll from the December 2004 tsunami are finally processed, it has been confirmed that the largest number of people who died were women and girls (Pittaway et al. (2007)).

Even though natural hazards are gender neutral; but their impacts are not. Men and women, boys and girls face different levels of exposure and vulnerability to natural hazards, driven by gender relations and discrimination in society. This results in differentiated impacts on endowments (health, education, assets); economic outcomes (employment, assets, wages, consumption); and voice and agency (child marriage, gender-based violence, women as agents of change). Women are disproportionately affected by disasters in several outcomes, including life expectancy, unemployment, labor force re-entry, and relative asset losses. Gender-based violence—a manifestation of systematic inequality between men and women—is exacerbated at times of emergency.

Even though women and girls often face challenges in society, these difficulties don't automatically mean that they'll have worse experiences during disasters. There's a common idea that women are more likely to lose their lives in disasters. However, in places like Europe and the United States, around 70 percent of the deaths caused by floods are actually men (Erman et al. (2021)). This is driven by several reasons, including an over-representation of men in rescue professions. In less developed countries, more women tend to die from disasters (Neumayer & Plümper (2007)). Although men are also over-represented in risky and rescue professions in these countries, gender gaps in access to information on disaster preparedness, access to public shelters and limits to mobility seem to contribute more to gendered mortality outcomes, putting women at a disadvantage (Erman et al. (2021)). Boys and girls are affected differently by disasters. The preferred treatment of boys means that girls are worse off when their families face scarcity due to disaster and families are more likely to take their daughters out of school if they cannot pay tuition or the domestic burden increases after a disaster. On the other hand, if labor needs increase—for example, in agriculture—boys are more likely to be taken out of school (Gil-Rivas (2014); Ashraf & Azad (2015); Erman et al. (2021); Edmonds & Pavcnik (2005); Bradshaw (2013)). Disaster impacts on education are also reflected in child and early marriage, and labor rates (Björkman-Nyqvist (2013), Blanco (2023)). From an economic perspective, the impacts of disasters exhibit gender-specific disparities, often to the detriment of women. Particularly in developing nations, the agricultural sector holds significant importance for female employment, yet women farmers tend to face higher vulnerability to disaster effects compared to their male counterparts. Furthermore, the aftermath of disasters often amplifies domestic responsibilities, disproportionately affecting women, consequently limiting their engagement in income-generating endeavors. Compounded by limited access to financial resources, women's assets remain less safeguarded than those of men (Erman et al. (2021); Doss et al. (2018)).

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<sup>1</sup>Impact of 2004 Tsunami in the Islands of Indian Ocean: Lessons Learned, <https://doi.org/10.1155/2011/920813>

Given this background, for studying the gender differentiated impact of natural disaster, data limitations create a significant challenge in understanding how gender dynamics influence disaster vulnerability, preparedness, and recovery. When assessing the impact of disasters on women and men and how they recover from them, some of the variables of interest—such as monetary poverty and disaster losses—are measured at household level. But treating households as a single unit assumes that disaster losses, and resources used to cope with disasters, are shared equally inside the households. Given the observed gaps in access to and control over assets between men and women, this is an unrealistic assumption. I tried to address this issue, where this study uses the datasets from the National Sample Survey (NSSO) for India and endeavors to dissect the gender-differentiated consequences of the 2004 tsunami through an exploration of the Monthly Per Capita Expenditure (MPCE) of households led by males, households led by females, and consumption patterns concerning female-oriented commodities within households. Despite lingering gaps in data availability and the persistent challenge of dissecting intra-household gender dynamics, this study pursue a focused analysis centered around female-specific goods. By using the household consumption expenditure surveys, I tried to delve into an under-explored domain i.e., the impact of the tsunami on consumption spending related to female goods. The findings highlight that certain female goods, notably expenses related to women’s clothing and personal care items such as sanitary products, indeed bore a significant impact. The study uses difference-in-difference (DiD) technique to identify the impact of 2004 tsunami in the affected districts of India. To examine the repercussions of the 2004 tsunami, the analysis focuses primarily on states severely devastated by the disaster, namely Tamil Nadu, Andhra Pradesh, Kerala, Pondicherry, and the Andaman and Nicobar Islands. A threshold of 100 casualties is adopted as a criterion for selecting districts to be included in the treatment group. This encompasses coastal districts that directly experienced the impact of the tsunami. In contrast, the control group consists of districts that were unaffected by the effects of the tsunami.

The study begins with a literature review, followed by descriptive and empirical analysis. The policy implications of natural disasters are then discussed in the final part of the study.



# Review of Literature

This study draws on an existing academic literature which studied the consequences of natural disasters. Natural disasters, as unpredictable and devastating events, have captured the attention of scholars seeking to understand their profound impact on societies and communities. Various research papers document the importance of natural disasters and their impact on economies. [Noy \(2009\)](#), for example, finds that the damages caused by natural disasters are multifaceted. To explain these differences, there are several studies which focus on economic consequences, supply-chain disruptions, social, and personal issues, as well as on the quality of a country's infrastructure and children development ([Caraka et al. \(2020\)](#); [Deuchert & Felfe \(2015\)](#); [Breckner et al. \(2016\)](#); [Ishizawa et al. \(2019\)](#); [Heger & Neumayer \(2019\)](#); [Tokui et al. \(2017\)](#)).

One strand of literature focuses on the socio-economic impact of natural disasters influenced by social norms, attitude, vulnerable groups, people's behaviors and social-protection ([Fleming et al. \(2014\)](#); [Brown et al. \(2018\)](#); [Filipski et al. \(2019\)](#)). For example, the study by [Blanco \(2023\)](#) highlights the repercussions of disasters on marriage timing for young women, revealing the complex interplay between cultural norms, migration, and economic choices. These studies collectively establish the complex relationships between disasters, social structures, economic choices, and psychological well-being. [Caruso \(2017\)](#) studied the inter-generational effects of natural disasters, focusing on Latin America, revealing enduring negative impacts on vulnerable groups like children in utero and young individuals, affecting human capital, health, and wealth. [Deuchert & Felfe \(2015\)](#) assesses natural disaster's influence on children's education and health, using super typhoon-induced housing damages as a measure of household shocks. The study identifies persistent negative effects on education, likely linked to altered parental investments, but no significant impact on children's health. Subgroup analysis highlight stronger effects for specific demographics. [Gunnsteinsson et al. \(2019\)](#) studied that timely "vitamin A" supplementation post-disaster safeguards infant health by mitigating negative effects, emphasizing the potential of early-life interventions to enhance resilience and well-being in low-income contexts. The influence of disaster exposure on risk attitudes, as evidenced by [Ingwersen et al. \(2023\)](#), puts emphasis on the temporal dynamics of post-disaster psychological responses, utilizing the 2004 Indian Ocean tsunami as a case study. On similar lines, [Filipski et al. \(2019\)](#) studied the psychological effects of an earthquake on savings and spending behavior. [Filipski et al. \(2019\)](#) find that the savings rate decrease by 0.17 percentage points for each percent of distance closer to the epicenter, is economically significant, and persists in the medium term.

Another strand of literature focussed on post-disaster economic losses and recovery, described by [Toya & Skidmore \(2007\)](#), which are measured in terms of income, labour market, economic openness, financial systems, infrastructure and technology. The better these conditions are, the less a country incurs economic losses ([Berlemann & Wenzel \(2018\)](#)). [Heger & Neumayer \(2019\)](#) examines the positive economic outcomes of well-coordinated reconstruction efforts and foreign aid following the 2004 Indian Ocean tsunami in Aceh, Indonesia, highlighting the role of effective reconstruction and coordinated aid in achieving sustainable recovery. On the other hand, for developing countries like India, [Friedt & Toner-Rodgers \(2022\)](#) uncovers lasting reductions in investment and shifts in Foreign Direct Investment (FDI) due to disasters, emphasizing the need to consider intra-national investment relocations and highlights the complex relationship between disasters, Foreign Direct Investment (FDI), and economic growth. [Friedt & Toner-Rodgers \(2022\)](#) showed that investment tend to flow into more developed, less disaster-prone regions, fueling the prominent divergence in India's economic growth. Collectively, these

studies shed light on the long-term impacts of disasters on welfare, financial systems, reconstruction, and investment, highlighting the importance of effective policies and strategies for mitigating disaster-induced vulnerabilities and fostering resilience. Additional research studies such as [Hoang et al. \(2020\)](#) emphasizes the ramifications of industrial disasters on labor markets, while [Gignoux & Menéndez \(2016\)](#) explores the economic recovery trajectory after earthquakes on the income and welfare of individuals in rural Indonesia. Furthermore, [Kirchberger \(2017\)](#) delve into the nuanced effects of disasters on job markets and wage dynamics, unveiling the intricate labor market adjustments. [Czura & Klonner \(2023\)](#) explores post-tsunami changes in financial allocations. In addition to this, numerous studies have explored how natural disasters affect social capital dynamics ([Cao et al. \(2022\)](#)). Furthermore, there have been studies which delved into the realm of technological advancements, as witnessed in the work of [Blumenstock et al. \(2016\)](#), demonstrating how progress in information and communication technologies has empowered individuals in developing nations to effectively manage economic upheavals through the facilitation of social support networks via mobile platforms. Similarly, [Escaleras & Register \(2016\)](#) highlights the idea that quality infrastructure mitigates the negative impact of natural disasters.

A third strand of the literature and the most relevant area in the context of this study, argues that natural disasters have a direct and indirect impact on household consumption instability ([Ebeke & Combes \(2013\)](#)). For example, [Warr & Aung \(2019\)](#) and [Bui et al. \(2014\)](#) note many studies which conclude that natural disasters reduce people's incomes and expenditures, and their further analysis supports the notion that income shocks lead to reduced consumption, which in turn increases poverty and inequality. [Kosec & Mo \(2017\)](#) summarize evidence after a natural disaster, showing the reduced willingness to consume, much of which is related to household expenditures, education, and wealth. [Cassar et al. \(2017\)](#) review changes in personal preferences after a natural disaster, concluding that increased risk aversion and impatience are viewed as deterring people from engaging in consumption.

Despite the inherent unpredictability of these calamitous situations, several authors have argued that consumption growth following a disaster is significantly influenced by past information, namely consumer confidence, consumption growth, and lagged income ([Flavin \(1981\)](#); [Campbell & Mankiw \(1989\)](#)). As a result, estimates typically factor in a lag in consumption growth, testing the permanent income hypothesis posited by [Friedman \(1957\)](#) that individuals base their consumption on a longer-term view of income, consuming a fraction of this permanent income in each period, such that the average propensity to consume is equal to the marginal propensity to consume. In turn, the marginal propensity to consume is shaped by a number of factors, including unemployment, household resources, and broader perceptions of uncertainty. Several studies have investigated whether large external shocks such as natural disasters or extremely disruptive civil conflicts have an effect on consumption. Notably, the work of [Miguel & Roland \(2011\)](#) delves into the enduring aftermath of the Vietnam War on regional economic dynamics. Their study discerns a modestly adverse impact of the conflict on consumption levels, extending until 1992-93, while also revealing a subsequent acceleration in consumption growth during the period spanning 1992-2002 ([Miguel & Roland \(2011\)](#)). On a similar line, [Gignoux & Menéndez \(2016\)](#) study the short- and long-term effects on individual economic outcomes of a set of earthquakes that occurred in rural Indonesia as of 1985. [Gignoux & Menéndez \(2016\)](#) analysed how the event affected people's money and well-being. [Gignoux & Menéndez \(2016\)](#) used the data from household surveys and geological information, where the study shows that these earthquakes lead to short-term losses in possessions, especially in farming. But, over time, individuals recover and even do better in the long run (6-12 years). This recovery is possible because people rebuild what they lost, like farms and public facilities. The study suggests that outside help, like aid and improved infrastructure, helps this recovery. Surprisingly, people didn't move away after earthquakes, which challenges the idea that disasters keep people poor. Instead, the study suggests that recovery efforts can help communities bounce back, even leading to long-term improvements. The research points out the importance of smart policies to help communities rebuild after disasters, focusing on things like restoring assets and improving infrastructure, which can boost the economy and overall well-being. These results suggest that any negative short-term impact from the large external shock on consumption dissipated over time, consistent with the permanent income hypothesis. Also, the impact of a natural disaster de-

pendents largely upon its intensity and duration. The negative impact on economic outcomes is stronger for more intense disasters (Lee et al. (2018)). Similarly, Baez et al. (2017) investigate the causal consequences of Tropical Storm Agatha, in 2010, on household welfare in Guatemala. The authors find that households reduced their food consumption by 10% on average, with a larger impact among urban households, for which average consumption per capita dropped by 12.6%. This greater impact is attributed to the strength of the shock itself, with much stronger excessive precipitation in urban areas (Baez et al. (2017)). More generally, Benson & Clay (1998) show that countries that suffer frequently from disasters tend to experience lower growth rates than countries with fewer disasters. The response of consumption patterns during crises exhibits asymmetry across various goods categories. It is widely acknowledged that discretionary purchases can be easily deferred, with some portion of deferred demand rebounding once conditions normalize (Rong et al. (2013)). Forbes (2017) examined post-earthquake consumption dynamics in Christchurch, New Zealand, finding that immediate post-event consumption focused on essential items like water, non-perishable food, communication access, and cleaning products (Forbes (2017)). In another context, Anttila-Hughes & Hsiang (2013) explored typhoon-induced economic effects in the Philippines, revealing a 7.1% decline in household spending linked to income losses, primarily affecting human capital-related expenses like medicine, education, and high-nutrient food. Conversely, spending on pure consumption goods such as recreation, alcohol, and tobacco experienced lesser declines (Anttila-Hughes & Hsiang (2013)). Similarly, Aladangady et al. (2017) showed that post-Hurricane Matthew in the United States, consumer discretionary spending reduced, notably by 4.1% at restaurants and 6.8% at clothing stores.

Given the contextual backdrop, limited attention has been devoted to comprehending the impact of natural disasters on the consumption spending behaviors, disaggregated by gender. There has been several research which has unveiled noteworthy insights into how a child’s gender can engender discernible shifts in parental decisions encompassing fertility considerations (Ben-Porath (1976); Ben-Porath & Welch (1976)), labor market engagement (Lundberg & Rose (2002)), and investments in childcare, nutrition, and education (Jayachandran & Kuziemko (2011); Barcellos et al. (2014)). In developing nations, such as India, and particularly in socioeconomically deprived regions, an asymmetrical interplay of social, institutional, and cultural factors persistently marginalizes women and girls. Indeed, a substantive body of empirical evidence highlights the inequitable distribution of resources, both in terms of education and health expenditures, between males and females in India (Subramanian & Deaton (1991); Kingdon (2005); Himaz (2009)). However, the intersection of consumption spending, natural disasters, and gender remains a largely unexplored terrain. This is primarily attributed to the challenges imposed by data limitations, which significantly impede the ability to effectively connect these aspects. When evaluating the repercussions of disasters on both women and men, along with their subsequent recovery trajectories, certain variables of interest — consumption expenditure are gauged at the household level. However, considering households as singular entities assumes an equitable distribution of disaster losses and coping resources within them. Given the observable disparities between genders, this assumption proves impractical. Building upon the previously explored insights, this study seeks to bridge this gap by deepening our understanding of consumption spending among both males and females in the aftermath of a major catastrophe. In terms of data, the household consumption expenditure data in India from NSSO, a dataset used by Nobel laureate Angus Deaton (Subramanian & Deaton (1991)), forms the bedrock of this research. In another paper, Deaton (1989) also classifies spending into different categories, specifically goods that are typically associated with males, females, and adults in general. This study aims to use the data on the Monthly Per Capita Expenditure (MPCE) of households led by males and females, as well as the consumption expenditure data to assess the trends pertaining to female-oriented commodities and adult goods within households. Despite persistent gaps in data availability and the enduring challenge of delving into the intricate gender dynamics within households, this study undertakes a focused analysis that revolves around goods specifically relevant to females. The aim is to explore possible biases connected to gender in people’s spending habits. Examining adult goods is important due to the indication that introducing a male child to the household leads to a reduction in adult goods expenditure comparable to a substantial decrease in total spending per member. However, this pattern is not observed in the case of female

children, as studies by [Deaton \(1989\)](#) and [Gibson & Rozelle \(2004\)](#)) suggest. Consequently, exploring the patterns of expenditure on typical adult goods can provide valuable insights into gender-specific impacts. Given that existing literature has thoroughly examined various ways in which natural disasters affect societies and economies, providing a sturdy foundation, this study is well-positioned to tackle the key research question : **Are households affected by the tsunami more likely to have an impact on the expenditure of female and adult goods? Does it reduce expenditure on female and adult goods?**

In the following section, I shall delve deeper into the intricacies of the data, variables, and analytical tools that will serve as the foundation for addressing my research question.

# Data and Variables

## (1) The National Sample Survey Data

The National Sample Survey Organisation (NSSO), is an organization under the Ministry of Statistics of the Indian Government, and they are involved primarily to collect data through nation-wide household surveys on various socio-economic subjects. It is a nationally representative multipurpose repeated cross-sectional survey that collects information on household expenditure and consumption, which will be used in this study. This study employs data from the NSSO Household Consumption Expenditure 63<sup>rd</sup>, 62<sup>nd</sup>, 61<sup>st</sup>, 60<sup>th</sup>, 59<sup>th</sup>, and 58<sup>th</sup> survey rounds. These surveys, conducted in the form of rounds extending normally over a period of one year though in certain cases the survey period was six months (see Table 8 in the Appendix). This dataset in each of these rounds encompasses various levels / blocks of information, detailing both household and personal attributes like age, gender, household size, household type, education level, household head's relationship, marital status, religion, social group, and region (rural and urban). The data from NSSO has been categorized by gender, with each household assigned a unique household identification number. Utilizing this household identification number as a common identifier, the data has been merged with the MPCE information. This enables the correlation of individual gender-specific data with their respective MPCE values, creating a comprehensive dataset that encapsulates both consumption behavior of a household and individual-specific characteristics of the households. The MPCE is defined first at the household level (household monthly consumer expenditure divided by the household size). This measure serves as the indicator of the household's level of living. After that, each individual's MPCE is defined as the MPCE of the household to which the person (man, woman or child) belongs to. This assigns to each person a number representing his or her level of living. The distribution of MPCE, thus, highlights the differences in levels of living of different segments of the population. The estimates for household MPCE has been displayed in Figure 2. The graph illustrates the MPCE, which entails the expenditure incurred by each member of a household on all goods and services in both tsunami affected and unaffected groups over the past 30 days. The NSSO also furnishes information on various commodities. In this case, the data provided by the NSSO relates to the "Total Consumption Value" of diverse commodities within each household, rather than focusing on per capita consumption value for different categories of goods. This information is categorized into different blocks (for instance durable goods, food and non-food, clothing etc.) within a specific survey round.

Household consumption expenditure encompasses the monetary value of all consumed items (goods and services), including imputed values for items procured through means other than direct purchase. Importantly, the expenditure on imputed rent for owner-occupied houses and any outlays on productive household enterprises are excluded from the calculation of household consumer expenditure. For the items, the survey collected information on quantity and value of household consumption with a reference period of "last 30 days" for MPCE, food and personal care items of consumption and "last 365 days" for some less frequently purchased items like clothing, durable goods and institutional goods.

This study uses the MPCE data, data on total consumption expenditure on adult good items and personal care items (such as shaving blades, shaving cream, and sanitary napkins) over the "last 30 days," while less frequently purchased items like clothing, durable goods (such as jewellery), with a reference period of "last 365 days. Lastly, the data includes details about the state and district, allow-

ing for the identification of consumption patterns and per capita consumption based on geographical location. Since the data is organized by state-code and district-code for all the blocks within a survey round, identification of the treatment and control groups for this particular study becomes easier.

To analyze the impact of the 2004 tsunami, the study particularly focuses on states severely affected by the disaster, which include Tamil Nadu, Andhra Pradesh, Kerala, Pondicherry, and the Andaman and Nicobar Islands.<sup>2</sup> A toll cut-off of **100** (see Figure 1) is employed to select districts for the treatment group (Treated), which comprises districts situated in coastal areas directly impacted by the tsunami. The control group (Control), on the other hand, encompasses districts unaffected by the tsunami (For details see Table 9 to Table 13 in the Appendix). This categorization allows for a comparative analysis, enabling a better understanding of the tsunami’s impact on the studied economic aspects.

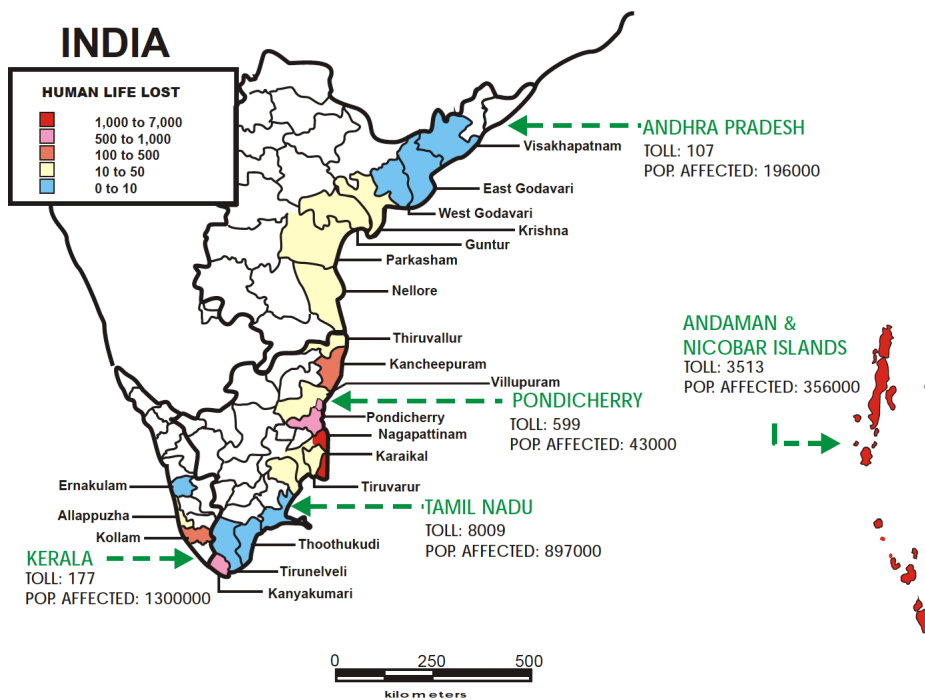


Figure 1: Map of the Tsunami Affected Areas

In the case of NSSO data, the comparison across different years is possible only at the aggregated regional unit, such as state, districts or NSS region. The study encompasses data from multiple survey rounds conducted between the periods of July-December 2002 (58th Survey Round) through July, 2006 - June, 2007 (63rd Survey Round). It is important to highlight that the 61st Survey Round, which took place from July, 2004 - June, 2005; marks a significant break-point in the data timeline due to the occurrence of the tsunami. The temporal framework spanning from the 58th Round (July-December, 2002) to the 61st Round (July, 2004-June, 2005) is designated as the pre-tsunami period. Subsequently, the survey rounds from the 62nd Round (July, 2005-June, 2006) to the 63rd Round (July, 2006-June, 2007) constitute the post-tsunami phase. Thus, the analysis considers a span of two years prior to and two years following the tsunami event. (see Figure 2).

<sup>2</sup>Tsunami Affected States of India: <https://reliefweb.int/map/india/india-map-tsunami-affected-areas>



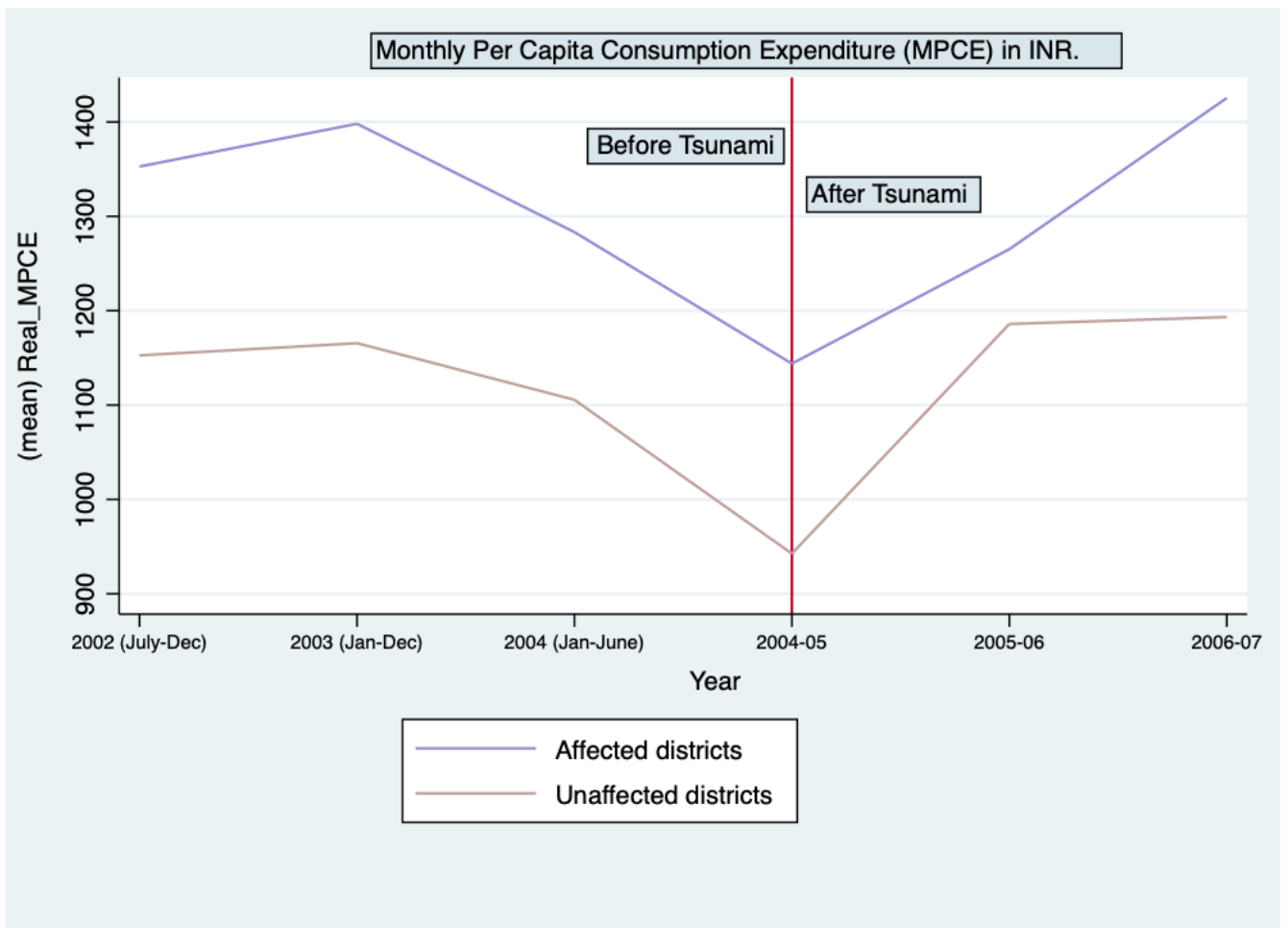


Figure 2: Trend in MPCE overtime (INR)

As you can see from [Figure 2](#) that there has been a decline in [MPCE](#) in both affected and unaffected districts. The decline in [MPCE](#) in both affected and unaffected districts following a tsunami could be attributed to interdependencies in supply chains, economic ties, and trade relationships between the districts, causing economic disruption and reduced consumer confidence. If the affected districts were significant suppliers of goods and services to the unaffected districts, the disruption caused by the tsunami could have disrupted supply chains, exacerbated by the geographic concentration of affected districts in coastal regions and tourist spots. The resulting supply shortages, coupled with psychological impacts, migration patterns, resource reallocation for relief efforts, and potential declines in tourism, collectively contributed to a cautious approach to spending, strained local resources, and broader economic volatility, ultimately influencing the observed decline in [MPCE](#).

Observing that both the affected and unaffected districts were initially impacted, the core emphasis of this study shifts from immediate effects to comprehending the genuine influence on the affected districts. Rather than solely focusing on the immediate responses and short-term adaptations that arise in the aftermath, the study pivots to assess the outcomes that manifest six months after the disaster. Immediate effects often reflect initial shock responses and short-term adjustments, which may not fully capture the enduring changes that unfold over time. By extending the analysis to a six-month post-disaster period, the study delves into the more subtle and potentially evolving repercussions that may emerge once initial upheavals have subsided.

Additionally, this time frame enables a more accurate depiction of how households and individuals adapt to the new circumstances through consumption expenditure. By examining consumption behavior over this extended period, the research aims to uncover patterns that may not be immediately apparent but contribute significantly to our understanding of the gender-specific impact of the disaster

on consumption habits. The study endeavors to shed light on how the tsunami's impact had an effect on male-headed households, female-headed households and gender-specific goods. All the expenditure values presented in this study have been adjusted for inflation using Consumer Price Index (CPI) data from the World Bank. This adjustment ensures that the values reflect their real purchasing power and provide a consistent and accurate analysis <sup>3</sup>.

## (2) Descriptive Statistics

To analyse the differential impact of the Tsunami on consumption expenditure, it becomes crucial to identify treatment and control groups within the affected states. As the disaster primarily affected the coastal areas, not all districts within the same states experienced the same level of impact. By categorizing the districts based on the severity of Tsunami effects, ensures that the treatment and control groups are comparable in terms of their pre-existing characteristics and thereby enables a more rigorous examination of the tsunami's effects. Table 1 presents the demographic characteristics of both the treatment and control groups. It is divided into five sections, i.e., gender, head of the household, marital status, age and household size. Regarding "Marital Status," the highest percentage of individuals in both groups are "Currently Married," accounting for nearly 48%. The "Never Married" category also comprises a substantial proportion, approximately 45%. "Widowed" and "Separated" individuals form smaller segments of the population. In the "Gender" category, the gender distribution is almost balanced, with females slightly outnumbering males in the control group, whereas it is just the opposite in the treatment group.

Table 1: Demographic Characteristics of the Household in the Treatment and Control Group

<b>Panel (A): Gender</b>					
	Control Group		Treatment Group		Observations
	Percentage	Std. err.	Percentage	Std. err.	
Male	49.78	0.61	50.23	1.03	260696
Female	50.22	1.03	49.77	1.03	
<b>Panel (B): Marital Status</b>					
	Control Group		Treatment Group		Observations
	Percentage	Std. err.	Percentage	Std. err.	
Never Married	44.89	0.61	45.78	1.02	260696
Currently Married	47.80	0.61	47.23	1.04	
Widowed	6.52	0.24	6.52	0.39	
Separated	0.79	0.09	0.47	0.10	
<b>Panel (C): Average Household Size</b>					
	Control Group		Treatment Group		Observations
	Mean	Std. err.	Mean	Std. err.	
Household Size	5	0.062	5	0.10	260696
<b>Panel (D): Head of the Household</b>					
	Control Group		Treatment Group		Observations
	Percentage	Std. err.	Percentage	Std. err.	
Male Headed Household	83.69	0.76	84.62	1.22	64399
Female Headed Household	16.31	0.76	15.38	1.22	
<b>Panel (E): Age of the Household Head</b>					
	Control Group		Treatment Group		Observations
	Mean	Std. err.	Mean	Std. err.	
Age	44.5	0.4	44.8	0.6	260696

Note: A comprehensive breakdown of both treated and untreated districts can be found in the tables within the Appendix section of this paper.

In Table 1, the "Head of the Household" category reveals that households primarily led by males account for the majority, with proportions of 83.69% in the control group and 84.62% in the treatment

<sup>3</sup>Inflation adjustment (deflation) methodology has been followed from here : <https://people.duke.edu/~rnau/411inflation.htm> and World Bank CPI Datasets are available here : <https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=IN>



group. In contrast, female-headed households comprise 16.31% in the control group and 15.38% in the treatment group. This distribution suggests a slightly lower prevalence of female-headed households within the treatment group. Further insight into household dynamics is offered by the "Average Age" and "Average Household Size" sections. The average age of household head in both groups hovers around 44-45 years. Likewise, the average household size remains constant at 5 members in both groups, with minor variations in standard errors.

[Table 2](#) undertakes a discerning comparative evaluation of regions that were subjected to treatment versus those that were not, thereby assessing the aggregate repercussions of the tsunami shock on households. The analysis involves contrasting male-headed households in treated and untreated categories, as well as comparing female-headed households in both treated and untreated groups. Similarly, I scrutinize the spending patterns for female goods in treated and untreated scenarios, and so on and so forth. This approach not only offers a comprehensive overview of the tsunami's impact across genders but also enables a deep exploration of potential differences in spending behaviors within households. The study adopts the most important avenue of inquiry by employing variables related to specific goods. These variables delve into the spending on items traditionally aligned with preferences among males, females, and adults. The purpose of considering adult goods is because adding a boy to the household reduces expenditure on adult goods by as much as would a nine-tenths reduction in total outlay per member, but girls have no effect on adult goods expenditure ([Deaton \(1989\)](#); [Gibson & Rozelle \(2004\)](#)). So, typical adult goods spending can also bring out some insights on the gender differential impact. The analysis is conducted separately for the time period before the tsunami and the time period after the tsunami. Hence, the key feature of this study is that the analysis extends its purview to encompass goods that conventionally resonate with each gender and the broader adult demographic. Thus, the study endeavors to illuminate profound insights into the gender-based differentials arising from the economic aftermath of the 2004 tsunami. The study aims to provide nuanced insights into the intricate dynamics within households that have been shaped by these gender-specific disparities within households. [Table 2](#) highlights the average expenditure values for each of the outcome variable groups, along with their corresponding standard errors, offering valuable insights into the average spending levels and the uncertainty surrounding these estimates. [Table 2](#) presents a detailed breakdown of the outcome variables that I am interested to look at i.e., the mean Monthly Per Capita Consumption Expenditure (MPCE) for male headed and female headed households, and average consumption expenditure on specific male, female and adult goods. There are several observations in [Table 2](#) which are noteworthy. The MPCE values exhibit higher mean expenditure in the treatment group (the group affected by the tsunami), however, the treatment group experienced a decline in the average MPCE after the tsunami for both male and female headed households. In the case of male, female and adult goods, I observe that "Men's Clothing," exhibit slightly lower consumption expenditure values in the treatment group both before and after the tsunami, when compared with the control group. When compared with the treatment group, before and after tsunami, expenditure on "Men's Clothing" increased from Rs. 274.5 to Rs. 299.2. Similarly, women's clothing experienced an increase in the treatment group when comparing before and after tsunami periods, i.e., from Rs.413.2 to Rs. 483.6. Now the question is whether this increase in average spending is due to the treatment effect i.e., due to the tsunami or not. Same logic applies for "Jewellery", "Tobacco", and "Intoxicants". Conversely, "Sanitary Napkins," display lower consumption expenditure values in the treatment group after the tsunami, which reduced from Rs.30.2 to Rs.28.4. The standard error values provided in parentheses offer an estimate of the precision of the sample mean. Generally, the precision of the sample mean estimates is moderate to high, indicating that the mean values are likely to be reliable representations of the true population mean. Given these results in the average expenditure, it is important to find out if these average changes are due to tsunami or not. For this exercise I conduct [OLS](#) and [DiD](#) regressions.

Table 2: Summary Statistics of the Outcome Variables

Variables	Before Tsunami: Mean (Std. err.)		After Tsunami: Mean (Std. err.)	
	Control Group	Treatment Group	Control Group	Treatment Group
<b>Panel (A): MPCE of Male and Female Headed Households</b>				
Male Headed Household	1034.7 (19.0)	1278.7 (53.7)	1079.5 (19.8)	1158.6 (24.3)
Female Headed Household	1079.7 (38.8)	1154.9 (72.8)	1038.7 (36.9)	1112.0 (52.1)
Observations	64,399			
<b>Panel (B): Average Consumption Expenditure on Typical Male Goods</b>				
Men's Clothing	285.5 (1.1)	274.5 (1.7)	301.0	299.2 (2.1)
Shaving Blades	10.0 (0.2)	12.8 (1.1)	9.9 (0.2)	10.3 (0.3)
After-shave cream / lotion	15.0 (1.7)	18.8 (1.8)	12.4 (0.4)	15.5 (0.8)
Observations	203,659			
<b>Panel (C): Average Consumption Expenditure on Typical Female Goods</b>				
Women's Clothing	425.2 (1.9)	413.2 (2.8)	479.4 (2.3)	483.6 (3.7)
Jewellery	4147.5 (117.0)	4410.6 (202.1)	5383.5 (163.1)	5540.2 (253.0)
Sanitary Napkins	26.5 (1.3)	30.2 (1.4)	26.2 (0.4)	28.4 (0.7)
Observations	56,003			
<b>Panel (D): Average Consumption Expenditure on Typical Adult Goods</b>				
Pan	59.2 (0.8)	87.7 (1.9)	56.9 (1.1)	84.7 (2.8)
Tobacco	95.9 (0.8)	98.1 (1.2)	101.4 (1.2)	99.8 (2.0)
Intoxicants	135.7 (1.5)	156.6 (2.2)	145.7 (2.0)	165.2 (3.2)
Observations	37,999			

*Note: The standard error values are provided in parentheses.*

*All the consumption expenditure values have been adjusted for inflation and are in INR.*

*Data on MPCE, adult goods and personal care items (such as shaving blades, shaving cream, and sanitary napkins) are reported over the "last 30 days," while less frequently purchased items like clothing, durable goods (such as jewellery), and institutional goods are collected with a reference period of "last 365 days."*

In conclusion, the descriptive statistics presented in Table 2 provide valuable insights into the consumption expenditure pattern and behavior of the control and treatment groups before and after the 2004 tsunami for the outcome variables that are to be taken into consideration for this study. These insights highlights the shifts in preferences and priorities that individuals undergo during times of upheaval. As I delve deeper into understanding the underlying causes and effects of these changes, I turn my attention to the DiD method. The DiD approach provides a robust framework for isolating the causal impact of a specific intervention – in this case, the 2004 tsunami – by analyzing the gender differential impact between the treatment and control group over time. By employing this method, I can disentangle the true effects of the tsunami from other concurrent influences and shed light on the effectiveness of recovery strategies, policy responses, and their implications for long-term well-being and resilience.

# Methodology

## (1) Ordinary Least Squares

In my attempt to understand the factors that affect per capita consumption expenditure, I utilized [OLS](#) regression. A simple [OLS](#) method enabled me to dissect the influence of a range of household characteristics, geographic locations, and temporal factors on the [MPCE](#). More specifically, the variables encompassing the period before and after the tsunami ( $after\_tsunami_t$ ), treatment and control districts ( $Treated_i$ ), gender of the household head, age of the household head, and marital status emerged as impactful determinants of [MPCE](#). This highlights the imperative of incorporating these multifaceted aspects when embarking on the analysis. The array of control variables collectively encapsulates dimensions that collectively mold household spending behaviors. For instance, the " $after\_tsunami$ " variable captures the influence of unforeseen natural disaster shocks, subsequently shaping households' consumption patterns. The " $Treated$ " variable accounts for nuanced regional disparities in costs of living and economic opportunities between the treatment and control groups, while the gender of the household head illuminates the intricate dynamics of decision-making within households. Additionally, the age of the household head and marital status offer insights into the composition and functional roles of the household. The statistical significance of these controls vividly highlights their indispensable role, steering the course of a comprehensive exploration into the impacts of the tsunami and gender-based differences in expenditure. The [OLS](#) regression equation incorporating control variables is as follows :

$$Y_{it} = \beta_0 + \beta_1 after\_tsunami_t + \beta_2 Treated_i + \beta_3 X_{it} + \epsilon \quad (1)$$

where,  $Y_{it}$  is the outcome variable which is log transformation of [MPCE](#). The variable  $after\_tsunami_t$  is a binary variable equal to 1 if time (t) is after the tsunami event (from 2005-2006) and 0 otherwise. The variable  $Treated_i$  is a binary variable equal to 1 if household (i) is in the treatment group (disaster-affected) and 0 otherwise. The variable  $X_{it}$  denotes the set of control variables used in the regression. The coefficient  $\beta_1$  captures the overall time effect, representing the difference in the outcome variable for all households between the pre-treatment and post-treatment periods. The coefficient  $\beta_2$  captures the average treatment effect, representing the difference in the outcome variable between the treatment and control groups. Lastly, the coefficient  $\beta_3$  captures the impact of each of the control variables.

## (2) Difference-in-Differences Identification Strategy

I estimate the impact of 2004 tsunami using [DiD](#), a strategy which estimates the differential effect of a treatment by comparing the changes in outcomes over time between a population affected by the treatment and an unaffected population ([Wooldridge \(2015\)](#)). To examine the repercussions of the 2004 tsunami, the analysis focuses primarily on states severely devastated by the disaster, namely Tamil Nadu, Andhra Pradesh, Kerala, Pondicherry, and the Andaman and Nicobar Islands. A threshold of **100** (TOLL) as a criterion (refer to [Figure 1](#)) is employed to select districts for the treatment group, encompassing coastal districts directly impacted by the tsunami. In contrast, the control group comprises districts that remained unaffected by the tsunami (for detailed information, please refer to the [Appendix](#)). This classification facilitates a comparative analysis, providing a clearer insight into the tsunami's influence on the examined economic facets.<sup>4</sup> Thus, I applied "difference-in-difference"

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<sup>4</sup>Tsunami Affected States of India: <https://reliefweb.int/map/india/india-map-tsunami-affected-areas>

technique in a natural experiment setting which has been used in other literature as well (Mottaleb et al. (2013), Nandi et al. (2018)). The analysis considers a span of two years prior to and two years following the tsunami event.

Firstly, I used DiD to delve into analysing the discernible influence of the tsunami event on MPCE. By delineating distinct treatment and control groups, both pre-and post-tsunami, I harnessed an interaction term ( $\mathbf{diff} = \text{Treated}_i \times \text{after\_Tsunami}_t$ ) that effectively captures the tsunami's impact on MPCE within the treated districts. This methodological framework allowed me to affirmatively establish that the tsunami bore a substantial impact on consumption expenditure. Consequently, this finding will provide a sturdy foundation for the ensuing gender-specific analysis. The regression equations used the same household control factors and the specification of the regression is as follows :

$$Y_{it} = \beta_0 + \beta_1 \text{after\_Tsunami}_t + \beta_2 \text{Treated}_i + \beta_3 (\text{Treated}_i \times \text{after\_Tsunami}_t) + \beta_4 X_{it} + \epsilon_{it} \quad (2)$$

The variable  $X_i$  are the different control variables. The control variables are the same as used in the OLS. Here, the outcome variable includes log transformation of MPCE for all households in general and log transformation of MPCE for male and female headed households. So, basically along with MPCE, I used DiD for evaluating the tsunami's impact for both male and female-headed households. This analysis was performed with and without the inclusion of control variables (Equation (2) and Equation (3)). This approach allowed for a comparison of MPCE between male-headed households in treated and untreated districts, as well as female-headed households in similar contexts. The coefficient of interest is  $\beta_3$ , reflects the differential impact of the tsunami shock on the outcome variable for the treatment group compared to the control group. These analytical frameworks collectively enable me to unravel the intricate dynamics of consumption expenditure patterns, laying the groundwork for exploring of the gender-based impact and related implications of the tsunami.

Subsequently, I directed my attention towards different categories of goods, specifically those relevant to males, females, and adults. In comparing the total consumption expenditure for each category (adjusted for inflation) between treated and untreated districts, I again used the DiD method. However, for goods pertaining to males, females, and adults, the inclusion of household characteristics as controls was not feasible due to the structure of the NSSO data. The model can be specified as follows :

$$Y_{it} = \beta_0 + \beta_1 \text{after\_Tsunami}_t + \beta_2 \text{Treated}_i + \beta_3 (\text{Treated}_i \times \text{after\_Tsunami}_t) + \epsilon_{it} \quad (3)$$

where,  $Y_{it}$  is the outcome variable which is the log transformation of the total consumption expenditure of different categories of goods (male, female and adult goods) in a household. The coefficients hold the same meaning as explained earlier. By employing this methodology, the DiD regression model effectively captures the intricate relationships at play. The resulting coefficients furnish valuable insights into the specific impact of the tsunami on consumption expenditure. This approach provides a comprehensive insight into the effects felt by the households led by males and females, as well as various consumption categories, such as goods for men, women, and adults, following the disaster.

## Key Identification Assumptions

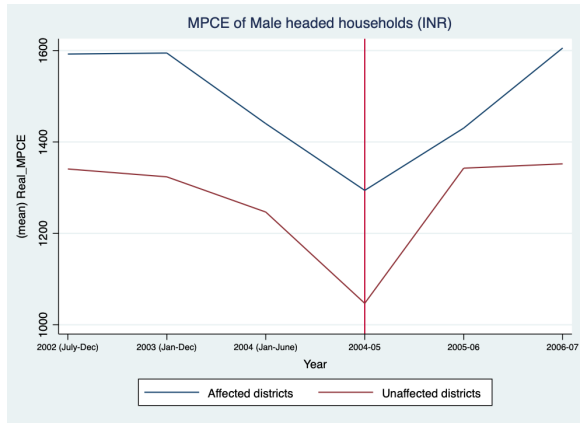
The DiD coefficient can be interpreted as the causal impact of the tsunami under the following assumptions. In this study, most of these assumptions are demonstrated to plausibly hold, alleviating potential threats to the validity of the identification strategy.

### (2.1) Parallel Pre-trends in Consumption Expenditure Outcomes

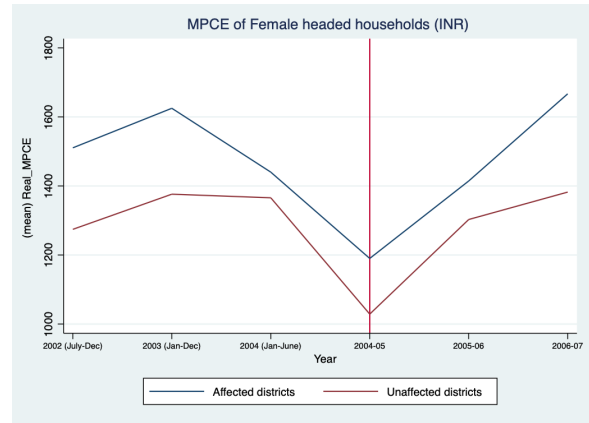
The key identification assumption for DiD is that in the absence of the treatment, outcome variables for the treatment and control groups would have evolved at a similar rate over time, such that any change to outcomes for the treated relative to the control results from the treatment. Before the occurrence of the 2004 Indian Ocean tsunami, the treatment (disaster-affected) and control (non-affected) groups are expected to exhibit similar trajectories in terms of consumption expenditure outcomes. This is

based on the assumption that households' consumption behaviors and economic conditions would have followed comparable paths in the absence of the disaster. The graphs in Figure 3 which are depicting parallel trends further substantiates this assumption. It illustrates that prior to the tsunami, both the treatment and control groups experienced relatively similar patterns of average consumption expenditure over time. This alignment suggests that any observed changes in consumption expenditure outcomes following the disaster can be attributed to the tsunami's impact, as opposed to pre-existing divergent trends between the two groups.

Figure 3: Pre-Parallel Trends: MPCE of male and female headed households

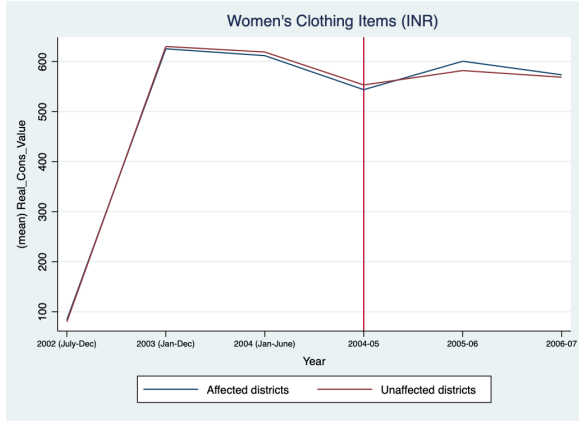


(a) Male Headed Household

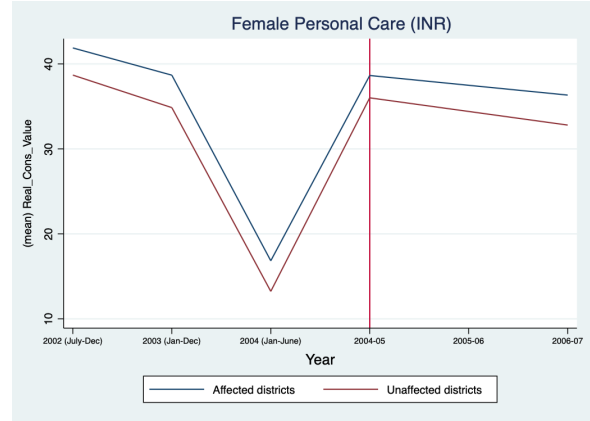


(b) Female Headed Household

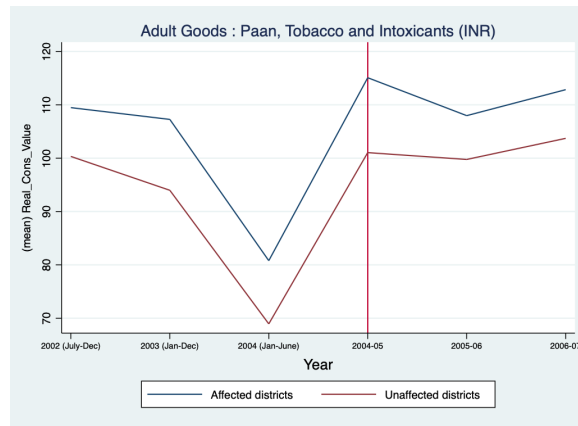
Figure 4: Pre-Parallel Trends: Total Consumption on Female and Adult Goods



(a) Women's Clothing Items



(b) Female Personal Care Items



(b) Adult Goods

The trends in MPCE in Figure 2 closely resembled those depicted in Figure 3 across male and female headed households. In the case of adult goods, there has been a sharp decline in consumption expenditure in 2004 (Jan-June). This maybe because the Government of India enacted in 2004 its comprehensive tobacco control law the Cigarettes and other Tobacco Products Act 2003 (COTPA 2003) (prohibition of advertisement and regulation of trade and commerce, production, supply and distribution), to reduce tobacco use (Pradhan et al. (2020)). A similar scenario is evident in the graph illustrating consumption spending on female personal care items (sanitary napkins). Menstrual Hygiene Management in India is a huge issue and nearly 70% of women in India cannot afford a sanitary napkin (McCarthy & Lahiri-Dutt (2020)). The natural disaster could potentially have led to an uptick in the distribution of sanitary items, resulting in increased consumption expenditure on these products. However, following the initial shock, there could have been a subsequent decrease in the availability of sanitary products due to depleted stock.

## (2.2) No Selection Bias and Quasi-random Treatment Assignment

The occurrence of the 2004 Indian Ocean tsunami was a natural disaster of unprecedented scale, impacting a wide geographical area. The assignment of households and districts into the treatment (disaster-affected) and control (non-affected) groups can be considered quasi-random due to the unforeseeable and indiscriminate nature of the disaster's impact. The disaster struck various coastal regions without any prior knowledge or control over which households would be affected, mitigating the likelihood of intentional selection bias. The tsunami's destructive nature did not discriminate based on households' characteristics, ensuring that the assignment of households to treatment and control groups was largely driven by the geographic proximity to the disaster-affected areas rather than any specific household attributes.

### **(2.3) No anticipatory effects**

The tsunami struck without any prior warning, leaving households in the affected regions with little to no time to anticipate or prepare for its impact. In the period preceding the tsunami, households in the treatment group (disaster-affected areas) would not have had any foreknowledge of the impending disaster and its associated treatment (tsunami). As a result, any changes or trends observed in their consumption expenditure during this period would have been influenced by pre-existing conditions and factors unrelated to the upcoming treatment. The absence of anticipatory effects is reinforced by the fact that the tsunami was triggered by a seismic event, which is inherently unpredictable in terms of its exact timing, magnitude, and location. This lack of predictability further diminishes the likelihood of households adjusting their consumption behaviors in anticipation of the disaster.

### **(2.4) Comparable Treatment and Control Groups**

The descriptive statistics presented in both [Table 1](#), and [Table 2](#) provide compelling support for the "Comparable Treatment and Control Groups" identification assumption. Across household head, the treatment and control groups exhibit closely aligned mean values of Monthly Per Capita Consumption Expenditure ([MPCE](#)) before and after the tsunami. This congruence establishes a baseline comparability, making any subsequent divergences in outcome variables post-tsunami indicative of the treatment effect. The similar patterns observed in consumption expenditure on male, female and adult goods between the treatment and control groups provide evidence that the assignment of households into these groups was not driven by systematic differences, reinforcing the validity of the "Comparable Treatment and Control Groups" assumption.

# Results

In this section, I will be presenting the results of OLS and DiD regression analysis which gives a step-by-step analysis and finally examines the gender-specific impact of the 2004 tsunami on consumption expenditure.

## Analyzing the Impact on Monthly Per Capita Consumption Expenditure

In the pursuit of comprehending the intricate interplay between household characteristics and MPCE, I conducted OLS regression analysis. The results, presented in Table 3, unveil a compelling narrative that highlights the profound influence of key household attributes on expenditure patterns. The study deliberately refrained from considering education or occupation controls as the problem of multicollinearity was affecting the results, and thus, focussing instead on a comprehensive set of determinants including household size, gender of the head of the household, age of the household head, marital status, location (treatment group and control), and temporal dynamics (pre and post-tsunami period). Thus, I selected the most relevant control variables for this exercise. The research sought to explore whether specific household characteristics contribute to variations in MPCE. This approach aimed to extract the true effects of household-specific factors on consumption behavior, before capturing the gender differential impacts.

Table 3: Regression Results: Overall impact on MPCE

Variables	Coefficient	(Standard Error)
<i>after_tsunami</i>	0.1297***	(0.0054)
Treated	0.1227***	(0.0056)
head_gender	0.0777***	(0.0118)
log_HHSize	-0.4146***	(0.0057)
log_age_of_head	0.4378***	(0.0101)
Marital_Status		
2.Currently_Married	-0.1315***	(0.0191)
3.Widowed	-0.5375***	(0.0221)
4.Seperated	-0.4554***	(0.0340)
Constant	5.7583***	(0.0434)
Observations	64,396	
R-squared	0.1385	

Note: Standard errors in parentheses. Logarithmic Transformation of the outcome variable i.e. was made for regression ( $\log\_MPCE$ ). Please note that *after\_tsunami*, *Treated*, *head\_gender* and *Marital\_Status* are dummy variables. The base is excluded for comparison.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

The initial observation reveals that the independent variable *after\_tsunami* displays a notable 12.97% upsurge in the outcome variable MPCE. This finding highlights the substantial impact of the post-tsunami time frame on household spending habits, regardless of whether households were in the treatment or control group. Notably, within the treatment group denoted by the independent variable



"Treated", **MPCE** is 12.27% higher, independent of the time period. This implies that the treated districts possess greater affluence, likely due to their proximity to coastal regions and their appeal as popular tourist destinations. Remember that both "*after\_tsunami*" and "Treated" are dummy variables. These trends collectively emphasize the joint influence of geographical location and temporal dynamics on **MPCE**. Delving deeper into household dynamics, the variable *head\_gender* which is also a dummy variable, reveals a noteworthy 7.77% increase in **MPCE**, suggesting that households with female heads tend to have higher **MPCE**, and thus, there is a potential shift in expenditure patterns based on the gender of the household head. This finding holds significant importance and will serve as a pivotal foundation for the analysis of the gender-specific impact of the tsunami. Moreover, the variables *log\_HHSize* and *log\_age\_of\_head* exhibit coefficients of -0.4146 ( $p < 0.01$ ) and 0.4378 ( $p < 0.01$ ) respectively. These findings reveal intriguing patterns: larger households tend to exhibit reduced **MPCE**, while households with older heads demonstrate higher expenditure. This could reflect varying consumption needs and preferences across households of different sizes and age compositions. The independent variable *Marital\_Status*, which is a dummy variable (the base is excluded for comparison i.e. Never Married), presents distinct coefficients for different marital statuses. Married households exhibit a negative impact on **MPCE** with a decrease of -13.15%, implying their tendency to spend less compared to other household types based on marital status. Widowed households demonstrate a markedly negative impact of -53.75%, indicating substantial shifts in expenditure behavior following the loss of a spouse. Similarly, separated households experience a significant negative impact of 45.54%, highlighting the pronounced influence of this marital status on spending patterns. This phenomenon can be attributed to changes in financial responsibilities and dynamics within each household type. Married households might distribute expenses differently due to shared financial obligations, resulting in relatively lower individual expenditures. In widowed households, the absence of one partner can lead to adjustments in spending habits, potentially due to reduced income or altered priorities. Separated households often experience financial disruptions due to the separation process, leading to changes in spending as households adapt to new living arrangements and individual financial management. These findings collectively explain the intricate relationship between marital status and expenditure behaviors.

Overall, the findings of this analysis shed light on the pivotal role played by household characteristics in shaping consumption expenditure. The observed effects emphasize the importance of considering household-specific attributes while gauging consumption behavior. Since my analysis will focus on gender-differentiated impact, certain variables tend to be of utmost importance. For example, "*after\_tsunami*" captures influences from natural disaster shocks, and policy alterations, affecting how households spend. "Treated" variables consider variations in living costs and economic opportunities across regions which affects household spending, while the gender of the household head mirrors the dynamics of decision-making. The statistical significance of these controls highlights their essential role, in guiding a comprehensive exploration of the impact of the tsunami and gender-related disparities in spending.

## Unveiling the Impact of the Tsunami on Monthly Per Capita Consumption Expenditure

In pursuit of unravelling the intricate dynamics surrounding the aftermath of the tsunami shock on consumption expenditure, I employed **DiD** approach, with household controls used in the earlier **OLS** exercise. The purpose behind this approach was to account for various factors that could influence **MPCE**, allowing me to isolate the genuine impact of the tsunami in treated districts.

Upon analyzing the coefficients, a substantial and favorable influence of the independent variables, "*after\_tsunami*" (13.68%) and "Treated" (13.05%), on the outcome variable **MPCE** becomes evident. These numerical outcomes suggest that the period following the tsunami resulted in a considerable upswing in spending among impacted households. Additionally, districts that underwent the treatment intervention which is basically the tsunami affected districts, display higher **MPCE**. Collectively,

this emphasizes the notion that major events like natural disasters can prompt heightened spending as households strive to recover and reconstruct.

Table 4: Regression Results: Impact of tsunami on [MPCE](#) in the treatment group

Variables	Coefficient	(Standard Error)
<i>after_tsunami</i>	0.1368***	(0.0063)
Treated	0.1305***	(0.0070)
diff	-0.0235**	(0.0118)
head_gender	0.0776***	(0.0118)
log_HHSize	-0.4145***	(0.0057)
log_age_of_head	0.4378***	(0.0101)
Marital_Status		
2.Currently_Married	-0.1316***	(0.0191)
3.Widowed	-0.5375***	(0.0221)
4.Seperated	-0.4554***	(0.0340)
Constant	5.7563***	(0.0434)
Observations	64,396	
R-squared	0.1386	

Note: Standard errors in parentheses. Logarithmic Transformation of the outcome variable i.e. was made for regression (*log\_MPCE*). Please note that *after\_tsunami*, *Treated*, *diff*, *head\_gender* and *Marital\_Status* are dummy variables. The base is excluded for comparison.  
\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

In my quest to emphasize the distinct impact of the tsunami in treated districts, I introduced the "diff" term which is the interaction term as mentioned in equation (2) from the Methodology section.

The "diff" term serves as an insightful measure of how the consumption patterns diverged between the treated and control districts post-tsunami. The negative sign indicates that the tsunami's impact had a dampening effect on consumption expenditure in the treated districts compared to the control counterparts with a decline of 2.35%. To capture the gender-specific dynamics, I carefully controlled for the gender of the household head ("head\_gender"). This control variable is found to have a statistically significant impact with an increase of 7.76% which again highlights the significance of gender as a determinative factor shaping consumption patterns within households. Furthermore, by controlling for household size ("log\_HHSize") and the age of the household head ("log\_age\_of\_head"), I aimed to account for the structural variations that inherently influence consumption behaviors. Notably, "log\_HHSize" exhibits a negative coefficient whereas "log\_age\_of\_head" boasts a positive coefficient, which are similar to the previous [OLS](#) results. Again these coefficients highlights the role that household composition and the age of the head play in shaping consumption decisions. As I delve into the realm of marital status ("Marital\_Status"), the results are similar to the previous [OLS](#) regression highlighting the differential impact of marital status on per capita consumption expenditure. In summation, this comprehensive regression analysis substantiates that the tsunami shock, coupled with the treatment intervention, did exert a discernible impact on [MPCE](#). The inclusion of control variables and the introduction of the "diff" term effectively captured the distinctive repercussions of the disaster in treated districts. Armed with these insights, I am going to embark on a gender-specific exploration, delving into the gender-based differentials arising from the tsunami's aftermath in the treated districts i.e., the tsunami affected areas.

## Moving towards gender-differentiated impact : Evaluating the Influence of the tsunami on Male and Female-Headed Households' [MPCE](#)

In this section, I delve into a refined analysis to discern the disparate effects of the tsunami shock on male and female-headed households. Before starting with the analysis, I would like to clarify why am

I considering male and female headed households. Male and female-headed households often exhibit distinct patterns of consumption and expenditure due to gender-related roles, responsibilities, and preferences. By analysing both types of households separately, I can uncover potential gender disparities in how the tsunami’s impact influenced their consumption behaviour. The tsunami’s impact may have differently affected male and female-headed households. For instance, if certain economic activities were gender-specific (e.g., fishing activities typically dominated by males), the tsunami’s repercussions could be more pronounced for one gender over the other. Examining these effects separately can help discern any gender-based differences. The regression results presented in Table 5 illuminate the nuanced dynamics underlying the consumption expenditure of these distinct household types, allowing us to unravel gender-based disparities ensuing from the catastrophic event.

Table 5: Regression Results (MPCE): Male and Female headed households

Variables	after_tsunami ( $\beta_1$ )	Treated ( $\beta_2$ )	diff ( $\beta_3$ )	Constant	Observations	R-squared
<b>Monthly Per Capita Consumption Expenditure (MPCE)</b>						
<b>Male Headed Households</b>	0.1639*** (0.0075)	0.1588*** (0.0078)	-0.0365*** (0.0135)	6.7883*** (0.0044)	53,998	0.0205
<b>Female Headed Households</b>	0.1538*** (0.0177)	0.1102*** (0.0189)	0.0315 (0.0332)	6.7746*** (0.0103)	10,400	0.0167

Note: Standard errors in parentheses. Logarithmic Transformation of the outcome variables were made for regression.  
\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

Table 5 encapsulates the outcomes of this intricate examination. Within the realm of male-headed households, the coefficient estimate of after\_tsunami ( $\beta_1$ ) suggest that there has been 16.39% increase in MPCE which accentuates a substantial positive impact of the tsunami on consumption expenditure, irrespective of the treatment status. Moreover, the "Treated" coefficient ( $\beta_2$ ) suggest that MPCE is 15.88% higher within the treated districts. These results concur with prior findings. Within the domain of female-headed households, the after\_tsunami coefficient ( $\beta_1$ ) suggest that there has been 15.38% increase, albeit at a slightly lower magnitude compared to male-headed households. The Treated coefficient ( $\beta_2$ ) suggest that MPCE is higher by 11.02% in the treated districts of coastal regions and again these results are consistent with the previous findings.

Now, I turn my attention to the coefficient of primary interest ( $\beta_3$ ), which studies the impact of the tsunami in treated districts. This finding implies a 3.6% reduction in MPCE for male-headed households in the aftermath of the tsunami within affected districts. In contrast, a positive albeit statistically insignificant coefficient ( $\beta_3$ ) which says that there has been a 3.15% rise in MPCE for female-headed households. This clearly indicates a less pronounced effect on female headed households. This divergence suggests a noteworthy gender-based variation in the impact of the tsunami in treated districts. I have estimated the results with and without using control variables, and the results are consistent. The observed gender-specific impact can be rooted in the traditional roles men and women hold in these coastal settings. Usually, men have been engaged in activities like fishing and maritime trades, which often formed a substantial portion of household income. The tsunami’s devastation significantly disrupted these activities, rendering them economically unviable due to the destruction of fishing equipment and infrastructure. Consequently, the capacity of men to contribute to household finances and maintain pre-tsunami consumption levels was severely compromised.

In contrast, women’s roles and economic pursuits diverged from the male norm in these coastal communities. Usually, women engaged in land-based activities such as agriculture, local trade, and household-based production. Despite being impacted by the tsunami, these activities may have experienced relatively less disruption compared to the male-dominated maritime sectors. This inherent resilience in women’s income-generating endeavors could have played a role in insignificant results for female headed households. In essence, the disparities in the impact of the tsunami on male-headed versus female-headed households in treated districts can be attributed to the traditional gender divisions of labor and their subsequent vulnerability to the immediate consequences of the disaster.

Table 6: Regression Results (MPCE): Male and Female headed households (With Controls)

VARIABLES	Male Headed Household (MPCE) (1)	Female Headed Household (MPCE) (2)
after_tsunami ( $\beta_1$ )	0.1342*** (0.0069)	0.1345*** (0.0167)
Treated ( $\beta_2$ )	0.1358*** (0.0072)	0.1117*** (0.0179)
diff ( $\beta_3$ )	-0.0351*** (0.0125)	0.0348 (0.0314)
log_age_of_head	0.4614*** (0.0095)	0.4020*** (0.0256)
log_HHSize	-0.5066*** (0.0063)	-0.1837*** (0.0104)
Marital Status		
2.Currently_Married	-0.1290*** (0.0168)	0.1673*** (0.0374)
3.Widowed	-0.4151*** (0.0230)	-0.4184*** (0.0395)
4.Seperated	-0.3427*** (0.0562)	-0.3443*** (0.0486)
Constant	5.8601*** (0.0332)	5.6718*** (0.0863)
Observations	53,997	10,399
R-squared	0.1620	0.1206

Standard errors in parentheses

Please note that *after\_tsunami*, *Treated*, *diff*, *head\_gender* and *Marital\_Status* are dummy variables.

The base is excluded for comparison.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## Exploring the impact on female and adult goods within households

Expanding upon the findings from the previous results, where households headed by men experienced a negative impact on MPCE, post-tsunami in the affected districts, and hence the question arises regarding its potential consequences on the purchasing patterns for specific items, especially those traditionally linked with women’s consumption preferences. The notable decline in spending among male-headed households can be attributed to the disruption of their main sources of income, which are closely tied to activities often concentrated in coastal regions. This disruption likely triggered changes in how these households manage their expenses. Given that the affected households are male-headed households, a pertinent question arises concerning whether this financial setback affected decisions related to household budgets, specifically in terms of items usually associated with women’s preferences. Hence, it becomes crucial to explore whether the reduction in spending among male-headed households led to any adjustments in the allocation of funds towards items usually intended for female family members. So, once again I have used DiD technique to understand the impact of the tsunami in the treated districts and how has it affected male, female and adult goods. The results are given in Table 7 below.

Table 7: Regression Results : Male, Female and Adult Goods

Variables	after_tsunami ( $\beta_1$ )	Treated ( $\beta_2$ )	diff ( $\beta_3$ )	Constant	Observations	R-squared
<b>Panel (A): Typical Male Goods :</b>						
Men’s Clothing	0.2306*** (0.006)	-0.0656*** (0.0063)	0.0490*** (0.011)	5.2328*** (0.0035)	169,463	0.0145
Shaving Blades	0.0591*** (0.0096)	-0.0175** (0.0087)	0.0052 (0.0167)	2.1812*** (0.0051)	28,780	0.0023
After-shave cream / lotion	0.2192*** (0.0223)	0.2364*** (0.0192)	-0.0633 (0.0399)	2.2398*** (0.011)	8,416	0.033
<b>Panel (B): Typical Female Goods :</b>						
Women’s Clothing	0.3017*** (0.0101)	-0.0389*** (0.0106)	0.0459** (0.0186)	5.7066*** (0.0059)	49,742	0.0272
Sanitary Napkins	0.2375*** (0.0212)	0.1376*** (0.0225)	-0.0734* (0.0378)	3.0106*** (0.0124)	4,164	0.0445
Jewellery	0.4388*** (0.06)	0.1011 (0.0684)	-0.099 (0.1171)	5.7177*** (0.0362)	2,097	0.0305
<b>Panel (C): Typical Adult Goods :</b>						
Pan	-0.0483* (0.027)	0.1966*** (0.0272)	0.0606 (0.0491)	3.7345*** (0.0152)	9,088	0.0102
Tobacco	0.0510*** (0.017)	-0.0302* (0.0175)	-0.0603* (0.0315)	4.2188*** (0.0096)	20,303	0.001
Intoxicants	0.0990*** (0.0208)	0.1921*** (0.0222)	-0.0001 (0.0392)	4.6333*** (0.0126)	8,608	0.0155

Note: Standard errors in parentheses. Logarithmic Transformation of the outcome variables were made for regression.  
 \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

The findings about women’s clothing provide us with important information about what happened after the tsunami. After the tsunami, there was a big increase of 30.17% in spending on women’s clothing, showing a big change, irrespective of the treatment status. In the treated districts, the coefficient  $\beta_2$  shows a 3.89% reduction in spending, indicating that these areas had lower expenditures on women’s clothing compared to the untreated districts. Shifting our attention to the coefficient of interest, represented as  $\beta_3$ , it reveals a 4.59% increase in spending on women’s clothing. This increase can be attributed to a range of factors. The aftermath of a significant event like a tsunami might have prompted households to allocate more resources to essential items such as clothing, particularly for women. This phenomenon could be driven by factors like rebuilding needs, changes in family dynamics, or shifting preferences. In the case of men’s clothing as well, the  $\beta_3$  coefficient suggest that there has been an increase in spending by 4.90%. Interventions provided post-disaster, including aid and economic stimulus, likely bolstered households’ purchasing power to some extent. The shift in priorities towards essentials like clothing, increased awareness, and the stability conferred by interventions

could have encouraged higher spending. Additionally, psychological factors, such as seeking comfort and normalcy, might have prompted households to allocate more resources for clothing.

Delving into a fundamental aspect of women's hygiene, I observe an increase in the spending of sanitary items by 23.75 for the post-tsunami variable, reflecting an impact on expenditure. The treated districts spend a higher amount by 13.76% on sanitary items. However, there has been a significant decline of 7.34% on spending of essential items like sanitary napkins in the treated districts after tsunami. The decrease in spending on sanitary napkins in treated districts highlights potential challenges faced by households in accessing or affording these items post-disaster, which might be influenced by a range of factors, including disruptions in supply chains or changes in household financial priorities.

The domain of jewellery, known for its cultural and aesthetic importance, did not exert a significant impact due to tsunami. Jewellery is often considered a form of investment or a symbol of cultural heritage, leading individuals to allocate funds to such items regardless of external shocks. Additionally, jewellery may not be as directly tied to immediate post-disaster recovery needs as other essential items. Moreover, jewellery might not be a primary expenditure category for households, and therefore, changes in spending patterns due to the tsunami might not be as pronounced in this domain.

Examining Panel (C) in [Table 7](#), I observe notable insights regarding the consumption of different items. Specifically, after the tsunami in treated districts, tobacco registered a significant negative impact of -6.03%, signaling reduced spending. Conversely, pan and intoxicants did not exhibit any significant impact. Notably, Indian tobacco products like khaini and gutkha are commonly consumed by a substantial number of men in India. The decline in spending on these items could imply a shift in resources towards other essential commodities. This redirection might be particularly influenced by the presence of a male child in the household, as suggested in prior research ([Deaton \(1989\)](#), [Gibson & Rozelle \(2004\)](#)). Such a trend points towards a potential gender-related bias in expenditure allocation.

Overall, it suggests that tsunami did have an impact on female goods like women's clothing and sanitary napkins, in the treated districts. It also had an impact on adult goods like Indian tobacco, which might indicate a possibility of gender bias.

# Robustness Checks and Extensions

To ensure the robustness of the outcomes derived from the main analysis, I conducted a comprehensive robustness assessment which delves into a finer granularity, directing our attention to the individual states within the affected areas. The aim here is to validate the main findings derived from the initial [DiD](#) analysis and pinpoint potential avenues for further investigation. In this section, I shift my focus to a more detailed level by looking at the impact of the tsunami within each individual state. I address the unique situation of the Andaman and Nicobar Islands, where the entire region was impacted by the tsunami. To better understand the specific impact on Andaman, I select Lakshadweep Island as a suitable control group for comparison. This deliberate choice allows me to make a meaningful comparison between the two island groups, shedding light on the distinct impact experienced by Andaman after the tsunami.

In my main analysis, I employed [OLS](#) regression and the [DiD](#) framework. This approach has also been adopted for the subsequent robustness assessment. Comprehensive tabulations detailing these outcomes are provided in the **Appendix** ([Table 14](#) and [Table 15](#)). Initially, I conducted [OLS](#) linear regression separately for each of the states affected by the tsunami, wherein each state was demarcated into treatment and control districts (as outlined in the **Appendix** in [Table 9](#) and [Table 13](#)). The model incorporated the same control variables, encompassing household characteristics, alongside treatment and time dummies. Notably, this robustness evaluation reveals that a substantial majority of states demonstrated statistically significant outcomes across a range of variables (especially the gender of the household) on [MPCE](#). Building upon the [OLS](#) findings, I promptly proceeded to implement the [DiD](#) methodology across all states.

The [DiD](#) robustness assessment finds significant impact of the tsunami on [MPCE](#) among male-headed households in some of the tsunami affected states. Specifically, the findings reveal that Tamil Nadu and Pondicherry witnessed a significant impact in this regard, while Andhra Pradesh, Kerala, and Andaman and Nicobar Islands exhibited no statistically significant influence. Tamil Nadu experienced a notable 6.06% decrease in the [MPCE](#) of male-headed households, a trend congruous with the main findings of the study. Conversely, Pondicherry registered a distinct upswing, with a substantial 22.98% rise in [MPCE](#) among male-headed households. Upon closer examination of the impact's robustness in Pondicherry, it's crucial to consider the potential factors that could contribute to the observed change. Various contextual elements, such as local economic dynamics and household behaviors, may have contributed to this change, warranting further investigation to establish the underlying drivers with confidence. In the context of female-headed households, the congruence between the robustness outcomes and the main findings reinforces the assertion that the [MPCE](#) among female-headed households remained unaffected within the treated districts.

Turning the focus towards female-oriented commodities, the analysis highlights Kerala and Tamil Nadu, which exhibited an increasing trend in women's clothing consumption expenditure. Consumption expenditure in this category surged by 8.2% in Kerala and 19.13% in Tamil Nadu. These outcomes remain consistent with the main results. However, the robustness analysis also unraveled an intriguing contrast concerning sanitary napkins. While the main analysis signaled a negative impact, the state-wise analysis did not detect any noteworthy influence on this category across all states. This disparity might be attributed to the intricate interplay of various factors beyond the direct effects of the tsunami. These intricate dynamics, ranging from socio-economic factors, to localized cultural practices



as mentioned in a study by [Bhattacharjee \(2019\)](#), could collectively contribute to the nuanced findings pertaining to sanitary napkins. In the case of jewellery, the study confirms that the main results related to jewellery remain consistent. The findings show a similar pattern across all states. Importantly, the influence of the tsunami on jewellery spending did not show any statistically significant impact in any of the states in the affected districts.

Conversely, in the realm of adult goods, a compelling narrative emerges. The analysis highlights a notably negative impact across all states, except for Andaman and Nicobar Islands, where an opposing pattern emerges. The idea of keeping adult goods in this analysis was to link it with gender bias as previous research suggests that households with more male children tend to spend less on adult goods ([Deaton \(1989\)](#); [Gibson & Rozelle \(2004\)](#)). This trend holds true for all states, excluding the unique scenario of the Andaman and Nicobar Islands. Here, a significant positive impact of 28.53% on adult goods expenditure calls for special attention, possibly indicating some special economic dynamics exclusive to these islands. Moreover, given the significant impact, it's worth noting that adult goods, such as intoxicants and tobacco, might have served as coping mechanisms during times of distress. This sheds light on how economic fluctuations can influence consumption patterns, emphasizing the need to consider broader societal contexts when interpreting spending behaviors.

Overall, the robustness check results contribute substantial coherence to the main findings. In general, I can say that a sub-group analysis highlights significant impact on male-headed households, women's clothing, and adult goods for specific states. The nuanced variations observed across categories and states emphasize the multifaceted nature of the tsunami's repercussions. These findings emphasize the significance of accounting for diverse underlying factors when aiming to comprehend the intricate shifts in the economy following a disaster, potentially guiding us towards further avenues of research.



# Conclusion and Policy Insights

My main analysis revealed that the occurrence of 2004 tsunami had a discernible impact on male-headed households within the treated districts after the tsunami. Building on this, I delved into an exploration of the effects on female-oriented commodities. The results of this analysis unveiled a multi-faceted pattern. Specifically, women's clothing expenditures exhibited a positive impact of 4.59% , whereas sanitary napkin expenditures demonstrated a negative response of 7.34%. Similarly, the outlay on tobacco experienced a negative impact of 6.03% following the event.

Traditionally, in many coastal communities, men have been primarily engaged in fishing and maritime trades, which played a pivotal role in generating a significant portion of household income. These activities not only provided livelihoods but also sustained the economic viability of these households. However, the impact of the 2004 tsunami was profound and far-reaching. The disaster led to widespread destruction of fishing equipment, boats, infrastructure, and coastal communities as a whole. As a result, the livelihoods of many men who depended on fishing and maritime trades were severely disrupted and rendered economically unviable. This disruption had a cascading effect on their ability to contribute to household finances and maintain their pre-tsunami consumption levels. To enhance the resilience of coastal communities, there is a need to promote diversification of livelihoods. Encouraging men to explore alternative sources of income, such as small-scale agriculture, aquaculture, or other trades, can help reduce their dependence on a single economic activity. This diversification can provide a safety net during times of crisis, such as natural disasters. Providing access to financial services, such as microfinance and savings mechanisms, can empower households to build financial resilience. Also, offering skill enhancement and training programs can equip with alternative livelihood skills that are less susceptible to the impacts of natural disasters. Training in areas such as carpentry, masonry, or small business management can open up new avenues for income generation. Investing in disaster-resilient infrastructure for fishing and maritime activities is also crucial. This includes promoting the construction of cyclone-resistant storage facilities, community shelters, and modernizing fishing equipment. Implementing targeted social safety net programs can provide temporary relief to families affected by disasters. These programs can include direct cash transfers, food assistance, and access to basic services, helping households bridge the gap until they can rebuild their livelihoods.

While addressing the challenges faced by male-headed households, it is essential to recognize and address the gender-specific impacts of disasters. Gender-inclusive policies should consider the unique vulnerabilities faced by women and men, and tailor interventions accordingly.

As male-headed households experienced significant effects from the disaster, it might be a possibility that less attention and funds were allocated to purchasing female-oriented goods, indicating a potential gender bias. To analyse this aspect, I examined consumption expenditure on female goods. The results suggest that there has been an increase in women's clothing. The increase in spending on women's clothing could be attributed to a variety of factors. Following a disaster, households may prioritize basic needs and essentials. Women's clothing, being a necessity, could have gained prominence in resource allocation as households aimed to rebuild their lives and ensure adequate clothing for all family members. This increase could also indicate a response to the loss or damage of clothing during the disaster.

The effect on sanitary napkins presents an ambiguous scenario, as the main analysis indicates a decline

while not passing the robustness checks. In India, where just 12% of women and girls have access to sanitary napkins, and a significant portion relies on unhygienic alternatives during menstruation, thus, the issue in itself is of serious concern (Rohatgi & Dash (2023)). This challenge cannot be solely attributed to the impact of the tsunami. The complex situation surrounding menstrual hygiene practices and access underscores a pre-existing issue that demands comprehensive attention.

Additionally, the impact of the tsunami on households' allocation of resources was assessed through the analysis of adult goods expenditure. Earlier research suggests that the presence of a male child seemed to lead to a decreased spending on adult goods, suggesting a preference for male children (Deaton (1989); Gibson & Rozelle (2004)). This highlights the importance of understanding gender dynamics within households. The decline in tobacco spending could signify a shift in priorities towards other essential items. Given that Indian tobacco products are often consumed by men, this change might reflect altered spending patterns influenced by male preferences.

In summary, this study does yield significant findings that might indirectly point towards a gender-specific impact after the tsunami in treated districts. Drawing from previous noteworthy research by Deaton (1989) and Gibson & Rozelle (2004), it can be inferred that the significant decrease in tobacco expenditure, given its predominant consumption by men in India, might indicate the presence of a male child and the prioritization of his needs, resulting in reduced spending on adult goods. Conversely, if the household had a girl child, it is likely that there would be no significant impact on this front. Policies that promote gender equality and empower women economically can help mitigate potential biases in resource allocation within households. This could include programs that enhance women's financial literacy and decision-making power. Encouraging family planning practices that are not influenced by gender preferences can lead to better resource distribution within households. Policies that diversify livelihood opportunities for both men and women can reduce dependency on specific income sources, thus minimizing biases in resource allocation. Also, promoting the importance of female-specific hygiene items and ensuring their accessibility can help address the decline in sanitary napkin expenditure, potentially enhancing women's well-being. By considering these policy implications, policymakers can work towards minimizing gender biases in resource allocation and promoting more equitable outcomes within households, even in the aftermath of a disaster.

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# Appendix

## (1) NSSO Survey Rounds

Table 8: NSSO Household Consumption Expenditure Survey Rounds

NSS Rounds	The Period of Survey
NSS 63 <sup>rd</sup> Round	July 2006 - June 2007 (Financial Year)
NSS 62 <sup>nd</sup> Round	July 2005 - June 2006 (Financial Year)
NSS 61 <sup>st</sup> Round	July 2004 - June 2005 (Tsunami on 26th Dec, 2004)
NSS 60 <sup>th</sup> Round	Jan - June 2004 (6 months)
NSS 59 <sup>th</sup> Round	Jan - Dec 2003 (Calendar Year)
NSS 58 <sup>th</sup> Round	July - Dec 2002 (6 months)

## (2) Treatment and Control Groups

Table 9: State and District Information (Part 1)

State Code	State	District Code	District
28	Andhra Pradesh	2811	Srikakulam (Control)
28	Andhra Pradesh	2812	Vizianagaram (Control)
28	Andhra Pradesh	2813	Visakhapatnam (Treatment)
28	Andhra Pradesh	2814	East Godavari (Treatment)
28	Andhra Pradesh	2815	West Godavari (Treatment)
28	Andhra Pradesh	2816	Krishna (Control)
28	Andhra Pradesh	2817	Guntur (Control)
28	Andhra Pradesh	2818	Prakasam (Treatment)
28	Andhra Pradesh	2819	Sri Potti Sriramulu Nellore (Treatment)
28	Andhra Pradesh	2820	Y.S.R. (Cuddapah) (Control)
28	Andhra Pradesh	2821	Kurnool (Control)
28	Andhra Pradesh	2822	Anantapur (Control)
28	Andhra Pradesh	2823	Chittoor (Control)

Table 10: State and District Information (Part 2)

State Code	State	District Code	District
32	Kerela	3201	Kasaragod (Control)
32	Kerela	3202	Kannur (Control)
32	Kerela	3203	Wayanad (Control)
32	Kerela	3204	Kozhikode (Control)
32	Kerela	3205	Malappuram (Control)
32	Kerela	3206	Palakkad (Control)
32	Kerela	3207	Thrissur (Control)
32	Kerela	3208	Ernakulam (Treatment)
32	Kerela	3209	Idukki (Control)
32	Kerela	3210	Kottayam (Control)
32	Kerela	3211	Alappuzha (Treatment)
32	Kerela	3212	Pathanamthitta (Control)
32	Kerela	3213	Kollam (Treatment)
32	Kerela	3214	Thiruvananthapuram (Control)



Table 11: State and District Information (Part 3)

State Code	State	District Code	District
33	Tamil Nadu	3301	Thiruvallur (Treatment)
33	Tamil Nadu	3302	Chennai (Treatment)
33	Tamil Nadu	3303	Kancheepuram (Treatment)
33	Tamil Nadu	3304	Vellore (Control)
33	Tamil Nadu	3305	Tiruvannamalai (Control)
33	Tamil Nadu	3306	Viluppuram (Treatment)
33	Tamil Nadu	3307	Salem (Control)
33	Tamil Nadu	3308	Namakkal (Control)
33	Tamil Nadu	3309	Erode (Control)
33	Tamil Nadu	3310	The Nilgiris (Control)
33	Tamil Nadu	3311	Dindigul (Control)
33	Tamil Nadu	3312	Karur (Control)
33	Tamil Nadu	3313	Tiruchirappalli (Control)
33	Tamil Nadu	3314	Perambalur (Control)
33	Tamil Nadu	3315	Ariyalur (Control)
33	Tamil Nadu	3316	Cuddalore (Treatment)
33	Tamil Nadu	3317	Nagapattinam (Treatment)
33	Tamil Nadu	3318	Thiruvarur (Control)
33	Tamil Nadu	3319	Thanjavur (Treatment)
33	Tamil Nadu	3320	Pudukkottai (Control)
33	Tamil Nadu	3321	Sivaganga (Control)
33	Tamil Nadu	3322	Madurai (Control)
33	Tamil Nadu	3323	Theni (Control)
33	Tamil Nadu	3324	Virudhunagar (Control)
33	Tamil Nadu	3325	Ramanathapuram (Treatment)
33	Tamil Nadu	3326	Thoothukkudi (Treatment)
33	Tamil Nadu	3327	Tirunelveli (Treatment)
33	Tamil Nadu	3328	Kanniyakumari (Treatment)
33	Tamil Nadu	3329	Dharmapuri (Control)
33	Tamil Nadu	3330	Krishnagiri (Control)
33	Tamil Nadu	3331	Coimbatore (Control)
33	Tamil Nadu	3332	Tiruppur (Control)

Table 12: State and District Information (Part 4)

State Code	State	District Code	District
34	Pondicherry	3401	Yanam (Control)
34	Pondicherry	3402	Puducherry (Treatment)
34	Pondicherry	3403	Mahe (Control)
34	Pondicherry	3404	Karaikal (Treatment)

Table 13: State and District Information (Part 5)

State Code	State	District Code	District
31	Lakswadweep Islands (Control)	Used for Robustness Check	
35	Andaman and Nicobar Islands	3501	Nicobars (Treatment)
35	Andaman and Nicobar Islands	3502	North & Middle Andaman (Treatment)
35	Andaman and Nicobar Islands	3503	South Andaman (Treatment)

### (3) Robustness Checks

Table 14: OLS Results : Impact on MPCE

VARIABLES	Andhra Pradesh	Kerela	Tamil Nadu	Pondicherry	Andaman and Nicobar Islands
after_tsunami ( $\beta_1$ )	0.1803*** (-0.0085)	0.0997*** (-0.0113)	0.1042*** (-0.0087)	0.1618*** (-0.0386)	0.0951*** (-0.0268)
Treated ( $\beta_2$ )	0.0456*** (-0.0097)	0.1019*** (-0.0124)	0.1237*** (-0.0086)	-0.1756*** (-0.0392)	0.0006 (-0.029)
head_gender	-0.0765*** (-0.0202)	0.0602*** (-0.0173)	-0.0518*** (-0.0174)	0.0314 (-0.0668)	0.0794* (-0.043)
log_age_of_head	0.3966*** (-0.0141)	0.3079*** (-0.0214)	0.3108*** (-0.015)	0.3447*** (-0.0572)	0.2075*** (-0.0462)
log_HHSize	-0.3948*** (-0.0087)	-0.5616*** (-0.0113)	-0.4101*** (-0.009)	-0.3957*** (-0.0332)	-0.5286*** (-0.022)
Marital Status					
Currently Married	-0.1229*** (-0.0256)	0.3648*** (-0.0338)	-0.2069*** (-0.0246)	-0.1534* (-0.0795)	0.2372*** (-0.0598)
Widowed	-0.4199*** (-0.0315)	0.0109 (-0.0399)	-0.5255*** (-0.0294)	-0.5575*** (-0.1008)	0.0709 (-0.0788)
Separated	-0.3708*** (-0.0549)	-0.0841 (-0.06)	-0.4204*** (-0.053)	-0.4780*** (-0.1608)	-0.0164 (-0.1376)
Constant	5.8535*** (-0.0479)	6.3001*** (-0.0782)	6.3472*** (-0.0525)	6.5175*** (-0.1994)	6.9645*** (-0.1623)
Observations	23,574	13,967	23,791	1,576	2,022
R-squared	0.1328	0.1817	0.1305	0.1567	0.2427

Note: Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

Table 15: DiD Robustness Check: State-wise Analysis

Variables	after_ tsunami ( $\beta_1$ )	Treated ( $\beta_2$ )	_diff ( $\beta_3$ )	Constant	Observations	R-squared
<b>Panel (A): MPCE of Male headed households</b>						
Andhra Pradesh	0.2057*** (0.0109)	0.0595*** (0.0135)	0.0154 (0.0226)	6.6619*** (0.0065)	20,746	0.0244
Kerela	0.1456*** (0.0165)	0.1534*** (0.0187)	-0.0413 (0.0318)	7.0526*** (0.0097)	10,476	0.0167
Tamil Nadu	0.1346*** (0.0123)	0.1524*** (0.0121)	-0.0606*** (0.0211)	6.7774*** (0.0071)	20,179	0.0153
Pondicherry	0.0251 (0.129)	-0.1730*** (0.0516)	0.2298* (0.1382)	7.1295*** (0.0456)	1,270	0.0251
Andaman and Nicobar Islands	0.0438 (0.0723)	0.0035 (0.0451)	0.0855 (0.0818)	7.2551*** (0.04)	1,689	0.0073
<b>Panel (B): MPCE of Female headed households</b>						
Andhra Pradesh	0.1417*** (0.0322)	0.0272 (0.0393)	0.064 (0.0683)	6.6078*** (0.0189)	2,829	0.0116
Kerela	0.1515*** (0.0286)	0.1654*** (0.0366)	0.0789 (0.0632)	6.9634*** (0.0165)	3,492	0.0241
Tamil Nadu	0.1855*** (0.0296)	0.1407*** (0.029)	-0.0268 (0.0504)	6.6930*** (0.0174)	3,612	0.0226
Pondicherry	-0.0099 (0.1856)	-0.1415 (0.0987)	0.1899 (0.2142)	7.0079*** (0.0835)	306	0.0132
Andaman and Nicobar Islands	0.0162 (0.1085)	0.0554 (0.071)	0.0896 (0.1452)	7.1740*** (0.0475)	333	0.0093
<b>Panel (C): Expenditure on Women's Clothing</b>						
Andhra Pradesh	0.3075*** (0.0158)	-0.0181 (0.0199)	-0.0257 (0.0339)	5.9124*** (0.0093)	20,735	0.0222
Kerela	0.2637*** (0.0229)	-0.0192 (0.0271)	0.0824* (0.0467)	5.8776*** (0.0133)	10,932	0.0184
Tamil Nadu	0.2451*** (0.0166)	-0.1781*** (0.0166)	0.1913*** (0.0288)	5.8624*** (0.0097)	21,675	0.0285
Pondicherry	1.1738*** (0.1504)	1.1950*** (0.06)	-0.9912*** (0.1616)	5.0043*** (0.0524)	1,446	0.2436
Andaman and Nicobar Islands	0.4609*** (0.1187)	0.2999*** (0.0686)	0.4211 (0.132)	5.7999*** (0.0603)	1,827	0.0351
<b>Panel (D): Expenditure on Female Personal Care</b>						
Andhra Pradesh	0.1778*** (0.0499)	0.0641 (0.0824)	0.0528 (0.1316)	3.1919*** (0.0308)	927	0.0192
Kerela	0.1736*** (0.0393)	0.1297*** (0.0446)	-0.0257 (0.0739)	3.2358*** (0.0219)	1,686	0.0227
Tamil Nadu	0.0690** (0.0282)	0.1314*** (0.0258)	-0.0158 (0.0453)	3.3533*** (0.0153)	2,944	0.0152
Pondicherry	0.4395 (0.3819)	-0.3921** (0.1847)	-0.0669 (0.4041)	3.4237*** (0.1708)	114	0.1166
Andaman and Nicobar Islands	-0.0216 (0.11)	0.1177* (0.0627)	-0.1889 (0.1291)	3.6118*** (0.0482)	277	0.0371
<b>Panel (E): Expenditure on Jewellery</b>						
Andhra Pradesh	0.5237*** (0.1202)	0.4124*** (0.1199)	-0.2916 (0.2324)	5.4778*** (0.0623)	658	0.0451
Kerela	0.3090** (0.1283)	-0.4089*** (0.1374)	0.3188 (0.2451)	5.9827*** (0.0639)	456	0.0436
Tamil Nadu	0.4572*** (0.1231)	0.0239 (0.1165)	-0.1466 (0.2463)	5.7475*** (0.0636)	659	0.0239
Pondicherry	-0.2755 (1.1094)	0.237 (0.4564)	0.5897 (1.5749)	6.1334*** (0.3077)	24	0.0278
Andaman and Nicobar Islands	-0.1401 (0.7156)	-0.2796 (0.3578)	0.4211 (0.8764)	6.5897*** (0.2921)	36	0.0231
<b>Panel (F): Expenditure on Adult Goods</b>						
Andhra Pradesh	0.0603*** (0.0176)	0.1161*** (0.0224)	-0.0719* (0.0404)	4.2388*** (0.0103)	15,303	0.0024
Kerela	0.1057*** (0.028)	0.1231*** (0.0307)	-0.1236** (0.0538)	4.2637*** (0.0162)	7,652	0.0033
Tamil Nadu	0.0345 (0.0228)	0.0264 (0.0233)	-0.0784* (0.0417)	4.0703*** (0.0128)	12,367	0.0003
Pondicherry	-0.0069 (0.4523)	-0.2203** (0.0885)	0.0921 (0.4615)	4.6022*** (0.0796)	776	0.0084
Andaman and Nicobar Islands	-0.0317 (0.1186)	0.1651** (0.0695)	0.2853** (0.1327)	4.1285*** (0.0609)	2,436	0.0149

Note: Standard errors in parentheses. Logarithmic Transformation of the outcome variables were made for regression.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .