NATURAL DISASTERS AND GENDER NORMS

A Thesis
Submitted to the Graduate Faculty
of the
North Dakota State University
of Agriculture and Applied Science

By

Mehadi Hasan Shawon

In Partial Fulfillment of the Requirements
for the Degree of
MASTER OF SCIENCE

Department:
Agribusiness and Applied Economics

May 2024

Fargo, North Dakota

# North Dakota State University
## Graduate School

**Title**

NATURAL DISASTERS AND GENDER NORMS

**By**

Mehadi Shawon

The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota

State University's regulations and meets the accepted standards for the degree of

**MASTER OF SCIENCE**

SUPERVISORY COMMITTEE:

Veeshan Rayamajhee

Chair

Raymond March

Kerianne Lawson

Dan Pemstein

Approved:

| 05/29/2024 | Cheryl Wachenheim |
|:---:|:---:|
| Date | Department Chair |

**ABSTRACT**

This empirical study investigates the effect of natural disasters on gender norms on the time allocation for market and non-market (household) labor. Using county-level natural hazards data in conjunction with the American Time Use Survey (ATUS) dataset, I find a convergence of men and women's time allocation for market and non-market work (specifically, household activities, childcare, adult care, and community service) following a natural disaster. Further, women spent less time in household activities and childcare but dedicated more time toward adult care and community service. I also find men allocated more time toward household tasks, but concurrently spent less time in community service and caring for others. Broadly, my findings indicate gender-specific labor allocation is adaptive and responsive following major disasters.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# 1. INTRODUCTION

The number of natural disasters in the US has increased since the 1960s (Kahn, 2005). In 2020 alone, over 100 natural disasters in the US resulted in 250 deaths and $119 billion in damages. Natural disasters can profoundly affect economic activity, leading to disruptions in routines, increased transaction costs, limited economic exchanges, and reduced availability of goods. As a result, post-disaster conditions often impose new constraints that prompt different choices toward market and non-market work time allocation from affected individuals. These choices can have long-lasting consequences for living standards, making understanding how households reallocate resources in the aftermath of disasters crucial.

Natural disasters also shape individual household production in many ways, such as household activities, caring for children and adults, and community service. Consequently, changes in household production also impact gender norms pertaining to market and non-market work[1.] Gender norms significantly shape labor market participation and market and non-market work distribution (Antecol, 2000; Bertrand et al., 2015; Blau & Kahn, 2007; Damaske & Frech, 2016). In particular, the level of husbands' contribution to housework is related to the woman's engagement in the labor market and/ or role in household production (Akerlof & Kranton, 2011; Bertrand et al., 2015; Ichino et al., 2019). Sociological analysis of gender norms notes additional psychological and other aspects related to wellbeing are also impacted by household division of labor (Cislaghi & Heise, 2020; Davis & Greenstein, 2009; Shelton & John, 1996).

---

[1] While the term non-market work can constitute a host of activities, I use the term to mean tasks specifically related to household production.

While not all-encompassing, market and non-market work time allocation provide a useful metric to assess gender-related norms. Because major disasters fundamentally change individuals and household constraints, they provide a valuable unit of analysis to see whether and how household production changes and, by extension, how gender norms adjust. While economic literature provides valuable insights into household time allocation, research on how natural disasters impact this allocation remains relatively scarce. Furthermore, examining post-disaster changes in household production allows us to assess the robustness of gender norms in shaping decisions related to market and non-market work time allocation. This study aims to address these gaps by exploring changes in household time allocation following major disasters.

The study contributes to the growing literature that examines how natural disasters impact gender norms, especially non-market work time allocation. By examining the differential impacts on men and women, this elucidates how natural disasters influence labor market outcomes and non-market activities through the lens of gender. These insights are crucial for developing gender-sensitive disaster response and recovery policies, emphasizing the necessity of supporting work-life balance, especially for women who may face increased market work responsibilities following disasters. The findings also contribute to discussions on economic resilience, highlighting the importance of integrating gender perspectives into resilience-building strategies. Additionally, this study offers a deeper understanding of shifts in household labor dynamics post-disaster, which is vital for creating effective family support systems. Methodologically, the research advances the field by employing sophisticated techniques to analyze the temporal effects of disasters, thus fostering further academic inquiry into the mechanisms driving these changes and their long-term implications for gender equality. By quantifying the gendered impacts of disasters, the research raises awareness of existing

disparities, informing advocacy and empowerment programs designed to mitigate adverse effects on women's labor participation and household responsibilities. Overall, this study provides practical policy implications, enriches academic knowledge, and enhances public awareness of gender equality in the context of natural disasters, making it a valuable addition to the literature in economics journals.

Thus, I examine the impact of major disasters on gender norms. Specifically, I aim to understand whether natural disasters lead to a convergence in gender norms of time allocation for non-market work. I specifically examine housework, food and drink preparation, presentation and clean-up, interior maintenance repair and decoration, exterior maintenance repair and decoration, lawn-garden and houseplants, animals and pets, vehicles, appliances, tools and toys, and household management, caring for and helping household and non-household members, including children and adults. These actions sample tasks with comparatively clear gender-related norms associated with them. They also provide a broad range of activities to more accurately assess how time is reallocated within households.

Using ordinary least squares (OLS) and other regression specifications, I find a convergence for market and non-market work specifically, household activities, childcare, adult care, and community service between men and women after a major disaster. Specifically, my analysis indicates women residing in the disaster affected counties spent less time in household activities and childcare while reallocating time toward adult care and community service comparing to the unaffected county residents. Conversely, men allocated more time comparing unaffected county peoples toward household tasks, but concurrently spent less time in community service and in caring for children and adults.

This thesis is structured as follows. Section two provides a review of relevant literature on economics and household production, gender norms, culture and time allocation, and post-disaster time allocation. Section three outlines the research approach and data sources of this study. In section four, I present my empirical findings, and section five concludes the paper, offering implications of the findings and directions for future research.

## 2. LITERATURE REVIEW

Disentangling economics and gender-specific household time allocation considerations into natural disasters' impact is essential to understand how natural disasters interact with market and non-market work time allocation. Specifically, understanding what occurs to time allocation based on gender norms after major disasters warrants further investigation. This section reviews previous literature on these interrelated subjects.

### 2.1. Household Production and Time Allocation

Household production refers to the creation of goods and services within a household, primarily for personal consumption (Becker, 1981). This process relies on the households' own resources, including capital and unpaid labor (Ironmonger, 2000). Becker (1965) introduced the model 'household as a factory' where households function like firms, producing both market and non-market goods. This theoretical framework has been influential in understanding how households optimize resource allocation, make tradeoffs, and respond to changes in wages, prices, and technology.

While abstract, Becker's insights provide a fruitful framework to understand division of labor in the household as well as what factors change this division and allocation of time toward market and non-market labor. One significant advancement in this area of research is precise quantification of household production through comprehensive surveys tracking time utilization (Rubiano Matulevich & Viollaz, 2019; Gamiez-nauden et al., 2020; D et al., 2011; T van et al., 2011; M et al., 2010; H G Bolemen et al., 2010).

According to the Organization for Economic Cooperation and Development (OECD), women in the U.S. dedicate approximately four hours daily to unpaid work, whereas men spend around 2.5 hours on similar tasks. The unequal allocation of household tasks between genders

has garnered considerable scholarly focus (Goldin, 1994; Jepsen & Jepsen, 2006; Schneebaum, 2013; Siminski & Yetsenga, 2022). With the rise in female labor force participation, there has been a growing emphasis on the female contribution to non-market work in household time allocation (Bianchi et al., 2000; Burda et al., 2013; Coltrane, 2000; Ralsmark, 2017). Like the narrowing gender wage gap and the decreasing disparities in labor force participation between men and women, there has also been a reduction in the gender gap related to housework.

Much of this reduction can be attributed to the decline in women's time spent on household chores. (Bianchi et al., 2012). Although men's involvement in housework saw an increase during the 1980s, there has been minimal change in their contribution since then (Bianchi et al., 2012; Winkler, 2018). Even with certain improvements, women still bear a disproportionate burden of housework and childcare responsibilities. Consequently, many employed women find themselves undertaking a "second shift" of work within the household (Hochschild & Machung, 1989). In 2014, married women who were employed dedicated slightly fewer hours to market work but significantly more time to household chores compared to their employed married male counterparts. This discrepancy led to an average total workload—defined as the combination of housework and market work—being 4.6 hours higher for women (Winkler, 2018).

More broadly, women's greater responsibility for housework and caregiving may be associated with decisions that reduce their labor market success compared to men's, including weaker labor force attachment (Mincer & Polachek, 1978), a lesser willingness to work long hours (Goldin, 2014), restricted job search and commuting time (Butikofer et al., 2019; Le Barbanchon et al., 2021) or supplying less effort for similar hours worked (Becker, 1985). These decisions, including choices related to part-time employment and the selection of specific

6

occupations and firms, are likely factors contributing to the "child penalty." This term refers to the decrease in women's earnings relative to men's earnings that occurs with the arrival of children. (Kleven et al., 2019; Waldfogel, 1998).

Shifting the focus to childcare responsibilities, scholars have observed the enduring unequal gender divisions in this domain. While both parents, irrespective of gender, now devote more time to childcare compared to the 1960s, mothers still consistently allocate more time to childcare than fathers (Gauthier et al., 2004).

## 2.2. Gender Norms, Culture, and Time Allocation

Gender norms play a significant role in determining the division of labor and time allocation within households (Hwang et al., 2019). Besides, gender norms contribute to the underrepresentation of women in the labor market, resulting in disproportionate (compared to men) engagement in housework (Rubiano Matulevich & Viollaz, 2019). Several studies document that inherited gender norms are a key determinant of women's labor market outcomes (Alesina et al., 2013; Fernández, 2013; Fernández et al., 2004; Marianne, 2011; Olivetti et al., 2020). Other studies emphasize the strong influence of peers on female labor market decisions (Maurin & Moschion, 2009; Nicoletti et al., 2018). Cavapozzi et al. (2021) studied whether women's labor market participation is shaped by the gender norms of their peers. Using detailed information on a sample of UK mothers with dependent children, they found that having peers with gender-egalitarian norms correlated with women being more likely to have a paid job and to have a greater share of the total number of paid hours worked within their household. However, this effect didn't translate into a significant impact in the number of hours worked by mothers. Most of these effects are driven by women who have lower levels of formal education.

Relatedly, many studies examine the impact of gender norms considerations on household production (Bertrand et al., 2015; Blau & Kahn, 2007; Robinson, 1987; Winkler, 2018). When household production is gender-specific, allocation of time toward household activities between men and women result in a "gender gap," which helps explain occupational choice, wages, and hours related to household production and occupation (Erosa et al., 2022). Gimenez-Nadal (2022) find the gender gap in unpaid work limits women's wages, thereby making it more difficult to increase female participation in the labor market. To reduce the gender gap, incentive toward gender-specific long working hours need to be taken away and it is applied in various sectors, such as technology, science, and health, but is less apparent in the corporate, financial, and legal worlds (Goldin, 2014). Besides, climate change also impacts on the labor supply and time allocation on the outdoor activities effecting the household production gender gap (Graff Zivin & Neidell, 2014). Thus, efforts to reduce the gender wage gap and equalize the roles of men and women in society may be helpful in reducing the gender gap in time allocation (Gimenez-Nadal, 2022).

Moreover, gender norms and cultural beliefs exert a lasting influence on economic results. Extensive research has delved into the impact of gender roles on labor market outcomes. Notably, studies have revealed that anti-egalitarian gender role attitudes are inversely related to female employment rates and the gender pay gap. Prevailing gender attitudes significantly shape women's economic participation and wage equality in OECD countries (Fortin, 2005). Likewise, A. F. Alesina & Giuliano (2007) utilize cross-country and second-generation immigrant data to explore the influence of family connections on diverse facets of labor market dynamics. Their research indicates that societies with robust family ties exhibit increased levels of home production, decreased rates of youth and female labor force participation, and limited

8

geographical mobility. This highlights the intricate impact of cultural norms on economic conduct. Additionally, cultures that endorse gender equality are linked to a higher likelihood of individuals sharing household chores, fostering a collective approach to domestic tasks (Marcén & Morales, 2021).

Several studies that focus on gender roles and time allocation, in particular. For instance, research has shown that more egalitarian gender attitudes are positively linked to increased gender equality in total work time. This conclusion is drawn from analyses of responses in the World Value Survey, which scrutinizes the gender distribution of both non-market and market work. (Anxo et al., 2011; Burda et al., 2013; Campaña et al., 2023; Sayer, 2005). This suggests that gender role attitudes play a crucial role in shaping the allocation of labor within households and labor market participation. The variation in the gender gap in housework time among immigrants particularly observed when immigrants originate from countries with low female labor force participation rates (Hwang et al., 2016). Álvarez & Miles (2003) employ the Oaxaca decomposition method to unravel the factors contributing to the asymmetric distribution of housework within Spanish dual-income couples and find gender-specific effects, rather than observable characteristics, primarily explain this disparity. Bittman et al. (2003), & Giménez et al. (2022) explore the effect of relative income on housework contribution (for each partner) and find that the wife tends to allocate more time to household chores when she receives a higher salary. Given these studies are conducted in Australia, Spain, and the U.S. respectively, they found household income is a reliable predictor for household allocation of time and resources.

### 2.3. Post-disaster Time Allocation

Natural disasters have significant and far-reaching impacts on individuals and communities, disrupting daily routines, infrastructure, and livelihoods (Guha-Sapir et al., 2013;

9

Paul et al., 2015). Therefore, disasters impact men and women differently, leading to gendered vulnerabilities and post-disaster challenges (E. Enarson et al., 2007). Moreover, natural disasters have varying impacts on individuals, prompting discussions regarding gender-specific vulnerabilities in disasters and the concept of a "gendered landscape of disasters"(Enarson, 1999).

Different social norms, cultural beliefs, and collective practices define the order of gender, and these gendered social systems are exacerbated in times of disaster (E. P. Enarson & Morrow, 1998). For example, during and following disasters, women are regularly "doubly burdened" (Juran & Trivedi, 2015). They work hard in the wake of disasters, while still maintaining their ascribed gendered expectations in the "private sphere" of the home and family (Enarson and Morrow, 1998; see also Scanlon, 1998). These practices during the post-disaster create a disparity within the allocation of time, including market and non-market work.

Furthermore, the immediate aftermath of natural disasters has been shown to intensify women's workload significantly. Alongside their traditional roles as caregivers and nurturers, women must now also integrate income-earning responsibilities into their daily lives because of the loss of family members and assets. Literature also indicates certain gendered impacts of natural disasters (Bradley et al., 2023; Bradshaw, 2004; Hasan et al., 2019). That is, natural disasters greatly impact women's economic insecurities, and they have less access to resources. In many instances, women who lose their husbands often find themselves unexpectedly shouldering the role of the primary breadwinner within the household. This shift is frequently accompanied by the constraints imposed by gender stereotypes and social structures, which may limit their opportunities for economic advancement.

Post-disaster environments necessitate adaptive decision-making, with individuals facing collective burdens of reconstruction and recovery. Chamlee-Wright & Storr (2009) argue that fostering a strong sense of place and community rebound is essential in disaster recovery. They stress the significance of collective efforts in reimagining and recreating a sense of place following the destruction caused by disasters. Furthermore, Shahid et al. (2022) emphasizes the importance of social capital in enabling self-governance and fostering resilience during post-disaster scenarios, where concerted efforts by the private sector, citizens, and public institutions are crucial for successful recovery.

The focus of this paper is on the gender norms following major disasters. I also aim to marry the literature on gender norms, natural disaster's effect on the market and non-market work, and time allocation research. A disaster, be it natural or man-made, provides social scientists an excellent opportunity to observe society at its most exposed state. Because disasters lay bare the workings of both men and women, they provide us with opportunities for a closer examination of the gendered impact (Neumayer & Plümper, 2007). This allows me to investigate whether natural disaster leads to convergence on gender norms in a post-disaster context. I look at several outcome variables that are indicative of different aspects of gender norms and draw conclusions based on the allocation of time affected by major disasters. I use the ordinary least square method to analyze natural disasters' effect on gender norms. Gender norms are directly linked with economic development and policy related matters, and therefore, I will be making conclusions regarding economic outcomes through my analysis.

## 3. APPROACH AND DATA

I estimate the effect of natural disasters on the time allocation towards market and non-market work separately for the men and women subsamples using the baseline regression model of the following form:

$$Yidmysct = \beta 0 + \beta 1\text{Disasterct} + \beta 2X + cd + dm + ey + fs + eidmys \qquad (1)$$

My study focuses on analyzing the impact of major disasters, defined as disasters that resulted in 25 or more fatalities. I investigate the relationship between these disasters and household labor allocation, denoted as Y, which includes both market work (i.e., income generating), and non-market work (i.e., household chores, childcare, adult care, and community service). These variables are measured in minutes per day for individual i, reported on day d, within month m, of year y, within a given state.

In my most concise model, the vector of covariates (denoted as X) includes respondent's age, age squared, and race/ethnicity (categorized into five mutually exclusive groups: Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian, Non-Hispanic Other, and Hispanic, with Non-Hispanic White serving as the reference category). Additionally, I control education using four discrete binary categories: less than High School, High School, Some College, and College+, where less than High School serves as the reference category. Additional set of control variables include the number of children within age groups 0-5, 6-12, and 13-17, respectively, as well as spousal characteristics such as spouse's age, age squared, race/ethnicity, and education.

All regression models include fixed effects for the day of the week, month, year, and state (denoted as cd, dm, ey, and fs, respectively). The error term is denoted as *e*.

The primary sample consists of all respondents from the American Time Use Survey (ATUS), including both men and women. I link ATUS with Spatial Hazard Events and Losses Database for the United States (SHELDUS) data to create my main dataset.

I begin by examining gender differences in time allocation for both market and non-market work. Additionally, I also compute the gender gap in these measures to provide an overview of the differences in labor allocation for men and women.

I then proceed to estimate the impact of natural disasters on household allocation of labor for market and non-market work using the regression models of the form specified above. Subsequently, I conduct a series of robustness checks including alternative specifications, fixed effects, and fatality thresholds.

### 3.1. American Time Use Survey (ATUS)

My main variables of interest are time allocation for market and non-market work, which I obtain from the American Time Use Survey (ATUS), conducted by the U.S. Bureau of Labor Statistics. Specifically, I use summary files of the time diary data from 2003 to 2021 waves of ATUS to conduct my analyses. I define market work as time allocated for income generating activities, as well as preparing for job, job search, interviewing and other related activities. Time spent on non-market work includes four main categories of activities: a) household activities, b) childcare, c) adult care, and d) community service. Household activities further include activities such as housework, food and drink preparation, presentation and clean-up, interior maintenance, repair and decoration, exterior maintenance, repair and decoration, lawn garden and houseplants, animals and pets, vehicles, appliances, tools and toys, and household management. Childcare includes time spent on caring for and helping household children, performing activities related to children's education, and activities related to children's health. Similarly, adult care includes

activities related to caring for and helping household adults. Finally, community service includes

activities related to caring for and helping non-household children and/or non-household adults,

their education and health.

The ATUS collects time diary data via telephone interviews based on respondents'

recollection of their previous day's activities, recording time spent on each activity during the

twenty-four-hour window. Interviewers collect information on all activities starting at 4 am the

previous day and ending at 4 am on the interview day. BLS notifies the respondents in advance

so that they may carefully record all the activities. All time use variables are measured in

minutes per day.

My main sample includes a total of 78,555 observations, which includes 34,516 men and

44,039 women.

### 3.2. Spatial Hazards Events and Losses Database for the United States (SHELDUS)

We obtain county-level natural hazards data from SHELDUS, which covers eighteen

types of natural hazards such as thunderstorms, hurricanes, floods, wildfires, and tornados and

perils such as flash floods and heavy rainfall. The database also contains information on the

location (county and state), and the cumulative disaster losses (property and crop losses, injuries,

and fatalities) in the county for each year, which allows us to link them to time diary data for the

years 2003-2021. The data contained in SHELDUS draw heavily on multiple hazard databases

housed under the umbrella of the National Centers for Environmental Information (NCEI) and

the U.S. Department of Agriculture. All the losses data are adjusted for county population and

inflation. In the following research fatality numbers are focused on measuring significant

disasters.

The focus of this study is on major disasters, which I define as a disaster resulting in total county-level fatalities of 25 or more, following previous literature (Boustan et al., 2020). However, for robustness and transparency purposes, we provide estimates of effects for various alternative fatality thresholds, ranging from 0 to 150.

## 4. RESULTS

I begin by examining differences in time allocation for market and non-market work between men and women in the sample. To that end, I classify non-market work into the following four categories (as discussed in section 3): household activities, childcare, adult care, and community service. In addition, I also consider market work, which is defined as time spent on income-generating activities or in related activities such as searching, applying for, and preparing to work.

Table 1 presents descriptive statistics for various activities by gender. A cursory glance shows discernable gender gaps in time allocated for market and non-market work. Not accounting for household composition and other demographic differences, women tend to spend 67 minutes more time in non-market work than men. The bulk of this gap can be explained by the gender gap in household activities (50 minutes) and childcare (15 minutes). On the other hand, men spend 62 minutes more time on market work compared to women.

Notably, the gaps are most extreme for non-market work among households with children under the age of 18. On average, women in households with children under the age of 18 spend 113 minutes more in non-market work compared to men. Most of these differences are driven by household chores (74 minutes) and childcare (38 minutes). Men, on the other hand, spend over two hour (120 minutes) more than women on market work. These differences support the notion that both men and women take on traditional gender roles with regards to interhousehold labor allocation. This holds true, although to varying degrees, for households with and without children under the age of 18.

In the next section, we analyze how major disasters impact the gender gap in market and non-market work.
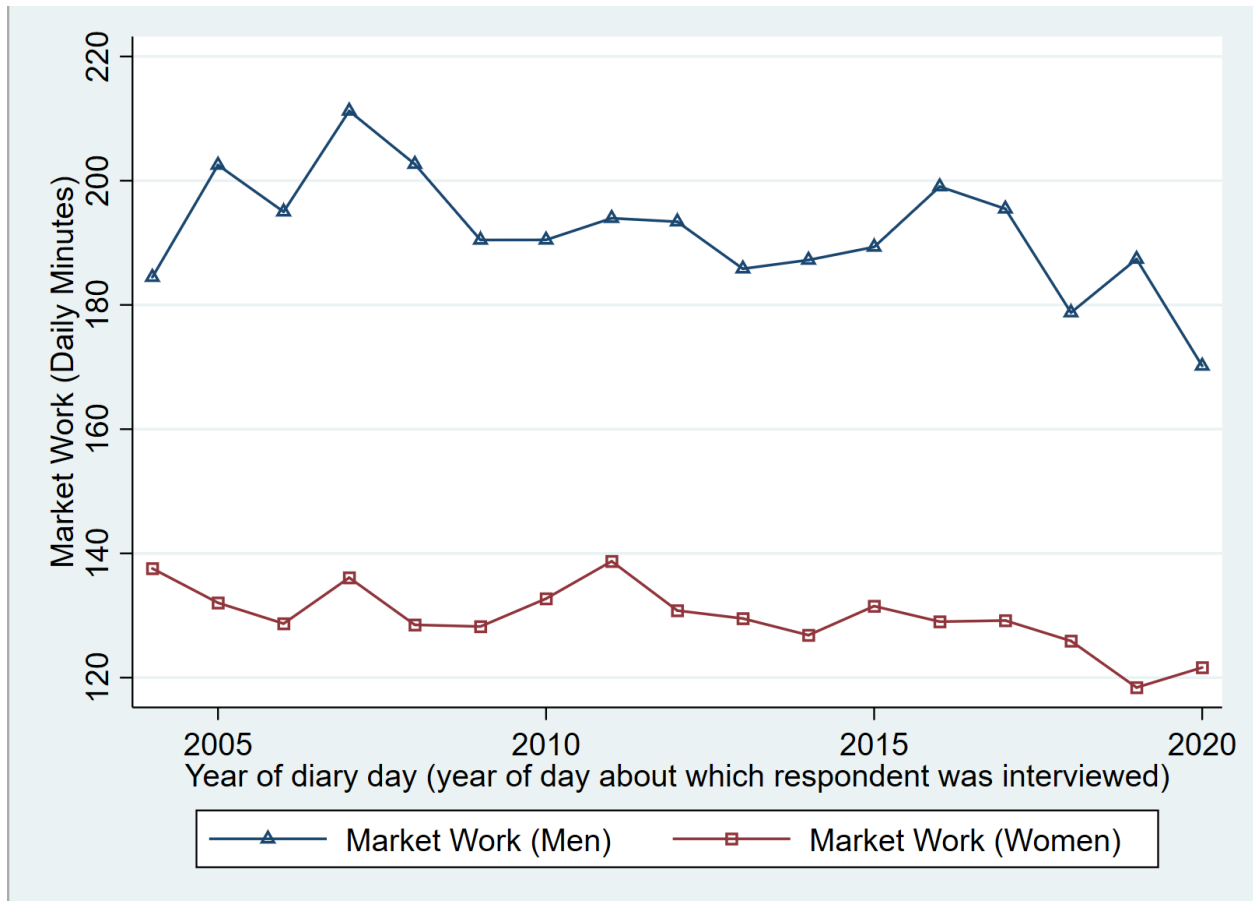
Figure 1

*Gender Gap within Market Work*

Figure 2

*Gender Gap within Non-market Work*
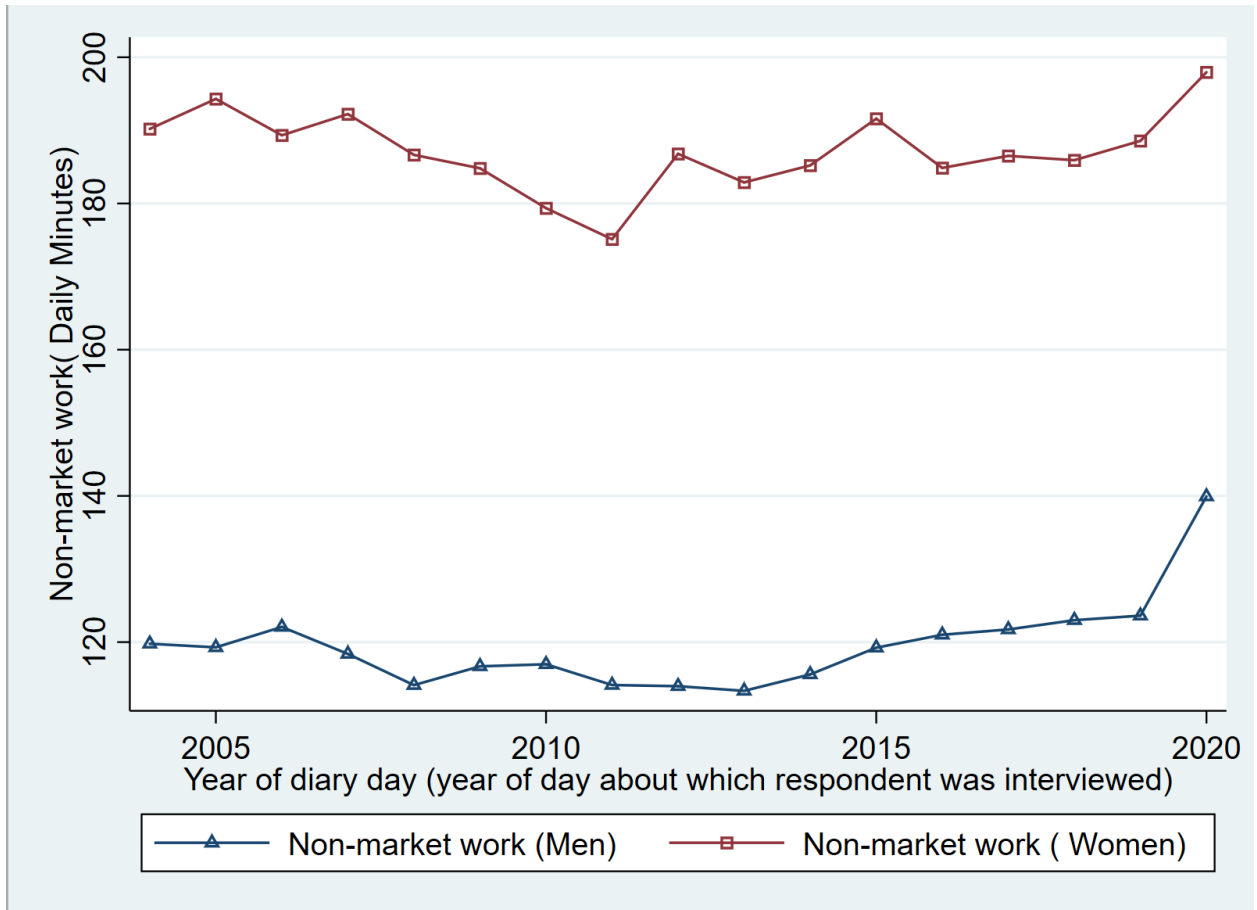
Table 1

*Time Spent on Non-market Work and Market Work*

| All | | Women | | Men | | Gender gap (Women-Men) | |
|---|---|---|---|---|---|---|---|
| **Panel A: All** | | | | | | | |
| Non-market work | 156.92 | Non-market work | 186.72 | Non-market work | 118.89 | Non-market work | 67.83 |
| Household activities | 118.92 | Household activities | 141.31 | Household activities | 90.35 | Household activities | 50.95 |
| Childcare | 28.11 | Childcare | 34.9 | Childcare | 19.45 | Childcare | 15.44 |
| Adult care | 1.66 | Adult care | 1.75 | Adult care | 1.55 | Adult care | .2 |
| Community service | 8.23 | Community service | 8.77 | Community service | 7.54 | Community service | 1.23 |
| Market work | 157.45 | Market work | 129.94 | Market work | 192.55 | Market work | -62.61 |
| N | 78,555 | N | 44,039 | N | 34,516 | | |
| **Panel B: All men and women with children under the age of 18** | | | | | | | |
| Non-market work | 216.22 | Non-market work | 268.67 | Non-market work | 155.66 | Non-market work | 113.01 |
| Household activities | 131.95 | Household activities | 166.33 | Household activities | 92.26 | Household activities | 74.06 |
| Childcare | 78.55 | Childcare | 96.49 | Childcare | 57.84 | Childcare | 38.65 |
| Adult care | 1.29 | Adult care | 1.23 | Adult care | 1.37 | Adult care | -.13 |
| Community service | 4.42 | Community service | 4.62 | Community service | 4.19 | Community service | .43 |
| Market work | 196.96 | Market work | 141.27 | Market work | 261.26 | Market work | -120 |
| N | 20,798 | N | 11,146 | N | 9652 | | |

Notes: Data are from waves 2003-2021 of the ATUS. Variables are measured in minutes per day. The sample includes respondents aged 18-64 who are married with a spouse aged 18-64 present in the household. Observations that fall on public holidays, natives born abroad, and same sex couples are excluded. Data are weighted using ATUS sampling weights adjusted so that each year receives the same weight.

**4.1. Impact of Major Disasters on both Market and Non-market Work**

We use equation 1 (section 3) to estimate the effect of major disasters on non-market and market work for men and women. Table 2 presents the results corresponding to different samples: Panel A for the full sample, Panel B for women subsample, and Panel C for men subsample. The first two columns (1 and 2) focus on non-market work, and the last two (columns 3 and 4) focus on market work. Odd columns exclude additional set of household controls, whereas the even columns include them. All models control the respondent's age and race/ethnicity, as well as day of the week, month, year, and state fixed effects. The even columns include estimates from my preferred specification.

Panel A estimates for the full sample indicate that major disasters have an overall negative impact on labor outcomes (both market and non-market). I find that individuals residing in counties affected by a major disaster reduce non-market work by 8.79 minutes per day. The effect for market work is a reduction of 14 minutes, but this impact is imprecisely estimated. The magnitudes remain stable to the inclusion or exclusion of additional sets of control variables.

Panel B provides estimates for a restricted sample that only includes women respondents (N=44,039). Estimates from the preferred specification indicates that women residing in major disaster affected counties spend 18.48 minutes less on non-market work compared to women in non-affected counties. We find that this effect is much smaller (1.82 minutes) and positive, but not statistically significant for men (see Panel C). These effects amount to 5.6 percent decrease for all men and women, 9.9 percent decrease for women, and 1.5 percent increase for men in non-market work time allocation due to major disasters.

Column 4 presents estimates for the effects of major disasters on market work. I find that major disasters result in a 14 daily minutes (equivalent to 8.8% of sample mean) reduction in market work for all men and women (Panel A). Analyses based on restricted sub-samples indicate that women in disaster affected counties spend 5.2 minutes (equivalent to 4% of sample mean) more time in market work compared to women in unaffected counties. However, the effects for both the inclusive sample and women-only restricted samples are imprecisely estimated. However, the effects for men-only sample show strong negative (and statistically significant) effect for men. On average, men in counties affected by major disasters work 35 minutes (equivalent to 18.3% of sample mean) less than their counterparts in counties unaffected by such disasters. This tells that the overall negative effect is driven mainly by the disasters' effects on men's labor market adjustment effects.

Estimates from the three panels in Table 2 and descriptive statistics from Table 1 jointly indicate that major disasters have an unintended consequence of shrinking the gender gap in both market and non-market work. Recall that men allocate more time than women to market work. Natural disasters have a positive effect on time allocated for market work for women (5 minutes), and a negative effect on men (35 minutes). As I noted in the previous section, women allocate 113 minutes more than men for non-market work. Table 2 (Panel B) shows that major disasters reduce women's time allocated for non-market work by 18.48 minutes and increase men's time by 1.82 minutes.

Table 2

*Effects of Major Disasters on Non-market Work & Market Work by Gender*

| Panel A: ALL Variables | (1) Non-market work | (2) Non-market work | (3) Market work | (4) Market work |
|---|---|---|---|---|
| Major disaster | -8.61*** | -8.79*** | -14.40 | -13.97 |
| | (2.76) | (2.76) | (8.61) | (8.39) |
| Observations | 78,555 | 78,555 | 78,555 | 78,555 |
| R-squared | .084 | .084 | .24 | .24 |
| Additional controls | No | Yes | No | Yes |
| Mean | 156.9 | 156.9 | 157.5 | 157.5 |
| Panel B: Women Only Variables | (1) Non-market work | (2) Non-market work | (3) Market work | (4) Market work |
| Major disaster | -17.85*** | -18.48*** | 4.268 | 5.162 |
| | (3.97) | (3.90) | (8.68) | (8.68) |
| Observations | 44,039 | 44,039 | 44,039 | 44,039 |
| R-squared | .052 | .053 | .196 | .197 |
| Additional Controls | No | Yes | No | Yes |
| Mean | 186.7 | 186.7 | 129.9 | 129.9 |

Table 2

*Effects of Major Disasters on Non-market Work & Market Work by Gender* (continued)

| Panel C: Men Only | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Variables | Non-market work | Non-market work | Market work | Market work |
| Major disaster | 1.75 | 1.82 | -35.27** | -35.26** |
| | (4.29) | (4.24) | (15.25) | (15.44) |
| Observations | 34,516 | 34,516 | 34,516 | 34,516 |
| R-squared | .058 | .059 | .28 | .28 |
| Additional controls | No | Yes | No | Yes |
| Mean | 118.9 | 118.9 | 192.5 | 192.5 |

Notes: The ATUS waves from 2003 to 2021 provided the time-use data. SHELDUS provides data on disasters. The ATUS respondent level serves as the observational unit. Dependent variables express in daily minutes. The relevant variable is Major Disaster, which predicts the likelihood that a major disaster will strike a county during a given year. A natural disaster is considered "major" if it results in 25 fatalities or more. A person's age, age squared, sex, race dummies for Black, Asian, Hispanic, and Other, with Non-Hispanic White serving as the reference category, and five cohort dummies (by decade), with pre-1970 serving as the reference cohort, are considered basic controls. Additional controls for education dummies for high school, some college, and colleges, number of children, and marital status are included in the preferred specification for even-numbered columns. Controls for fixed effects such as day of the week, month, year, and state's inclusion is in all specifications. Ensuring that each year gives the same weight, data are weighted using ATUS sampling weights. Parentheses provide robust standard errors clustered at the state level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

## 4.2. Digging Deeper into Non-market Work

Next, we explore how major disasters affect the gender gap in non-market work. To do so, we analyze different categories of non-market work available in the ATUS dataset, including household activities, childcare, adult care, and community service. Preferred specification based on equation 1 for the four categories are presented in even-numbered columns (2, 4, 6, and 8). Table 3 is organized similarly into three panels: Panel A presents estimates for the full sample, Panel B for the women-only sub-sample, and Panel C for the men-only sub-sample.

Column 2 presents estimated effects of major disasters on household activities. I find that disasters led to a small decrease in time allocated for household activities (2.7 minutes, equivalent to 2.3% of sample mean) for the full sample (Panel A). When I rerun the analysis for the sub-sample constituting only women, I find that women residing in disaster-affected counties reduce time allocated for household activities by 12 minutes (equivalent to 8.5% of sample mean) compared to their counterparts in non-affected counties (Panel B). Interestingly, I find that the effect is opposite for men. Male respondents in counties affected by major disasters spend 8.15 minutes (equivalent to 9% of sample mean) more on household activities than their male counterparts in non-affected counties.

Column 4 provides preferred specification estimates for time allocated for childcare. I find that major disasters result in a 5.9 minute (equivalent to 21% of sample mean) decrease in time allocated for childcare for the full sample comprising both men and women (Panel B). Panels B and C show that the effects are consistent for both men and women. The impact for women is a 7.22-minute (equivalent to 20.7 % of sample mean) reduction, whereas that for men is a 4.79-minute reduction (equivalent to 24.6% of sample mean).

Similarly, column 6 provides estimated time allocation effects for adult care based on the preferred empirical specification. The effects for the overall sample and women are small and imprecise (not statistically significant). The effects are relatively larger, negative, and statistically significant for men. Major disasters led to a reduction in time allocated for adult care by 0.3 minutes (1.8% of sample mean) for the overall sample, and a 0.17 minute (9.7% of sample mean) increase for the women-only sample. For men, the effect is a 0.8-minute (51% of sample mean) reduction and statistically significant. Overall, we find that negative effect is driven primarily by major disasters' negative effect on time allocated for adult care by men.

Finally, column 8 presents results for community service. However, since none of the results are statistically significant and the estimated effects are small, we omit discussion on community service.

Overall, we find that major disasters effect in reducing gender gap in non-market work can be explained in large part by their effects on household activities. Following a major disaster, men take increased participation in household activities, whereas women reduce their participation, thus reducing the gap. The effects on time allocated for childcare are present for both men and women, but women reduce their childcare time slightly more than men, thereby (interestingly) reducing gender gap.

Table 3

*Non-market Work (different categories) by Gender*

Panel A: All

| Variables | (1) Household activities | (2) Household activities | (3) Childcare | (4) Childcare | (5) Adult care | (6) Adult care | (7) Community service | (8) Community service |
|---|---|---|---|---|---|---|---|---|
| Major disaster | -2.5 | -2.7 | -6*** | -5.90*** | -.3 | -.3 | .2 | .1 |
| | (2.68) | (2.70) | (.91) | (.90) | (.63) | (.63) | (.78) | (.79) |
| Observations | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 |
| R-squared | .087 | .087 | .089 | .09 | .002 | .002 | .006 | .006 |
| Additional controls | No | Yes | No | Yes | No | Yes | No | yes |
| Mean | 118.9 | 118.9 | 28.11 | 28.11 | 1.66 | 1.66 | 8.23 | 8.23 |

Panel B: Women

| Variables | (1) Household activities | (2) Household activities | (3) Childcare | (4) Childcare | (5) Adult care | (6) Adult care | (7) Community service | (8) Community service |
|---|---|---|---|---|---|---|---|---|
| Major disaster | -11.70*** | -12.06*** | -7.09*** | -7.22*** | .18 | .17 | .77 | .64 |
| | (1.76) | (1.75) | (1.55) | (1.54) | (1.07) | (1.18) | (1.18) | (1.20) |
| Observations | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 |
| R-squared | .064 | .064 | .105 | .106 | .003 | .003 | .009 | .01 |
| Additional controls | No | Yes | No | Yes | No | Yes | No | yes |
| Mean | 141.3 | 141.3 | 34.9 | 34.9 | 1.75 | 1.75 | 8.77 | 8.77 |

Table 3

*Non-market Work (different categories) by Gender* (Continued)

Panel C: Men

| Variables | (1) Household activities | (2) Household activities | (3) Childcare | (4) Childcare | (5) Adult care | (6) Adult care | (7) Community service | (8) Community service |
|---|---|---|---|---|---|---|---|---|
| Major disaster | 8.24* | 8.15* | -4.99*** | -4.79*** | -.8*** | -.8*** | -.69 | -.73 |
| | (4.75) | (4.81) | (.87) | (.84) | (.2) | (.2) | (1.65) | (1.65) |
| | | | | | | | | |
| Observations | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 |
| R-squared | .063 | .063 | .056 | .058 | .004 | .004 | .007 | .007 |
| Additional controls | No | Yes | No | Yes | No | Yes | No | yes |
| Mean | 90.35 | 90.35 | 19.45 | 19.45 | 1.55 | 1.55 | 7.54 | 7.54 |

Notes: The ATUS waves from 2003 to 2021 provided the time-use data. SHELDUS provides data on disasters. The ATUS respondent level serves as the observational unit. Dependent variables express in daily minutes. The relevant variable is Major Disaster, which predicts the likelihood that a major disaster will strike a county during a given year. A natural disaster is considered "major" if it results in 25 fatalities or more. A person's age, age squared, sex, race dummies for Black, Asian, Hispanic, and Other, with Non-Hispanic White serving as the reference category, and five cohort dummies (by decade), with pre-1970 serving as the reference cohort, are considered basic controls. Additional controls for education dummies for high school, some college, and colleges, number of children, and marital status are included in the preferred specification for even-numbered columns. Controls for fixed effects such as day of the week, month, year, and state's inclusion is in all specifications. Ensuring that each year gives the same weight, data are weighted using ATUS sampling weights. Parentheses provide robust standard errors clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

## 4.3. Probing Beyond Work

While substitution between market and non-market work may explain a big part of a household's overall response to major disasters, households may also adjust on other margins to accommodate new labor demands created by the disaster. Time diary data allows us to examine closely how major disasters' impact on work (both market and non-market) materializes. We adjust equation 1 to examine how major disasters may differentially impact men's and women's participation in the following activities: a) sports, exercise, and recreation, b) volunteering activities, c) religious and spiritual activities, and d) socializing, relaxing, and leisure activities.

Table 5 presents the results. Even-numbered columns (2, 4, 6, and 8) present estimates from my preferred empirical specification with all the relevant controls for the four outcomes. For the overall sample, we only find statistically significant effects on time spent on religious activities. Individuals in a county affected by a major disaster spend 4 minutes more on religious activities relative to their counterparts in non-affected county. Results from restricted samples for female respondents (Panel B) indicate that the effect on religious activities are driven by women: women in disaster-affected counties spend 10.74 more minutes on religious activities compared to women in non-affected counties. I observe that the effect for men is small and negative (-1.7), but not statistically significant.

I also find negative effects for a) sports, exercise, and recreation and b) volunteering activities, and positive effects for d) socializing, but these effects are not statistically significant. There are three estimates that are statistically significant, and thus worth noting. The effects on the sports and exercise for women is negative and statistically significant (4.7 minutes). However, the women in my sample experienced an increase in religiosity because of a major

28

disaster – they spent 10.74 more minutes for religious activities. I also observe a small and negative effect on volunteering activities for men.

Overall, I observe an increase in religiosity for the overall sample, driven mainly by an increase in time allocated for religious activities by women. I also find some indication that women reduce participation in physical exercise and men reduce participation in volunteering activities. The findings reported in this section suggest that a great part of household adjustment of time allocation occurs between work-related activities (market versus non-market). Thus, while non-work-related activities are important for many reasons, their influence on gender gap seems minimal, at least in the short run.

Table 4

*Effect of Disasters on Sports & Exercise, Volunteer Activities, Religious Activities[2] and Socializing*

Panel A: All

| VARIABLES | (1) Sports Exercise and Recreation | (2) Sports Exercise and Recreation | (3) Volunteer Activities | (4) Volunteer Activities | (5) Religious and Spiritual Activities | (6) Religious and Spiritual Activities | (7) Socializing Relaxing and Leisure | (8) Socializing Relaxing and Leisure |
|---|---|---|---|---|---|---|---|---|
| Major Disasters | -4.683 (2.87) | -3.523 (2.96) | -0.97 (5.09) | -0.488 (5.01) | 3.942* (2.10) | 4.063* (2.03) | 7.031 (11.32) | 3.238 (12.11) |
| | | | | | | | | |
| Observations | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 | 78,555 |
| R-squared | 0.032 | 0.039 | 0.014 | 0.016 | 0.061 | 0.062 | 0.173 | 0.179 |
| Additional Controls | No | Yes | No | Yes | No | Yes | No | Yes |
| Mean | 19.8 | 19.8 | 9.14 | 9.14 | 12.06 | 12.06 | 295 | 295 |

---

[2] Religious and spiritual activities include attending religious services, participation in religious practices, waiting associated with religious and spiritual activities, and religious education activities.

Table 4

*Effect of Disasters on Sports & Exercise, Volunteer Activities, Religious Activities[2] and Socializing* (Continued)

Panel B: Women

| VARIABLES | (1) Sports Exercise and Recreation | (2) Sports Exercise and Recreation | (3) Volunteer Activities | (4) Volunteer Activities | (5) Religious and Spiritual Activities | (6) Religious and Spiritual Activities | (7) Socializing Relaxing and Leisure | (8) Socializing Relaxing and Leisure |
|---|---|---|---|---|---|---|---|---|
| Major Disasters | -6.269* | -4.762* | 4.675 | 5.683 | 10.41** | 10.74** | 18.39* | 14.8 |
|  | (3.43) | (2.83) | (7.12) | (6.78) | (4.71) | (4.57) | (9.77) | (12.29) |
|  |  |  |  |  |  |  |  |  |
| Observations | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 | 44,039 |
| R-squared | 0.036 | 0.043 | 0.02 | 0.023 | 0.075 | 0.075 | 0.185 | 0.189 |
| Additional Controls | No | Yes | No | Yes | No | Yes | No | Yes |
| Mean | 14.62 | 14.62 | 9.782 | 9.782 | 14.23 | 14.23 | 279.2 | 279.2 |

Table 4

*Effect of Disasters on Sports & Exercise, Volunteer Activities, Religious Activities[2] and Socializing* (Continued)

| VARIABLES | (1) Sports Exercise and Recreation | (2) Sports Exercise and Recreation | (3) Volunteer Activities | (4) Volunteer Activities | (5) Religious and Spiritual Activities | (6) Religious and Spiritual Activities | (7) Socializing Relaxing and Leisure | (8) Socializing Relaxing and Leisure |
|---|---|---|---|---|---|---|---|---|
| Major Disasters | -3.297 (5.93) | -2.61 (6.05) | -5.320* (2.85) | -5.147* (2.95) | -1.752 (1.51) | -1.753 (1.55) | 2.289 (11.79) | -0.882 (10.96) |
| Observations | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 | 34,516 |
| R-squared | 0.033 | 0.039 | 0.02 | 0.021 | 0.053 | 0.053 | 0.173 | 0.182 |
| Additional Controls | No | Yes | No | Yes | No | Yes | No | Yes |
| Mean | 26.42 | 26.42 | 8.32 | 8.32 | 9.281 | 9.281 | 315.1 | 315.1 |

Notes: The ATUS waves from 2003 to 2021 provided the time-use data. SHELDUS provides data on disasters. The ATUS respondent level serves as the observational unit. Dependent variables express in daily minutes. The relevant variable is Major Disaster, which predicts the likelihood that a major disaster will strike a county during a given year. A natural disaster is considered "major" if it results in 25 fatalities or more. A person's age, age squared, sex, race dummies for Black, Asian, Hispanic, and Other, with Non-Hispanic White serving as the reference category, and five cohort dummies (by decade), with pre-1970 serving as the reference cohort, are considered basic controls. Additional controls for education dummies for high school, some college, and colleges, number of children, and marital status are included in the preferred specification for even-numbered columns. Controls for fixed effects such as day of the week, month, year, and state's inclusion is in all specifications. Ensuring that each year gives the same weight, data are weighted using ATUS sampling weights. Parentheses provide robust standard errors clustered at the state level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

## 4.4. Robustness Checks

### 4.4.1. Alternative Fatality Thresholds

One concern with our empirical specification is the choice of the fatality thresholds to define a disaster as "major." To avoid arbitrariness, we adopt the fatality threshold from prior empirical research on a related topic (Boustan et al., 2012). However, for transparency and completeness reasons, we follow the strategy suggested in the existing literature and re-estimate our model using alternative fatality thresholds, ranging from 0 to 150 (Boustan et al., 2012; Rayamajhee and Paudel, forthcoming). I present results from these models in Tables 5 and 6.

My findings are consistent with the related literature which suggests that the effects of disasters are likely to increase nonlinearly as higher fatality thresholds are chosen. For the sake of presentation, I will discuss results for non-market work for three fatality thresholds: 0, 25 (chosen), and 75. For the overall sample, disaster (defined as fatality of 0 or higher) led to a 2.2-minute increase in time allocated for non-market work. This effect is mainly driven by the impact on women (5 minutes increase), as the effect on men are small and not statistically significant. Recall that for our chosen threshold of 25 or more, the effects were as follows: 8.7-minute reduction (significant) for the overall sample, 18.4 reduction (significant) for women-only sample, and 1.82-minute increase (not significant) for men-only sample. When fatality threshold of 75 is considered instead, the effect for the overall sample remains negative and larger (a 10-minute reduction). For women, the effects remain consistently statistically significant and negative, but the effect size is smaller (8.6-minute reduction). For men, the effects remain statistically non-significant, but the sign changes.

Overall, we conclude that our estimates are consistent irrespective of our choice of alternative fatality thresholds.

33

### 4.4.2. Other Checks and Controls

As previously noted, all the results discussed in this section are robust to the inclusion (or exclusion) of a comprehensive set of controls. My preferred models incorporate controls for the number of children within three age ranges: 0-5, 6-12, and 13-17. It is important to underscore that these controls do not account for the gender composition of the children. All regression analyses incorporate a comprehensive suite of control variables that encompass various respondent characteristics and external factors. Initially, I control the respondent's age, employing both linear and quadratic terms (age square). Furthermore, I account for race/ethnicity, categorized into five mutually exclusive groups: Non-Hispanic White (utilized as the reference category), Non-Hispanic Black, Non-Hispanic Asian, Non-Hispanic Other, and Hispanic. Subsequently, I introduce controls for education, classified into four discrete groups: less than High School (serving as the reference group), High School, Some College, and College+. Additionally, I integrate controls for children, represented by the number of children within age groups 0-5, 6-12, and 13-17. Further, I incorporate controls related to spouse characteristics, encompassing spouse age, age squared, race/ethnicity, and education. Importantly, all the regression models consistently incorporate fixed effects for the day of the week, month, year, and state to ensure the robustness of my findings and account for temporal and regional variations.

Taken together, the results from Tables 2-5 collectively confirm a robust and consistent relationship between major disasters and the gender gap in the context of time allocation for both market and non-market work.

34

Table 5

*Effects of Major Disasters on Market and Non-market Work*

| Variables | All | | Women | | Men | |
|---|---|---|---|---|---|---|
| | Non-market work | Market work | Non-market work | Market work | Non-market work | Market work |
| No fatality | 2.192** | -.4 | 5.03*** | -3.78** | .30 | 3.98* |
| | (1.22) | (1.35) | (1.74) | (1.74) | (1.72) | (1.98) |
| 10 fatalities | -10*** | -3.54 | -11.2*** | 2.38 | -9.77** | -10.95 |
| | (2.75) | (3.15) | (2.96) | (5.59) | (3.66) | (6.90) |
| 25 fatalities | -8.7*** | -13.97 | -18.4*** | 5.16 | 1.82 | -35.26** |
| | (2.76) | (8.39) | (3.99) | (8.68) | (4.24) | (15.44) |
| 50 fatalities | 1.20 | -11.6* | -5.28 | -1.89 | 11.44 | -26.46 |
| | (4.81) | (6.62) | (4.43) | (9.53) | (7.61) | (26.18) |
| 75 fatalities | -10*** | .32 | -8.62** | 2.81 | -10.99 | -3.26 |
| | (3.64) | (2.80) | (3.89) | (19.41) | (7.89) | (22.22) |
| 100 fatalities | -7.84* | -1.07 | -12.10* | -22*** | -2.06 | 23.17*** |
| | (3.92) | (4.48) | (7.14) | (4.49) | (3.90) | (6.35) |
| 150 fatalities | -7.84* | -1.07 | -12.10* | -22*** | -2.06 | 23.17*** |
| | (3.92) | (4.48) | (7.14) | (4.49) | (3.90) | (6.35) |

Notes: The ATUS waves from 2003 to 2021 provided the time-use data. SHELDUS provides data on disasters. The ATUS respondent level serves as the observational unit. Dependent variables express in daily minutes. The relevant variable is Major Disaster, which predicts the likelihood that a major disaster will strike a county during a given year. A natural disaster is considered "major" if it results in 25 fatalities or more. A person's age, age squared, sex, race dummies for Black, Asian, Hispanic, and Other, with Non-Hispanic White serving as the reference category, and five cohort dummies (by decade), with pre-1970 serving as the reference cohort, are considered basic controls. Additional controls for education dummies for high school, some college, and colleges, number of children, and marital status are included in the preferred specification for even-numbered columns. Controls for fixed effects such as day of the week, month, year, and state's inclusion is in all specifications. Ensuring that each year gives the same weight, data are weighted using ATUS sampling weights. Parentheses provide robust standard errors clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1.

## 4.5. Dynamic Effects on Market and Non-market Work

We use equation 1 (section 3) to estimate the dynamic effects of major disasters( 3 lags and leads) on non-market and market work for men and women. Table 6 presents the results corresponding to different samples: All for the full sample,  women and men are subsample . We included the values for market and non-market work considering an additional set of household controls. All models control the respondent's age and race/ethnicity, as well as day of the week, month, year, and state fixed effects.

All category encompassing all men and women estimates for the full sample indicate that major disasters have an overall negative impact on non-market work and positive impact on market work, particularly considering major disaster lag1. I find that individuals residing in counties affected by a major disaster reduce non-market work by 20.62 minutes per day. The effect for market work is an addition of 14 minutes, but this impact is imprecisely estimated.

Third and fourth column provides estimates for a restricted sample that only includes women respondents (N=44,039). Estimates from the preferred specification indicates that women residing in major disaster affected counties spend 22.91 minutes less on non-market work compared to women in non-affected counties for major disaster lag1. We find that this effect is almost similar (21.71 minutes) and negative, but not statistically significant for men (see Men designated column).

Row 3 and 4 present estimates for the effects of major disasters on market and non-market work for  lag2 and lag3. I find that major disasters lag2 result in a 19 daily minutes reduction in non-market work for all men and women . Analyses based on restricted sub-samples indicate that women in disaster affected counties spend 32 minutes less time in non-market work compared to women in unaffected counties for lag2. Additionally, the effects for men-only

36

sample for major disaster lag2 show  negative effect for both market and non-market work. On average, men in counties affected by major disasters lag2 work 6 minutes  less than their counterparts in counties unaffected by such disasters. This tells that the overall negative effect is driven mainly by the disasters' effects on women's labor market adjustment effects.

Estimates from the Table 6 indicate that major disasters for all 3 lag and lead have negative effect on non-market work which establishes that the impact of major disaster, without lag and lead, act to reduce the gender gap as this estimates from the three panels in Table 2 and descriptive statistics from Table 1 jointly indicate that major disasters have an unintended consequence of shrinking the gender gap in both market and non-market work. Recall that men generally allocate more time than women to market work. The analysis indicates that natural disasters increase the time women allocate to market work by 5 minutes, while reducing the time men allocate by 35 minutes. Additionally, as noted previously, women allocate 113 minutes more than men to non-market work. Table 2 (Panel B) demonstrates that major disasters reduce the time women allocate to non-market work by 18.48 minutes, while increasing the time men allocate by 1.82 minutes. Overall, the disaster year data from the SHELDUS dataset indicates a reduction in the gender gap. However, the analysis with 3 lags and leads does not establish a clear trend of gender gap reduction in non-market work.

Table 6

*Dynamic Effects on Market and Non-market Work*

| Variables | All | | Women | | Men | |
|---|---|---|---|---|---|---|
| | Non-market work | Market work | Non-market work | Market work | Non-market work | Market work |
| Major Disaster lag1 | -20.62* | 1.008 | -22.91 | 1.518 | -21.71 | 3.635 |
| | (11.31) | (22.23) | (14.71) | (24.51) | (16.24) | (30.18) |
| Major Disaster lag2 | -19.91* | 7.419 | -31.83* | 19.22 | -6.522 | -4.345 |
| | (11.68) | (24.44) | (16.11) | (25.58) | (19.24) | (28.58) |
| Major Disaster lag3 | -11.20 | -0.595 | -7.754 | -0.521 | -15.30 | 1.597 |
| | (12.95) | (12.94) | (18.96) | (10.92) | (14.04) | (25.67) |
| Major Disaster lead1 | -42.0*** | 5.059 | -51.68*** | 9.983 | -17.34 | -8.906 |
| | (5.512) | (12.35) | (12.21) | (13.96) | (17.56) | (30.59) |
| Major Disaster lead2 | 9.520 | -11.44 | 3.261 | 14.82 | 20.12 | -56.17** |
| | (14.99) | (13.10) | (18.75) | (18.55) | (17.50) | (26.29) |
| Major Disaster lead3 | -4.954 | -0.212 | -6.269 | 3.564 | -2.090 | -8.769 |
| | (11.85) | (16.25) | (10.95) | (23.78) | (19.46) | (35.92) |

Notes: The ATUS waves from 2003 to 2021 provided the time-use data. SHELDUS provides data on disasters. The ATUS respondent level serves as the observational unit. Dependent variables express in daily minutes. The relevant variable is Major Disaster, which predicts the likelihood that a major disaster will strike a county during a given year. A natural disaster is considered "major" if it results in 25 fatalities or more. A person's age, age squared, sex, race dummies for Black, Asian, Hispanic, and Other, with Non-Hispanic White serving as the reference category, and five cohort dummies (by decade), with pre-1970 serving as the reference cohort, are considered basic controls. Additional controls for education dummies for high school, some college, and colleges, number of children, and marital status are included in the preferred specification for even-numbered columns. Controls for fixed effects such as day of the week, month, year, and state's inclusion is in all specifications. Ensuring that each year gives the same weight, data are weighted using ATUS sampling weights. Parentheses provide robust standard errors clustered at the state level. *** p<0.01, ** p<0.05, * p<0.

## 5. CONCLUSION

In the years preceding the 1990s, despite the growing participation of women in the labor force and a decline in the gender wage gap since the 1980s, there has been a persistent and substantial gender disparity in non-market work. Even when employed, women continue to dedicate significantly more time to household chores compared to men. This enduring gap in time allocation within households likely influences gender disparities in labor market outcomes. A critical inquiry in this context pertains to the adaptability of this division of labor within market and non-market work sectors in the face of major disasters. This study addresses this inquiry by utilizing the American Time Use Survey alongside disaster datasets to assess the impact of significant disasters on gender norms concerning the allocation of time for both market and non-market work in the United States. An essential aspect of this research is its focus on analyzing the impact of major disasters on gender norms within the context of non-market work time allocation, encompassing both men and women.

The frequency of natural disasters is on the rise, wreaking havoc on affected communities. Existing literature on the influence of natural disasters on economic outcomes and time allocation presents conflicting conclusions. Gender norms governing the allocation of time in both market and non-market work roles play a crucial role in guiding the economic recovery post major disasters. These norms, varying by region, might contribute to the disparate outcomes observed in the literature. While it is impossible to prevent natural disasters, formulating disaster recovery policies based on gender norms within the context of time allocation can facilitate adaptive and responsible actions that minimize lasting economic and human impacts. The analyses conducted and the resulting data indicate a convergence in market and non-market work, specifically in household activities, childcare, adult care, and community service,

39

following significant disasters. Women tended to spend less time on household tasks and childcare, reallocating their time towards adult care and community service. Men, on the other hand, increased their involvement in household tasks but reduced their participation in community service and caring for children and adults. This research concludes that gender-specific labor allocation demonstrates adaptability and responsiveness in the aftermath of major disasters.

The aftermath of major disasters instigates a profound transformation of gender norms and cultural perspectives. A potential avenue for further exploration lies in studying culture-based gender norms among different generations of immigrants (native, 1st generation, 2nd generation) in the United States post major disasters. This area, extending beyond the scope of this paper, could yield valuable insights.

While economic literature offers valuable perspectives on household time allocation, research on how natural disasters impact this allocation remains limited. Additionally, analyzing post-disaster changes in household production allows for an assessment of the resilience of gender norms in shaping decisions related to market and non-market work time allocation. This study endeavors to bridge these gaps by examining alterations in household time allocation following major disasters. The research contributes to the expanding body of literature investigating how natural disasters influence gender norms, particularly in the allocation of non-market work time.

# 6. REFERENCES

Akerlof, G., & Kranton, R. E. (2011). Identity Economics: How Our Identities Shape Our Work, Wages, and Well-Being [Economics Books]. Princeton University Press.

Alesina, A. F., & Giuliano, P. (2007). The Power of the Family (SSRN Scholarly Paper 980948). https://doi.org/10.2139/ssrn.980948

Alesina, A., Giuliano, P., & Nunn, N. (2013). On the Origins of Gender Roles: Women and the Plough*. The Quarterly Journal of Economics, 128(2), 469–530. https://doi.org/10.1093/qje/qjt005

Álvarez, B., & Miles, D. (n.d.). Husbands' Housework Time: Does Wives' Paid Employment Make a Difference? Studies on the Spanish Economy, Article 173.

Antecol, H. (2000). An examination of cross-country differences in the gender gap in labor force participation rates. Labour Economics, 7(4), 409–426. https://doi.org/10.1016/S0927-5371(00)00007-5

Anxo, D., Mencarini, L., Pailhé, A., Solaz, A., Tanturri, M. L., & Flood, L. (2011). Gender Differences in Time Use over the Life Course in France, Italy, Sweden, and the US. Feminist Economics, 17(3), 159–195. https://doi.org/10.1080/13545701.2011.582822

Becker, G. S. (1965). A Theory of the Allocation of Time. The Economic Journal, 75(299), 493–517. https://doi.org/10.2307/2228949

Becker, G. S. (1981). Altruism in the Family and Selfishness in the Marketplace. Economica, 48(189), 1–15. https://doi.org/10.2307/2552939

Becker, G. S. (1985). Human Capital, Effort, and the Sexual Division of Labor. Journal of Labor Economics, 3(1,), S33–S58.

Bertrand, M., Kamenica, E., & Pan, J. (2015). Gender Identity and Relative Income within Households *. The Quarterly Journal of Economics, 130(2), 571–614. https://doi.org/10.1093/qje/qjv001

Bianchi, S. M., Milkie, M. A., Sayer, L. C., & Robinson, J. P. (2000). Is anyone doing the housework? Trends in the gender division of household labor. Social Forces, 79(1), 191–228. https://doi.org/10.2307/2675569

Bianchi, S. M., Sayer, L. C., Milkie, M. A., & Robinson, J. P. (2012). Housework: Who Did, Does or Will Do It, and How Much Does It Matter? Social Forces, 91(1), 55–63. https://doi.org/10.1093/sf/sos120

Bittman, M., England, P., Sayer, L., Folbre, N., & Matheson, G. (2003). When Does Gender Trump Money? Bargaining and Time in Household Work. American Journal of Sociology, 109(1), 186–214. https://doi.org/10.1086/378341

Blau, F. D. (n.d.). The Gender Wage Gap: Extent, Trends, and Explanations.

Blau, F. D., & Kahn, L. M. (2007). Changes in the Labor Supply Behavior of Married Women: 1980–2000. Journal of Labor Economics, 25(3), 393–438. https://doi.org/10.1086/513416

Bradley, T., Martin, Z., Upreti, B. R., Subedu, B., & Shrestha, S. (2023). Gender and Disaster: The Impact of Natural Disasters on Violence Against Women in Nepal. Journal of Asian and African Studies, 58(3), 354–371. https://doi.org/10.1177/00219096211062474

Bradshaw, S. (n.d.). Socio-economic impacts of natural disasters: A gender analysis.

Brines, J. (1994). Economic Dependency, Gender, and the Division of Labor at Home. American Journal of Sociology, 100(3), 652–688.

Burda, M., Hamermesh, D. S., & Weil, P. (2013). Total work and gender: Facts and possible explanations. Journal of Population Economics, 26(1), 239–261. https://doi.org/10.1007/s00148-012-0408-x

Butikofer, A., Løken, K. V., & Willén, A. (2019). Building Bridges and Widening Gaps: Efficiency Gains and Equity Concerns of Labor Market Expansions (SSRN Scholarly Paper 3472984). https://doi.org/10.2139/ssrn.3472984

Campaña, J. C., Gimenez-Nadal, J. I., & Velilla, J. (2023). Measuring Gender Gaps in Time Allocation in Europe. Social Indicators Research, 165(2), 519–553. https://doi.org/10.1007/s11205-022-03026-0

Cavapozzi, D., Francesconi, M., & Nicoletti, C. (2021). The Impact of Gender Role Norms on Mothers' Labor Supply. Journal of Economic Behavior and Organization, 186, 113–134. https://doi.org/10.1016/j.jebo.2021.03.033

Chamlee-Wright, E., & Storr, V. H. (2009). "There's No Place like New Orleans": Sense of Place and Community Recovery in the Ninth Ward after Hurricane Katrina. Journal of Urban Affairs, 31(5), 615–634. https://doi.org/10.1111/j.1467-9906.2009.00479.x

Cislaghi, B., & Heise, L. (2020). Gender norms and social norms: Differences, similarities and why they matter in prevention science. Sociology of Health & Illness, 42(2), 407–422. https://doi.org/10.1111/1467-9566.13008

Coltrane, S. (2000). Research on Household Labor: Modeling and Measuring the Social Embeddedness of Routine Family Work. Journal of Marriage and Family, 62(4), 1208–1233. https://doi.org/10.1111/j.1741-3737.2000.01208.x

Connell, R., & Pearse, R. (2014). Gender: In World Perspective. John Wiley & Sons.

Cortés, P., & Pan, J. (2019). When Time Binds: Substitutes for Household Production, Returns to Working Long Hours, and the Skilled Gender Wage Gap. Journal of Labor Economics, 37(2), 351–398. https://doi.org/10.1086/700185

Damaske, S., & Frech, A. (2016). Women's Work Pathways Across the Life Course. Demography, 53(2), 365–391. https://doi.org/10.1007/s13524-016-0464-z

Davis, S. N., & Greenstein, T. N. (2009). Gender Ideology: Components, Predictors, and Consequences. Annual Review of Sociology, 35(1), 87–105. https://doi.org/10.1146/annurev-soc-070308-115920

Enarson, E. (1999). Violence Against Women in Disasters: A Study of Domestic Violence Programs in the United States and Canada. Violence Against Women, 5(7), 742–768. https://doi.org/10.1177/10778019922181464

Enarson, E., Fothergill, A., & Peek, L. (2007). Gender and Disaster: Foundations and Directions. In H. Rodríguez, E. L. Quarantelli, & R. R. Dynes (Eds.), Handbook of Disaster Research (pp. 130–146). Springer. https://doi.org/10.1007/978-0-387-32353-4_8

Enarson, E. P., & Morrow, B. (1998). The Gendered Terrain of Disaster: Through Women's Eyes. Bloomsbury Academic.

Erosa, A., Fuster, L., Kambourov, G., & Rogerson, R. (n.d.). Hours, Occupations, and Gender Differences in Labor Market Outcomes.

Fernández, R. (2013). Cultural Change as Learning: The Evolution of Female Labor Force Participation over a Century. The American Economic Review, 103(1), 472–500.

Fernández, R., Fogli, A., & Olivetti, C. (2004). Mothers and Sons: Preference Formation and Female Labor Force Dynamics. The Quarterly Journal of Economics, 119(4), 1249–1299.

Fortin, N. M. (2005). Gender Role Attitudes and the Labour-market Outcomes of Women across OECD Countries. Oxford Review of Economic Policy, 21(3), 416–438. https://doi.org/10.1093/oxrep/gri024

Gauthier, A. H., Smeeding, T. M., & Furstenberg Jr., F. F. (2004). Are Parents Investing Less Time in Children? Trends in Selected Industrialized Countries. Population and Development Review, 30(4), 647–672. https://doi.org/10.1111/j.1728-4457.2004.00036.x

Giménez, J. I., Molina Chueca, J. A., & Sevilla, A. (2022). Effort at Work and Worker Well-Being in the Us. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.4114895

Gimenez-Nadal, J. I. M. (2022). The gender gap in time allocation. IZA World of Labor. https://doi.org/10.15185/izawol.497

Goldin, C. (1994). Labor Markets in the Twentieth Century (Working Paper 58). National Bureau of Economic Research. https://doi.org/10.3386/h0058

Goldin, C. (2014). A Grand Gender Convergence: Its Last Chapter. American Economic Review, 104(4), 1091–1119. https://doi.org/10.1257/aer.104.4.1091

Graff Zivin, J., & Neidell, M. (2014). Temperature and the Allocation of Time: Implications for Climate Change. Journal of Labor Economics, 32(1), 1–26. https://doi.org/10.1086/671766

Greenstein, T. N. (2000). Economic Dependence, Gender, and the Division of Labor in the Home: A Replication and Extension. Journal of Marriage and Family, 62(2), 322–335. https://doi.org/10.1111/j.1741-3737.2000.00322.x

Guha-Sapir, D., D'Aoust, O., Vos, F., & Hoyois, P. (2013). The Frequency and Impact of Natural Disasters. In D. Guha-Sapir & I. Santos (Eds.), The Economic Impacts of Natural Disasters (p. 0). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199841936.003.0002

Hasan, Md. R., Nasreen, M., & Chowdhury, Md. A. (2019). Gender-inclusive disaster management policy in Bangladesh: A content analysis of national and international regulatory frameworks. International Journal of Disaster Risk Reduction, 41, 101324. https://doi.org/10.1016/j.ijdrr.2019.101324

Heidi Gottfried. (n.d.). Who Cares? Retrieved October 14, 2023, from https://cuidado.cebrap.org.br/en/equipe/heidi-gottfried/

Hochschild, A. R., & Machung, A. (1989). The Second Shift: Working Parents and the Revolution at Home. Viking.

Hwang, J., Lee, C., & Lee, E. (2019). Gender Norms and Housework Time Allocation among Dual-Earner Couples. Labour Economics, 57, 102–116. https://doi.org/10.1016/j.labeco.2019.01.007

Ichino, A., Olsson, M., Petrongolo, B., & Thoursie, P. S. (2019). Economic Incentives, Home Production and Gender Identity Norms. Economic Incentives.

Ironmonger, D. (n.d.). Household Production and the Household Economy.

Jepsen, C. A., & Jepsen, L. K. (2006). The Sexual Division of Labor within Households: Comparisons of Couples to Roommates. Eastern Economic Journal, 32(2), 299–312.

Juran, L., & Trivedi, J. (2015). Women, Gender Norms, and Natural Disasters in Bangladesh. Geographical Review, 105(4), 601–611.

Kahn, M. E. (2005). The Death Toll from Natural Disasters: The Role of Income, Geography, and Institutions. The Review of Economics and Statistics, 87(2), 271–284.

Kleven, H., Landais, C., & Søgaard, J. E. (2019). Children and Gender Inequality: Evidence from Denmark. American Economic Journal: Applied Economics, 11(4), 181–209. https://doi.org/10.1257/app.20180010

Le Barbanchon, T., Rathelot, R., & Roulet, A. (2021). Gender Differences in Job Search: Trading off Commute against Wage*. The Quarterly Journal of Economics, 136(1), 381–426. https://doi.org/10.1093/qje/qjaa033

Lennon, M. C., & Rosenfield, S. (1994). Relative fairness and the division of housework: The importance of options. American Journal of Sociology, 100(2), 506–531. https://doi.org/10.1086/230545

Marcén, M., & Morales, M. (n.d.). Culture and the cross-country differences in the gender commuting gap: Evidence from immigrants in the United States.

Marianne, B. (2011). Chapter 17—New Perspectives on Gender. In D. Card & O. Ashenfelter (Eds.), Handbook of Labor Economics (Vol. 4, pp. 1543–1590). Elsevier. https://doi.org/10.1016/S0169-7218(11)02415-4

Maurin, E., & Moschion, J. (2009). The Social Multiplier and Labor Market Participation of Mothers. American Economic Journal: Applied Economics, 1(1), 251–272. https://doi.org/10.1257/app.1.1.251

McCarthy, N., & Kilic, T. (2017). Stronger Together: Intra-Household Cooperation and Household Welfare in Malawi. World Bank, Washington, DC. https://doi.org/10.1596/1813-9450-8043

Mincer, J., & Polachek, S. (1978). An Exchange: The Theory of Human Capital and the Earnings of Women: Women's Earnings Reexamined. The Journal of Human Resources, 13(1), 118–134. https://doi.org/10.2307/145305

Neumayer, E., & Plümper, T. (2007). The Gendered Nature of Natural Disasters: The Impact of Catastrophic Events on the Gender Gap in Life Expectancy, 1981–2002. Annals of the Association of American Geographers, 97(3), 551–566. https://doi.org/10.1111/j.1467-8306.2007.00563.x

Nicoletti, C., Salvanes, K. G., & Tominey, E. (2018). The Family Peer Effect on Mothers' Labor Supply. American Economic Journal: Applied Economics, 10(3), 206–234. https://doi.org/10.1257/app.20160195

Olivetti, C., Patacchini, E., & Zenou, Y. (n.d.). Mothers, Friends and Gender Identity.

Paul, L. A., Felton, J. W., Adams, Z. W., Welsh, K., Miller, S., & Ruggiero, K. J. (2015). Mental Health Among Adolescents Exposed to a Tornado: The Influence of Social Support and Its Interactions With Sociodemographic Characteristics and Disaster Exposure. Journal of Traumatic Stress, 28(3), 232–239. https://doi.org/10.1002/jts.22012

Pleck, J. H., & Staines, G. L. (1985). Work Schedules and Family Life in Two-Earner Couples. Journal of Family Issues, 6(1), 61–82. https://doi.org/10.1177/019251385006001005

Ralsmark, H. (2017). Education, norms, and gender equality (Working Papers in Economics 702). University of Gothenburg, Department of Economics. https://econpapers.repec.org/paper/hhsgunwpe/0702.htm

Robinson, W. C. (1987). The Time Cost of Children and Other Household Production. Population Studies, 41(2), 313–323. https://doi.org/10.1080/0032472031000142816

Rubiano Matulevich, E. C., & Viollaz, M. (2019). Gender Differences in Time Use: Allocating Time between the Market and the Household (SSRN Scholarly Paper 3437824). https://papers.ssrn.com/abstract=3437824

Sayer, L. C. (2005). Gender, Time and Inequality: Trends in Women's and Men's Paid Work, Unpaid Work and Free Time. Social Forces, 84(1), 285–303. https://doi.org/10.1353/sof.2005.0126

Scanlon, J., & McMahon, T. (2011). Dealing with mass death in disasters and pandemics. Disaster Prevention and Management, 20(2), 172–185. https://doi.org/10.1108/09653561111126102

Schneebaum, A. (2013). The Economics of Same-Sex Couple Households: Essays on Work, Wages, and Poverty. Open Access Dissertations. https://doi.org/10.7275/aan3-2p77

Shahid, M.-A., Rayamajhee, V., & Bohara, A. (2022). Does social capital help in post-disaster recovery? Evidence from the Gorkha earthquake of Nepal. International Journal of Disaster Risk Reduction, 82, 103359. https://doi.org/10.1016/j.ijdrr.2022.103359

Shelton, B. A., & John, D. (1996). The Division of Household Labor. Annual Review of Sociology, 22, 299–322.

Siminski, P., & Yetsenga, R. (2022). Specialization, Comparative Advantage, and the Sexual Division of Labor. Journal of Labor Economics, 40(4), 851–887. https://doi.org/10.1086/718430

Waldfogel, J. (1998). Understanding the "Family Gap" in Pay for Women with Children. Journal of Economic Perspectives, 12(1), 137–156. https://doi.org/10.1257/jep.12.1.137

Winkler, A. E. (2018). Trends in Work and Family: Data Sources and Definitions. Journal of Legal Economics, 24, 3.

Yogev, S., & Brett, J. (1985). Patterns of work and family involvement among single- and dual-earner couples. Journal of Applied Psychology, 70(4), 754–768. https://doi.org/10.1037/0021-9010.70.4.754