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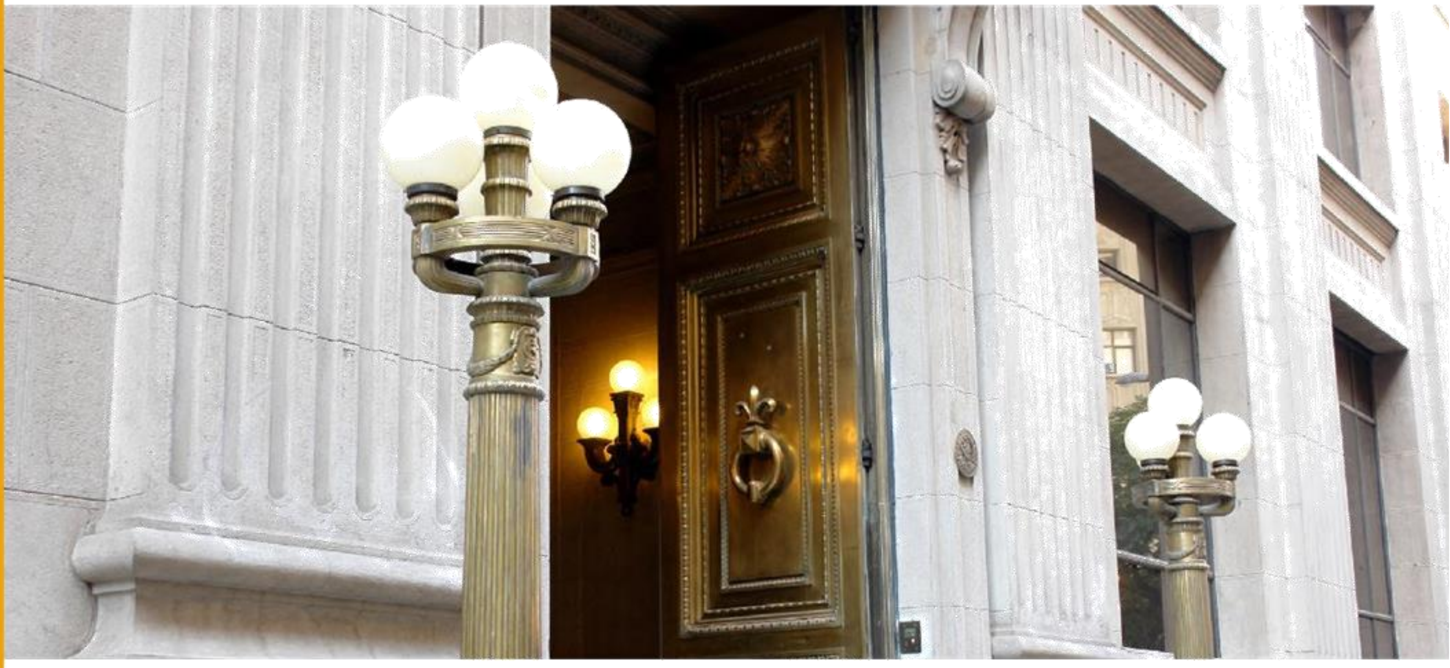

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Documento de Trabajo N° 1062 **Working Paper N° 1062**

Natural Disasters and Slow Recoveries: New Evidence from Chile*

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Resumen
Estudiamos las respuestas macroeconómicas de las regiones chilenas ante shocks climáticos extremos —inundaciones e incendios forestales— utilizando proyecciones locales y datos administrativos. Nuestros resultados muestran pérdidas persistentes del PIB, caídas temporales en el consumo y una recuperación rezagada de la inversión, acompañadas de un aumento del empleo pero con disminución de los salarios y de las horas efectivas trabajadas. Estos patrones contrastan con la evidencia a nivel de condado en Estados Unidos sobre desastres naturales, lo que resalta el papel del tamaño del desastre y de los factores institucionales y financieros en la recuperación en economías emergentes. Interpretamos estas dinámicas a través de cuatro mecanismos: destrucción del capital productivo, condiciones financieras más restrictivas que limitan la reconstrucción, reasignación de la producción y pérdidas de riqueza de los hogares que deprimen el consumo mientras impulsan el empleo en tareas de reconstrucción de baja remuneración. Al incorporar estos elementos en un modelo de ciclos económicos reales con fricciones financieras, mostramos que las restricciones financieras amplifican los impactos del desastre y ralentizan la recuperación. Nuestros hallazgos subrayan la importancia de políticas financieras y de reconstrucción focalizadas para evitar un daño económico persistente en el largo plazo.

Abstract
We study the macroeconomic responses of Chilean regions to extreme weather shocks—floods and wildfires—using local projections and novel administrative data. Our results show persistent GDP losses, temporary declines in consumption, and a delayed rebound in investment, accompanied by rising employment but falling wages and effective hours. These patterns contrast with U.S. county-level evidence on natural disasters, highlighting the role of disaster size, and institutional and financial factors in shaping recovery in emerging markets. We interpret the dynamics through four mechanisms: destruction of productive capital, tighter financial conditions that constrain rebuilding, reallocation of production, and household wealth losses that depress consumption while fueling low-wage reconstruction employment. Embedding these insights into a real business cycle framework with financial frictions, we show that financial constraints amplify disaster impacts and slow recovery. Our findings underscore the importance of targeted financial and reconstruction policies to prevent long-term economic scarring.

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* The views expressed are those of the author and do not necessarily reflect the views of the Central Bank of Chile or its board members. Any errors are the sole responsibility of the authors. This study was developed within the scope of the research agenda conducted by the Central Bank of Chile (CBC) in economic and financial affairs of its competence. The CBC has access to anonymized information from various public and private entities, by virtue of collaboration agreements signed with these institutions. To secure the privacy of workers and firms, the CBC mandates that the development, extraction and publication of the results should not allow the identification, directly or indirectly, of natural or legal persons. Officials of the Central Bank of Chile processed the disaggregated data. All the analysis was implemented by the authors and did not involve nor compromise Chilean IRS, Chilean Customs or Superintendency of Pensions. The information contained in the databases of the Chilean IRS is of a tax nature originating in self-declarations of taxpayers presented to the Service; therefore, the veracity of the data is not the responsibility of the Service.

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1 Introduction

Climate change research has largely focused on rising global temperatures, yet an important pressing dimension is the increasing frequency and intensity of natural disasters*. These events have profound consequences for both society and the macroeconomy, and their expected acceleration poses substantial challenges for adaptation and policy design (IPCC, 2021; USGCRP, 2017). Understanding their economic impacts and adjustment mechanisms in the short and medium term is essential.

Most empirical evidence to date comes from developed countries, especially the United States. However, developing economies may experience markedly different outcomes due to their distinct economic structures, adaptive capacities, and levels of insurance coverage. Identifying these differences is crucial for designing adaptation and mitigation strategies tailored to diverse contexts.

Despite growing interest, key questions remain unresolved: What are the macroeconomic impacts of extreme weather shocks in developing economies, and through which channels do they operate? Do these events primarily destroy productive capital, or do they generate broader productivity declines? Addressing these questions is central to understanding how economies adjust to disasters and to informing effective adaptation policies.

This study contributes to filling this gap by examining the macroeconomic consequences of extreme weather events - floods and wildfires- in Chile, an emerging economy with rich regional data and frequent exposure to natural hazards. Using local projections à la Roth Tran and Wilson (2024), we exploit quarterly regional data on GDP, consumption, employment, commercial debt, and, crucially, investment and wages from administrative records for the period 2013–2024, complemented with high-frequency electronic invoice data (2018–2024). The availability of administrative information on investment and wages is particularly valuable, as it allows us to more precisely identify the channels through which regional economies ad-

*Along the paper we will use the terms natural disaster, extreme weather shocks and climate extremes as synonyms, understanding that there are some differences. For example,earthquakes are natural disasters that are not extreme weather shocks. Hence, when referring to this particular shock, we will state it clearly.

just after disasters. This setting enables us to measure the effects of extreme weather shocks and to uncover the underlying mechanisms of post-disaster adjustment. Ultimately, even relative to existing studies on emerging economies, the richness of the Chilean data provides a unique opportunity to disentangle channels of adjustment that have remained obscured in advanced economy contexts, thereby offering a novel contribution to the literature on climate shocks and macroeconomic dynamics. In what follows, we show that these data allow us to uncover distinct adjustment channels that had not been clearly documented before.

Our findings reveal at least three complementary channels of adjustment. First, the destruction of productive capital depresses output, reflecting the direct impact on the economy's productive capacity, while financial frictions cause investment to recover with a lag. Second, the destruction of housing reduces household wealth and consumption while generating low-wage reconstruction employment, highlighting the interaction between consumption smoothing and labor reallocation. Third, we cannot rule out the possibility that, facing greater uncertainty and lower demand after the disaster, firms do not replace capital as quickly as predicted by a standard neoclassical mechanism. We further distinguish the effects by shock type and, given the richness of the data, interpret the responses within a real business cycle framework with financial frictions. In general, the results underscore the critical role of financial constraints in shaping the pace and nature of post-disaster recovery.

The rest of the paper is organized as follows. Section II reviews the related literature. Section III describes the data, while Section IV presents the methodology. Section V reports the main results, and Section VI presents robustness checks. Section VII interprets the findings within a real business cycle framework, including a version with borrowing constraints, and Section VIII concludes.

2 Literature Review

The literature examining the long-term economic impacts of natural disasters reveals a variety of empirical findings that highlight the complexity of these effects. Researchers have identified multiple potential long-term trajectories following disasters, which can manifest as economic outcomes that are below, at, or above pre-disaster trends. This diversity of results complicates the ability to draw definitive conclusions about the economic repercussions of disasters, suggesting that the context and nature of each event play critical roles in shaping outcomes. Recent cross-country evidence by Ehlers et al. (2025) further emphasizes this complexity, showing that the macroeconomic and sectoral effects of different weather disasters can be sizable and long-lived, with GDP and key industries such as agriculture and energy experiencing persistent negative impacts, while inflationary pressures remain more contained but uneven across components.

Key studies contribute substantially to this ongoing debate. For instance, Hsiang and Jina (2014) using a panel of countries present a compelling case, arguing that cyclones typically inflict long-lasting declines in national GDP per capita. This statement is supported by a wealth of data indicating that such disasters disrupt economic activity in the affected regions, leading to protracted recovery periods. However, contrasting studies challenge this perspective, particularly those focusing on high-income countries. These studies suggest that the economic effects of disasters can be less severe or even positive, particularly when considering factors such as robust infrastructure and effective emergency response mechanisms.

In the context of the United States, the evidence becomes even more nuanced. Studies such as Jerch et al. (2023) and Kim and Chung (2024) consistently document negative long-term effects of disasters on economic indicators, particularly persistent declines in GDP per capita. Complementing this evidence, Deryugina (2017) show that natural disasters also entail substantial fiscal costs, reinforcing the view that their economic aftermath can be long-lasting. Yet, a contrasting narrative emerges from research on Hurricane Katrina and Hurricane Rita. Deryugina et al. (2018) and Groen et al. (2020) show that, under certain conditions, disasters can generate positive long-term impacts, largely through channels such as increased federal investment in infrastructure and subsequent inflows of population. Adding further complexity, Roth Tran and Wilson (2024) find that disasters triggering federal aid programs are associated with long-term increases in income, wages, and home prices—primarily in the case of hurricanes and tornadoes—while leaving employment and population levels largely unaffected. Their results underscore the importance of federal transfers and insurance in shaping economic outcomes, though broader spillovers at the regional level appear limited.

Regarding developing economies, there's very scarce studies on the economic impact of climate extremes and channels of impact. Contrary to the U.S., literature finds that local governments often focus on disaster recovery rather than building adaptive capacity (Mirza 2003; Hay and Mimura 2010). This results could imply a negative GDP impact for emerging economies.

Last, in the case of Chile, literature has been focus so far on the impacts of slow growing effects of climate change throughout recent decades, but there is few or none on the economic impacts of climate extremes. These studies so far shows that rising temperatures and decreasing precipitation have adversely affected key economic sectors, and find that extreme temperatures and droughts exacerbate the effects of climate change (Hernández and Madeira 2021; Reszczynski 2024). The Central Bank of Chile (Central Bank of Chile 2024; Central Bank of Chile 2025) also conducts a survey on climate change effects on firms and found that over 50% of companies in 2025 declared to have been affected by extreme weather events in the last 12 months, 18% reported a decrease in production and 9% a loss of capital. In addition, Marulanda et al. (2022) finds that the country has a significant financial risk due to the substantial resources required to address extreme disasters, emphasizing potential considerable impacts for the national economy.

From these varied findings, several key takeaways emerge. First, many studies tend to focus on single disaster types, which may limit the generalization of their conclusions across different contexts. This single-focus approach risks overlook the broader implications of how various disasters affect economic trajectories. In addition, cross-country analyses often fail to adequately account for local dynamics, particularly in the United States and developing countries like Chile, where the availability and efficacy of disaster aid can vary dramatically. This disparity in aid responses can lead to significantly different economic outcomes in similar disaster scenarios. Finally, considerable gap remains in our understanding of the underlying mechanisms that contribute to heterogeneity and spatial dynamics after a disaster. More comprehensive research is needed to explore these complexities, as they are crucial to formulate effective policies and interventions aimed at mitigating the long-term economic consequences of climate extremes.

3 Data

This study leverages a robust dataset to investigate the regional economic impacts of extreme weather events in Chile. The economic variables of interest include quarterly data on regional Gross Domestic Product (GDP), household consumption, investment, and labor market outcomes such as employment, real wages, and hours, spanning from 2013 to first quarter of 2024. In addition, we incorporate financial information on the stock of debt held by companies. These indicators offer a temporal dimension, enabling the examination of economic trends over time.

Most of the GDP information and its components come from official statistics compiled and published by the Office of National Accounts at the Central Bank of Chile, which has been supplemented with increasingly timely regional indicators of activity. This dataset includes: regional GDP, household consumption, and its disaggregation. In addition, we complement this with a novel database of investment calculated from microdata of administrative records, as the regional stock of capital is not available in official statistics. In particular, we utilize data on investment flows, which are not publicly available at the regional level, calculated using electronic invoices between companies from Chilean IRS data and import records from the Chilean Customs Service.

An important consideration regarding regional investment data is that the ideal metric for analysis would be the regional capital stock. Unfortunately, these data are not available. The capital stock is composed of the capital from the previous period, current period investments, capital losses, and depreciation. Access to such data would allow us to observe immediate destruction of productive capital, as might occur following a natural disaster. However, the constructed dataset only captures the flow of new investments. As a result, it does not reflect capital losses or depreciation, but only the acquisition of new capital assets by firms.

As a complement to GDP, we also utilize regional sales data from electronic invoices, which are publicly available at the CBC's data center every month, starting from 2018.

Employment data is derived from monthly official statistics from the National Statistics Institute (INE, in Spanish), which provide a comprehensive picture of labor market movements within regions and at the sectoral level. For wages, which are not publicly available, we calculate regional statistics using administrative data from the Superintendency of Pensions. This data captures only the formal sector of the economy. In the case of Chile, this represents approximately 70% of the total workforce. To obtain real wages, we deflate using the headline Consumer Price Index (CPI).

Finally, financial information on the stock of debt of companies is sourced from official statistics of the Financial Market Commission (CMF, in Spanish), available at a monthly level. This stock includes the stock of commercial loans, export and import credits, factoring, and commercial leasing requested by companies from financial institutions supervised by the CMF. The data is published in nominal terms; to obtain real values, we deflate using the CPI.

Economic and financial data are seasonally adjusted using the X-13ARIMA-SEATS Seasonal Adjustment Program from the U.S. Census Bureau. Figure 7 and 8 describes selected economic variables at the regional level.

Together with these economic variables, the study incorporates natural disasters[†] data sourced from the Emergency Events Database (EMDAT)[‡], managed by the Centre for Research on the Epidemiology of Disasters (CRED) at the Université Catholique de Louvain. This dataset captures various natural disaster shocks, allowing analysis of their frequency, intensity, and regional distribution. By combining these economic and disaster data, the research aims to elucidate the complex interactions between regional economic performance and the impacts of extreme climates, providing valuable insights into resilience and recovery strategies in the Chilean context.

Figure 1 presents a comprehensive visualization of Chile's population, broken down by region, along with an analysis of economic activity in each area. Generally, a positive correlation is observed between population and economic activity, indicating that regions with higher population densities tend to exhibit higher levels of economic activity. However, this general trend shows a notable exception in the northern part of the country, where the economy is heavily influenced by mining. This economic sectorization results in disproportionately high economic activity, despite a relatively low population compared to other regions, highlighting the significant role of extractive activities in shaping the regional economic landscape.

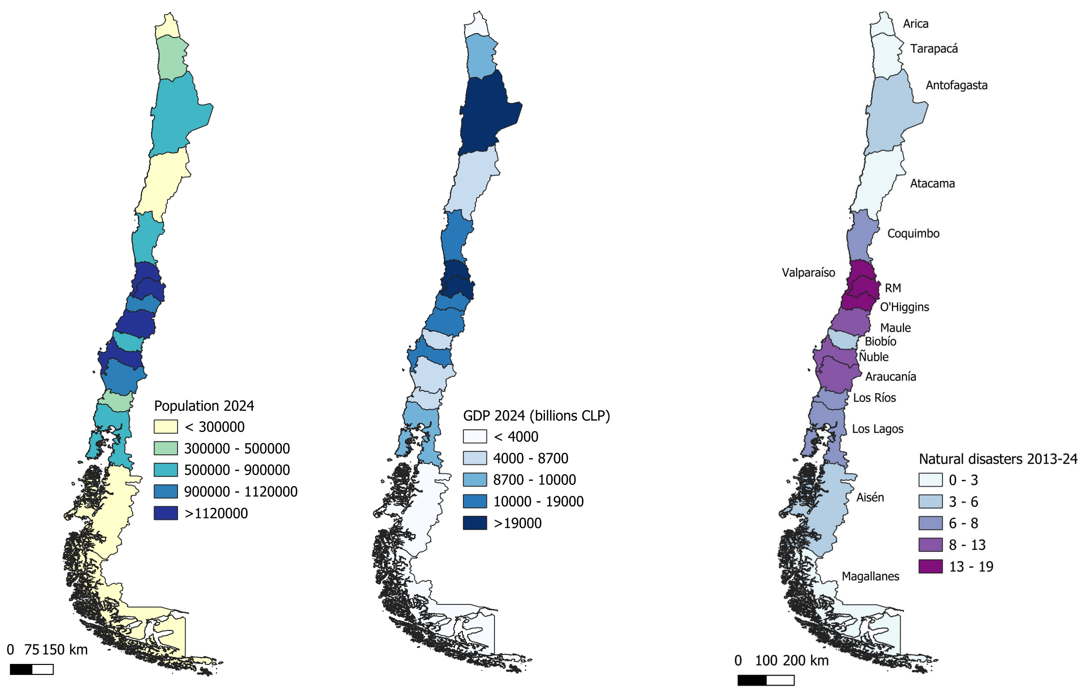
In addition, the figure includes an analysis of the frequency of natural disasters by region, adding a crucial dimension to understanding the risks faced by these areas. Thus, Figure 1 not only illustrates the distribution of the population and its economic activity but also highlights the complex interrelationship between these factors and exposure to extreme climate events. This information is vital to formulate public policies that promote sustainable and resilient economic development in all regions of Chile, especially those facing unique challenges due to their predominant economic activities and geography. Ultimately, understanding natural disasters is important because they occur in densely populated areas.

[†]The inclusion criteria for an event to be considered a disaster include: At least ten deaths (including dead and missing), at least 100 affected (people affected, injured, or homeless), and a call for international assistance or an emergency declaration.

[‡]EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be

The extreme climate events analyzed in the study are categorized into two main types for analysis purposes: wildfires and floods. Floods will encompass three types of events: floods, storms, and mass movements (including landslides and mudslides). All three disasters are related to meteorological or hydrological phenomena of heavy and torrential rains, and some produced in addition landslides of land, mud, snow, or rock. In the case of wildfires, they are described as part of the climatological subgroup by EMDAT, and some are described as associated with heat waves, high temperatures, and strong winds. A total of 116 disasters are considered, of which sixty percent are floods and the remaining are wildfires. Tables 1 and 2 show the number of extreme events by year and region included in the sample.

Figure 1: Population, Activity and Natural Disasters



Note: Own elaboration with data from EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be, Central Bank of Chile, and the National Institute of Statistics (INE).

4 Methodology

We estimate the dynamic causal effects to extreme weather shocks using local projections à la Jordà (2005) modified for panel data. In our baseline specification, we estimate the following equation for a series of horizons $h \geq 0$:

$$y_{r,t+h} - y_{r,t-1} = \alpha_t^h + \gamma_r^h + \theta^h D_{r,t}^{shock} + x_t'\beta + \epsilon_{t+h} \tag{1}$$

$y_{r,t}$ is an economic outcome of interest in region r in period t, measured in logs. $D_{r,t}^{shock}$ is the key treatment variable, equaling one if the region experienced a disaster in period t and zero otherwise. x_t is a vector of controls: lags of previous growth rates. α_r^h and γ_t^h represent quarter and region fixed effects. Our specification in equation 1 is the same as that used by Roth Tran and Wilson (2024).

In this specification, the variable of interest will be the long difference $(y_{r,t+h} - y_{r,t-1})$, which is interpreted as the cumulative regional effect from receiving the shock in each period in regard to time zero with respect to not affected regions. We refer to the dynamic cumulative causal effects up to horizon h as the Cumulative Impulse Response Function (CIRF).

5 Results

5.1 Main results

The estimates in Figure 2 show the results for the main economic variables of the study from the estimation of equation 1. In each figure, time zero represents the moment the shock occurs, and we then examine the effect over the next twenty quarters. To check for pre-trends in the data, we also display the eight quarters preceding the shock. Recalling, as stated in the methodology section, each CIRF represents the cumulative effect at the regional level of receiving the shock with respect to time zero, as opposed to not being affected, similar to an average treatment effect.

First, regional GDP suffers a significant and persistent drop from the quarter the shock hits. The point estimate results indicate that, immediately, regional GDP falls by about 1.5% with respect to pre-shock levels. This drop persists until the end of the studied period, at year five, where we finally see an average recovery back to pre-shock levels. Although significance is lost in some periods, the average and bands remain below zero on average.

Regarding demand, household consumption drops significantly, not at time zero, as with GDP, but at subsequent periods, showing a behavior compatible with intertemporal smoothing and precautionary savings due to the shock. Moreover, it goes back to pre-shock levels after three years.

However, investment flows remain flat and with no significant movements until three years after the shock. Here, as stated in the data section, we do not observe the stock of regional capital since it is not available from official statistics. From microdata, we can only observe the additional investment in each period. This implies that we cannot directly observe the loss of capital due to the shock. However, since government consumption is a minor component of GDP and household consumption falls but recovers afterwards, the loss in GDP from time zero must stem from a capital loss or a negative productivity shock. Then this loss is not recovered until year five, after investment flows start increasing and start accumulating capital from year four.

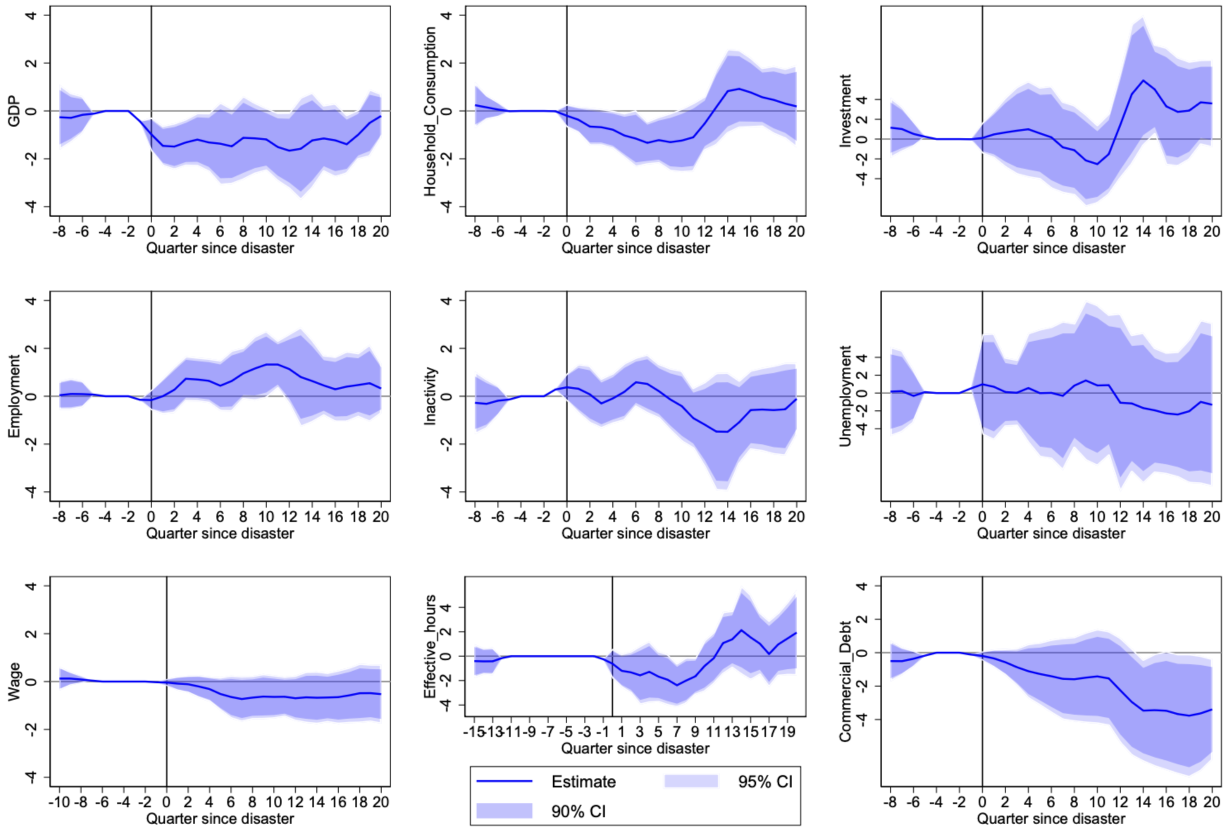
Labor market information is shown in the second and third rows of the figure. First, we observe the effects on the workforce and inactivity. Employment shows a significant increase after one year and another three years after. This initial move is explained by emergency activities when we disaggregate by sector (see Section 5.2). Since unemployment remains the same, this must be explained by a movement from inactivity into the labor market and employment. Regarding wages, we observe a persistent decline, although with a significant degree of uncertainty, and effective hours also experience a fall in the first years. Overall, although total employment increases in some periods, the data are compatible with a deterioration of the labor market.

Finally, when we examine the response in Commercial debt, we observe a drop in the average, which is significant after three years. This data corresponds to the stock of debt, so this result is compatible with a decrease in new credit flows throughout the three years, as well as debt that is left to expire or prepaid. This result is contrary to what one would expect, as companies need to rebuild and require additional resources. Hence, the increase in investment in year three suggests that resources come from profits, regional transfers, or other sources of credit rather than banks. There are two options: they could come from public or private investment. However, since the government's share of total capital is smaller, there must be at least a portion of private firms investing. Furthermore, there must be larger firms, since they are the ones that can access other sources of funding, as stated by (Fernández et al., 2017)[§] They show, based on the data per loan of banks' balance sheets, that although bigger companies explain the majority of the stock of bank credit, they are the ones that can access other sources of lending, such as local and foreign bonds and foreign credit.

As a final note, these estimates require careful interpretation, as they represent averages across disasters of varying intensities. By construction, the inclusion criteria pools together heterogeneous events that may propagate through distinct channels, which could mask important variation in the underlying effects.

[§]The authors describe the credit market in Chile for non-banking companies.

Figure 2: Impact of Extreme Weather Shocks on Key Economic Variables



Note: CIRF of Regional data to Extreme Weather Shocks (logx100). Includes floods and wildfires. Standard errors are clustered at the regional level.

5.2 Other results

5.2.1 Main results for floods & wildfires

We perform the same analysis presented in the above section, but now separating it for only those events associated with floods and wildfires. Figure 9 shows the results for floods and 10 wildfires. Comparing the two graphs, we can see that the average results for both shocks are primarily driven by floods, which are the most common type of shock in our sample, and the main results support this.

In the case of wildfires, we observe some differences. First, we can see that the response in GDP is more uncertain, in contrast to what typically occurs after a flood. Wildfires exhibit an increasing trend across quarters, although this response is less statistically significant and characterized by higher dispersion in confidence intervals.

Regarding the other economic variables, in wildfires, we can observe a shorter effect on consumption and a muted response in the labor market. In this case, we also see a drop at the end of the studied period in commercial debt and a muted response in investment. Implying that, in this case, we observe a lack of investment throughout the entire studied period, until year five.

5.2.2 GDP by sector

In this section, we analyze the dynamics of regional activity from the perspective of supply and sectors. In this case, it is relevant to mention that at regional and sectoral level, the information available from official statistics is more aggregated than national data. Specifically, at the regional level, we have five groups of economic sectors, in contrast to the country level, which has sixteen main activities.

This fact implies that within a group of activities, we can observe a muted response; however, it may be that at a more detailed level, there are relevant responses in different directions.

Figure 11 presents the results. We observe that the initial drop is linked to the services sector, which, compared to commerce magnitudes, has a low impact; however, given its incidence in the overall economy (67.8%), it is relevant and statistically significant. Due to the level of data aggregation at the regional level, which limits further breakdown, the services sector encompasses many activities[¶]. Some of these, such as transport or personal services, which include education and tourist-related services, such as restaurants and hotels, would be expected to be more heavily affected, while others, like financial services or public administration, may be less impacted. Regarding manufacturing and other goods, we see

[¶]GDP services include: restaurants and hotels, transport, information and communications services, financial services, business services, dwelling services and real estate, personal services, and public administration.

no significant changes. However, this latter category, which represents 22% of total activity, aggregates the natural resources sectors[‖]. From media records and interviews Central Bank of Chile (2024), we have information indicating that the agricultural sector is heavily affected by floods, so we would expect this sector to have a negative impact. In turn, in some floods, as recorded in Briones et al. (2023), heavy rain associated with floods can be beneficial for the electricity sector, specifically hydroelectric generation, providing a boost to activity that could counteract the adverse effects of agriculture.

5.2.3 Consumption by components

This section presents a breakdown of household consumption. The available regional data includes the subcategories of non-durable goods, durable goods, and services, which represent 43.4%, 7.6%, and 49.1% of private consumption, respectively.

Figure 12 shows the results for the consumption subcategories. As expected, the decline is more pronounced in durable goods and services, in contrast to the effect on non-durable goods, which makes sense, as these are the types of products whose replacement can be delayed. On the other hand, we also highlight that the increase in consumption from the third year onward is mainly attributed to services and durable goods, although all three components return to the zero area.

In summary, the pattern of regional consumption following a natural disaster aligns with a narrative in which durable goods are the most affected. Eventually, after the disaster, there is a rebound in the consumption of durable goods, which were previously hit hard, as well as in services. One possible interpretation is that, in response to capital destruction or emergency management, non-essential consumption shifts to redirect economic resources toward more urgent priorities, such as precautionary savings, or due to reduced supply.

[‖]Other goods include: Agriculture and forestry, Fishery, Electricity, gas, water, and waste management

5.2.4 Employment by sector

In this subsection, we explore the heterogeneity within employment sectors, following those covered in the GDP section. Figure 13 presents the results. We can see that, with this disaggregation, the movements of the total are mainly explained by construction activities, divided into two waves. We interpret the first wave as an initial response to the disaster related to emergency activities and reconstruction, followed by a second wave of longer-term investments and projects. This behavior may be related to a reevaluation of disaster costs and/or adaptation or mitigation measures that involve a more extended development process.

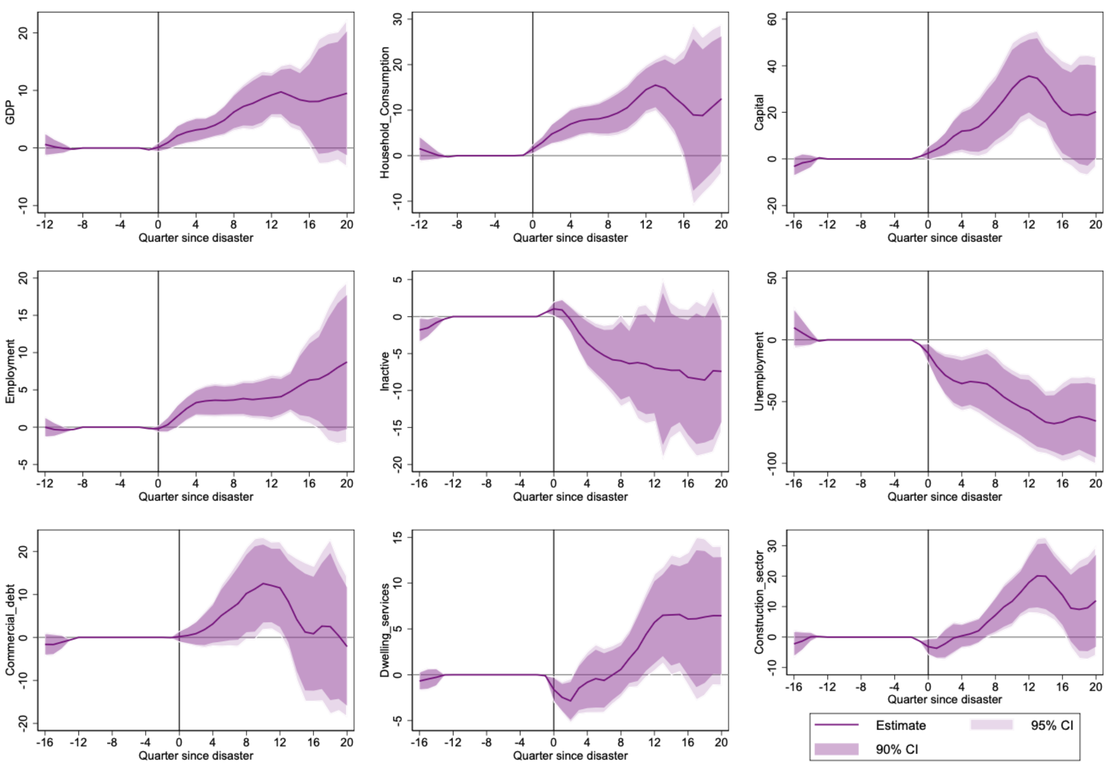
5.2.5 Earthquake

On February 27, 2010, Chile was hit by an earthquake of magnitude 8.8 on the Richter scale. It is the second strongest earthquake to have struck the country, after the 1960 Valdivia earthquake. Six regions were severely affected, covering more than 70% of the national GDP (as of 2013), and a subsequent earthquake at sea also damaged several coastal areas.

Besides the tremendous cost in human lives, there are records of significant loss in housing and public infrastructure, such as hospitals, schools, and bridges. [**]. The government estimated a loss equivalent to 18% of the 2009 national GDP and set up a reconstruction plan for four years, valued at over 8 billion US dollars.

[**]"Plan de reconstrucción de terremoto y maremoto del 27 de febrero de 2010, Resumen Ejecutivo", Gobierno de Chile. https://www.desarrollosocialyfamilia.gob.cl/pdf/plan-reconstruccion-resumen-ejecutivo.pdf

Figure 3: Macroeconomic impact of the 2010 Earthquake in Chile



Note: CIRF of Regional data to 2010 Earthquake (logx100). Standard errors are clustered at the regional level.

We will use this event to contrast the economic effects with the extreme weather shocks already estimated in previous sections. In this case, we calculate the effects of this shock as a dummy in the specific quarter in a set of selected economic variables at a national level following a simpler version of equation 1:

$$y_{t+h} - y_{t-1} = \alpha + \theta^h D_t^{shock} + x_t'\beta + \epsilon_{t+h} \tag{2}$$

Figure 3 shows the results. We find significant effects in all the selected variables. In this case, in contrast to extreme climates, we observe a positive effect on GDP, household consumption, and capital over the following four years after the earthquake, in line with a positive shock of reconstruction following the disaster, which actually takes the economy above pre-shock levels.

In terms of sectoral activity, this is reflected in the construction sector, following the stock of capital increase, and an initial negative shock in dwelling services. This sector is partly measured by national accounts, which include an estimation of the stock of housing, thereby reflecting the earthquake losses. After three years, it returns to its level before the earthquake and remains above it.

In the labor market, we also observe a positive shock in employment, characterized by a decrease in unemployment and an inactive population following the increase in GDP.

Finally, in the financial sector, we see the stock of commercial debt increasing throughout the years until year four, indicating that it is not only public investment driving back recovery but also private expenditure, which is being funded partly by bank debt.

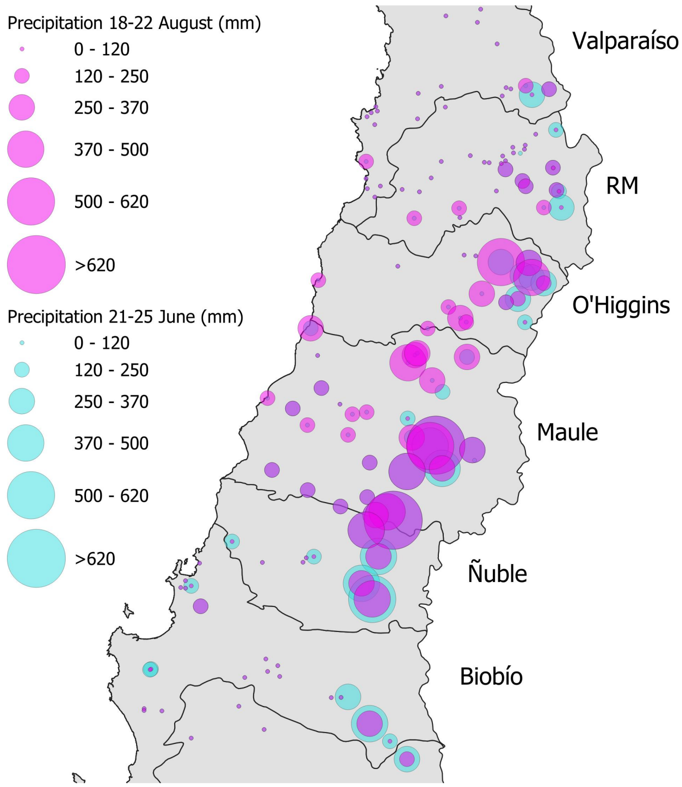
Overall, this result is consistent with the positive effects found at the county level in the U.S. for hurricanes, where the reconstruction shock following the disaster leads the economy above pre-shock levels. The contrast with the negative results found at a local level in extreme climates, such as floods and wildfires, underscores the importance of not overlooking more minor or local shocks, which can, as we have shown, lead to sustained and persistent negative losses in GDP.

5.2.6 Application: Floods 2023

In 2023, Chile experienced significant floods in June and August, marking the most severe floods since 2018. These disasters were particularly notable for their extensive water volume and widespread impact on the territory (Figure 4). To assess the economic consequences, we used the calculated CIRF to estimate the cumulative effect of the floods by the end of the fourth quarter of 2023. In the exercise, we consider the number of affected regions and reconstruct levels from time zero when each shock occurs, using the lower interval estimated for floods. We then calculate an average for the year to assess the impact at the end of 2023. Our analysis, which takes a conservative approach given the uncertainty associated, suggests that the floods likely resulted in a reduction of at least 0.2 percentage points in the country's

GDP for the year. This estimate reflects the substantial economic disruption caused by the floods, which affected both production and infrastructure across affected regions.

Figure 4: Extreme precipitation events in 2023



Note: Own elaboration based on data from Center for Climate and Resilience Science (CR2).

6 Robustness exercises

In this section, we briefly present two robustness exercises to validate the findings discussed earlier. Additional details and figures are provided in the appendices.

- **Monthly company invoices:** In order to contrast the results found in regional GDP, we estimate the monthly impact of extreme weather-related shocks, exploiting the administrative database of company invoices, which will be a proxy for a subset of economic sectors. Figure 14 presents this result. Overall, the main results for GDP are consistent with company invoices. In this case, we observe a significant and persistent decline, although it begins one year after the shock and persists thereafter. Differences in the first year are most likely related to sectors that are not captured in company invoices, as Agriculture and others.

- **Removing regions of the sample:** Another question is whether a particular region's movement is driving the overall result. So we perform an exercise of excluding regions one by one and estimating the CIRF. Figure 15 presents the results. In this case, we observe that no particular region drives the results, and they shift across the confidence interval when removing each one.

7 Discussion

Natural disasters are complex events that operate through multiple channels rather than a single mechanism. Based on our evidence, we highlight at least four as shown in Figure 5: (i) a capital destruction shock, where firms face tighter credit conditions following heightened risk perceptions; (ii) a reallocation channel, where reduced credit partly reflects shifts in production due to lower demand or activity being redirected toward less-affected areas; (iii) a household wealth channel, where the destruction of homes and assets constrains consumption and investment decisions; and a negative productivity shock, where the destruction of public infrastructure reduces overall productivity, combined with the spatial reorganization of some firms adjusting to the new post-disaster reality, which may occur either in response to demand or as a reorganization of supply. To organize the discussion, we begin with the simplest neoclassical distinction between capital destruction and productivity shocks, then deepen the analysis by examining investment behavior in relation to credit dynamics and the predictions of economic theory.

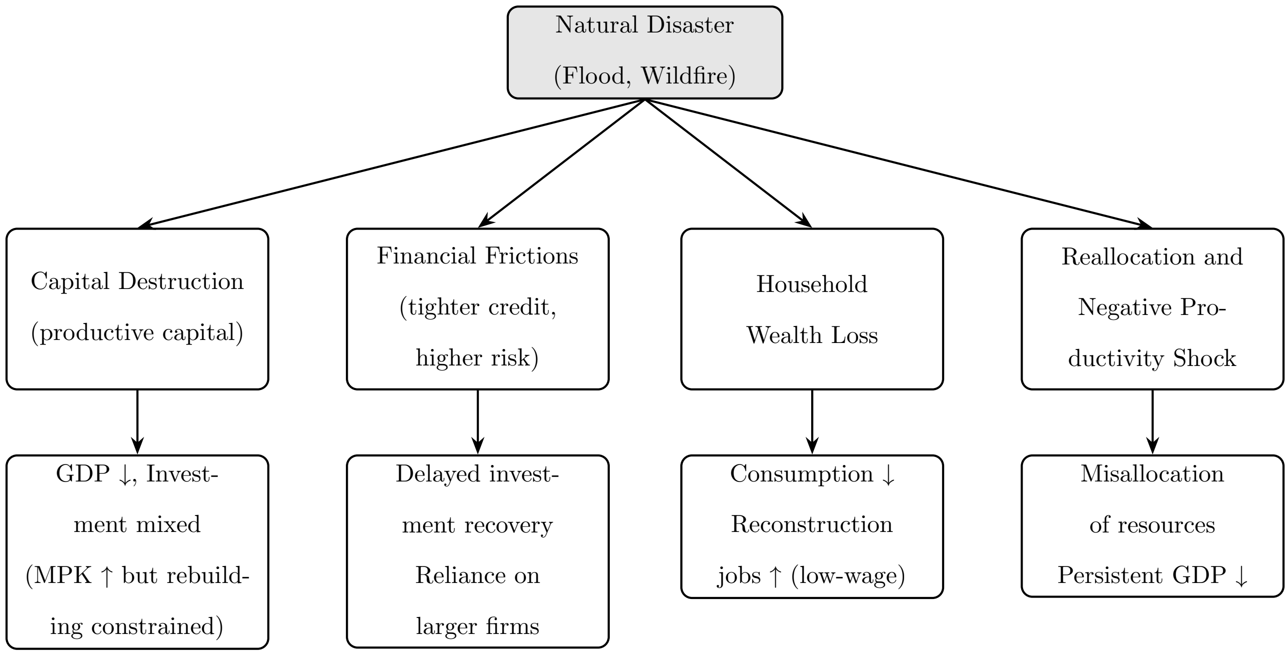


Figure 5: Conceptual framework summarizing four mechanisms through which natural disasters affect local economies: capital destruction, financial frictions, household wealth loss, and reallocation/productivity shocks. These channels interact to shape investment, consumption, and labor market dynamics, ultimately driving persistent GDP declines.

7.1 Interpretation with neoclassical mechanism

The central question of this section is why investment does not recover as a standard neoclassical mechanism would predict. Such a mechanism implies that it is efficient for firms to replenish destroyed capital, since its marginal product exceeds the marginal cost.

A natural concern is whether this pattern reflects a negative total factor productivity (TFP) shock triggered by the natural disaster. However, based on the behavior of the empirical IRFs, this does not appear to be the case, as employment rises. A negative capital shock increases both investment and the marginal product of capital (MPK), whereas a negative TFP shock reduces both variables. In this sense, a natural disaster resembles a capital destruction shock more closely. (Details of the IRFs are provided in the appendix D.)

It is true that non-productive capital exists and that a housing channel may play a role, but in this section, we focus on the dynamics of productive investment.

7.2 RBC with financial frictions

Among the results, we document a decline in commercial credit, which motivates a closer examination of the collateral channel to account for the investment response. The hypothesis is that, while firms face incentives to replenish destroyed capital—implying higher investment—there exists an opposing force that dampens this response. Given the contraction in credit, we argue that this channel constrains investment on the supply side. The mechanism is that, after experiencing a natural disaster shock, firms are perceived as riskier; as a result, financial conditions tighten, reducing credit availability and thereby limiting investment.

We formalize this mechanism through a model adapted from Jermann and Quadrini (2012). The framework features credit constraints and a working capital mismatch, whereby firms must meet their obligations before they can produce. The constraint follows the logic of a financial friction à la Kiyotaki and Moore (1997).

The version presented below of an RBC model augmented with borrowing constraints is based on Sims (2020) and features only an additional capital destruction shock.

7.2.1 Model

Firms

There are a continuum of firms in the [0,1] interval. But there is no idiosyncratic uncertainty so it is as though there is just a representative firm. They produce output according to:

$$y_t = z_t(\omega_t k_t)^\theta n_t^{1-\theta} \tag{3}$$

Capital evolves according to:

$$k_{t+1} = i_t + (1-\delta)\omega_t k_t \tag{4}$$

Firms use equity, d_t, and debt, b_t. In addition, they use an intraperiod loan, l_t. The real interest rate is r_t. There is a tax advantage to debt. The effective gross interest rate available to firms is $R_t = 1 + r_t(1 - \tau)$, where τ represents the tax benefit. This is kind of like assuming that the firms are impatient – you need a mechanism in the model to get the firms to hold debt so that their borrowing constraint will end up binding. Our extension is to add a capital destruction shock, ω_t.

The intraperiod loan is used to finance all payments; the basic idea is that you have to pay workers, bond holders, and equity holders prior to producing. So we have:

$$l_t = w_t n_t + i_t + \varphi(d_t) + b_t - \frac{b_{t+1}}{R_t} \tag{5}$$

b_{t+1} are one-period discount bonds that pay out in $t + 1$. They sell at price $\frac{1}{R_t}$. So b_t is the payment to existing bond holders, whereas b_{t+1}/R_t is the issuance of new debt (which reduces the amount of the working capital loan). Working capital must cover labor payments, new investment, and payouts to equity holders, $\varphi(dt)$. Dividends are potentially subject to an adjustment cost – see below. Without the adjustment cost, $\varphi(dt) = d_t$.

The firm's budget constraint is:

$$b_t + w_t n_t + i_t + \varphi(d_t) = y_t + \frac{b_{t+1}}{R_t} \tag{6}$$

On the "expenditure side," the firm pays off interperiod debt, pays workers, pays for new capital, and pays dividends, d_t, which are potentially subject to an adjustment cost. On the "income side," the firm earns revenue from output and issues new debt. New debt trades at price $1/R_t$. Combining (5)–(6), we see that the intraperiod loan is equal to output, $l_t = y_t$.

The firm is subject to an enforcement constraint:

$$l_t \leq \xi_t \left(k_{t+1} - \frac{b_{t+1}}{1 + r_t} \right) \tag{7}$$

Stochastic variations in ξ_t will be considered financial shocks. Basically, the idea is that the firm's intraperiod loan is constrained by the liquidation value of its net assets – which is $k_{t+1} - b_{t+1}/(1+r_t)$ (it's $1+r_t$ because the lender doesn't get the tax benefit).

It is assumed that there is an adjustment cost to changing the equity payout. It is given by:

$$\varphi(d_t) = d_t + \kappa(d_t - \bar{d})^2 \tag{8}$$

$\kappa \geq 0$ will be important for the way the model performs. If $\kappa = 0$, then changes in financial conditions can basically be offset by changing dividends – in other words, tightening or loosening of the borrowing constraints on intraperiod debt can be undone through adjusting the dividend payout.

Let $m_{t,t+s}$ be the stochastic discount factor. The value of the firm is:

$$V_t = \mathbb{E}_t \sum_{s=0}^{\infty} m_{t,t+s} d_{t+s}$$

Where with the adjustment cost we have:

$$\varphi(d_t) = d_t + \kappa(d_t - \bar{d})^2 = z_t(\omega_t k_t)^{\theta} n_t^{1-\theta} - w_t n_t - k_{t+1} + (1-\delta)\omega_t k_t - b_t + \frac{b_{t+1}}{R_t} \tag{9}$$

Effectively, the actual dividend payout is what it would normally be, minus $\kappa(d_t - \bar{d})^2$. The problem is therefore to pick d_t, b_{t+1}, k_{t+1}, and n_t subject to the budget constraint and the borrowing constraint:

$$\max_{d_t, n_t, k_{t+1}, b_{t+1}} E_t \sum_{t=0}^{\infty} m_{0,t} d_t$$

s.t.

$$\varphi(d_t) = z_t(\omega_t k_t)^{\theta} n_t^{1-\theta} - w_t n_t - k_{t+1} + (1-\delta)\omega_t k_t - b_t + \frac{b_{t+1}}{R_t}$$

$$\xi_t \left(k_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \geq z_t(\omega_t k_t)^{\theta} n_t^{1-\theta}$$

Let λ_t be the multiplier on the budget constraint, and μ_t be the multiplier on the enforcement constraint. A Lagrangian is:

$$\mathbb{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} m_{0,t} \Bigg\{ d_t + \lambda_t \Big[z_t(\omega_t k_t)^\theta n_t^{1-\theta} - w_t n_t - k_{t+1} + (1-\delta)\omega_t k_t - b_t + \frac{b_{t+1}}{R_t} - \varphi(d_t) \Big]$$
$$+ \mu_t \Big[\xi_t \Big(k_{t+1} - \frac{b_{t+1}}{1+r_t} \Big) - z_t(\omega_t k_t)^\theta n_t^{1-\theta} \Big] \Bigg\}$$

The FOC are:

$$\frac{\partial L}{\partial d_t} = 1 - \lambda_t \varphi'(d_t)$$
$$\frac{\partial L}{\partial n_t} = \lambda_t \left[(1-\theta) z_t(\omega_t k_t)^\theta n_t^{-\theta} - w_t \right] - \mu_t (1-\theta) z_t (\omega_t k_t)^\theta n_t^{-\theta}$$
$$\frac{\partial L}{\partial b_{t+1}} = \lambda_t \frac{1}{R_t} - \frac{\mu_t \xi_t}{1+r_t} - m_{t,t+1}\lambda_{t+1}$$
$$\frac{\partial L}{\partial k_{t+1}} = -\lambda_t + \mu_t \xi_t + \mathbb{E}_t m_{t,t+1}\lambda_{t+1} \left(\theta z_{t+1} \omega_{t+1}^\theta k_{t+1}^{\theta-1} n_{t+1}^{1-\theta} + (1-\delta)\omega_{t+1} \right) - \mathbb{E}_t m_{t,t+1} \mu_{t+1} \theta z_{t+1} \omega_{t+1}^\theta k_{t+1}^{\theta-1} n_{t+1}^{1-\theta}$$

Setting these equal to zero, we can solve out for λ_t:

$$\lambda_t = \frac{1}{\varphi'(d_t)} \tag{10}$$

Now substitute this into the different FOC. We can write the labor supply condition as:

$$(1-\theta) z_t (\omega_t k_t)^\theta n_t^{-\theta} - w_t = \varphi'(d_t) \mu_t (1-\theta) z_t (\omega_t k_t)^\theta n_t^{-\theta}$$

Or:

$$w_t = (1 - \mu_t \varphi'(d_t))(1-\theta) z_t (\omega_t k_t)^\theta n_t^{-\theta} \tag{11}$$

The FOC for bonds can be written:

$$\frac{\lambda_t}{R_t} = \frac{\mu_t \xi_t}{1 + r_t} + \mathbb{E}_t m_{t,t+1} \lambda_{t+1}$$

After eliminating λ_t, we can write this as:

$$1 = \varphi'(d_t) \mu_t \xi_t \frac{R_t}{1 + r_t} + \mathbb{E}_t m_{t,t+1} R_t \frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \tag{12}$$

Now go to the FOC for capital. Setting it equal to zero, we have:

$$\lambda_t = \mu_t \xi_t + \mathbb{E}_t m_{t,t+1} \lambda_{t+1} (1 - \delta) \omega_{t+1} + \mathbb{E}_t m_{t,t+1} \theta z_{t+1} \omega_{t+1}^{\theta} k_{t+1}^{\theta-1} n_{t+1}^{1-\theta} (\lambda_{t+1} - \mu_{t+1})$$

Which can be written:

$$1 = \frac{\mu_t \xi_t}{\lambda_t} + \mathbb{E}_t m_{t,t+1} \frac{\lambda_{t+1}}{\lambda_t} (1 - \delta) \omega_{t+1} + \mathbb{E}_t m_{t,t+1} \frac{1}{\lambda_t} \theta z_{t+1} \omega_{t+1}^{\theta} k_{t+1}^{\theta-1} n_{t+1}^{1-\theta} (\lambda_{t+1} - \mu_{t+1})$$

Which can be simplified further:

$$1 = \frac{\mu_t \xi_t}{\lambda_t} + \mathbb{E}_t m_{t,t+1} \frac{\lambda_{t+1}}{\lambda_t} (1 - \delta) \omega_{t+1} + \mathbb{E}_t m_{t,t+1} \frac{\lambda_{t+1}}{\lambda_t} \theta z_{t+1} \omega_{t+1}^{\theta} k_{t+1}^{\theta-1} n_{t+1}^{1-\theta} \left(1 - \frac{\mu_{t+1}}{\lambda_{t+1}}\right)$$

But then given the definition of λ_t, this becomes:

$$1 = \mu_t \xi_t \varphi'(d_t) + \mathbb{E}_t m_{t,t+1} \frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \Big[(1 - \delta) \omega_{t+1} + (1 - \mu_{t+1} \varphi'(d_{t+1})) \theta z_{t+1} \omega_{t+1}^{\theta} k_{t+1}^{\theta-1} n_{t+1}^{1-\theta} \Big] \tag{13}$$

Households

There is a representative household. Its utility function is:

$$U(c_t, n_t) = \ln c_t + \alpha \ln(1 - n_t)$$

Its budget constraint is:

$$c_t + p_t s_{t+1} + \frac{b_{t+1}}{1+r_t} = w_t n_t + b_t + s_t d_t + s_t p_t - T_t \tag{14}$$

Here s_t is the number of shares of equity the household enters a period with; d_t is the equity payout and p_t is the price. The household can consume, buy more shares, or issue more bonds. Its income comes from working, payouts on existing bonds, dividend plus capital gains on shares, less a lump sum tax.

A Lagrangian is:

$$L = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln c_t + \alpha \ln(1-n_t) + \nu_t \left(w_t n_t + b_t + s_t d_t + s_t p_t - T_t - c_t - p_t s_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \right\}$$

The FOC are:

$$\frac{\partial L}{\partial c_t} = \frac{1}{c_t} - \nu_t$$

$$\frac{\partial L}{\partial n_t} = -\frac{\alpha}{1-n_t} + \nu_t w_t$$

$$\frac{\partial L}{\partial b_{t+1}} = -\nu_t \frac{1}{1+r_t} + \beta \mathbb{E}_t \nu_{t+1}$$

$$\frac{\partial L}{\partial s_{t+1}} = -p_t \nu_t + \beta \mathbb{E}_t \nu_{t+1}(d_{t+1} + p_{t+1})$$

Eliminating the multiplier, we get:

$$\frac{\alpha}{1-n_t} = \frac{w_t}{c_t} \tag{15}$$

$$1 = \beta \mathbb{E}_t \frac{c_t}{c_{t+1}}(1+r_t) \tag{16}$$

$$p_t = \beta \mathbb{E}_t \frac{c_t}{c_{t+1}}(d_{t+1} + p_{t+1}) \tag{17}$$

The stochastic discount factor is just:

$$m_{t-1,t} = \beta \frac{c_{t-1}}{c_t} \tag{18}$$

Equilibrium Conditions

The competitive equilibrium conditions include the optimality conditions for the household and firm along with their budget constraints, the borrowing constraint, and the law of motion for capital. We have:

$$\frac{\alpha}{1-n_t} = \frac{w_t}{c_t} \tag{19}$$

$$1 = \beta \mathbb{E}_t \frac{c_t}{c_{t+1}}(1+r_t) \tag{20}$$

$$p_t = \beta \mathbb{E}_t \frac{c_t}{c_{t+1}}(d_{t+1} + p_{t+1}) \tag{21}$$

$$m_{t-1,t} = \beta \frac{c_{t-1}}{c_t} \tag{22}$$

$$w_t = \big(1 - \mu_t \varphi'(d_t)\big)(1-\theta) z_t (\omega_t k_t)^\theta n_t^{-\theta} \tag{23}$$

$$1 = \varphi'(d_t)\mu_t \xi_t \frac{R_t}{1+r_t} + \mathbb{E}_t m_{t,t+1} R_t \frac{\varphi'(d_t)}{\varphi'(d_{t+1})} \tag{24}$$

$$1 = \mu_t \xi_t \varphi'(d_t) + \mathbb{E}_t m_{t,t+1} \tfrac{\varphi'(d_t)}{\varphi'(d_{t+1})} \Big[(1-\delta)\omega_{t+1} + (1 - \mu_{t+1}\varphi'(d_{t+1}))\theta z_{t+1} \omega_{t+1}^\theta k_{t+1}^{\theta-1} n_{t+1}^{1-\theta}\Big] \tag{25}$$

$$c_t + \frac{b_{t+1}}{1+r_t} = w_t n_t + b_t + d_t - T_t \tag{26}$$

$$\varphi(d_t) = z_t(\omega_t k_t)^\theta n_t^{1-\theta} - w_t n_t - k_{t+1} + (1-\delta)\omega_t k_t - b_t + \frac{b_{t+1}}{R_t} \tag{27}$$

$$\xi_t \left(k_{t+1} - \frac{b_{t+1}}{1+r_t} \right) \geq z_t(\omega_t k_t)^\theta n_t^{1-\theta} \tag{28}$$

$$k_{t+1} = i_t + (1-\delta)\omega_t k_t \tag{29}$$

$$y_t = z_t(\omega_t k_t)^\theta n_t^{1-\theta} \tag{30}$$

$$\ln z_t = \rho_z \ln z_{t-1} + s_z \varepsilon_{z,t} \tag{31}$$

$$\log(\xi_t) = (1-\rho_x)\log(\xi^s) + \rho_x \log(\xi_{t-1}) + \gamma_\xi \ln \omega_{t-1} + \sigma_x \varepsilon_t \tag{32}$$

$$\ln \omega_t = \rho_\omega \ln \omega_{t-1} + s_\omega \varepsilon_{\omega,t} \tag{33}$$

$$R_t = 1 + r_t(1-\tau) \tag{34}$$

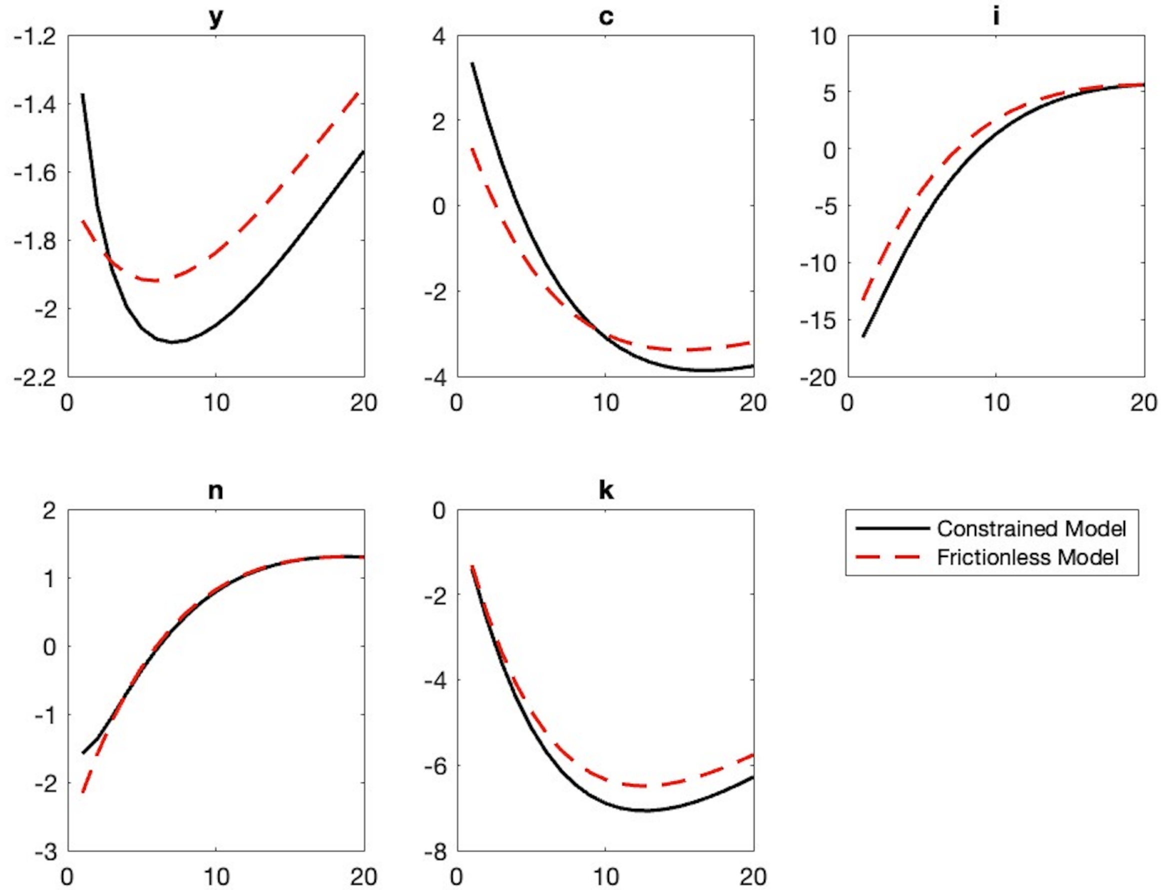
$$T_t = b_{t+1}\left[\frac{1}{R_t} - \frac{1}{1+r_t}\right] \tag{35}$$

As long as $\tau > 0$, we have $R_t < 1+r_t$, so this term is positive. Effectively, the government is subsidizing firms issuing debt and funding this by taxing the household.

Figure 6 displays the IRF to a capital destruction shock. In addition to the endogenous treatment, we introduce a cross-correlation between this shock and the stochastic shock to financial conditions. The interpretation is that capital destruction not only raises firms' borrowing needs but also tightens credit access through a channel driven by heightened risk perception.

As a result, we find that, under the Jermann–Quadrini calibration, a capital destruction shock generates a decline in both output and investment. Moreover, we show that in a model without frictions, capital recovery occurs more rapidly. In other words, the financial friction amplifies the negative effects of a capital destruction shock.

Figure 6: IRF to a Capital Destruction Shock with borrowing constraints



8 Conclusion

This paper studies the aggregate and regional macroeconomic responses of Chilean regions to extreme weather shocks —floods and wildfires— using a panel local projections approach. We document persistent losses in GDP, temporary contractions in private consumption, and a delayed rebound in investment, accompanied by labor market shifts characterized by rising employment alongside declining wages and effective hours. These findings stand in contrast to county-level evidence from the United States, highlighting the importance of institutional and financial factors in shaping disaster recovery in emerging markets. At the same time, they are consistent with the view that large-scale events can trigger substantial inflows of income or aid, as emphasized by Roth Tran and Wilson (2024), which resonates with the preliminary evidence from the 2010 Chile earthquake. Our contribution is to shed light on the reasons behind the persistence of output declines, emphasizing the role of investment dynamics, which we can document thanks to the richness of administrative data.

A central contribution of this study is the use of novel administrative records, which allow us to capture regional investment responses with a high degree of granularity. These data provide a clearer view of how micro-level shocks to firms and households aggregate into macroeconomic outcomes, thereby enabling the design of more informed reconstruction and mitigation policies. By linking firm-level credit constraints and capital losses to regional dynamics, we demonstrate how microeconomic vulnerabilities can lead to persistent macroeconomic scarring.

Financial frictions emerge as a central element of this adjustment process. Firms affected by natural disasters face heightened risk perceptions, which tighten credit conditions and slow the pace of capital recovery. This mechanism amplifies the adverse effects of capital destruction, providing a natural interpretation of why investment does not follow the recovery path predicted by standard neoclassical models. Survey evidence documenting both capital losses and tighter credit conditions following extreme weather events lends further support to this channel.

Overall, our results shed light on the mechanisms through which local economies in emerging markets adjust to natural disasters. They underscore the importance of financial constraints in shaping recovery dynamics and the role of targeted reconstruction and financial policies in preventing long-term economic scarring.

A key limitation of our analysis is that the estimated effects represent averages across disasters, without distinguishing between events of varying intensity. In particular, we do not account for differences in the number of individuals or firms directly affected, which may shape both the magnitude and persistence of economic impacts. Moreover, given the inclusion criteria used in the dataset —requiring at least ten deaths (including missing), at least 100 people affected, or the issuance of an emergency declaration or international assistance request— we are effectively pooling together heterogeneous events that may propagate through distinct channels. As a result, our findings should be interpreted as reflecting broad average effects, rather than the potentially divergent dynamics associated with disasters of different scales and mechanisms.

Taken together, our findings suggest that extreme weather events propagate through at least four complementary channels: (i) a capital destruction shock, where firms face tighter credit conditions following heightened risk perceptions; (ii) a reallocation channel, where the decline in credit partly reflects shifts in production due to reduced demand or firms redirecting activity toward less-affected areas; (iii) a household wealth channel, where the destruction of homes and assets constrains consumption and investment decisions; and (iv) a negative productivity shock, where the destruction of public infrastructure reduces overall productivity. Distinguishing across these mechanisms helps clarify why output losses are so persistent, despite the theoretical incentive in neoclassical models to rebuild capital. While our analysis primarily emphasizes the financial friction channel, the broader evidence indicates that the interaction of these forces shapes the dynamics of post-disaster recovery.

A key avenue for future research is to examine the heterogeneity of investment and credit responses across firms. Prior work has emphasized that financial heterogeneity plays a central role in investment dynamics (Ottonello and Winberry (2020); Khan and Thomas (2013); Gilchrist et al. (2014)). This study opens the question on which types of firms respond most strongly to disaster shocks, and through which mechanisms. Our working hypothesis is that firm size and sectoral characteristics would matter significantly, with smaller and more collateral-constrained firms facing the tightest restrictions. Exploring these dimensions would provide a more granular understanding of how financial frictions mediate recovery and which policies may best support post-disaster investment.

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Appendix

A Descriptive statistics

Figure 7: Economic variables by region (index 2015=100, seasonally adjusted)

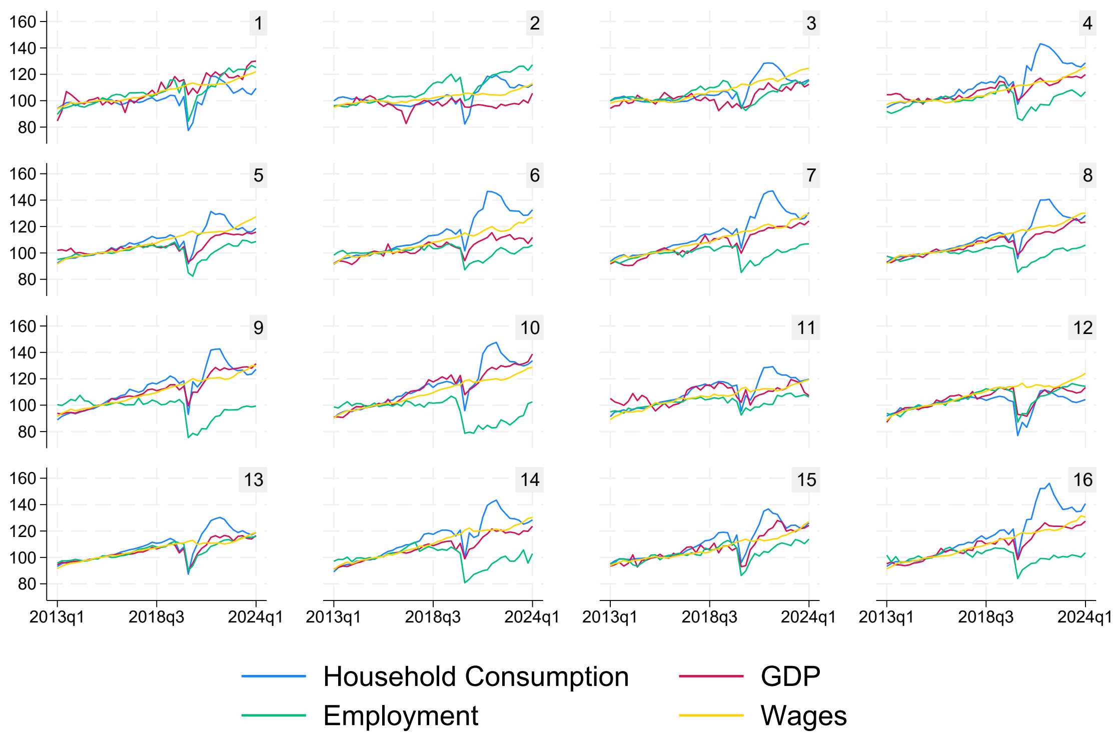
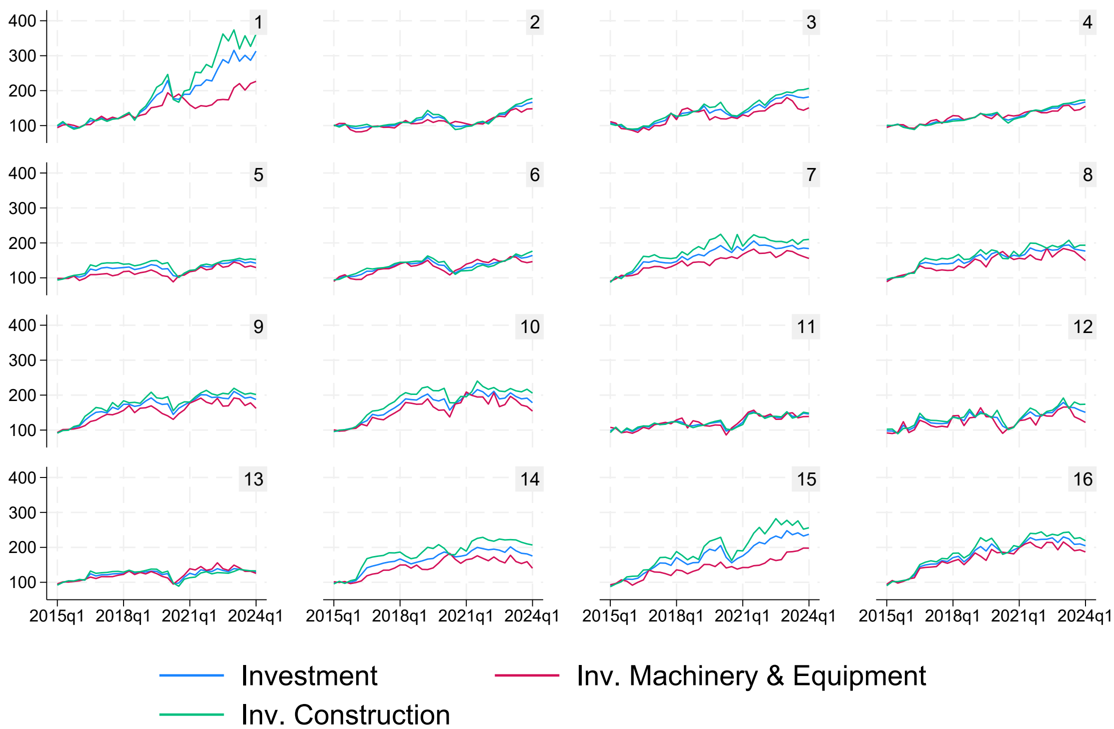


Figure 8: Investment by region (index 2015=100, seasonally adjusted)



Region	2014	2015	2016	2017	2019	2021	2023
Antofagasta	0	3	0	1	1	0	0
Araucania	1	1	0	1	0	2	0
Arica	0	0	0	0	1	0	0
Atacama	0	2	0	1	0	0	0
Aysén	1	1	0	0	0	0	0
Biobío	1	0	0	1	0	2	1
Coquimbo	1	3	0	3	0	0	0
Los Lagos	1	1	0	2	0	1	0
Los Ríos	1	1	0	1	0	1	0
Maule	1	0	0	1	0	1	2
Ñuble	1	0	0	0	0	0	2
O'Higgins	1	1	0	2	0	1	2
RM	1	0	1	2	0	1	2
Tarapacá	0	0	0	0	1	0	0
Valparaíso	1	1	0	2	0	1	2
Total	11	14	1	17	3	10	11

Table 1: Floods by year and region in Chile
Source: EM-DAT, CRED/UCLouvain, Brussels, Belgium.

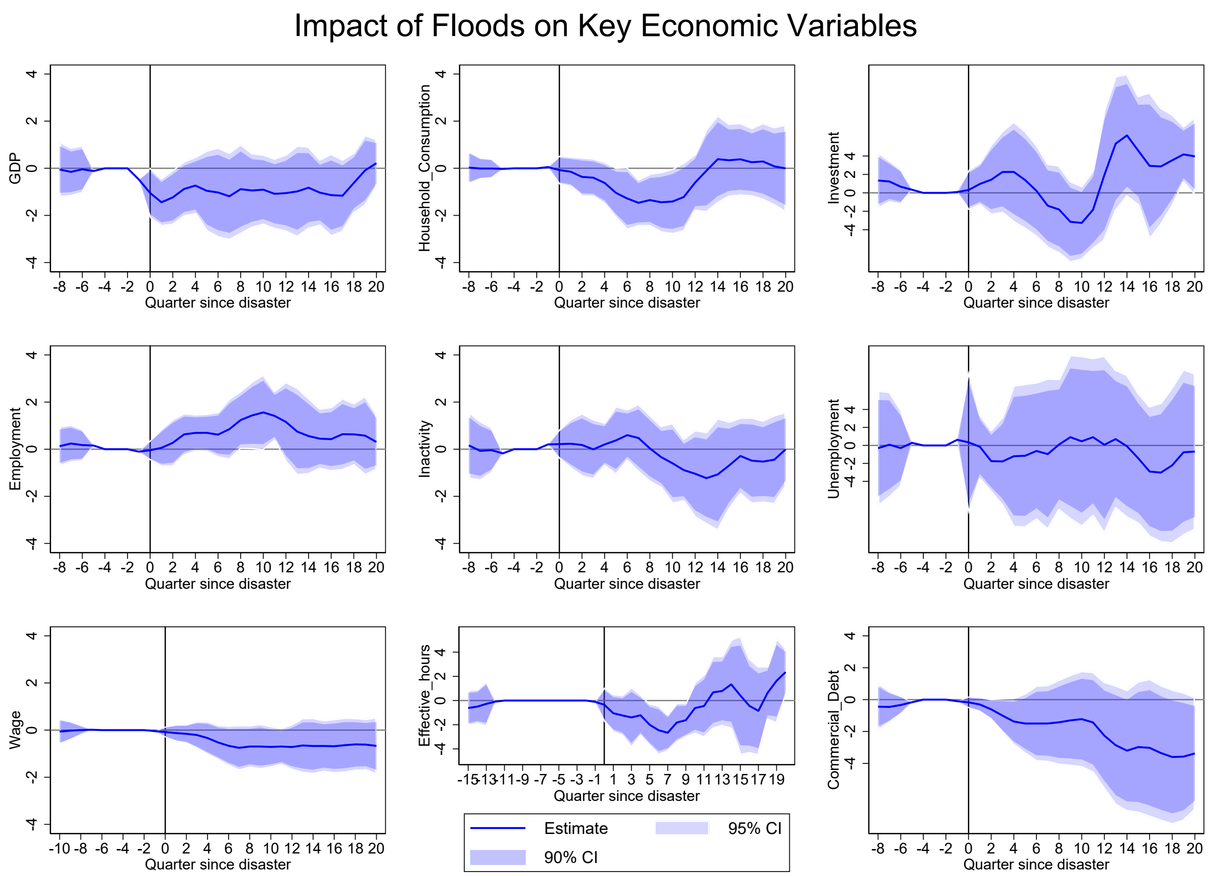
Region	**2014**	**2015**	**2017**	**2019**	**2022**	**2023**	**2024**
Araucania	0	0	3	0	1	1	1
Aysén	0	0	0	0	0	1	1
Biobío	0	0	3	0	1	1	0
Los Lagos	0	0	0	0	0	1	0
Los Ríos	0	0	0	0	0	1	1
Maule	0	0	3	0	0	1	1
Ñuble	0	0	3	0	0	1	1
O'Higgins	0	0	3	0	0	2	1
RM	0	0	3	0	1	2	0
Valparaíso	1	1	3	1	1	2	2
Total	1	1	21	1	4	13	8

Table 2: Wildfires by year and region in Chile
Source: EM-DAT, CRED/UCLouvain, Brussels, Belgium.

B Other results

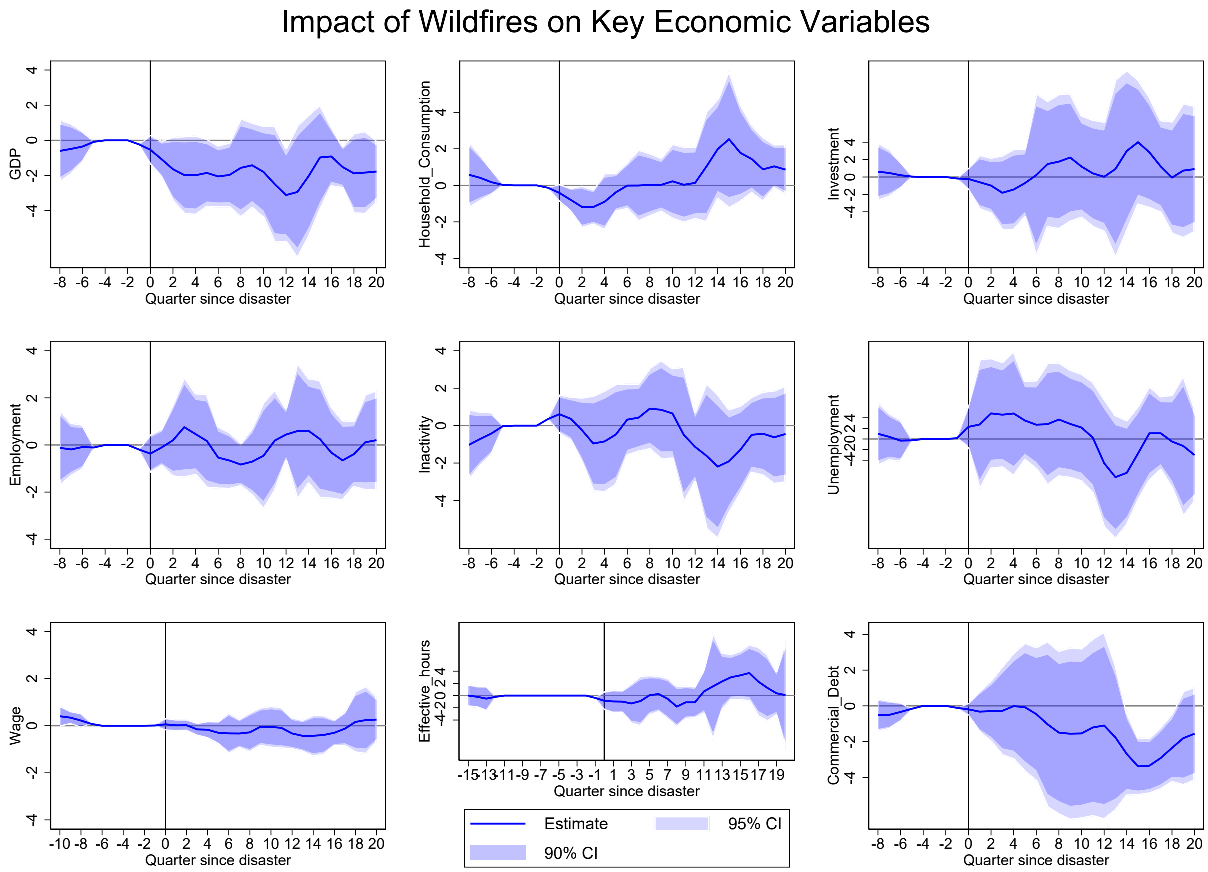
B.1 Main results for floods & wildfires

Figure 9: Big picture: floods



Note: CIRF of Regional data to Extreme Weather Shocks (logx100). Standard errors are clustered at the regional level.

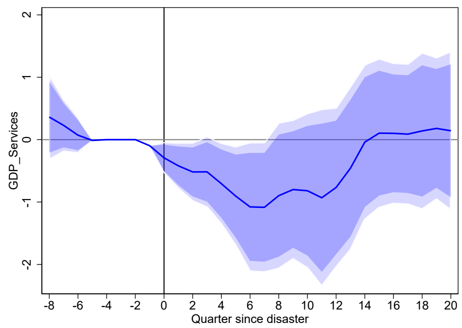
Figure 10: Big picture: wildfires



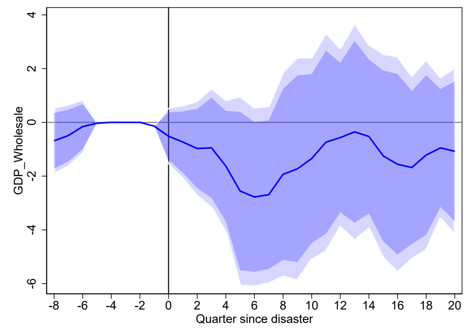
Note: CIRF of Regional data to Extreme Weather Shocks (logx100). Standard errors are clustered at the regional level.

B.2 GDP by sector

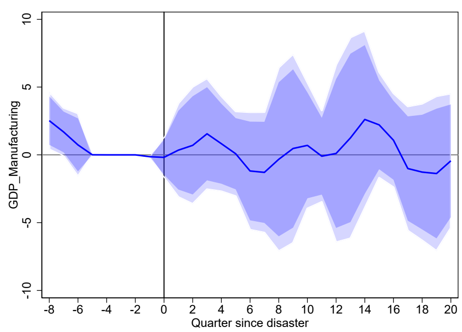
Figure 11: CIRF of selected Regional GDP sectors to Extreme Weather Shocks



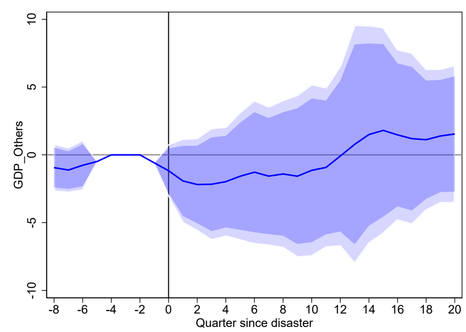
(a) Services(67.8%)



(b) Wholesale and retail trade (9.4%)



(c) Manufacturing industry (9.2%)

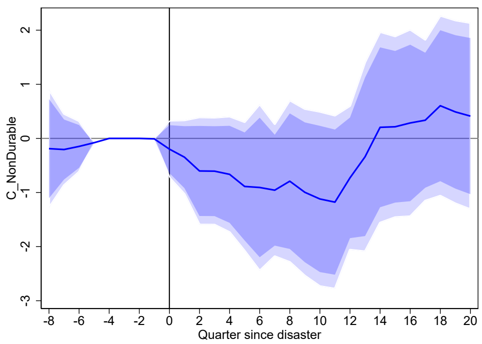


(d) Other goods (22.0%)

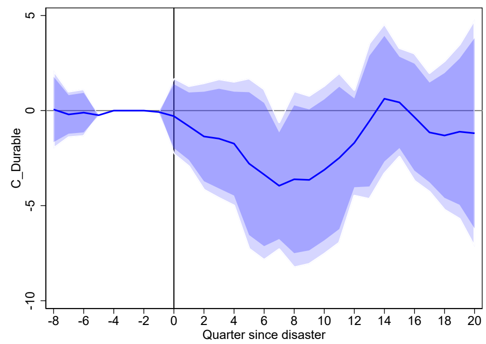
Note: Standard errors are clustered at the regional level. Percentage in parenthesis is participation over total GDP in 2023.

B.3 Consumption by component

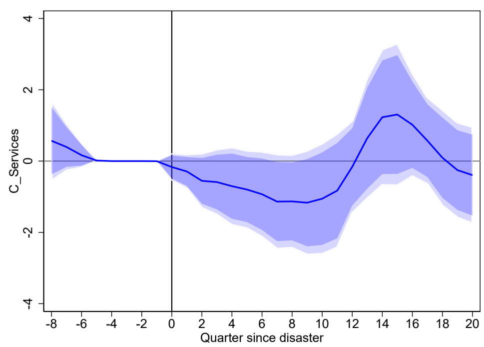
Figure 12: CIRF of components of Household Consumption to Extreme Weather Shocks



(a) Non durable goods (43.4%)



(b) Durable goods (7.6%)

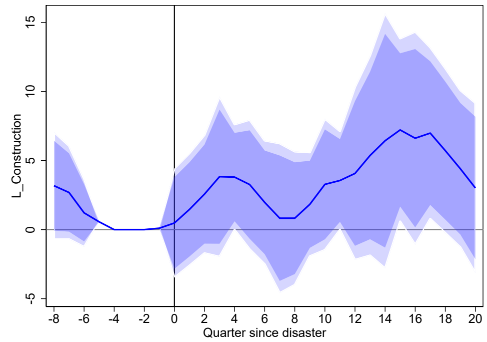


(c) Services (49.1%)

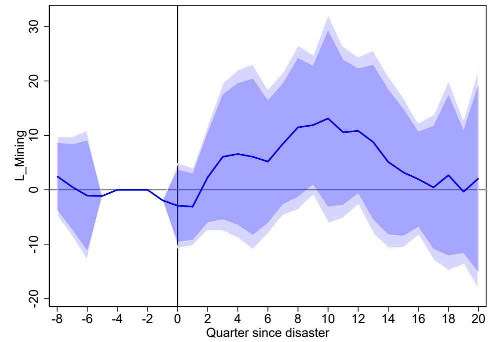
Note: Standard errors are clustered at the regional level. Percentage in parenthesis is participation over total Household Consumption in 2023.

B.4 Employment by sector

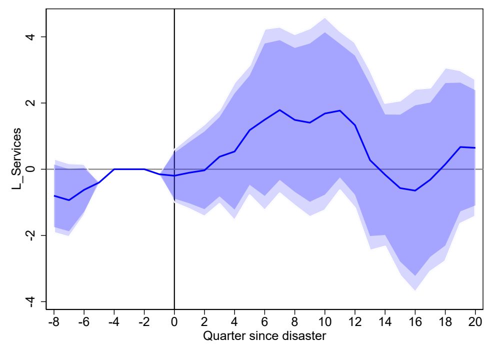
Figure 13: Impulse Response of selected employment sectors to Extreme Weather Shocks



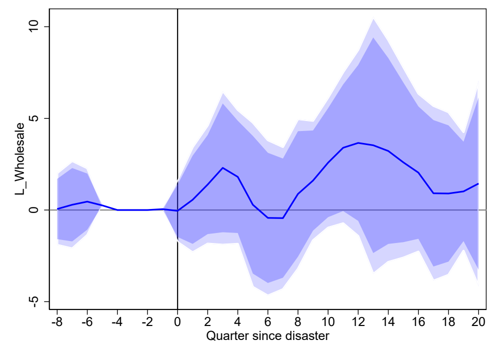
(a) Construction (8.0%)



(b) Mining (3.1%)



(c) Services (52.4%)



(d) Wholesale and retail trade (19.2%)

Note: Standard errors are clustered at the regional level. Participation of 2023 employment is in parentheses.

C Robustness exercises

C.1 GDP: Monthly company invoices

This exercise involves estimating equation 1 , but with monthly data using company billing data. Company billing serves as a monthly proxy for activity since it's a portion of the data that is compiled by National Accounts to calculate GDP.

The benefits of company billing include its availability at a monthly frequency, unlike regional GDP. However, a downside is that it relies on more recent time series spanning from 2018 until 2024, and it does not cover all of the economic sectors. For instance, it's a good proxy for Services and retail trade, but not for the mining sector or construction.

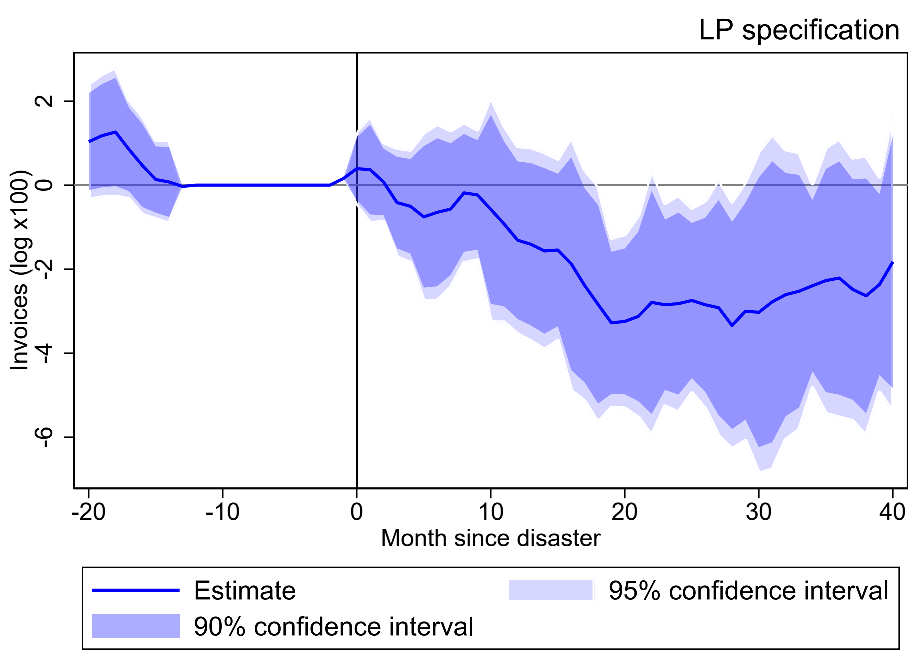
Table 3 shows the correlation between annual growth of regional GDP and the company billing.

The results of the estimation are shown below.

Regions	Name	Corr(X,Y)
1	Región de Tarapacá	0.51
2	Región de Antofagasta	-0.09
3	Región de Atacama	0.71
4	Región de Coquimbo	0.57
5	Región de Valparaíso	0.89
6	Región del Libertador General Bernardo OHiggins	0.58
7	Región del Maule	0.54
8	Región del Biobío	0.48
9	Región de La Araucanía	0.54
10	Región de Los Lagos	0.54
11	Región de Aysén del General Carlos Ibáñez del Campo	0.23
12	Región de Magallanes y de la Antártica Chilena	0.91
13	Región Metropolitana de Santiago	0.96
14	Región de Los Ríos	0.77
15	Región de Arica y Parinacota	0.62
16	Región de Ñuble	0.80

Table 3: Correlation between annual variation (%) regional FE and regional GDP.

Figure 14: Impulse Response of Company Invoices to Extreme Weather Shocks

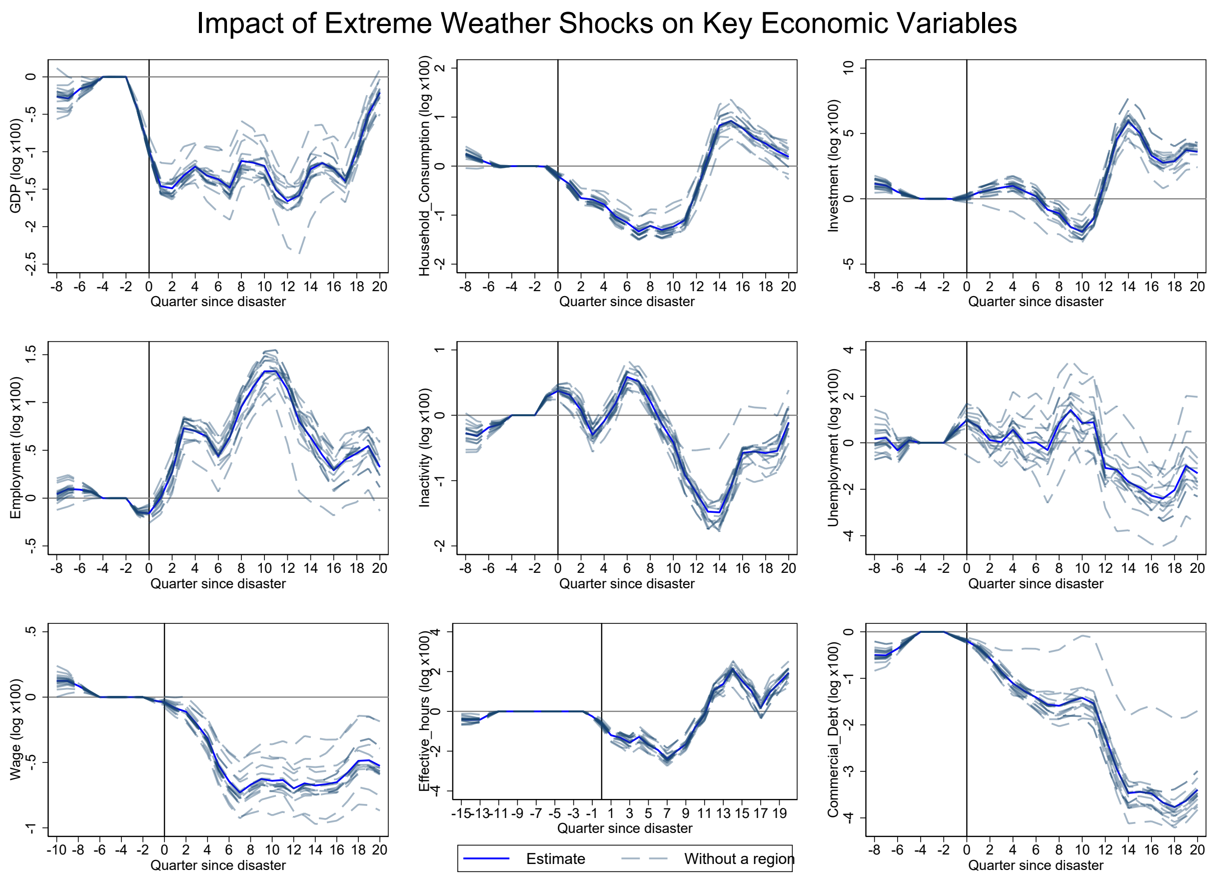


Note: Standard errors are clustered at the regional level.

We note that overall, the directions and orders of magnitude are similar to those of the regional data, although, due to the volatility of the series, the estimation is less smooth.

C.2 Removing regions of the sample:

Figure 15: Big picture: Robustness



Note: CIRF of Regional data to Extreme Weather Shocks (logx100).

D Economic Shocks in an RBC Model

Figure 16: IRF to a Capital Destruction Shock

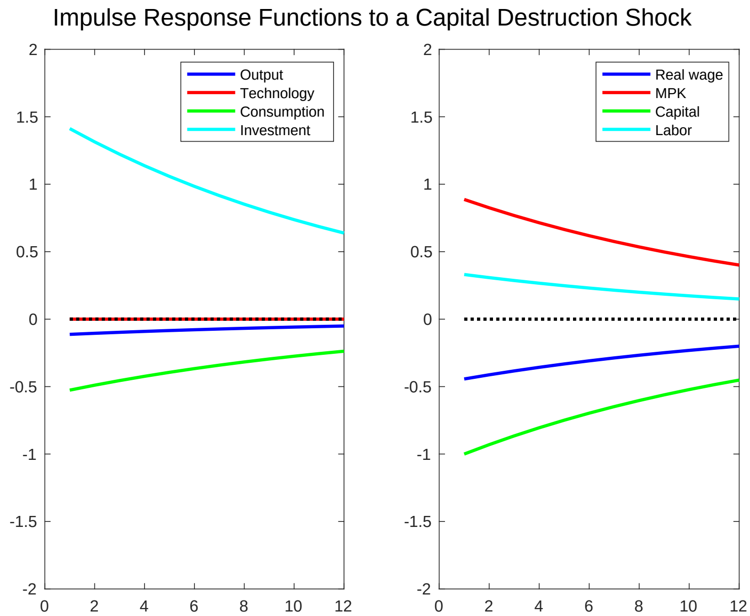
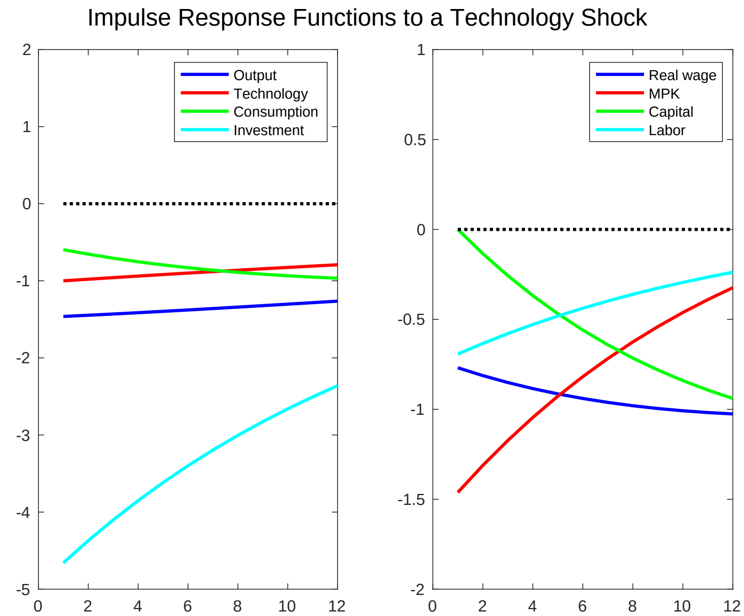


Figure 17: IRF to a Negative TFP Shock



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