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Climate Change and Monetary Policy: Navigating Physical Risks

Tatjana Dahlhaus
Canadian Economic Analysis Department
Bank of Canada
tdahlhaus@bank-banque-canada.ca

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Introduction

Climate change has become an increasingly important consideration for central banks due to its wide-ranging economic implications. While monetary policy cannot prevent climate-related events, they pose direct threats to economic stability. In Canada, the most common hazards—wildfires, floods, and storms—can destroy crops, production facilities, housing, and critical infrastructure, while also disrupting domestic and global supply chains. In 2024, for the first time in Canadian history, insured losses alone caused by severe weather events surpassed $8 billion.[1]

Beyond their immediate humanitarian and fiscal costs, many of these events can reduce output while simultaneously exerting upward pressure on prices. This creates the potential for an inflation-output trade-off as monetary policy faces a difficult balancing act: stabilizing inflation may require tighter policy in the face of elevated inflation, but doing so risks deepening output losses. Conversely, supporting growth through accommodative policy could exacerbate inflationary pressures, especially in the face of supply constraints.

These trade-offs are potentially more acute for small open economies that are deeply integrated into global trade networks, where disaster shocks can also transmit through external demand and terms-of-trade effects. Finally, the monetary policy trade-off could intensify and become more persistent as extreme weather events are expected to become more frequent, severe, and geographically widespread (Bush et al., 2022).

This note examines the implications of physical climate risks for monetary policy along two dimensions. First, we review the literature on how climate-related disasters affect economic activity and inflation, and we assess the historical evidence on the output-inflation trade-off in the Canadian context. Second, to better understand how these trade-offs may evolve in a future marked by more frequent and severe natural disasters, we employ a structural modeling approach to quantify their potential macroeconomic impacts and the associated trade-offs for monetary policy.

Economic Effects of Physical Risks

The macroeconomic impacts of physical climate risks are often short-lived. Natural disasters such as wildfires, floods, and storms can last for weeks, while events like droughts can persist

[1] See Insurance Bureau of Canada (2025). The 2024 total is more than double the total insured losses recorded in 2023 (in 2023 CAD). The second highest recorded loss was $6 billion in 2016, following the Fort McMurray wildfires.

for several quarters. These extreme climate events affect Canada's economy through several key channels, influencing both economic output and inflation.

- A first and direct channel is the **destruction of physical capital**. Natural disasters can severely damage infrastructure, housing, production facilities, and public assets, weighing on output. This loss in capital stock often necessitates substantial reconstruction spending, which may divert resources from other investments and contribute to rising construction and housing costs.
- A second channel relates to the **disruption of production and supply chains**, as disasters damage infrastructure and delay the movement of goods, potentially raising input costs and prices while reducing output. These effects can be especially relevant in sectors like energy, transportation, and agriculture.
- Labour markets are also affected. Disasters may directly displace workers, while extreme temperatures and poor air quality can **reduce labour productivity and lead to lost work hours.**
- In agriculture and natural resource sectors—key pillars of Canada's economy—climate shocks like droughts or fires can **lower yields and export volumes**, contributing to sectoral GDP losses.
- At the same time, **physical climate risks can suppress demand.** Wealth and income losses, as well as heightened uncertainty about future events, may reduce consumer and business spending—dampening both output and inflation.
- Adaption, government relief, and insurance can mitigate these negative effects of physical climate risks.[2]

The overall macroeconomic impact of extreme climate events depends on the interplay between supply- and demand-side effects. For monetary policy, potential trade-offs arise mainly in the short run, when the decision is whether to "look through" the inflationary impact of a temporary disruption. However, if the frequency or persistence of such events is underestimated, monetary policy may be miscalibrated.

Empirical evidence based on historical data from extreme weather events and natural disasters offers little support for a consistent output-inflation trade-off. The strength and direction of the effects depend on the nature and severity of the physical risks, as well as the socioeconomic and environmental characteristics of the affected region.

Empirical studies have identified, in many cases, negative effects of extreme weather events and natural disasters on near-term economic activity (see, e.g., Botzen et al., 2019; NGFS, 2024

[2] Despite the mitigating role of federal aid, as extreme weather events become more frequent and severe, increasing reliance on government aid could lead to significant public debt accumulation, weakening a country's fiscal position.

for reviews). These effects are often driven by the immediate destruction and disruption caused by the disaster. However, both short- and long-term impacts on output can vary significantly—from positive to negative—across countries, regions, disaster types and severities, (socio)economic conditions, and the presence of adaptation and mitigation measures (see Usman et al., 2024; Roth Tran & Wilson, 2024; Bodenstein & Scaramucci, 2025 for recent contributions). For example, countries with stronger institutions, higher literacy and income, greater trade openness, and robust public spending better withstand disaster shocks and limit macroeconomic spillovers by more effectively mobilizing reconstruction resources (Noy, 2009). Moreover, private insurance (von Peter et al., 2024) and government disaster relief programs (Canova & Pappa, 2021; Dahlhaus et al., 2025) can cushion or even offset some of the economic losses.

While output effects have received considerable attention, the inflationary consequences of such events are less studied. As with output, whether climate-related disasters are inflationary or disinflationary depends on the nature of the event and the affected region. Available evidence suggests these effects are context-dependent, varying by country, sector, and disaster type. Food price inflation is the most commonly identified channel. For instance, Parker (2018) finds that storms and floods raise food inflation in the short term, while Faccia et al. (2021) link extreme summer heat to food price spikes.[3]

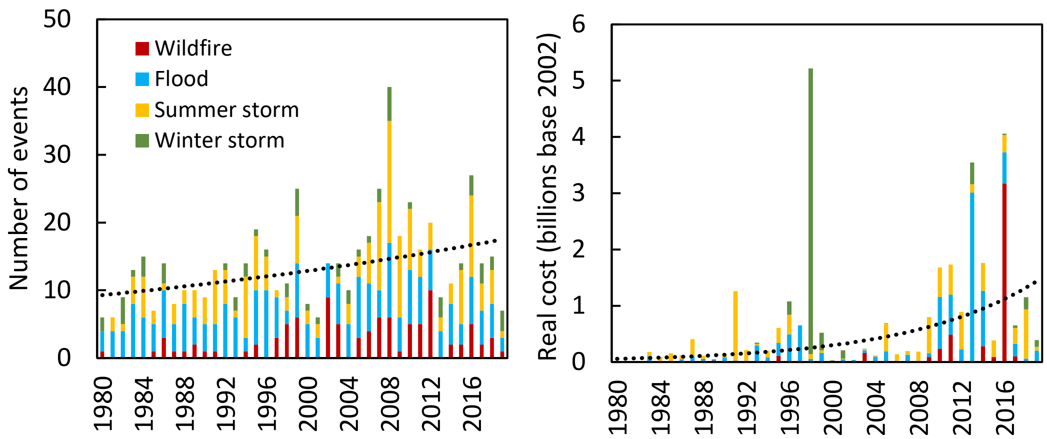
Evidence from the Canadian Economy

To assess the relevance of an output-inflation trade-off in the Canadian context, we examine the historical responses of output and inflation following natural disasters using local projection methods.[4] We use monthly data on provincial economic activity and inflation combined with a dataset of natural disasters compiled by Duprey, Jo, and Vallée (2024), covering the period from 1980 to 2019. This dataset is based on the Canadian Disaster Database maintained by Public Safety Canada (2024) and highlights both the frequent occurrence of natural disasters in Canada and their increasing severity and frequency since 1980 (see Chart 1).

[3] Kotz et al. (2024) show that higher temperatures in already hot months and regions can raise both headline and food inflation. Ciccarelli et al. (2024) further document that hotter summers may also affect services inflation in southern euro area countries, likely driven by higher food costs and the heat sensitivity of tourism-related services. Relatedly, Gagnon and López-Salido (2020) document that following Hurricane Katrina food prices rose a little more in New Orleans than the corresponding national average in the months after the disaster.

[4] In this note, we summarize the key findings from a series of Bank of Canada staff analytical notes examining the macroeconomic effects of natural disasters (Dahlhaus, Duprey, and Johnston, 2025), including their impact on inflation (Duprey and Fernandez, 2025).

Chart 1: Frequency and severity of natural disasters in Canada since 1980



Source: Duprey, Jo and Vallee (2024) leveraging data from the Canadian Disaster Database (Public Safety Canada)

A province's level of fiscal capacity plays an important role in shaping the provincial GDP response to natural disasters (Dahlhaus, Duprey, and Johnston, 2025). When fiscal capacity is high, GDP tends to rise following a disaster, suggesting that sufficient aid is available to support relief and recovery efforts, and that the benefits of these efforts outweigh the costs of the disaster. Conversely, when fiscal capacity is low, GDP declines—indicating that these provinces struggle to mobilize adequate support. These adverse effects are primarily driven by wildfires and floods. However, federal assistance—particularly through the Disaster Financial Assistance Arrangements (DFAA) program—has helped mitigate the negative GDP impacts.

Inflation responses also vary depending on the type of disaster. Duprey & Fernandes (2025) find that floods are inflationary with higher shelter costs being a key transmission channel Similarly, winter storms tend to increase inflation primarily through an increase in energy-related costs.[5]

As in the international literature, Canadian evidence suggests that the presence of an output-inflation trade-off depends on the nature of the disaster, the economic context, and the effectiveness of relief efforts. While monetary policy may not always face a trade-off following disasters, the cumulative impact of frequent and severe events can increase GDP and inflation volatility at the national level (Dahlhaus, Duprey, and Johnston, 2025; Duprey & Fernandes, 2025). This heightened volatility raises uncertainty about the path of key macroeconomic variables, complicating real-time assessments for central banks.

[5] Duprey and Fernandes (2025) further show that during periods of provincial economic contraction, summer storms (and to a lesser extent wildfires) tend to reduce CPI inflation excluding food and energy, largely because shelter costs decline. One possible explanation is out-of-province migration, which could depress housing demand.

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Empirical studies often exploit cross-sectional variation, such as comparing provinces differently affected by a disaster, to improve statistical precision. However, this approach does not capture general equilibrium spillovers, including cross-provincial migration or labor market adjustments, which may be important for aggregate outcomes. Moreover, our Canadian evidence is based on provincial-level aggregates, which can mask individual-level heterogeneity and the localized effects of extreme or tail events. Aggregation may dilute the measured impact of disasters by averaging outcomes across regions and sectors that are affected in very different ways, while also smoothing over short-term disruptions or obscuring localized policy responses. To better assess the monetary policy trade-off, in the next section, we rely on a model-based approach featuring case studies of the costliest historical natural disasters in Canada—events that primarily operate as supply shocks within the model.

At the same time, the model-based approach allows us to explore how the increasing severity and frequency of climate-related disasters may affect the monetary policy trade-off. It provides a framework to address key forward-looking questions: To what extent could future climate shocks make inflation more persistent and volatile? And could the growing frequency of disasters lead to a severe output-inflation trade-off?

Quantifying the Inflation-Output Trade-off

Few works have assessed the macroeconomic effects of natural disasters and extreme weather events and their implications for monetary policy using a model-based approach. Monetary policy (DGSE) models incorporating natural disasters show that inflation targeting remains the welfare optimal regime, see Cantelmo et al. (2024) and Cantelmo (2022).

To quantify the potential monetary policy trade-off arising from extreme climate-related events, we integrate natural disasters into a medium-scale policy analysis model. In particular, we build on the Bank's of Canada's medium scale DSGE model, Baby-ToTEM[6], and include damages from natural disasters. In the model, natural disasters can affect the economy via various channels—capital destruction, decreased aggregate productivity, decreased productivity and price fluctuations in the commodity sector, and government support payments. We design illustrative scenarios motivated by the costliest Canadian disasters and extrapolate trends of increasing severity and frequency of such events to analyze the effects on output and inflation and to quantity the monetary policy trade-off.[7]

Four scenarios are based on domestic disasters which were the costliest climate-related events in Canadian history: the 1998 Ice storm, the 2013 Alberta floods, the 2016 Fort McMurray wildfires and the 2024 Alberta hailstorm. Although relatively short in duration,

[6] See Lepetyuk et al. (2020).

[7] For details of the modelling approach and scenarios as well as the full set of results, see Dahlhaus, Shukayey, and Ueberfeldt (forthcoming).

these events were highly destructive, causing significant physical damage to infrastructure and other assets. However, they differ in terms of their impact on physical capital and the broader economy, the sectors most affected, and the scale and nature of government assistance provided in each case (see Table A1 in the Appendix).[8] For example, in terms of output and capital losses as a percentage of GDP, the 1998 Ice Storm was by far the costliest disaster. It affected a highly populated area, leading not only to direct physical capital destruction but also to losses from electricity outages and unrealized retail trades. The 2016 Fort McMurray wildfire, while somewhat less severe in aggregate terms, was still highly costly as it disrupted the commodity sector by halting oil production in the affected area. **The fifth and sixth scenarios focus on some of the costliest droughts in the Western Canada prairies in 2001-2002 and the 1988 North American drought which affected both Canada and the US.** Droughts tend to last longer, creating extended risks of reduced productivity and disrupted economic activity, often making them more costly than short-duration weather-related disasters. Their primary impact is typically on agricultural output and commodity prices.

Drawing on the available information about the capital and economic impacts of each disaster, the most affected sectors, and the nature of government assistance provided, we calibrate the activation and relative strength of the transmission channels through which these events affect output and inflation in the model (see Table A2). All disasters are modelled as one-period shocks with the exceptions of the 2001-2002 and 1988 droughts which are represented by shocks that last for five and two periods, respectively.

In line with the calibrations, **the model suggests that the ice storm and the longer-lasting droughts yield significant output losses while the other disasters had a relatively smaller impact. In all disaster scenarios inflation rises mildly under the historical monetary policy rule.** This environment presents monetary policymakers with a dilemma between stabilizing inflation and stabilizing the output gap. In other words, excess supply could be eliminated, but only at the cost inflation, so that it will be the monetary policy stance determining the combination of positive inflation and negative output gaps.

We quantify this trade-off by replacing the historical monetary policy rule in the model with a simple rule. The simple rule allows varying the weights on the inflation and output gap in a way that implies the central bank trades off stabilizing inflation or stabilizing the output gap. The trade-off is characterized by a weight of α on inflation, and $1-\alpha$ on the output gap, that is, $\alpha\,(\pi_t-\pi^*)+(1-\alpha\,)(y_t-y^*)\,=0$, where $(\pi_t-\pi^*)$ is the deviation of contemporaneous CPI inflation (q/q) from the 2% target and (y_t-y^*) is the output gap.[9]

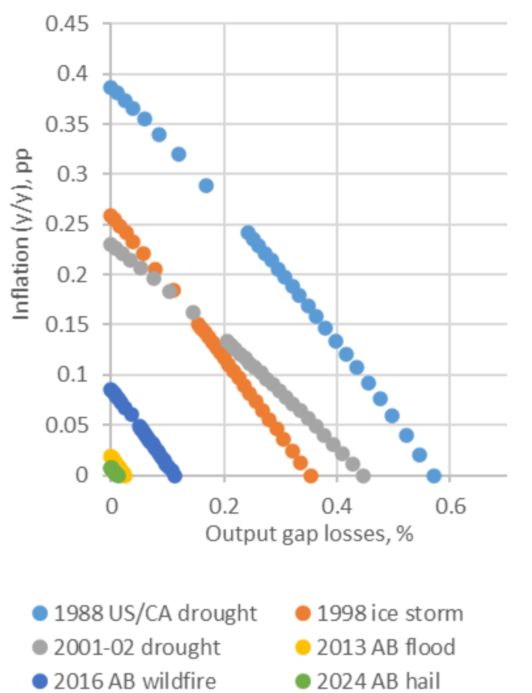
[8] The data sources used to collect the specifics of each disaster include official records, insurance estimates, reports, academic studies, news articles, and Wikipedia pages. Official estimates were preferred, followed by insurance payouts, agency reports, academic studies, and lastly, news articles and Wikipedia pages. However, they do not fully account for all economic costs or social burden.

[9] This simple rule follows Del Negro et al. (2023).

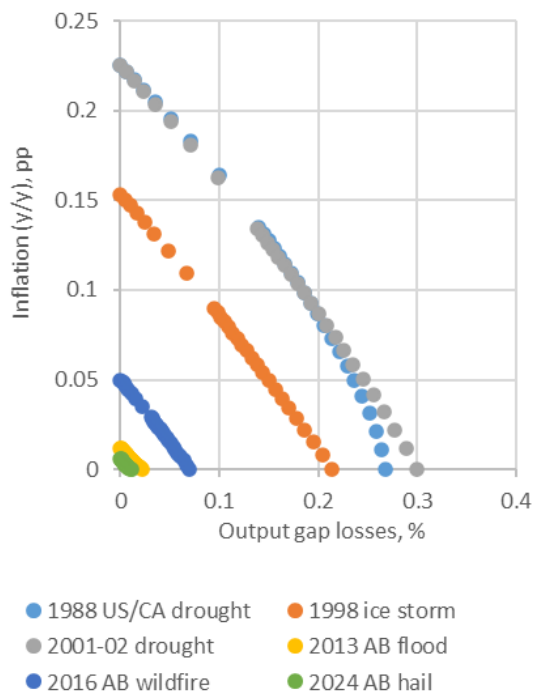
For each alternative monetary policy rule—corresponding to α ∈ [0, 1]—we obtain the associated effects on the output gap and inflation. Chart 2 illustrates the trade-off frontiers, showing the average deviation of CPI inflation (y/y) from target against the output gap for each value ofα, across the various disaster scenarios over one- and two-year periods after the disaster.

Chart 2: CPI inflation-output trade-off across disaster scenarios

a) One-year averages



b) Two-year averages



The largest trade-offs are associated with the costliest disasters—those that damaged infrastructures or significantly disrupted the commodity sector. For instance, in the case of the 1998 ice storm (Chart 2a, orange dots), if the central bank focused on stabilizing output and closing the output gap (α = 0), CPI inflation (y/y) could be about 0.25 pp higher on average over the one-year period following the disaster. Conversely, if the central bank aimed to stabilize inflation (α = 1), this would result in a drag on output, with the output gap averaging about -0.35 percent over the same period. The trade-offs for the longer-lasting droughts are larger. In the case of the 1988 US/CA drought, inflation could average about 0.39 pp above target over a one-year period if the central bank focused on stabilizing output. The trade-offs are generally smaller over the two-year period as the effects on output and inflation generally peak within a few quarters following the disasters (Chart 2b). **The trade-off frontiers demonstrate that the trade-off could be sizable over the monetary policy horizon in response to tail events but well maneuverable in the current flexible-inflation targeting**

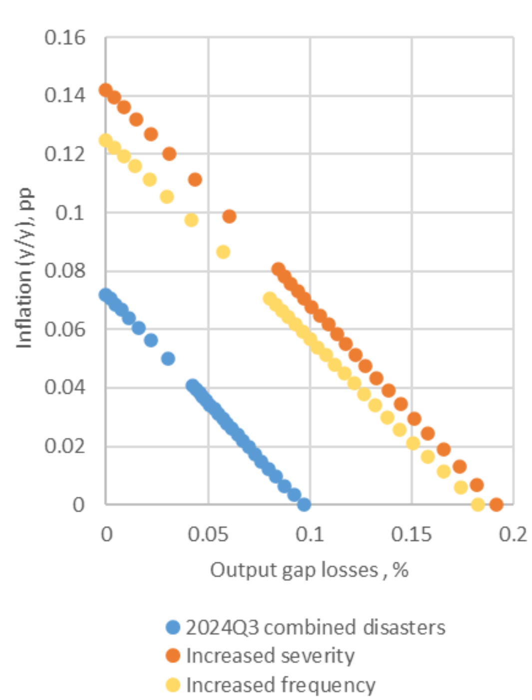
framework. Even if the central bank chose to fully close the output gap, the inflationary impacts would remain within the tolerance range of the current framework.

While our model-based analysis suggests that the trade-off is currently manageable, **this balance may shift as climate-related disasters are expected to increase both in severity and frequency. To illustrate the potential impact on the trade-off, we consider three hypothetical situations:**

- **Combined disasters**: The 2023 Alberta flood, the 2016 Fort McMurray wildfire, and the 2024 Alberta hailstorm all occur in the same quarter, with the strength of the events scaled to match the insurance payouts in 2024Q3, as 2024 was the costliest year in history.
- **Increased severity**: Based on projected trends in insurance losses from climate-related disasters, we double the size of the above combination of disaster shocks.
- **Increased Frequency**: Motivated by projected trends in the frequency of disasters, we assume that the combination of disaster shocks occurs in two consecutive quarters.

Chart 3: CPI inflation-output trade-off across hypothetical disaster situations

a) One-year averages



b) Two-year averages

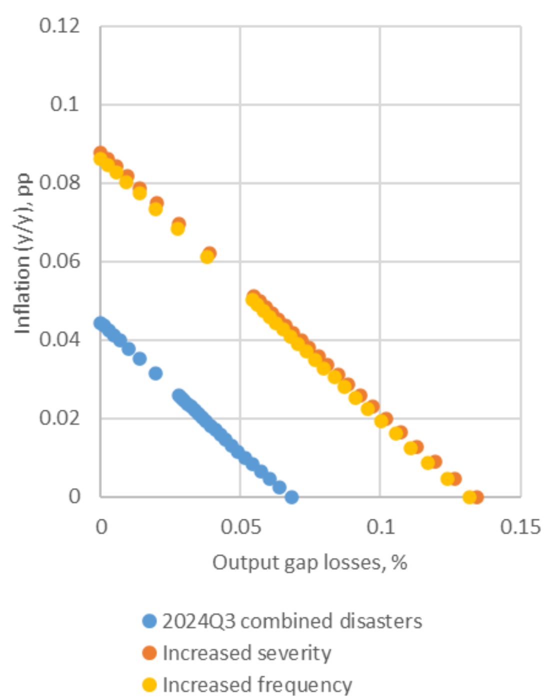


Chart 3 shows the trade-off frontiers for these three hypothetical situations. **While the trade-offs remain manageable, it becomes clear that potential disaster combinations, increased frequency and severity can worsen the trade-off.** For example, having a combination of disasters occurring in two consecutive quarters (increased frequency) could nearly double the average cost on inflation over a one-year period if the central bank fully stabilized output (Chart 3a).

It is important to note that there is a high degree of uncertainty regarding the cost, severity, and frequency of future disasters. This depends on factors such as the location of the disaster; for example, repeated and more frequent ice storms would lead to more severe trade-offs in densely populated areas. Additionally, longer-lasting droughts combined with other disasters could result in more severe trade-offs. However, the current framework should provide enough flexibility to manage these challenges over the medium term.

Conclusion

When navigating physical risks, central banks may be faced with an inflation-output trade-off. So far, empirical evidence based on historical data offers no consistent support for an output-inflation trade-off in response climate-related events.

However, empirical studies all face the same caveat as they are relying on historical data and only allow for an ex-post analysis. The frequency, severity, and scope of natural disasters could increase further. Forward-looking model-based analysis helps central banks to assess the relevance of the output-inflation trade-off under these potential circumstances.

Model-based analysis incorporating climate-related disasters suggest that disasters can result in short-term trade-offs for monetary policy. This balance may shift as the severity and frequency of such disasters increase. Hypothetical disaster scenarios illustrate that combined disasters, increased severity, and increased frequency could worsen the trade-off, but it remains manageable over the medium-term. Even if the central bank chose to fully look through inflationary pressures and to fully stabilize output, the inflationary impacts would likely remain within the tolerance range of the current framework.

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Appendix

Table A1: Economic Impacts of Natural Disasters Scenarios

Impact Channel	QC/ON Ice Storm (1998 Q1)	AB Floods (2013 Q2)	Fort McMurray Wildfire (2016 Q2)	AB Hailstorm (2024 Q3)	AB/SK Drought (2001-02)	Regional (US/CA) Drought (1988)
Physical Capital Impact	$3.7 billion (1.6% of 1997Q4 GDP)	$1.7 billion (0.36% of 2013Q1 GDP)	$3.6 billion (0.72% of 2024Q2 GDP)	$3.25 billion (0.36% of 2024Q2 GDP)	N/A	N/A
GDP Impact	$2.6 billion (1.13% of 1997Q4 GDP	$0.55 billion (0.12% of 2013Q1 GDP), with 60% in energy	$0.4% of 2016Q1 GDP	N/A	$5.8 billion (2.01% of 2001Q2 GDP)	$3.06 billion (2.00% of 1988Q1 GDP)
Government Assistance	$0.9 billion (0.39% of 1997Q4 GDP)	$1.016 billion federal, $0.937 billion provincial (0.42% of 2013Q1 GDP)	$1.484 billion (0.30% of 2016Q1 GDP)	N/A	$3.0 billion (1.04% of 2001Q2 GDP)	$0.75 billion (0.49% of 1988Q1 GDP)
Most Impacted Sectors	Utilities, Agriculture, Retail	Oil and gas services, General services	Oil and gas production, Housing	Structures, Vehicles	Agriculture and related industries	Agricultural prices and output

Table A2: Active Impact Channels Across Disaster Scenarios

Impact Channel	QC/ON Ice Storm (1998 Q1)	AB Floods (2013 Q2)	Fort McMurray Wildfire (2016 Q2)	AB Hailstorm (2024 Q3)	AB/SK Drought (2001-02)	Regional (US/CA) Drought (1988)
Capital Destruction	✓	✓	✓	✓		
General Labour Productivity	✓	✓			✓	
Commodity-Sector Productivity		✓	✓		✓	✓ (coupled with external price increase)
Government Spending	✓ (100% in Q1)	✓ (50% in Q2, 50% in Q3)	✓ (50% in Q2, 40% in Q3, 10% in Q4)		✓ (20% in each quarter, 2001Q3-2002Q3)	✓ (50% in Q2, 50% in Q3)