

Written Testimony
US Senate Budget Committee

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Good morning Senator Whitehouse – Ranking member Grassley and other Senators with us today.

It is an honour to be here today on behalf of Resilience, a company using sustainability intelligence to help business quantify nature and climate-related risks and opportunities for strategic advantage.

The US derives substantial economic value from global trade. In 2022, the US bureau of economic analysis estimated that exports contributed \$3 trillion to US GDP, while imports on the other hand provide many of the raw materials, commodities and products that are required for economic production and a healthy and robust economy. The US economy is dependent on a complex global web of interconnected supply chains. While the network of global trade routes may appear robust from the outside, supply chains are vulnerable to the physical effects of climate change.

A meta-analysis of peer reviewed research found that supply chains relying on specialised products and key infrastructure are at acute risk of serious disruption from climate-related weather events. The direct impact of extreme weather events can cascade through supply chains affecting the flow of commodities and goods to regions and sectors, leading to increased costs to business and to the broader economy¹. And as we saw during the COVID-19 pandemic, when supply chains are disrupted, there is a sharp increase in global commodity prices². Research completed by the Federal Reserve Bank of St Louis concluded that the disruption to the supply of semi-conductors during this period, directly led to an increase in prices with significant macroeconomic implications³.

¹ Ghadge, Abhijeet, Hendrik Wurtmann, and Stefan Seuring. 'Managing Climate Change Risks in Global Supply Chains: A Review and Research Agenda'. *International Journal of Production Research* 58, no. 1 (2 January 2020): 44–64. <https://doi.org/10.1080/00207543.2019.1629670>.

² Bernanke, Ben, and Olivier Blanchard. 'What Caused the U.S. Pandemic-Era Inflation?' *Monetary Policy*, 2023.

³ Leibovici, Fernando, and Jason Dunn. 'Supply Chain Bottlenecks and Inflation: The Role of Semiconductors'. *Economic Synopses* 2021, no. 28 (2021). <https://doi.org/10.20955/es.2021.28>.

Evidence from past events shows that major damage to ports across the world from climate-related hazards is already occurring and such impacts are projected to increase in the future due to cascading climate risks⁴. Planning for such hazards is not systematically incorporated into adaptation planning, which leaves supply chains exposed and vulnerable to climate risks.

One example of a specialised product supply chain is that of the microchip industry. Taiwan is the world's largest producer of microchips, accounting for over 60% of the global supply of semi-conductors and about 90% of the world's most advanced microchips. As a small island nation in the middle of the South China sea, Taiwan is highly vulnerable to the impacts of climate change. The Island is located on the typhoon belt and is frequently hit by storms which cause widespread flooding and damage to factories. Research shows that the strength of typhoons has considerably increased over the last four decades, caused by an average increase of 0.55°C in Sea Surface Temperature⁵. There is a growing consensus among climate scientists that global warming may prime the atmosphere to produce fewer but stronger storms⁶. While fewer typhoons would be a welcome relief, stronger storms cause more damage⁷. Fewer storms also give rise to water scarcity due to more severe droughts which also has an impact on the fabrication of microchips.

The fabrication of microchips is an energy-intensive process. It is also highly water-dependent and requires large quantities of water for cleaning and etching silicon wafers. Both of these critical inputs are vulnerable to the effects of climate change. One manufacturing plant located in the Southern Taiwan Science Park, alone, consumes 138,000 m³ of water per day⁸. This is equivalent to the daily usage of a city of nearly half a million people⁹.

Microchips are a vital component in many durable goods, such as iPhones, vehicles and military hardware. According to the St Louis Fed's estimate,

⁴ Er Kara, Merve, Abhijeet Ghadge, and Umit Sezer Bititci. 'Modelling the Impact of Climate Change Risk on Supply Chain Performance'. *International Journal of Production Research* 59, no. 24 (17 December 2021): 7317–35. <https://doi.org/10.1080/00207543.2020.1849844>.

⁵ Pandey, Ravi & Liou, Yuei-An. (2022). Typhoon strength rising in the past four decades. *Weather and Climate Extremes*. 36. 100446. 10.1016/j.wace.2022.100446.

⁶ Voiland, Adam, "In a Warming World, Storms May Be Fewer but Stronger", <https://earthobservatory.nasa.gov/features/ClimateStorms> (accessed 27 Sep 2023);

⁷ Miller, Brandon, Kann et al. "Hurricanes are becoming more dangerous. Here's why", <https://edition.cnn.com/interactive/2020/12/us/hurricanes-climate-change/> (accessed 27 Sep 2023)

⁸ TSMC 2022 Sustainability Report p. 109. https://esg.tsmc.com/download/file/2022_sustainabilityReport/english/e-all.pdf

⁹ Assuming average individual consumption of 282 litres per day based on 2021 estimates (Water Resources Agency)

microchips are used as an input into one-quarter of all manufacturing sectors, which in turn account for 39% of all US manufacturing output¹⁰. Even though microchips typically account for only a small fraction of total input costs, scarcity of microchips can halt production. The long lead time and high investment costs required to develop new chip fabrication centres therefore raises concerns about vulnerabilities to the economy and to national security.

In a 2022 survey by the Commerce Department, it was found that the inventory of semiconductors in the US had fallen from 40 days in 2019 to less than 5 days in 2021¹¹. This means that disruptions caused by climate impacts in Taiwan could have substantial knock-on effects in the US.

It's not just the lost productivity of US firms and the furlough of US workers, it's also the cascading impacts on US exports that depend on microchips within production processes. In sum, multiple sectors across the US economy could be severely disrupted with consequential economic impacts.

The manufacture and supply of microchips is just one example for how the growing physical risks from climate change will impact the trade of critical goods across and within US borders. US corporations are starting to realise the business imperative of mitigating and adapting to climate risks and accelerating their progress towards net-zero. The US Government can help support this process by incentivizing companies to build resilient supply-chains and promoting the disclosure of these material financial risks, as these can have wide-ranging impacts across the US and the global economy.

¹⁰ Leibovici, Fernando & Dunn Jason, "Supply Chain Bottlenecks and inflation: the role of semiconductors" St Louis Fed Economic Synopses No 28, 2021, <https://research.stlouisfed.org/publications/economic-synopses/2021/12/16/supply-chain-bottlenecks-and-inflation-the-role-of-semiconductors> (accessed 10 Oct 2023)

¹¹ U.S. Department of Commerce. 'Results from Semiconductor Supply Chain Request for Information', 25 January 2022. <https://www.commerce.gov/news/blog/2022/01/results-semiconductor-supply-chain-request-information>.