Internet Society Pulse

Internet Society Pulse NetLoss Calculator:

Methodology for Measuring the Economic Impact of Internet Shutdowns

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This document contains a detailed description of the methodology used in estimating the economic impacts of Internet shutdowns for the Internet Society Pulse NetLoss Calculator.

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Introduction

Increasingly, governments around the world disrupt Internet access during civil unrest and violent protests, to stop the spread of misinformation, and to minimize the harm from cybersecurity threats, among other reasons. Such actions cause interruptions to daily life as well having significant implications for economic productivity. Deliberate Internet shutdowns can last only a few hours, while others continue for months. Some shutdowns may involve blocking access to specific services such as social media, while others may block all access to the Internet in a specific geographical area. No matter the length or severity of a shutdown, removing Internet access has disasterous consequences for a country's economy.

Quantifying the Cost of a Shutdown

There are different methods such as the Brookings methodology (West, 2016), The Collaboration on International ICT Policy for East and Southern Africa (CIPESA) framework, both of which are used in the Cost of Shutdown Tool (COST) by Netblocks. that can be used to measure and quantify the economic loss as a result of an Internet shutdown. Each technique has its own merits as well as disadvantages.

The NetLoss Calculator uses an economic framework to understand the impacts, and uses econometric tools to provide a rigorous and precise estimate of the economic impact of Internet shutdowns.

This document outlines the methodology used to estimate the economic loss that can be attributed to an Internet shutdown.

Estimation Framework

In an ideal world, the causal impact of Internet shutdowns could be studied on various outcomes if shutdowns occurred randomly and did not have any antecedents. However, in practice, shutdowns are often planned and announced by governments beforehand to meet specific objectives (e.g. maintaining law and order). Since shutdownsdo not occur randomly, estimating their impacts on an economy-wide level requires a careful understanding of the context in which shutdowns take place.

The NetLoss calculator's methodologyovercomes these limitations by using an econometric framework to estimate the implications of Internet shutdowns on a range of economic, social, and other outcomes of interest. There are two main motivations for adopting this type of framework:

(a) it allows us to explore with clarity the means through which Internet shutdowns might affect economic outcomes

(b) it allows us to explore a wider range of economic impact beyond traditional measures of economic output (e.g., GDP).

Data Sources

The methodology relies on *publicly available* datasets to calculate the economic impact of an Internet shutdown. Using open datasets makes our methodology reproducible as well as transparent The datasets are detailed below:

- **Shutdowns data**: Detailed event-level data is available from Internet Society Pulse starting in 2019. The data only contains information on government-mandated shutdown events s and classifies shutdowns as either national or regional shutdowns or service blocking.
- **Protests and civil unrest**: The Armed Conflict Location & Event Data Project (ACLED, Raleigh et al., 2010) provides detailed event-level data on various events since 2016. Each event is classified as belonging to one of five types: (a) battles; (b) protests; (c) riots; (d) strategic developments; or (e) violence against civilians. It also logs the start and end dates for these events, and provides details of who the involved parties were, and if there were any fatalities associated with the event.
- **Elections**: This data comes from the Constituency-Level Elections Archive (CLEA, Kollman et al., 2019) maintained by Yale University. We use data from elections to the lower chambers, that is available for more than 150 countries at the month-year level since 1960.
- **Socioeconomic indicators**: Data on economic indicators (GDP per capita in USD purchasing-power-parity terms, constant prices of 2011), employment (International Labor Organization or ILO estimates, separately for male and female), Inflation (percentage), Foreign Direct Investment (FDI, as a percentage of GDP as well as net inflows) from the World Bank. In addition to these economic indicators, there are other factors that could explain country-specific economic outcomes, such as age dependency ratio (percentage of working 18-65 years old to total population), fraction of population residing in urban areas, and percentage of the labor force with basic education.

A detailed list of variables and their definitions as well as the data treatment is available in Appendix A.

Model and Estimation

The NetLoss calculator makes use of "unique identifiers," which are factors that can explain Internet shutdowns but are not directly linked to economic outcomes. We use two unique identifiers: (a) elections, because political uncertainty during election times could lead to Internet shutdowns but may not directly affect the economy, and (b) previous shutdowns, because past government policies around Internet censorship and control could explain future shutdowns. By using these unique

identifiers, we created a two-stage model to estimate the likelihood of an Internet shutdown, and then test the validity of their approach using different diagnostic tests.

$$Y_{it} = \gamma + \delta_1 \widehat{Shutdown}_{it} + \delta_2 Country_{it} + \eta_{it} \quad (1)$$

Where, Y_{it} is the outcome variable of interest (GDP PPP at current prices, unemployment rate, and share of FDI in GDP) for the i[th] country at year t. $\widehat{Shutdown}_{it}$ is the predicted duration of the Internet shutdown (predicted by factors outlined previously), and $Country_{it}$ is a set of variables that could explain economic outcomes – these include the level of inflation, age dependency ratio, labor force with basic education, and urbanization. Each of these variables were selected on the basis of past literature that suggests their links with economic growth and development. The second stage equation is estimated as a Panel OLS with country fixed effects, including the above predicted values, and is run on the entire sample of countries for which data on all variables are available consistently.

Equation (1) specified above relies on a two-stage estimation framework. In the first stage, Internet shutdowns (defined as duration or as incidence) are regressed on a range of explanatory factors as below:

$$Shutdown_{it} = \alpha + \beta_1 Conflicts_{it} + \beta_2 Election_{it} + \beta_3 Shutdown_{it-1} + \eta_{it} \quad (2)$$

Where, $Conflicts_{it}$ is a categorical variable from ACLED that uses "Battles" as a base outcome to capture if a civil conflict of a particular type occurred in that country-year-month; $Shutdown_{it-1}$ is a dummy variable that takes a value of 1 if there was an election in that country-year-month, and zero otherwise; is an indicator variable that indicates if there was a previous shutdown in that same country-year. This is estimated using Ordinary Least Squares (OLS) methods with year and month fixed effects.

The model for shutdown duration uses a count variable (duration of shutdown in days), which is conditioned on observing a shutdown. Since duration is counted only for those country-months where a shutdown was observed, estimation by ordinary least squares or other linear methods will be biased. We, therefore, use a censored regression approach (where the dependent variable of duration is censored at zero). The predicted values are used in the second stage (equation 1).

Shutdown Risk

We estimate the shutdown risk using a dummy variable that takes a value of 1 if there was an Internet shutdown in that period and zero otherwise. Equation (2) is then estimated using a linear probability model (LPM) and its predicted values are interpreted as the shutdown risk when expressed in

percentage terms. The shutdown risk is the likelihood of a country facing an Internet shutdown in a particular year, and ranges between 0 to 100. Values <0 or >100 are changed to 0 and 100, respectively.

Data Availability

The data used in the NetLoss calculator is complete across all indicators for 2019-2021, and are used as the basis for the estimations described below. For more recent years (2022 onward), the estimation is based off the most recently available data. For example, elections and conflict data is only available until 2021, therefore the Shutdown risk estimation will reflect the most recently available data (2021). Similarly, for any other indicator (GDP, Unemployment, or FDI), if the most recently available data is 2021, then the calculator will return these values.

Formula for Economic Impacts

Once the two-step estimation procedure is implemented, it generates a coefficient (δ_1) of predicted duration of Internet shutdowns on the chosen economic indicator. The coefficient is then used to generate the output of economic impact using the below formula:

$$\text{Impact} = \delta_1 \times 100 \times Y_{it} \times Duration_{it} \times TypeShare_t$$

Where, $Duration_{it}$ is the actual (or anticipated) duration of the Internet shutdown, and $TypeShare_t$ is the (annualized) ratio of a particular type of shutdown to all shutdown events in that year. Here is a brief illustration of how the formula is implemented for estimating the impact of a 10-day total Internet shutdown on the GDP PPP in current prices in India in 2021, assuming that the coefficient estimated is -0.0000085 and that 35% of all Internet shutdowns in that year were national or regional shutdowns:

-0.0000085 x 100 x $ 10193555145927.3/365 days x 10 days x 0.35 =

$ 83,084,456 loss

Similarly, for estimating the impact on FDI or Unemployment, Y_{it} is defined as the dollar value foregone in FDI (or FDI Loss) and Unemployment rate multiplied by the total labor force (data from the World Development Indicators), respectively. These are **annualized impacts**, and not daily losses.

Feedback

For any questions, comments, and concerns about the NetLoss Calculator, please contact the Internet Society Pulse team (pulse@isoc.org)

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Appendix A: Data Treatment

Dataset	Variable	Definition	Transformation
ISOC Pulse	Shutdown	A dummy variable that takes the value of 1 if there was a shutdown in that month-year in the country, and zero otherwise.	None
	Duration	A continuous variable that counts the number of days from the start of the shutdown to the end date for each country	None
	Shutdown type	A categorical variable was recorded from the original dataset to have only two categories. Takes a value of 1 if there was a shutdown that involved only service blocking, and 2 if it was a national/regional shutdown	None
ACLED	Conflict type	A categorical variable that takes a value of 1 for Battles; 2 for Protests; 3 for Riots; 4 for Strategic developments; and 5 for Violence against civilians. 1 is taken as the base category for each event.	None

	Fatalities	Number of fatalities (if any) associated with the event.	None
CLEA	Election	A dummy variable that takes the value of 1 if there was an election in the lower chamber for that country in that month-year.	None
World Bank World Development Indicators	GDP per capita	Measured using the GDP per capita at current prices in purchasing power parity (PPP) terms;	Natural logarithm
	GDP	Measured using the GDP at current prices in purchasing power parity (PPP) terms;	Natural logarithm
	Total unemployment	Unemployment, total (% of total labor force) (modeled ILO estimate)	None
	Labor force education	Labor force with basic education (% of total working-age population with basic education);	Natural logarithm
	Dependency ratio	Age dependency ratio (% of working-age population);	Natural logarithm
	Urbanization	Urban population (% of total population);	Natural logarithm
	FDI (% of GDP)	Measured using net inflows of Foreign Direct Investment (as a % of GDP);	Natural logarithm

	Inflation GDP-linked	Measured using Inflation: GDP-linked deflator (annual %)	Natural logarithm