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Integrating Out Natural Disaster Shocks*

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Abstract

We study the role of international financial integration in buffering natural disaster shocks, using a large sample of advanced and emerging economies. Conditioning on such exogenous events addresses the endogeneity between financial structures and economic conditions. We document that integration improves shock absorption: output, consumption, and investment are significantly higher after a shock in states of high integration than in states of low integration. However, the benefits of international risk sharing mostly come to advanced economies. Emerging markets only profit from more integration if they have good institutions or high debt assets, whereas higher debt liabilities weaken the recovery.

Keywords: Financial integration, natural disasters, international risk sharing, dynamic panel model, emerging markets.

JEL Classifications: Q54, E44, F36, F62, G11, G15.

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1 Introduction

Since the global financial crisis, globalization has come to a halt and financial integration has stalled. In 2023, the world economy is on the brink of disintegrating into multiple blocks. At the same time, climate change is global and does not stop at borders. The repercussions of increasing temperature are felt worldwide, for long in developing countries and by now also in advanced economies. North America has experienced extreme heat waves. Europe is plagued by historic drought, wildfires, and water shortages. In this paper, we ask whether global financial integration helps countries buffer large natural disasters by improving international risk sharing of these domestic shocks.

The literature on international risk sharing does not consider natural disasters and is largely descriptive (Kose et al., 2009; Rangvid et al., 2016; Hoffmann et al., 2019). Some studies of domestic risk sharing identify the financial effects of natural disasters but they typically use a difference-in-difference approach (Cortés and Strahan, 2017; Schuewer et al., 2019; Koetter et al., 2020). While this strategy provides a sharp picture of the regional mechanisms it does not deliver aggregate country effects or insights into international risk sharing.

We bring these two approaches together. We use natural disasters as exogenous shocks, as in the literature on domestic risk sharing, but assess whether international financial integration shapes the recovery from these shocks at the aggregate country level, as in the literature on international risk sharing. We measure financial integration as the size of cross-border assets, liabilities, or both. We document that financial integration helps buffer the domestic shocks in advanced countries but not in emerging markets unless they have good institutions or high external debt assets.

We exploit that floods, earthquakes, and storms are unpredictable and unrelated to the state of financial integration and the domestic economy at short horizons. The goal is to investigate whether financial integration changes the response to such adverse shocks and how the responses differ by country group and pattern of integration. The pattern and level of external assets and liabilities can affect a country's response to adverse domestic shocks through

different channels. First, more financial openness typically leads to a lower cost of capital, which fosters investment and output growth as well as recovery growth after adverse shocks. Second, by facilitating international borrowing and lending, the integration of financial markets can reduce the sensitivity of consumption and income to domestic fluctuations. Moreover, the more a country's foreign asset holdings are diversified, the better it should be able to smooth consumption fluctuations that result from domestic shocks. Finally, external liabilities may allow for sharing negative shocks with foreign creditors and owners, but in case of emerging markets can also exacerbate the shocks.

We build a large quarterly dataset, spanning 1970Q1-2018Q4 and including 61 advanced and emerging economies. To measure integration, we use data on external asset and liability positions from the External Wealth of Nations (EWN) database by Lane and Milesi-Ferretti (2018). We consider external assets and liabilities which include portfolio positions (cross-border holdings of stocks, shares, bonds), foreign direct investment (FDI), other investment (cross-border loans, deposits), and foreign reserves. To measure natural disasters, we use the economic damage to property, crops, and livestock reported in the Emergency Events Database (EM-DAT). We estimate dynamic panel models to trace out the economic effects of disaster shocks in states of high compared to low financial integration.

For advanced economies, we document that the recovery from natural disasters is stronger when external financial positions are high. Above-median financial integration—through assets, liabilities, or both—is associated with significantly higher output, consumption, and investment for two years after a shock than below-median positions. The current account is lower in such cases and imports increase more. Together, the estimates suggest that better access to income flows from abroad improves the recovery. The main message from these results is that financial integration helps significantly in buffering natural disaster shocks. In contrast, for emerging market economies, we find no significant effects of total cross-border assets or liabilities on shock absorption. Either their integration into global financial markets is too low or domestic frictions thwart international risk sharing. Indeed, we find that only emerging

markets with good institutions can profit from international integration.

Then, we conduct a more detailed analysis to see whether some types of assets and liabilities are more beneficial than others and to guide policy decisions. For advanced economies, we find that both more international equity and debt stocks help the recovery. High debt assets have the strongest stabilizing effect, consistent with fixed income assets generating constant revenue streams. For emerging economies, we find no supporting effect of equity integration, neither on the asset nor on the liability side. For debt, we obtain a sharp divide. While more debt assets, including foreign reserves, imply higher consumption after a shock, higher debt liabilities are associated with lower consumption. Overall, regulators and policy makers might want to take these differences into account when designing policies.

Our study relates to several strands of the literature. A first set of papers investigates the relation between financial integration and international risk sharing (Soerensen et al., 2007; Hoffmann et al., 2019; Cimadomo et al., 2020; Rangvid et al., 2016; Bremus and Buch, 2018). These link integration measures to cross-country risk sharing using a single-equation estimation approach with the risk-sharing parameter allowed to vary with the degree and type of integration. They find that the benefits of integration depend upon the financial instruments and the country sample. While risk sharing increases in external financial positions in advanced economies, it does not in emerging and developing countries (Kose et al., 2009; Islamaj and Kose, 2022, 2016; Wei, 2018).[1] Hevia and Serven (2018) show that financial integration and exchange rate flexibility correlate with better risk sharing but that the gap between consumption smoothing in advanced and emerging economies has widened. Levy-Yeyati and Williams (2014) argue that emerging economies benefit less from financial openness than advanced economies because the portfolio diversification in

[1]Regarding the effects of the composition of external financial positions, a mixed picture emerges. Some studies present evidence that portfolio debt assets and liabilities (Kose et al., 2009; Bremus and Buch, 2018) as well as cross-border interbank lending (Hoffmann et al., 2019) do not improve or even harm risk sharing, whereas portfolio (long term) debt improves it (Cimadomo et al., 2020; Fratzscher and Imbs, 2009; Martin Fuentes et al., 2022). According to Hoffmann et al. (2019), portfolio equity positions have particularly favorable characteristics for shock absorption.

the former is overestimated. Bai and Zhang (2012) demonstrate theoretically that risk sharing does not necessarily increase with financial liberalization if capital flows are restricted by default risk. Focusing on consumption growth volatility, Bekaert et al. (2006) find that equity market liberalization does not significantly affect volatility in emerging economies. In contrast, for a sample of G20 and EU economies, Donadelli and Gufler (2021) show that price-based financial integration indicators are related to higher consumption volatility.

Overall, the risk-sharing literature looks at all fluctuations of GDP (not just those due to disasters) that cannot be shared internationally and, therefore, affect consumption. This approach is general but only descriptive. Instead, our approach addresses the endogeneity of domestic fluctuations by considering exogenous shocks and thereby allows drawing policy conclusions. The drawback is less generality as we consider a specific type of shock. It is likely (and unfortunate) that these shocks will become more important.

Our identification strategy is inspired by Ramcharan (2007) who uses natural disasters to study whether the exchange rate regime affects the absorption of real shocks. He uses annual data from a sample of 67 developing countries and estimates random effects models. Instead, we use quarterly data in fixed effects models and our sample contains advanced and emerging countries. Quarterly data are needed because natural disasters often wash out in the yearly data of advanced economies and fixed effects are important to control for countries' susceptibility to disasters. Moreover, our focus is on international financial integration, whereas he studies exchange rate regimes. He finds that the recovery is quicker under flexible exchange rates but not stronger. We complement the evidence on the international sharing of domestic shocks by documenting that the recovery is economically and statistically significantly stronger in financially better integrated countries.

A small number of papers analyzes the implications of disasters for financial stability based on country-level data. For advanced and developing countries, Klomp (2014) shows that bank stability decreases in response to a natural disaster, especially in emerging and financially less developed economies. Yang (2008) and David (2011) present empirical evidence that private capital flows

out of developing economies after a natural disaster due to increased repayment uncertainty, while foreign aid and remittances attenuate part of the shock.

Another strand of the literature focuses on lending after natural disasters using micro-level data on bank credit and bank-firm relations. Cortés and Strahan (2017) exploit natural disasters in the US as a source of exogenous variation in local credit demand. They document that financially integrated banks reallocate credit to affected markets, such that bank lending significantly increases in the months following a disaster shock. Focusing on bank market structure for the recovery from disasters, Duqi et al. (2021) use US mortgage data to show that counties with less competitive banking sectors recover faster. Schuewer et al. (2019) document that local banks supported a faster recovery after Hurricane Katrina in US regions. Studying the response of bank lending to a flood, Koetter et al. (2020) present evidence that relationship lending helps overcome the increased information asymmetries between borrowers and lenders due to destroyed capital. We complement this literature in that we provide cross-country evidence on the country-wide effects of foreign finance on the recovery from natural disasters in advanced and emerging economies.

2 Data and empirical strategy

2.1 Data

We assemble an extensive dataset from various sources to analyze the role of financial integration in the absorption of natural disasters in both advanced and emerging economies. Tab. A.1 lists the countries and groupings. Tab. A.2 contains detailed information on the variables and sources.

2.1.1 Financial integration

To capture financial integration on both the asset and funding side, we focus on the following three main measures. First, taking a broad measure frequently used in the literature, we consider total external positions, both assets and liabilities. We use harmonized annual data from the External Wealth of Na-

tions (EWN) database that covers stocks of cross-border assets and liabilities for a large sample of countries as of 1970 (Lane and Milesi-Ferretti, 2018).[2] We sum external assets and liabilities and divide them by GDP, interpolating the annual data to obtain a quarterly dataset.

Second, we differentiate between financial integration via the asset versus the funding (or liability) side of the external balance sheet. If a country is hit by a natural disaster that destroys part of its capital stock, the resulting downturn could be stabilized by factor income from abroad, for example, by dividend or interest payments on external assets. Thus, an economy in a state of high foreign assets is expected to be less affected in terms of income and consumption declines after a large adverse shock that an economy in a state of low external asset. In contrast, the impact of external funding on the recovery can be positive or negative. On the one hand, a country in a state of close linkages to foreign investors may be better able to buffer the shocks as domestic funding sources can be substituted, for example, by foreign banks that are not directly affected by the shock. Thereby, private investment to re-build the capital stock can be financed more easily and at lower cost.[3] On the other hand, catastrophes increase repayment uncertainty and uninsured damaged or destroyed collateral increases the information asymmetry between borrowers and lenders. As shown by Yang (2008) and David (2011) for developing economies, private capital, especially foreign bank loans, are retrieved. Thus, if foreign investors withdraw from an affected economy, capital outflows may reinforce the downturn and external liabilities amplify the shock.

Third, we disaggregate both external assets and liabilities into equity and debt positions. While equity includes data on portfolio equity and FDI positions from the EWN, our measure of external debt comprises portfolio debt holdings, other investment, and foreign reserves. Both are expressed relative to GDP and interpolated to the quarterly frequency. On the asset side both external equity positions and debt should help to buffer part of the domestic

[2] https://www.brookings.edu/articles/the-external-wealth-of-nations-database/

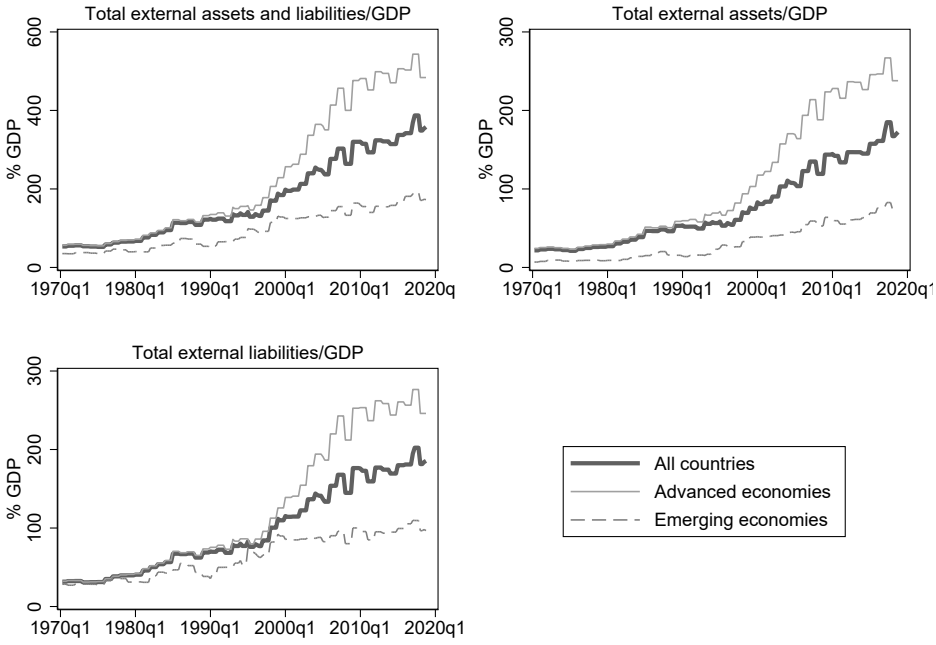
[3] Multinational banks may engage in recovery lending, for example, if the affected markets are core markets with local branches that allow for closer monitoring and screening (Koetter et al., 2020; Cortés and Strahan, 2017; Schuewer et al., 2019).

income losses due to a natural disaster shock. Still, the effects of financial integration through equity and debt holdings abroad may differ in size. In contrast, at the liability side, external equity and debt positions have, according to theory, opposite effects on international risk sharing. While equity liabilities include shares, stocks, and other papers that denote ownership of equity, portfolio debt covers bonds and other fixed income instruments. The *ex ante* nature of equity contracts that leads to automatic sharing of profits as well as losses may be more suited for income and consumption smoothing. With equity liabilities, shocks can be absorbed through varying dividend payments, while in the case of debt contracts, interest payments are fixed and independent of the situation of the debtor. Moreover, debt funding, especially short-term debt, can be unfavorable in times of economic stress as investors may withdraw when funding is most needed. This pro-cyclical behavior then impedes the recovery instead of mitigating the shock. Moreover, in case of weak economic performance, losses are only shared with creditors in case of insolvency. According to the literature, equity funding tends to be more favorable than debt for international risk sharing (Hoffmann et al., 2019; Kose et al., 2009). Overall, we expect a high share of external equity liabilities to provide better shock absorption than a low share.

Fig. 1 shows the evolution of the three measures of financial integration, separately for advanced and emerging economies. Tab. A.3 in the Online Appendix contains summary statistics for all variables in the analysis. On average, advanced economies are more financially integrated than emerging economies. External assets significantly increased since the mid-1990s, both in the emerging and in the advanced economies, with the latter showing a steeper upward trend though, especially during the runup to the global financial crisis. In contrast, foreign liabilities increased in the advanced economies, while external funding stagnated in the emerging marktes during the last decades.

For each of the three variables of financial integration, we generate a binary indicator that equals 1 whenever a one-quarter trailing four-quarter moving average of the variable is above the sample median; and 0 otherwise. Thereby, we aim to investigate whether a state of high financial integration makes a

Figure 1: Evolution of financial integration by country group



Notes: The figure shows the (unweighted) sample means of the main financial integration variables used in the empirical analysis for 25 advanced and 27 emerging economies.

country more resilient to shocks. We use a moving average for smoothing and one lag to prevent that the state variable is affected by current economic conditions. Figures A.1-A.6 show that the indicators vary over time for the majority of the countries, switching between states.

To analyze the mechanisms in more detail, we also decompose both assets and liabilities into two subcomponents, for which we generate indicators as before. Overall, we compute four additional indicators based on the following variables: equity assets, debt assets, equity liabilities, and debt liabilities.

Tab. 1 shows the summary statistics for all variables of financial integration, expressed in percent of GDP, that are used to construct the indicators. We split the sample into three groups: advanced countries, emerging markets, and financial centers. Tab. A.1 lists the countries in each subsample. The number of observations in advanced and emerging countries is high. The external

Table 1: Summary statistics for financial integration

	Obs.	Mean	SD	Min	Max
Advanced economies					
Equity assets	4314	47.0	90.1	0.0	941.2
Debt assets	4326	68.8	71.0	2.9	514.7
Equity liabilities	4274	47.3	75.2	0.5	819.9
Debt liabilities	4326	85.7	77.8	5.5	542.6
Emerging economies					
Equity assets	2458	15.0	28.6	0.0	216.9
Debt assets	2458	32.8	18.9	3.3	101.4
Equity liabilities	2458	39.7	35.4	1.2	259.3
Debt liabilities	2458	43.5	26.9	6.3	211.3
Financial centers					
Equity assets	1220	807.8	2004.2	-1.4	13920.9
Debt assets	1220	756.8	1395.7	4.6	6677.0
Equity liabilities	1220	1014.4	2472.7	-0.5	16210.5
Debt liabilities	1220	509.0	819.1	26.2	4299.9

Note: The table shows summary statistics for the different indicators of financial integration for the regression samples.

positions (relative to GDP) in the advanced economies strongly exceed those in the emerging markets, except for equity liabilties that are more similar. For example, foreign debt and equity assets are about two and three times larger, respectively, in advanced countries. Because of these pronounced differences, we split the sample for the following analysis, such that each subsample is more homogeneous, while retaining sufficient variation in the financial aggregates.

The bottom panel summarizes descriptive statistics for financial centers. These are different with substantially higher external positions. To avoid that the outliers affect the results, we exclude financial centers from the baseline analysis but retain them for the sensitivity tests.

2.1.2 Natural disasters

The basis for the shock variable is the EM-DAT database from the Centre for Research on the Epidemiology of Disasters (CRED).[4] Collecting data from a

[4]https://www.cred.be/

variety of sources (UN agencies, governments, insurance companies, and press agencies), the database contains information on meteorological, geophysical, and climatological disasters that occurred worldwide since 1900. For an event to be reported, one of the following criteria must be met: 10 or more people were killed; 100 or more people were affected, injured, or made homeless; the country declared a state of emergency or appealed for international assistance.

The database provides information on each disaster's start date, its duration, as well as the human and economic impact. Following the literature on the economic effects of disasters (Noy, 2009), we use the estimated direct damage to property, crops, and livestock (in thousands of US dollars), valued at the event's occurrence. To focus on unexpected and exogenous shocks, we limit the selection to those types of disasters that have a sudden and immediate impact: earthquakes, landslides, floods, and storms. We exclude catastrophes that unfold slowly (such as droughts). To generate a quarterly shock variable, we take into account that events taking place earlier in the quarter have a larger impact on that quarter's output than shocks occurring toward the end of the quarter. We weight the estimated damage (DAM) by the onset month (OM), that is, the month of the reported starting date of the disaster, such that $DAMw = DAM(3 - OM)/3$. Then, we sum the impact of all disasters per country within quarter. We standardize the damage by quarterly nominal GDP in US dollars one year prior to the event to compare it across countries.

We use data covering 1970Q1-2018Q4. To investigate large, nationally relevant disasters, we limit the analysis to events above the median of the weighted and standardized shocks. We winsorize the shocks at the 97.5th percentile to deal with outliers. This yields 1026 shocks with a minimum, mean, and maximum damage of 0.03%, 0.37%, and 2.46% of GDP, respectively.

Tab. 2 combines the data on natural disasters with the three main indicators of integration. It shows the distribution of shocks across high and low states of integration as well as for advanced and emerging economies. All subgroups are affected by disasters. The number of shocks is balanced across states and indicators. The minimum and maximum number of shocks per group is 102 and 153, respectively. There is no systematic pattern. The suf-

Table 2: Distribution of shocks by financial indicator

	Total	Assets	Liabilities
Advanced economies			
High financial integration	153	148	152
Low financial integration	141	144	140
Emerging economies			
High financial integration	102	115	103
Low financial integration	130	117	123

Note: The table shows the number of natural disasters in advanced and emerging economies in the high (above sample median) and low (below sample median) states of the three financial indicator variables. Total = (external assets + liabilities)/GDP, Assets = total external assets/GDP, Liabilities = total external liabilities/GDP.

ficient number of shocks in each group suggests that we can reliably estimate the impact of the shocks depending on the level of financial integration.

2.1.3 Economic and institutional data

We collect quarterly data for the 1970Q1-2018Q4 period. We obtain real and seasonally adjusted data on output, private consumption, and private investment from the OECD national account statistics and from national sources. If real or seasonally adjusted data are not available, we transform them.

We also collect data from a variety of sources for control variables on institutional quality, capital account openness, the exchange rate regime, GDP, the debt-to-GDP ratio, and total reserves (Tab. A.2). The dimensions of the dataset and of the regression samples are dictated by the joint availability of the variables included. The baseline sample starts in 1970Q1. For the regressions, we use only observations for which we jointly have data on GDP, consumption, and investment, so that the estimates are comparable.

2.2 Empirical strategy

We estimate the dynamic effects of natural disasters, depending on the state of financial integration, using the following panel model:

$$\begin{aligned}\Delta y_{i,t} = &\sum_{j=0}^{J}[\beta_j S_{i,t-j} + \gamma_j FI_{i,t-j} + \delta_j FI_{i,t-j}S_{i,t-j} \\ &+ \eta_j \text{GDPpc}_i^{1995Q1} S_{i,t-j} + \lambda_j \text{Inst}_{i,t-j} S_{i,t-j} + \alpha_j \text{Inst}_{i,t-j}] \\ &+ \rho \Delta y_{i,t-1} + \nu_i + \theta_{Year} + \phi' Q + \epsilon_{i,t},\end{aligned} \tag{1}$$

where $\Delta y_{i,t} = \Delta log(Y_{i,t}) - \Delta log(Y_t)$. $\Delta y_{i,t}$ is the quarterly rate of change in an economic variable for country i in quarter t minus the average sample growth rate of that variable in this quarter. Y is either GDP, private consumption, or private investment, and Y_t measures the world aggregate. Common fluctuations cannot be shared so we substract them to focus on idiosyncratic country risk, following the literature on risk sharing (Kose et al., 2009; Hoffmann et al., 2019). This is similar to including a full set of quarter dummies. We add year fixed effects, θ_{Year}, to account for common unobservable factors that affect all countries alike within a year and that are not captured by $\Delta log(Y_t)$. We include country fixed effects, ν_i, to correct for time-invariant country characteristics, like geographic conditions. Q is a vector of quarter-of-year dummies. The disaster shock is $S_{i,t-j}$.

$FI_{i,t-j}$ is the dummy variable that indicates the state of financial integration (high = 1, low = 0). We consider the alternative measures of financial integration discussed in the previous section, one at a time. In the baseline, we use the dummy variables to ease the quantitative interpretation of the results. We show that the results hold when using continuous measures of financial integration. We set the lag length to $J = 7$ to compute impulse responses over two years as the effects of natural disasters tend to dissipate thereafter.[5]

The key variables in (1) are the interactions between the shock and the

[5]This lag length selection is based on the significance of the results as information criteria tend to underestimate the true lag length and are often contracting. We show that the results hold when setting $J = 11$.

integration dummy. The corresponding coefficients δ_j capture the difference in the dynamic effects of the shocks between states with high and low external financial positions. The state of financial integration may have an impact on how an economy recovers from the shocks. Specifically, we test the following

Hypothesis: *GDP, consumption, and investment after a natural disaster are higher in states of high financial integration than in states of low financial integration.*

In addition, we include interactions between the shock and GDP per capita in 1995, GDPpc_i^{1995Q1}, as well as a measure of institutional quality, $\text{Inst}_{i,t-j}$, and the latter in levels. GDP per capita approximates the average level of development of the country in the sample, which could affect the disaster response.[6] Similarly, the quality of institutions could influence the response.

To remove possible autocorrelation in the error term $\epsilon_{i,t}$, we include one lag of the dependent variable. The results hold when using two lags (Fig. D.16). To account for the dynamic effects through the lagged endogenous variable, we use a parametric bootstrap for statistical inference, following Romer and Romer (2004). We use the estimated covariance matrix of the coefficients to draw 500 new coefficients from a multivariate normal distribution and compute a distribution of impulse responses.

To see whether the assumption of strict exogeneity of the distributed lag model holds, we compute the autocorrelation of the residuals and conduct Granger causality tests. Tab. B.4 shows no signs of remaining persistence. Furthermore, Tab. B.5 does not provide statistically significant evidence that the growth rate of the dependent variable Granger causes natural disasters. Nevertheless, we show that the results hold when using local projections, which do not assume strict exogeneity (Fig. D.19).

We identify the impact of financial integration on shock recovery from both within and between variation. The estimates compare the recovery from the shock of a country that is highly integrated to the recovery of a reference case

[6] We use 1995 because we have an unbalanced panel with GDP data starting only in the 1990s for some countries and need to ensure that this base value exists and refers to the same year for all countries.

that is lowly integrated. The reference case can be either the same country in a situation of low integration or another country with currently or permanently low integration. We illustrate the identification strategy, following Ramcharan (2007). For simplicity, we consider the case of zero lags, $J = 0$, and compile all controls in (1) in the vector $C_{i,t}$, such that the simplified model is

$$\Delta y_{i,t} = \beta S_{i,t} + \gamma FI_{i,t} + \delta FI_{i,t} S_{i,t} + \xi' C_{i,t} + \epsilon_{i,t}. \tag{2}$$

The expected value of $\Delta y_{i,t}$ conditioned on $C_{i,t}$ and given that a shock occurs is $\mathbb{E}(\Delta y_{i,t}|S_{i,t} > 0, C_{i,t})$. Then, the average effect of the shock is

$$\begin{aligned}\mathbb{E}(\Delta y_{i,t}|S_{i,t} > 0, C_{i,t}) - \mathbb{E}(\Delta y_{i,t}|S_{i,t} = 0, C_{i,t}) = \beta S_{i,t} + \delta \mathbb{E}(FI_{i,t}|S_{i,t} > 0, C_{i,t}) S_{i,t} \\ + \gamma[\mathbb{E}(FI_{i,t}|S_{i,t} > 0, C_{i,t}) - \mathbb{E}(FI_{i,t}|S_{i,t} = 0, C_{i,t})] \\ + \mathbb{E}(\epsilon_{i,t}|S_{i,t} > 0, C_{i,t}) - \mathbb{E}(\epsilon_{i,t}|S_{i,t} = 0, C_{i,t}).\end{aligned} \tag{3}$$

To simplify (3), we make two assumptions. First, we assume that the unobserved drivers of the dependent variable, captured by $\epsilon_{i,t}$, are unrelated to the shock $S_{i,t}$. Then, $\mathbb{E}(\epsilon_{i,t}|S_{i,t} > 0, C_{i,t}) = \mathbb{E}(\epsilon_{i,t}|S_{i,t} = 0, C_{i,t}) = 0$. We justify this assumption by the randomness of the shocks. While disaster incidence differs across countries, the country fixed effects correct for such general susceptibility. Hence, for a given country, the timing of an event is unpredictable.

Still, it might be that the recording of a disaster and/or the documented damage is not random. Felbermayr and Gröschl (2014) suggest that the reported damage is positively associated with GDP per capita as the monetary losses are larger and the insurance coverage is higher in richer economies. This would induce an upward bias in the estimated impact of natural disasters on GDP growth. However, this possibility is less problematic in our context as we are not interested in the impact of disasters on growth, but only whether the impact changes with the state of financial integration. Fig. D.14 shows that the results hold when using a dummy for the 10% costliest disasters. This dummy reduces the risk that the documentation of the damage, or our scaling

by prior year's GDP, introduces endogeneity.

The second assumption to simplify (3) is that the state of financial integration is not affected by the disaster. Then, $\mathbb{E}(FI_{i,t}|S_{i,t} > 0, C_{i,t}) = \mathbb{E}(FI_{i,t}|S_{i,t} = 0, C_{i,t}) = FI_{i,t}$ and the unconditional effect of integration, γ, cancels out. There is little reason to suspect that a country switches state because of a single disaster, given that the stocks of external assets and liabilities and, hence, the state variables, are rather persistent. Moreover, we embed technically that the state variable is slow-moving and predetermined as we compute it as a moving average lagged by one quarter. Finally, using an indicator instead of a continuous measure also reduces the risk of transition as the level of integration would have to cross the median.

We confirm this assumption empirically. We estimate linear fixed effects and logit models, regressing each state variable on the shocks and their lags. Tab. B.6 shows that the states are not systematically related to the disaster shocks. Section 4 presents additional tests that support the assumption.

These two assumptions simplify (3) to

$$\mathbb{E}(\Delta y_{i,t}|S_{i,t} > 0, C_{i,t}) - \mathbb{E}(\Delta y_{i,t}|S_{i,t} = 0, C_{i,t}) = \beta S_{i,t} + \delta FI_{i,t} S_{i,t}, \qquad (4)$$

such that δ measures the contemporaneous difference in the recovery from natural disasters between states of high and low integration, provided that we control for other nonlinearities. By adding lags of the shocks and the endogenous variables, (1) allows for dynamic effects.

Other nonlinearities could be country characteristics that comove with the integration indicator. Therefore, we control for other potential shock absorbers in the baseline specification through the interaction terms of the shock with the level of development and institutions. The interaction terms relax the standard assumption in panel models of common slopes across panels. Moreover, Section 4 shows that the results are little affected when considering alternative potentially comoving variables.

3 Financial integration and natural disasters

This section contains the core results. First, we briefly develop a notion about the average economic effects of catastrophes. These typically destroy the capital stock, directly damaging houses, machinery, and infrastructure. Business interruption can also be a consequence. Fratzscher et al. (2020) show that natural disasters are contractionary and inflationary on impact and, thus, can be interpreted as adverse supply shocks. Insurance payouts can increase household consumption, while the reconstruction and replacement of destroyed capital may increase investment. Additional multiplier effects can raise GDP (Kousky, 2014). We hypothesize that the strength of these effects differs across states of financial integration.

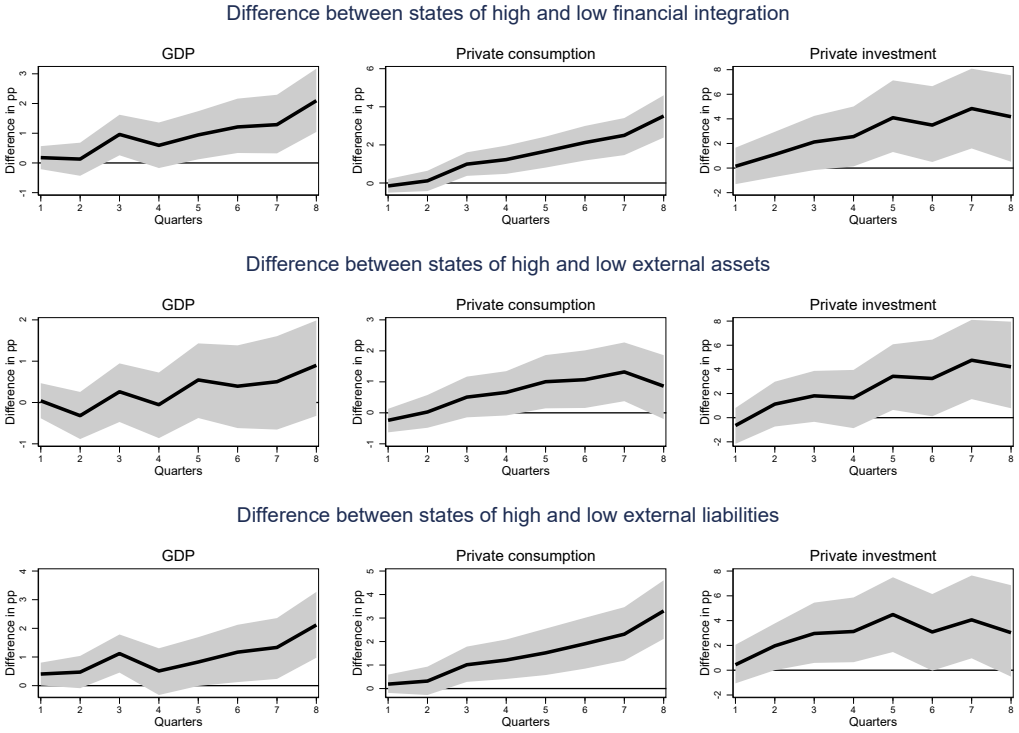
3.1 Financial integration buffers shocks in advanced economies

Fig. 2 presents the estimates for advanced economies and the three main indicator variables based on total external positions, foreign asset holdings, and foreign liabilities graphically. The tabular point estimates and standard errors for all figures of the main text are in Tab. C.7-Tab. C.13. To investigate how financial integration affects the ability to smooth shocks, we consider the responses of GDP, private consumption, and private investment. For each variable, we compute the cumulative difference between the response in a state of high integration and the response in a state of low integration. The differential responses take into account the direct effect of integration on the dependent variable and the indirect effects through the lagged endogenous variable.

The first column shows that, conditional on a natural disaster, GDP is significantly higher in a state of high financial integration. The difference in GDP between high and low states of external positions relative to GDP is about two percentage points (pp) two years after the shock. When looking at the effects separately at the asset and liability side of the external balance sheet, it appears that output recovers faster in states of high external liabilities, while the difference between high and low states of external assets is positive,

too, but insignificant. Thus, easier access to funding from abroad and/or the sharing of losses with foreign investors seem to stabilize output in the aftermath of a natural disaster shock.

Figure 2: Impact of financial integration on the recovery from natural disasters in advanced economies



Notes: The figure shows the cumulative difference of GDP, private consumption, and private investment between states of high and low financial integration following a natural disaster based on model (1) in 25 advanced economies (in percentage points, y-axis). The thick line is the point estimate. The shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the timing of the disaster in quarters. The financial integration indicator is based on the total external assets and liabilities in the top panels, on total assets in the middle panels, and on total liabilities in the bottom panels.

The middle column sheds light on important drivers of the better output performance. Private consumption is higher when the economy is more integrated into international financial markets. The difference in consumption is largest and most significant when the state variable is based on total external

positions (top middle panel). When splitting up external assets and liabilities, it appears that funding from abroad mostly drives the positive difference in consumption between high and low states of overall financial integration (bottom panel). The difference is positive and significant as of the second quarter following the shock and increases up to about 3pp two years after the shock. In states of high external assets (middle panel), consumption is higher as well than in states of low stocks following the disaster, but the effect is smaller and less statistically significant.

The right column looks at the differential private investment response. For all three state variables, the difference is positive and mostly statistically significant in the second year after the shock. The peak effect lies between 4 and 5pp. In contrast to output and consumption, investment tends to profit especially from close international financial linkages via assets. A state of high external assets relative to GDP (middle panel) implies a (statistically significant) cumulative difference of roughly 4pp after two years. This may be due to net factor income from abroad; for example, dividend or interest payments on assets originated in other countries, or returns on foreign direct investment. The hedge can stabilize domestic income and thereby foster investment to rebuild the destroyed capital stock. For external liabilities, the effect is of a similar magnitude but not statistically significant at the end.

Alternative evidence on the role of aggregate financial conditions for shock absorption is scarce. According to Noy (2009), more exchange reserves and deeper domestic financial markets enhance shock absorption capacity, while capital account openness rather hinders the recovery, potentially due to capital flight. Using the credit to GDP ratio as a measure of financial development, McDermott et al. (2014) show that the negative fallout from natural disasters is more persistent for less financially developed economies. Theory predicts that credit constraints hinder investment after the shock to fully replace the destroyed capital stock. In contrast, higher financial development supports the recovery such that the negative output effects eventually disappear.

To gain further intuition about the mechanisms at work, Fig. 3 shows

the differential responses of the current account, imports, and exports.[7] The current account is lower in states of high financial integration, reflecting better access to and more reliance on foreign funds. Consistently, imports are higher and exports are lower - stronger domestic absorption is also reflected in stronger imports.

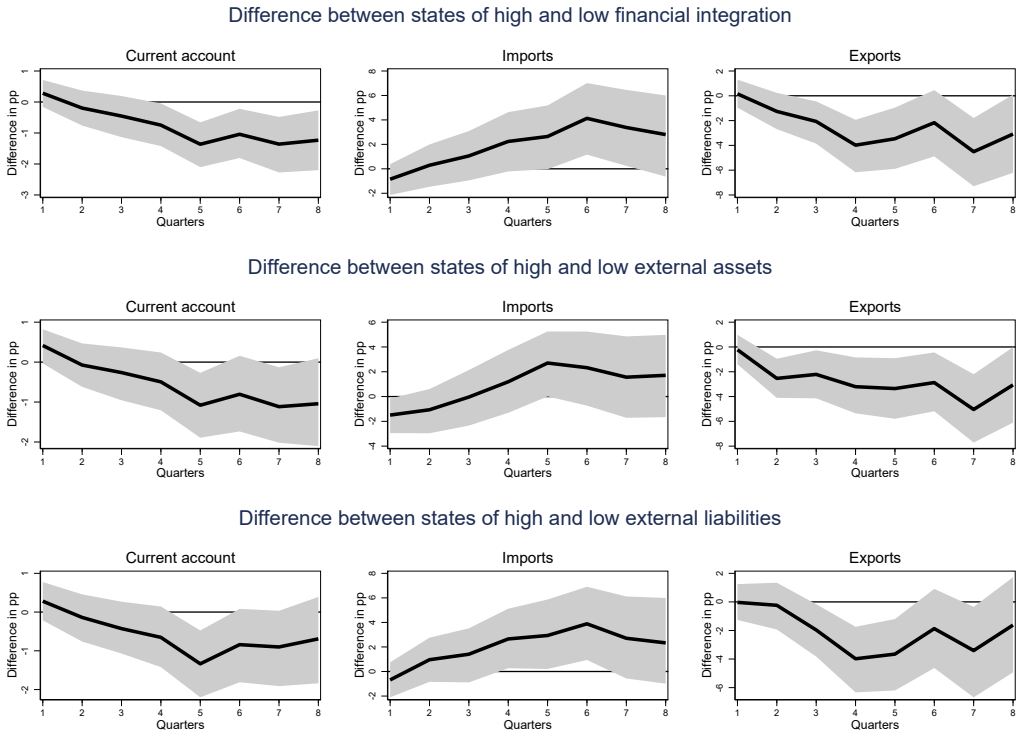
Together, these patterns indicate an important role for international financial integration in absorbing domestic natural disasters. More capital flows to a better integrated economy, which creates favorable domestic financing conditions when hit by an adverse shock. Moreover, the negative difference in the current account suggests a positive financial account (neglecting the typically very small capital account in advanced economies). Hence, the home country exports financial assets by increasing net exports of home assets and/or of foreign assets. In other words, it adds to external liabilities or reduces external assets, which function as a war chest.

The last interpretation seems to conflict with the identifying assumption of an unchanged state after a shock, but it does not. First, the state is an indicator variable such that the shock would need to be large enough not only to change the level of external positions but to induce a transition from the high to the low state across the median value. This is not the case as natural disasters are small in the sample with a mean of 0.25% of GDP and thus do not affect the state variable (Tab. B.6). Moreover, the main results hold when we use constant indicator variables that do not vary over time (Fig. D.13).

To investigate which types of financial integration are particularly helpful to absorb domestic shocks, we now use the disaggregated indicators for external assets and liabilities as described in Section 2. Given that we have four alternative state variables, namely equity and debt instruments at the asset and at the liability side, Fig. 4 focuses on the differential responses of private consumption to a disaster shock in order to analyze how risk sharing varies by state of financial integration.

[7] The current account is composed of the trade balance, net factor income from abroad, and net unilateral transfers. The last two components are typically small in advanced economies, but both may provide some stabilization as returns on foreign assets are not affected by domestic shocks and payments on external liabilities can be reduced.

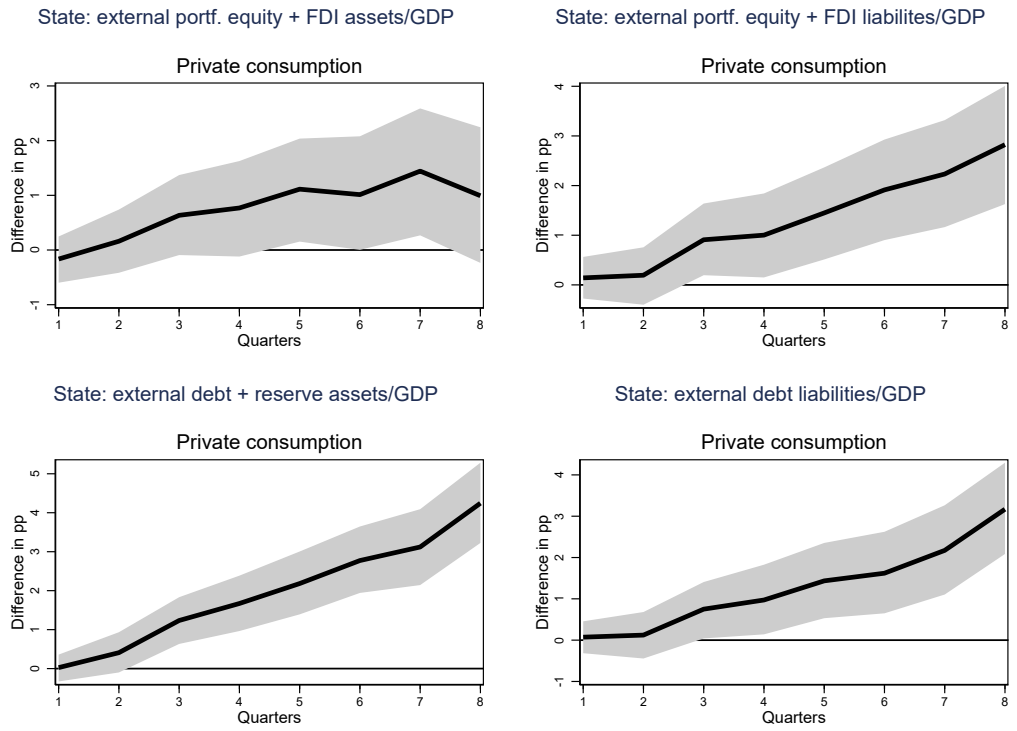
Figure 3: Differential responses of current account, imports and exports in advanced economies



Notes: The figure shows the cumulative difference of the current account, imports, and exports between states of high and low financial integration following a natural disaster based on model (1) in 25 advanced economies (in percentage points, y-axis). The thick line is the point estimate. The shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the timing of the disaster in quarters. The financial integration indicator is based on the sum of external assets and liabilities in the top panels, on total assets in the middle panels, and on total liabilities in the bottom panels.

First, we differentiate between equity and debt on the asset side (left column). Equity includes portfolio holdings like stocks and foreign direct investment, debt comprises bond holdings or bank credit extended to foreign counterparties as well as foreign reserves. The top panel indicates that foreign debt assets are favorable for private consumption after a shock. The response of consumption is strongly significant and increasing during the two years after the shock, whereas the difference between high and low states of equity

Figure 4: Differential response of private consumption for disaggregated state variables in advanced economies



Notes: The figure shows the cumulative difference between the response of consumption in states of high and low financial integration following a natural disaster based on model (1) in 25 advanced economies (in percentage points, y-axis). The thick line is the point estimate. Shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the timing of the disaster in quarters. The financial integration indicator is based on external equity assets in the top left panel, on external equity liabilities in the top right panel, on external debt assets in the bottom left panel, and on external debt liabilities in the bottom right panel.

holdings is smaller and less significant. This finding is in line with evidence for European economies (Cimadomo et al., 2020). More investment in foreign bonds and other fixed income instruments seems to increase the shock absorption capacity through stable interest income that helps smooth income fluctuations resulting from domestic shocks. Moreover, debt asset holdings are on average about 20pp larger than equity assets (Tab. 1).

Second, we investigate how the state of equity and debt liabilities affects the

response of private consumption (right column). On the funding side, more equity liabilities support the recovery. This pattern is consistent with the idea that dividend payments to foreigners can be reduced or withheld flexibly, depending on the economic situation of firms. Moreover, equity liabilities provide an ex ante insurance mechanism as potential losses are directly shared with foreign owners. Yet, even if for debt liabilities, this is only the case if the debtor becomes insolvent, in advanced economies, higher external debt holdings and foreign reserves also hedge consumption losses after a natural disaster. This may be due to the fact that access to funding from abroad is easier for economies that already had closer financial linkages to foreign creditors before the shock. The finding that the structure of external positions improves risk sharing is in line with previous literature (Hoffmann et al., 2019; Kose et al., 2009; Martin Fuentes et al., 2022; Cimadomo et al., 2020).

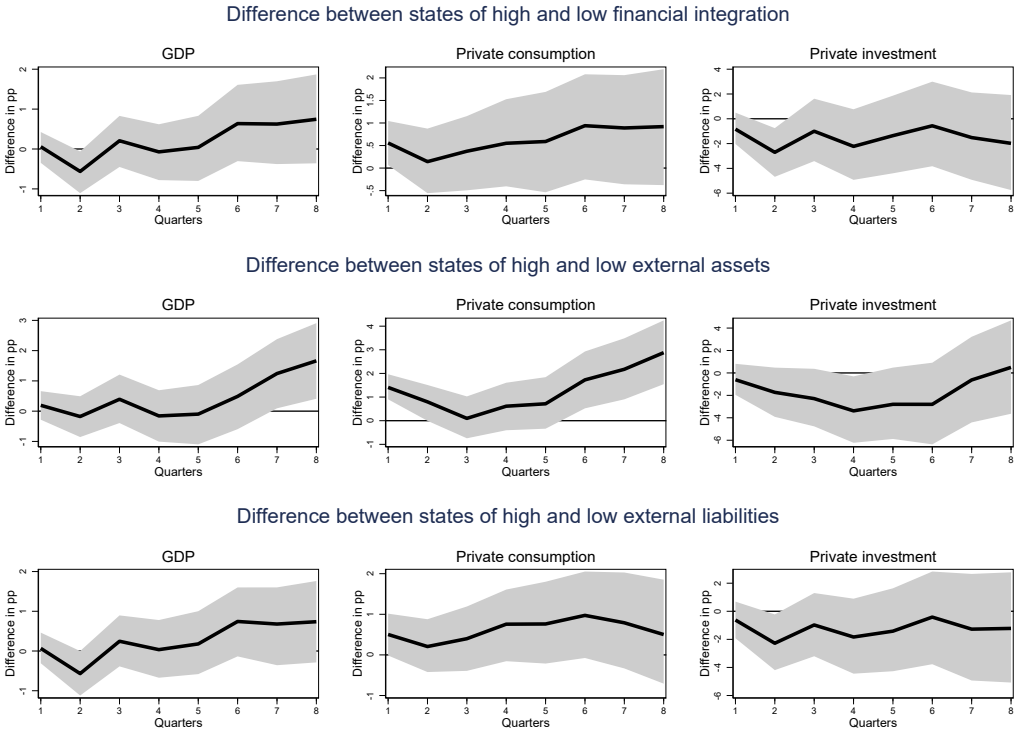
Taken together, the results indicate that states of higher external positions, on both the asset and liability side, support the recovery from natural disasters in advanced economies. GDP, consumption, and investment are higher in states of more financial integration than in states with low integration. On the asset side, debt holdings are particularly favorable for shock absorption. On the liability side, equity and debt are both stabilizing. The results document the benefits of financial integration for advanced economies. At the same time, they indicate that these may differ between types of assets and liabilities.

3.2 Emerging markets do not profit

Now, we use the sample of emerging economies. Returning to the three aggregate indicators of financial integration, Fig. 5 plots the differential responses of GDP, consumption, and investment between high and low states of integration. In contrast to the results for the advanced economies, the responses are mostly insignificant. Only high external asset holdings tend to induce somewhat higher consumption after several quarters, but the investment response is mostly negative.

In line with these results for output and private demand, there is also no

Figure 5: Impact of financial integration on the recovery from natural disasters in emerging economies

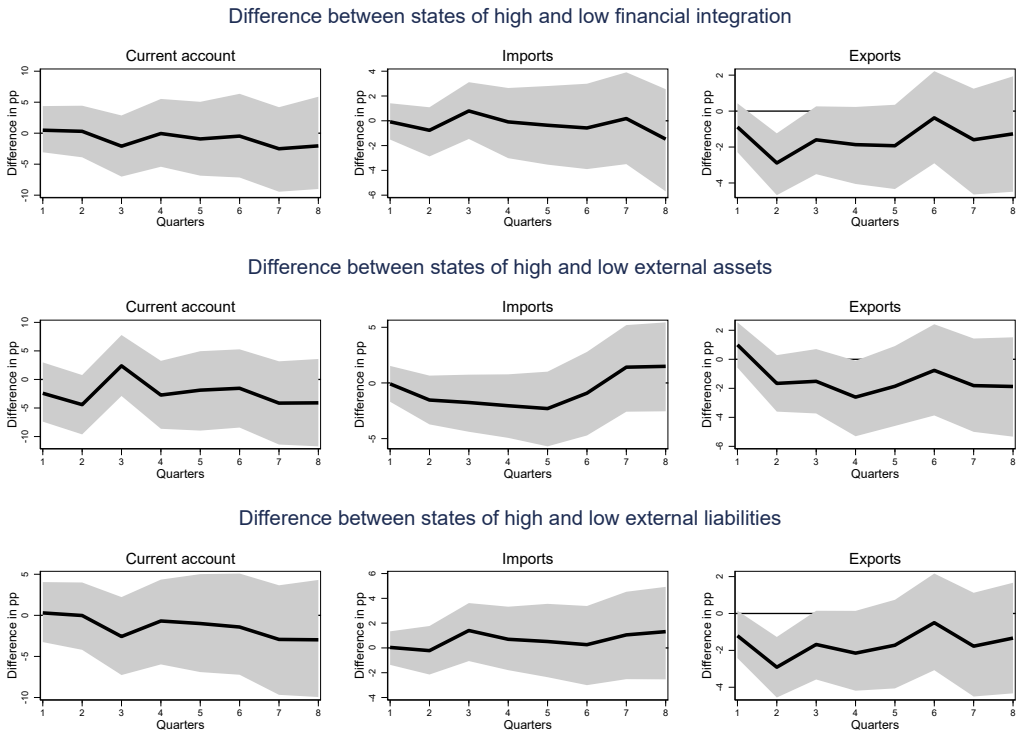


Notes: The figure shows the cumulative difference of GDP, private consumption, and private investment between states of high and low financial integration following a natural disaster based on model (1) in 27 emerging market economies (in percentage points, y-axis). The thick solid black line is the point estimate. The shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the timing of the disaster in quarters. The financial integration indicator is based on the sum of total external assets and liabilities in the top panels, on total assets in the middle panels, and on total liabilities in the bottom panels.

clear pattern of the differences in the current account across states (Fig. 6). Even if the differences in the current account tend to be negative, they are insignificant. The responses of imports do not significantly differ across states of financial integration. If anything, exports are lower in states of high external positions during a short period after the shock.

In Fig. 7, we perform the same disaggregated analysis for the emerging economies as for the advanced economies. We split both assets and liabili-

Figure 6: Differential responses of current account, imports and exports in emerging economies

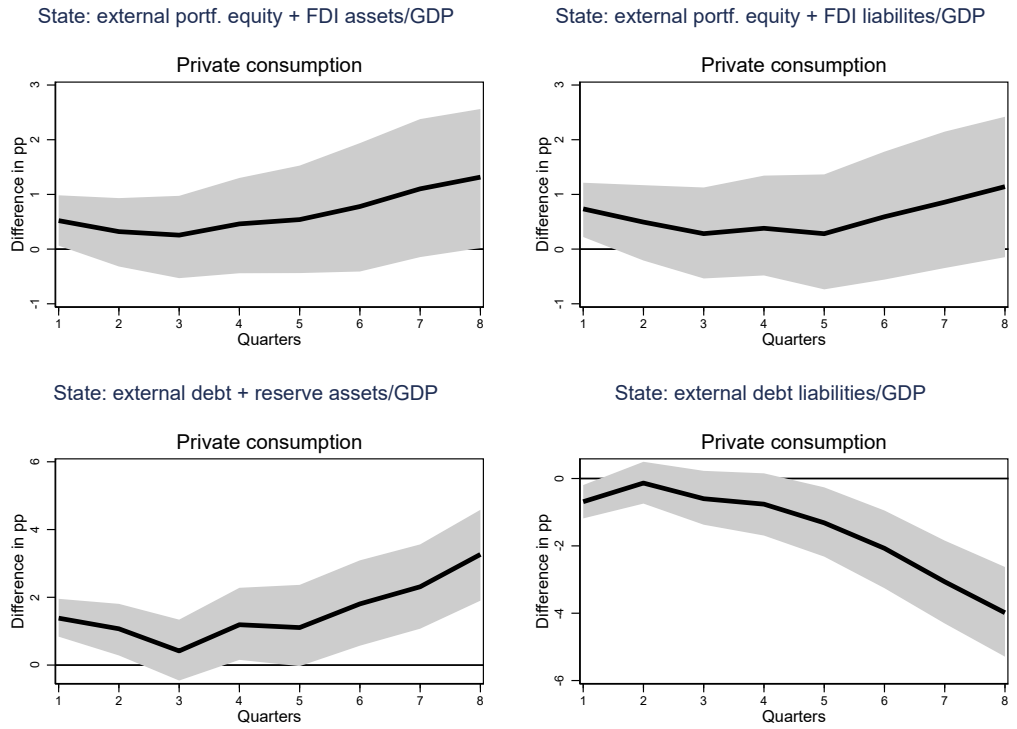


Notes: The figure shows the cumulative difference of the current account, imports, and exports between states of high and low financial integration following a natural disaster based on model (1) in 27 emerging market economies (in percentage points, y-axis). The thick line is the point estimate. The shaded areas are one-standard error confidence bands based on 500 draws. The x-axis displays the timing of the disaster in quarters. The financial integration indicator is based on the sum of external assets and liabilities in the top panels, on total assets in the middle panels, and on total liabilities in the bottom panels.

ties into two subcomponents (equity and debt). A higher degree of financial integration via debt assets and foreign reserves benefits shock absorption in emerging economies. Two years after the shock, private consumption is nearly 4pp higher in a state of high versus low external debt assets. In contrast, high external debt liabilities significantly hamper the recovery after a natural disaster, resulting in a negative cumulative difference in private consumption of 4pp at the end of the horizon. These results are in line with earlier findings

by Kose et al. (2009) who point out the negative effect of debt liabilities on consumption risk sharing in emerging economies.

Figure 7: Differential response of private consumption for disaggregated state variables in emerging economies



Notes: The figure shows the cumulative difference between the response of consumption in states of high and low financial integration following a natural disaster based on model (1) in 27 emerging market economies (in percentage points, y-axis). The thick solid black line is the point estimate. Shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the timing of the disaster in quarters. The financial integration indicator is based on external equity assets in the top left panel, on external equity liabilities in the top right panel, on external debt assets in the bottom left panel, and on external debt liabilities in the bottom right panel.

Overall, the lack of significant risk sharing through financial integration for emerging markets is in line with previous work on the costs and benefits of capital account openness in emerging and developing economies (Kose et al., 2009; Islamaj and Kose, 2016, 2022). There are several potential explanations. First and foremost, financial integration is substantially lower for

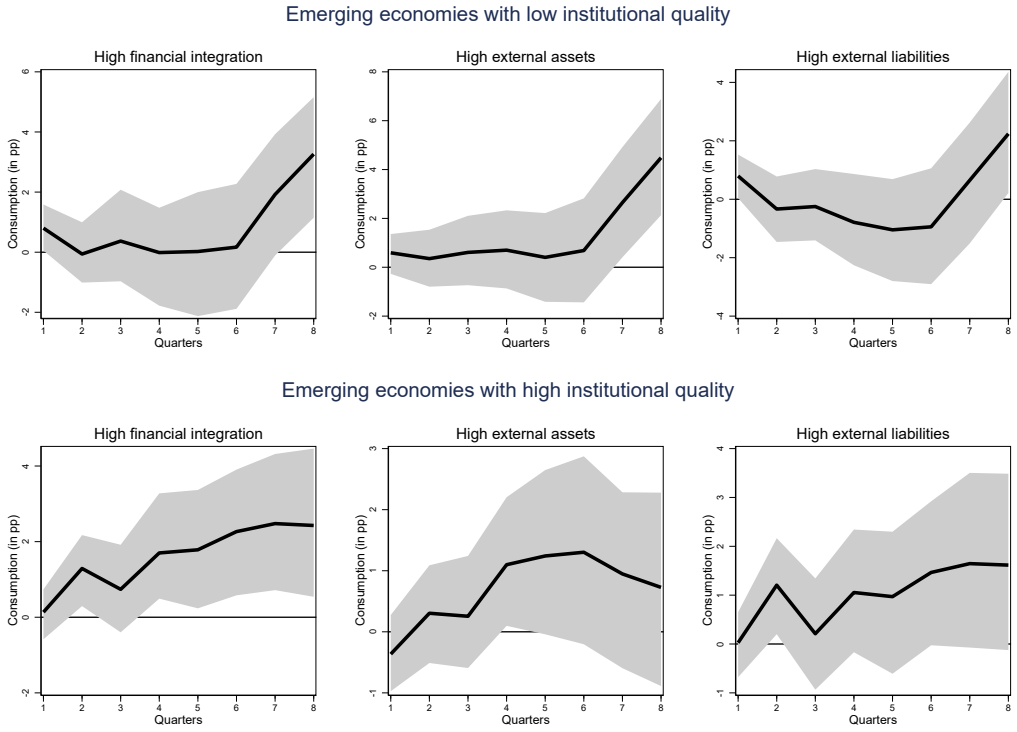
these economies. Their external positions relative to GDP are often 2-3 times smaller than those of advanced economies (Tab. 1). This explanation suggests that a lack of integration and related threshold effects impede gains from international risk sharing, which could be overcome through more integration. At the same time, the literature points to several deeper reasons for the absence of emerging markets from international risk sharing (Wei, 2018). Most of these refer to domestic frictions, including agency problems, over-regulation, and weak governance, which in turn often originate in less developed institutions. This explanation would call for difficult but important reforms, given that emerging economies tend to be more exposed to natural disasters.

We test the hypothesis about the quality of institutions explicitly. We split the sample of emerging economies into those with a quality of institutions above and below the sample median. Fig. 8 supports the hypothesis. The top panels shows the differential response of private consumption to a disaster shock for emerging economies with low institutional quality conditioning on the three baseline integration measures. The differences are largely insignificant. Financial integration does not seem to help the recovery if the quality of institutions is low. By contrast, the difference between states of high and low integration tends to be significant in the emerging markets with above median quality of institutions (see bottom panels). The beneficial effect of integration is most significant for the overall measure of integration.

4 Sensitivity analysis

This section contains an extensive sensitivity analysis. We tested many alternative specifications for the sample of emerging markets. For example, we use a fixed classification of the financial indicators, dividing the sample into high and low integration countries depending on whether the country mean is above or below the sample median. However, the results remain largely insignificant or negative if we do not condition on institutions (Fig. D.7). This is also the case for many other specifications for the emerging markets so we do not report the estimates and focus on the advanced economies.

Figure 8: Differential response of private consumption in emerging economies conditional on the quality of institutions



Notes: The figure shows the cumulative difference (in percentage points, y-axis) between the response of private consumption in states of high and low financial integration following a natural disaster based on model (1) in emerging economies. The sample in the top panels include emerging markets with below median quality of institutions, the bottom panels those with above median quality. Shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the quarters after the natural disaster shock.

The first three sets of tests for the advanced economies address the main identifying assumptions that there are no omitted nonlinearities, that the financial indicator variable does not switch after a shock, and that the shock is orthogonal to the outcome variable conditional on country characteristics. The fourth set contains technical checks. We summarize all tests and results verbally here. Online Appendix D contains the differential impulse responses, focusing on private consumption.

We control for potentially omitted nonlinearities in two ways. First, we

add, one at a time, a large number of alternative shock absorbers interacted with the shock. We do this for all lags and retain the interactions with institutional quality. In Fig. D.8, we control for internal markets to provide funding by adding the level of financial development, the domestic credit/GDP ratio, or GDP size and interaction terms of these with the shock. In Fig. D.9, we correct for the exchange rate regime, capital account openness, and public debt. Across all six alternative specifications, the results are little affected. The only exception is the differential response for external assets when conditioning on capital account openness as the two measures are nearly collinear. In other words, it is difficult to separate de jure and de facto financial openness if the latter is measured as total external assets.

Alternatively, we control for nonlinearities by changing the country sample. We include financial centers (Tab. A.1) or we add the emerging markets. Moreover, we consider only euro area members to enhance the institutional and economic homogeneity. The question of financial integration is particularly important for these countries given the aim for a European capital markets union. These three sample changes leave the baseline findings largely unchanged (Fig. D.10). In addition, we split the advanced countries at their median government debt ratio to test whether the effect of having access to foreign funding depends on the overall riskiness of repayment, proxied by the total amount of government debt outstanding (relative to GDP). Indeed, the top panels in Fig. D.11 suggest that countries with low public debt profit from better access to international funding, whereas the bottom panels indicate that the favorable effect of integration is muted in case of high public debt.

To assess the second main identifying assumption, we check whether the results are driven by the definition of the financial integration variables and whether these switch after a natural disaster. First, we use the continuous financial integration measures (as ratios to GDP) instead of 0/1 indicator variables. The results hold or even strengthen (Fig. D.12). Only the interpretation is a little bit more difficult. The top left panel, for example, suggests that in a situation with 100pp more external assets and liabilities relative to GDP a country produces 1pp more after a natural disaster after two years.

Alternatively, we compute the indicators as country specific state variables. We estimate country specific log trends and define the high integration state equal 1 when the two year trailing moving average of the continuous financial integration variable is above the trend; and 0 otherwise. In that way, we compare countries to themselves, reducing the risk that our interaction terms, sample composition, and fixed effects do not fully control for a cross-sectional correlation of our baseline indicators and other country characteristics. As another test, we compute the state indicator based on the previous quarter financial integration variable only instead of using a four-quarter moving average. In this way, the state variable is more volatile. At the other extreme, we construct time-invariant integration indicators based on whether the average external position per country is above or below the sample median. In all cases, the results hold (Fig. D.13).

The third identifying assumption is essentially untestable. However, we use six different disaster measures to see whether the results are affected by the construction or potential endogeneity of the shock (Fig. D.14, Fig. D.15). First, we drop the weighting by the onset month and use the plain damage as percent of GDP within month to check whether the precision of the event dating, which may depend on the level of development, makes a difference. Second, we account for spillovers into the next quarter by allocating the damage over three consecutive calendar months. Third, we consider all shocks, not only the largest 50%, to investigate whether the coverage or reporting matters. Fourth and fifth, we use the same disaster measure as in the baseline but winsorize it at the 99% and 95% level, respectively. Finally, we use an indicator variable equal to 1 for the 10% largest shocks, and 0 otherwise, to reduce the risk that the measuring of the damage or the scaling by previous year's GDP introduces endogeneity. Overall, the results hold.

The fourth set contains checks of the specification and estimator. In Fig. D.16, we use raw GDP growth of country i as the dependent variable instead its difference to average quarterly growth in that quarter, we include two lags of the endogenous variable, or we drop the quarter and year fixed effects. In Fig. D.17, we drop the country fixed effects and use either a robust

or feasible generalized least squares with heteroskedastic errors covariance estimator. In Fig. D.18, we include a full set of quarterly time dummies, dropping the year dummies. In Fig. D.19 we estimate local projections to see whether the strict exogeneity assumption of the distributed lag model is too strong. We use the same controls as in the baseline specification plus one lag of the disaster shock. In Fig. D.20, we use the baseline distributed lag model and extend the impulse response horizon to 12 quarter. All in all, the results hold.

5 Conclusions

We build a large quarterly dataset for 61 advanced and emerging market economies. We use natural disasters to measure adverse domestic shocks and to address the endogeneity between international financial integration and domestic economic conditions. Disasters are exogenous with respect to the external financial position and to the state of the economy. Conditioning financial integration on an exogenous event allows tracing out the contribution of integration to economic performance after a disaster shock.

For advanced economies, we document that output, consumption, and investment are significantly and persistently higher in states of high integration than in states of low integration after the shock. This is coupled with more income flows from abroad that support the recovery. Within alternative financial instruments, external debt assets are most conducive. In contrast, we find less statistically significant evidence that higher external financial positions help emerging market economies to share disaster risk internationally, unless they have good institutions. We also find some beneficial effects of debt assets in emerging markets, whereas high debt liabilities hinder shock absorption.

Overall, the findings document that financial integration can be beneficial. It helps countries to smooth domestic shocks, especially such shocks that will become more important as climate change continues and the disaster frequency increases. Hence, the de-globalization that has started with the financial crisis in 2009 and gained steam with the mounting rivalry between the US and China and the war in Ukraine can be costly, in particular for advanced economies.

The gains of financial disintegration may be that countries are less susceptible to external shocks. Whether these gains outweigh the costs is an open question. An answer would also guide policy prescription for emerging markets whether efforts to increase financial integration are sensible.

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Online Appendix

Integrating Out Natural Disaster Shocks

by F. Bremus[1] and M. Rieth[2]

This online appendix provides information on data in Appendix A, additional tests of the identification assumption in Appendix B as well as additional sensitivity analysis in Appendix D.

A Data

We define the set of advanced economies as the OECD founders and all euro area countries. We exlcude Turkey from the advanced group although it is an OECD founder, as it has institutional and economic characteristics that are more similar to emerging market countries, and instead include South Korea. We add euro area countries given their similar financial institutions and because financial integration is particularly important for currency members for which the common monetary policy does not buffer country-specific shocks.

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Table A.1: List of countries

Advanced economies	Emerging economies	Financial centers
Australia	Argentina	Cyprus
Austria	Bolivia	Hong Kong (China)
Belgium	Brazil	Iceland
Canada	Bulgaria	Ireland
Denmark	Chile	Luxembourg
Estonia	Colombia	Malta
Finland	Croatia	Mauritius
France	Czech Republic	Singapore
Germany	Ecuador	Switzerland
Greece	Hungary	
Italy	India	
Japan	Indonesia	
Korea	Israel	
Latvia	Kazakhstan	
Lithuania	Mexico	
Netherlands	Nigeria	
New Zealand	Paraguay	
Norway	Peru	
Portugal	Philippines	
Slovakia	Poland	
Slovenia	Romania	
Spain	Russia	
Sweden	Serbia	
United Kingdom	South Africa	
United States	Thailand	
	Turkey	
	Uruguay	

Note: The table shows the countries included in different regression samples.

Table A.2: Variable descriptions

Variable	Definition	Source
Shock	Damage from natural disasters incurred within one quarter, in % of GDP; upper 50th percentile of reported damage; winsorized at the 99th percentile	EM-DAT, IMF-IFS, OECD, national sources
$GDPpc^{1995q1}$	GDP per capita in 1990Q1, nominal, in USD	World Bank
Government effectiveness	Institutional quality indicator, defined over the interval [-2.5,2.5], with higher calues indicating higher effectiveness, available from 1996-2016, extrapolated	World Bank, The Worldwide Governance Indicators
GDP	Real per capita GDP growth, seasonally adjusted	OECD, national sources, WDI
Private consumption	Real private consumption growth, seasonally adjusted	OECD, national sources
Private investment	Gross capital formation, seasonally adjusted	OECD, national sources
Imports	Real import growth, seasonally adjusted	OECD, national sources
Exports	Real export growth, seasonally adjusted	OECD, national sources
Overall financial integration	Total external assets plus total external liabilities relative to GDP	EWN
Total external assets (% of GDP)	Claims by domestic residents on nonresidents (portfolio equity and debt, FDI, other investment, derivatives, reserves) relative to GDP	EWN
Total external liabilities (% of GDP)	Liabilities by domestic residents to nonresidents (portfolio equity and debt, FDI, other investment, derivatives) relative to GDP	EWN
Debt assets (% of GDP)	Portfolio debt assets (e.g. bonds) plus other investment (e.g. loans, deposits, trade credit) plus foreign reserves (central bank foreign exchange reserves excluding gold) to GDP.	EWN
Debt liabilities (% of GDP)	Portfolio debt liabilities plus other investment to GDP.	EWN
Equity assets (% of GDP)	Portfolio equity assets (e.g. stocks, shares) plus FDI assets (e.g. controlling stakes by domestic firms in overseas' affiliates) to GDP.	EWN
Equity liabilities (% of GDP)	Portfolio equity liabilities plus FDI liabilities to GDP.	EWN
FX index	Official exchange rate, national currency to USD, index: 2000 = 100	Datastream

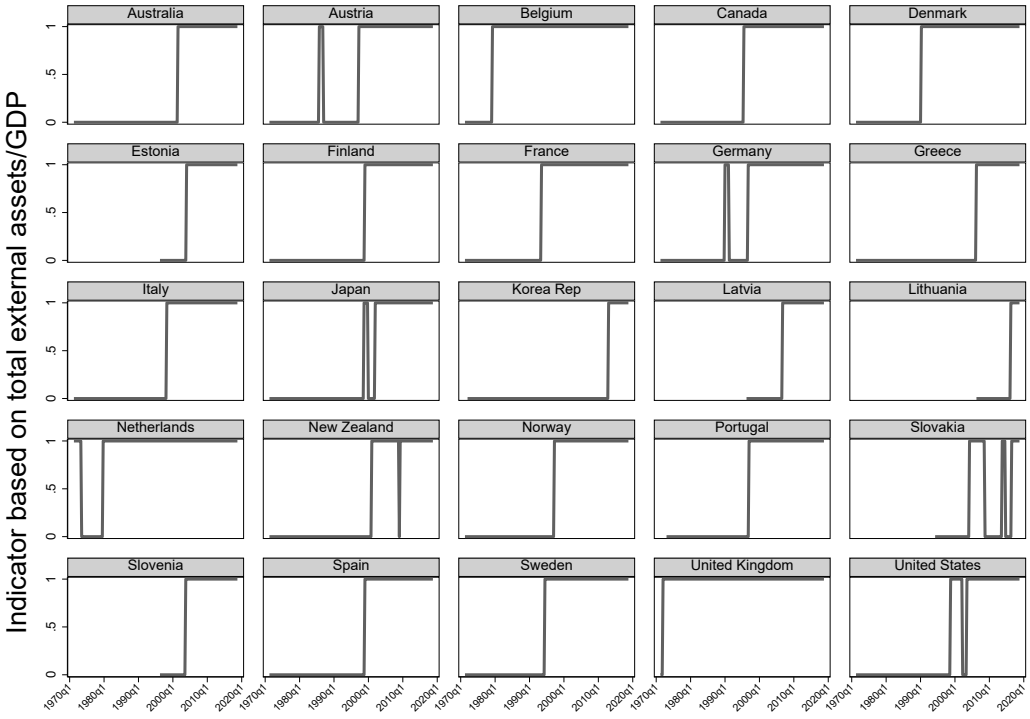
Table A.3: Summary statistics

Variable	Obs.	Mean	S.d.	Min.	Max.
Disaster shock (in % of GDP)	4343	0.0	0.1	0.0	6.8
External assets and liabilities/GDP (in %)	4333	248.0	285.9	18.4	2482.2
External assets/GDP (in %)	4333	115.6	147.4	6.2	1272.1
External liabilities/GDP (in %)	4333	132.4	140.8	8.3	1210.1
External equity assets/GDP (in %)	4314	47.0	90.1	0.0	941.2
External equity liabilities/GDP (in %)	4274	47.3	75.2	0.5	819.9
External debt assets/GDP (in %)	4326	68.8	71.0	2.9	514.7
External debt liabilities/GDP (in %)	4326	85.7	77.8	5.5	542.6
GDP growth (in %)	4343	0.7	1.3	-14.1	9.9
Consumption growth (in %)	4343	0.6	1.3	-14.6	12.7
Investment growth (in %)	4343	0.7	4.4	-63.7	96.0
Current account growth (in %)	4106	0.0	1.3	-22.4	34.7
Import growth (in %)	4343	1.2	4.3	-35.4	42.0
Export growth (in %)	4343	1.3	3.8	-33.0	33.5
GDP per capita	4343	22249.9	8950.0	2675.2	36629.0
GDP size	4268	1.0e+12	2.3e+12	4.6e+09	2.1e+13
Institutional quality	4343	2.6	0.4	1.5	3.3
Exchange rate regime	3758	1.0	0.2	0.0	1.0
Public debt/GDP (in %)	3023	61.0	39.1	3.7	237.6
Domestic credit/GDP (in %)	4183	80.7	43.9	0.1	221.3
Financial development	3563	0.6	0.2	0.0	1.0
Capital account openness	4323	1.5	1.2	-1.9	2.4

Figure A.1: Indicator variable based on total external assets and liabilities, advanced economies

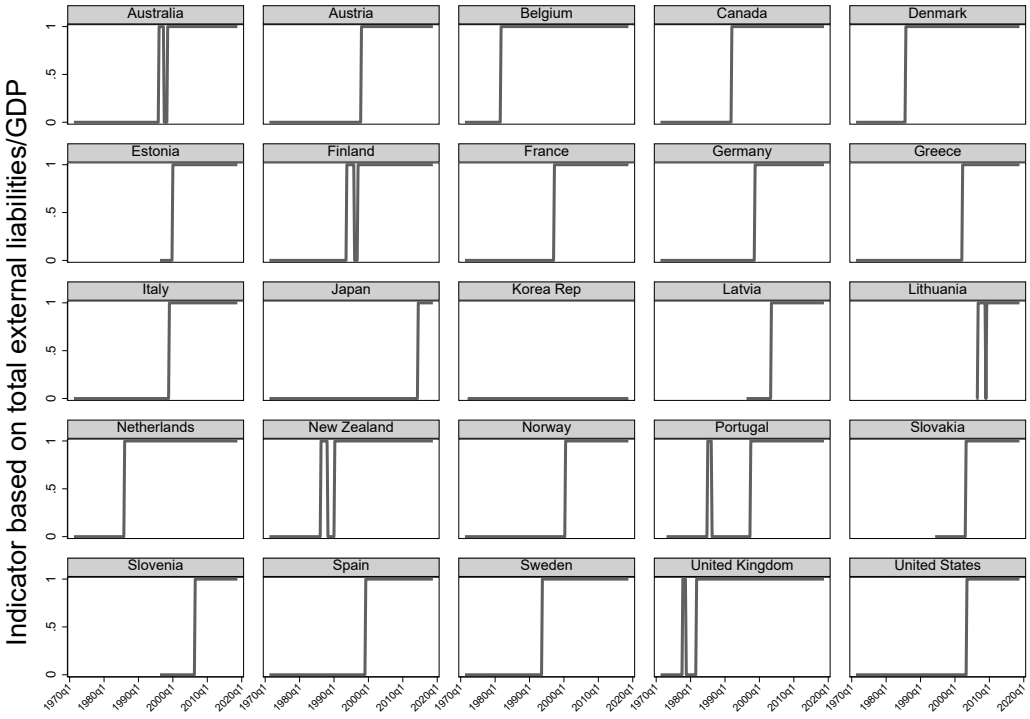
Notes: The figure illustrates the values of the indicator variable by country, based on total external assets plus liabilities relative to GDP. The sample is for advanced economies as listed in Tab. A.1.

Figure A.2: Indicator variable based on total external assets, advanced economies



Notes: The figure illustrates the values of the indicator variable by country, based on external assets relative to GDP. The sample is for advanced economies as listed in Tab. A.1.

Figure A.3: Indicator variable based on total external liabilities, advanced economies

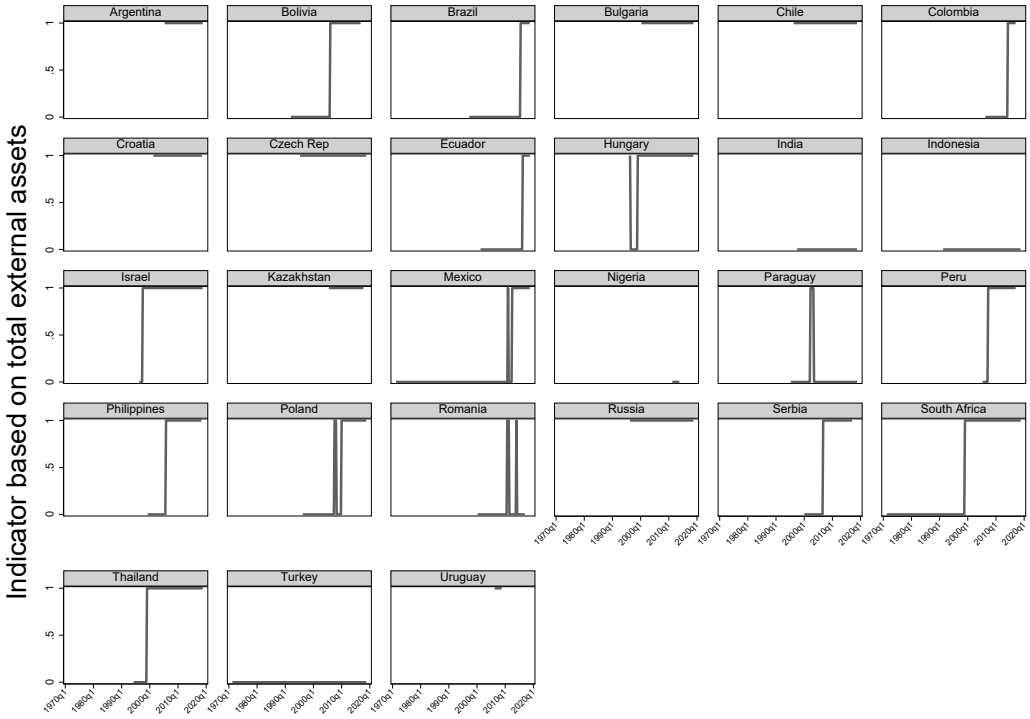


Notes: The figure illustrates the values of the indicator variable by country, based on total external liabilities to GDP. The sample is for advanced economies as listed in Tab. A.1.

Figure A.4: Indicator variable based on total external assets and liabilities, emerging economies

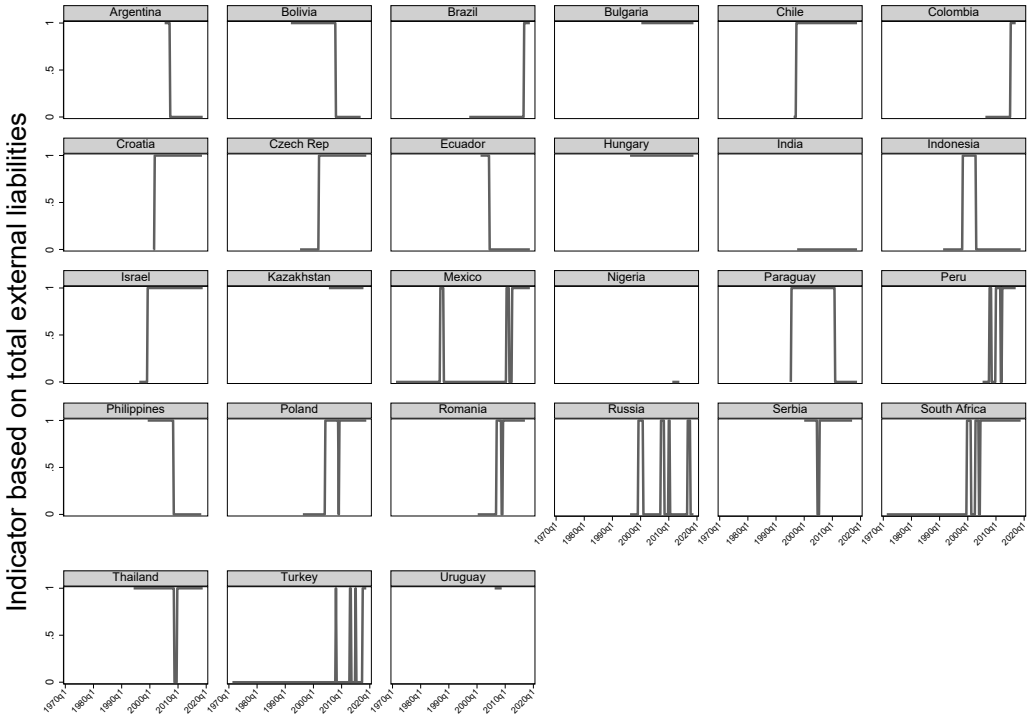
Notes: The figure illustrates the values of the indicator variable by country, based on total external assets plus liabilities relative to GDP. The sample is for emerging economies as listed in Tab. A.1.

Figure A.5: Indicator variable based on total external assets, emerging economies



Notes: The figure illustrates the values of the indicator variable by country, based on external assets relative to GDP. The sample is for emerging economies as listed in Tab. A.1.

Figure A.6: Indicator variable based on total external liabilities, emerging economies



Notes: The figure illustrates the values of the indicator variable by country, based on total external liabilities to GDP. The sample is for emerging economies as listed in Tab. A.1.

B Specification tests

Table B.4: Test of residual autocorrelation

Residual	GDP growth	Consumption growth	Investment growth
Residual $t-1$	-0.006	0.000	0.007
S.E.	(0.016)	(0.016)	(0.016)
Observations	4008	4008	4008
R^2	0.000	0.000	0.000
p-value F-test	0.711	0.977	0.643

Note: The table shows fixed effects regressions of the residuals of (1) on one lag of the residuals and a constant (not reported) when the dependent variable in (1) is country specific GDP growth, consumption growth, or investment growth, respectively. The p-value in the bottom refers to the F-test of significance of first order autocorrelation.

Table B.5: Granger causality tests

Granger causality of	GDP growth	Consumption growth	Investment growth
Point estimate	0.001	0.002	-0.000
p-value	(0.356)	(0.183)	(0.963)
Observations	4318	4318	4318
R^2	0.000	0.001	0.000
F-statistic GC test	0.852	1.770	0.002
p-value GC test	0.356	0.183	0.963

Note: The table shows Granger causality tests of the null hypothesis that natural disasters are Granger caused by, respectively, GDP growth, consumption growth, or investment growth. The model includes one lag of the potentially Granger causing variable and of the disaster shock as well as country fixed effects.

Table B.6: Determinants of indicator variables

	Fixed effects			Logit		
	(1)	(2)	(3)	(4)	(5)	(6)
	Total	Assets	Liabilities	Total	Assets	Liabilities
Lag 0 disaster	0.056	0.017	0.048	0.077	0.004	0.079
	(0.039)	(0.039)	(0.039)	(0.049)	(0.055)	(0.059)
Lag 1 disaster	0.049	0.017	0.049	0.072	-0.001	0.080
	(0.039)	(0.039)	(0.039)	(0.051)	(0.056)	(0.061)
Lag 2 disaster	0.033	0.012	0.035	0.054	-0.003	0.066
	(0.039)	(0.039)	(0.039)	(0.050)	(0.053)	(0.060)
Lag 3 disaster	0.019	0.010	0.027	0.030	-0.023	0.047
	(0.039)	(0.039)	(0.039)	(0.051)	(0.052)	(0.061)
Lag 4 disaster	0.018	0.002	0.024	0.033	-0.036	0.035
	(0.039)	(0.039)	(0.039)	(0.056)	(0.056)	(0.061)
Lag 5 disaster	0.027	-0.013	0.014	0.051	-0.044	0.028
	(0.039)	(0.039)	(0.039)	(0.054)	(0.054)	(0.061)
Lag 6 disaster	0.021	-0.017	0.012	0.039	-0.049	0.018
	(0.040)	(0.040)	(0.040)	(0.054)	(0.053)	(0.061)
Lag 7 disaster	0.022	0.028	0.021	0.034	0.008	0.023
	(0.039)	(0.040)	(0.040)	(0.055)	(0.055)	(0.060)
Lag 8 disaster	0.015	0.015	0.005	0.033	-0.006	0.023
	(0.039)	(0.040)	(0.040)	(0.054)	(0.055)	(0.066)
GDP growth	0.008**	-0.003	0.016***	-0.014***	-0.024***	-0.006
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)
GDP (USD bn.)	0.002	0.006	-0.003	-0.006***	0.004	-0.011***
	(0.004)	(0.004)	(0.004)	(0.002)	(0.003)	(0.002)
Trade openness	0.040	-0.162***	0.114**	0.175***	0.094***	0.270***
	(0.047)	(0.047)	(0.047)	(0.021)	(0.021)	(0.024)
Capital account	0.063***	0.055***	0.066***	0.092***	0.092***	0.106***
opennes	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Institutional	0.126***	0.268***	-0.228***	0.263***	0.304***	0.272***
quality	(0.049)	(0.050)	(0.050)	(0.015)	(0.017)	(0.016)
Time FE	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	no	no	no
Observations	4062	4062	4062	3900	3937	3525
R2	0.68	0.66	0.66			
p-value F-test	0.714	0.998	0.800	0.594	0.987	0.797

Note: The table shows estimation results for regressions of the binary financial indicator variables on the disaster shock and its lags. Total = 1 if total external assets plus liabilities (to GDP) are larger than the sample median, 0 otherwise. Assets = 1 if total foreign assets (to GDP) are lager than the sample median, 0 otherwise, Liabilities = 1 if total foreign liabilities (to GDP) are larger than the sample median, 0 otherwise. Columns (1)-(3) show the results from a fixed effects model, while columns (4)-(6) present the average marginal effects of a logit model.

C Supplementary results main analysis

Table C.7: Regression results underlying Fig. 2

Horizon	GDP			Consumption			Investment		
	Mean	Confidence interval		Mean	Confidence interval		Mean	Confidence interval	
	Difference between states of high and low financial integration								
1	0.2	-0.2	0.5	-0.2	-0.5	0.1	0.1	-1.3	1.4
2	0.1	-0.4	0.6	0.0	-0.4	0.5	1.0	-0.7	2.8
3	0.9	0.3	1.5	0.9	0.3	1.5	1.9	-0.1	4.0
4	0.6	-0.2	1.3	1.1	0.4	1.9	2.5	0.0	4.9
5	0.9	0.1	1.8	1.6	0.7	2.4	3.8	1.0	6.6
6	1.2	0.3	2.2	2.1	1.2	3.0	3.3	0.2	6.2
7	1.4	0.4	2.3	2.5	1.5	3.5	4.6	1.3	7.7
8	2.2	1.1	3.2	3.5	2.3	4.5	4.0	0.7	7.4
	Difference between states of high and low external assets								
1	0.0	-0.4	0.4	-0.3	-0.7	0.1	-0.8	-2.2	0.6
2	-0.3	-0.8	0.3	0.0	-0.5	0.5	1.0	-0.8	2.8
3	0.3	-0.5	1.0	0.5	-0.2	1.1	1.8	-0.3	3.8
4	0.0	-0.9	0.8	0.6	-0.1	1.3	1.5	-1.0	3.9
5	0.5	-0.4	1.4	1.0	0.1	1.8	3.3	0.5	6.3
6	0.4	-0.6	1.4	1.0	0.0	1.9	3.3	0.1	6.5
7	0.5	-0.6	1.5	1.3	0.3	2.2	4.7	1.3	8.0
8	0.9	-0.2	2.0	0.8	-0.3	1.9	4.1	0.6	7.9
	Difference between states of high and low external liabilities								
1	0.4	0.0	0.8	0.2	-0.2	0.6	0.5	-1.1	2.0
2	0.5	-0.1	1.1	0.3	-0.3	0.8	2.0	0.0	3.9
3	1.1	0.4	1.9	0.9	0.2	1.6	2.9	0.3	5.3
4	0.5	-0.4	1.4	1.2	0.3	2.0	3.1	0.3	6.0
5	0.7	-0.2	1.7	1.4	0.6	2.3	4.3	1.2	7.5
6	1.1	0.0	2.1	1.9	0.9	2.9	3.1	-0.3	6.5
7	1.3	0.1	2.5	2.3	1.2	3.3	4.0	0.5	7.9
8	2.0	0.8	3.2	3.3	2.1	4.4	3.2	-0.7	7.3

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

Table C.8: Regression results underlying Fig. 3

Horizon	Current account			Imports			Exports		
	Mean	Confidence interval		Mean	Confidence interval		Mean	Confidence interval	
	Difference between states of high and low financial integration								
1	0.3	-0.1	0.7	-0.9	-2.2	0.3	0.2	-1.0	1.3
2	-0.1	-0.7	0.4	0.4	-1.3	2.0	-1.1	-2.6	0.4
3	-0.4	-1.0	0.3	1.1	-0.9	3.1	-1.9	-3.7	0.0
4	-0.7	-1.4	0.0	2.3	-0.2	4.6	-3.8	-5.8	-1.6
5	-1.3	-2.1	-0.5	2.9	0.3	5.7	-3.5	-5.9	-1.3
6	-1.0	-1.9	-0.1	4.3	1.3	7.0	-2.1	-4.8	0.6
7	-1.3	-2.2	-0.4	3.6	0.5	6.7	-4.4	-7.4	-1.5
8	-1.2	-2.2	-0.1	3.1	-0.1	6.3	-3.2	-6.4	-0.2
	Difference between states of high and low external assets								
1	0.4	0.0	0.9	-1.4	-2.6	-0.1	-0.3	-1.5	0.9
2	-0.1	-0.6	0.4	-1.0	-2.7	0.7	-2.4	-3.8	-0.9
3	-0.3	-0.9	0.3	0.2	-1.9	2.3	-2.1	-3.9	-0.3
4	-0.5	-1.2	0.2	1.2	-1.0	3.6	-2.9	-5.0	-0.9
5	-1.1	-1.8	-0.4	2.6	-0.1	5.3	-3.0	-5.3	-0.6
6	-0.8	-1.6	0.0	2.2	-0.6	4.9	-2.6	-5.1	-0.2
7	-1.1	-2.0	-0.2	1.4	-1.5	4.3	-4.8	-7.5	-2.3
8	-1.1	-1.9	-0.2	1.6	-1.8	4.8	-2.9	-6.1	0.0
	Difference between states of high and low external liabilities								
1	0.3	-0.2	0.8	-0.6	-2.1	0.8	-0.1	-1.4	1.2
2	-0.2	-0.8	0.4	0.8	-1.1	2.7	-0.2	-2.0	1.5
3	-0.5	-1.2	0.3	1.4	-1.0	3.5	-2.1	-4.0	-0.1
4	-0.7	-1.6	0.1	2.4	0.0	4.7	-4.1	-6.3	-1.8
5	-1.4	-2.4	-0.6	2.7	-0.2	5.5	-3.8	-6.3	-1.1
6	-0.9	-1.9	0.0	3.8	0.8	6.9	-1.8	-4.5	1.0
7	-1.0	-2.2	0.0	2.6	-0.7	5.6	-3.5	-6.4	-0.3
8	-0.8	-1.9	0.2	2.1	-1.1	5.5	-1.7	-4.8	1.5

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

Table C.9: Regression results underlying Fig. 4

	External equity assets			External debt assets			External equity liabilities			External debt liabilities		
Horizon	Mean	CI		Mean	CI		Mean	CI		Mean	CI	
1	-0.1	-0.6	0.3	0.0	-0.4	0.3	0.1	-0.3	0.5	0.1	-0.3	0.5
2	0.2	-0.4	0.8	0.4	-0.1	0.9	0.1	-0.5	0.8	0.2	-0.4	0.8
3	0.7	-0.1	1.4	1.2	0.5	1.8	0.9	0.1	1.7	0.8	0.1	1.5
4	0.8	0.0	1.6	1.7	0.9	2.4	1.0	0.1	1.9	1.0	0.3	1.9
5	1.2	0.4	2.1	2.2	1.3	3.0	1.4	0.4	2.3	1.5	0.6	2.5
6	1.1	0.1	2.2	2.8	1.9	3.8	1.8	0.8	2.8	1.8	0.8	2.8
7	1.6	0.4	2.6	3.1	2.0	4.1	2.1	1.0	3.2	2.3	1.2	3.5
8	1.0	-0.2	2.2	4.3	3.1	5.4	2.7	1.5	3.9	3.3	2.1	4.6

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

Table C.10: Regression results underlying Fig. 5

Horizon	GDP			Consumption			Investment		
	Mean	Confidence interval		Mean	Confidence interval		Mean	Confidence interval	
	Difference between states of high and low financial integration								
1	-0.1	-0.5	0.4	0.4	-0.1	0.9	-1.1	-2.4	0.4
2	-0.7	-1.2	-0.1	-0.1	-0.8	0.6	-2.9	-4.9	-0.8
3	0.1	-0.7	0.8	0.2	-0.7	1.1	-1.8	-4.3	0.7
4	0.0	-0.8	0.8	0.3	-0.7	1.3	-2.7	-5.6	0.1
5	0.3	-0.7	1.2	0.5	-0.6	1.6	-1.6	-4.8	1.6
6	0.8	-0.2	1.8	0.8	-0.4	1.9	-0.6	-4.1	3.0
7	0.9	-0.2	2.0	0.7	-0.7	2.0	-1.5	-5.3	2.4
8	1.0	-0.1	2.2	0.6	-0.8	2.0	-2.1	-6.2	2.1
	Difference between states of high and low external assets								
1	0.0	-0.5	0.4	0.9	0.3	1.4	-1.0	-2.5	0.4
2	-0.7	-1.3	0.0	0.3	-0.5	1.1	-2.7	-4.9	-0.5
3	-0.2	-0.9	0.6	-0.3	-1.2	0.7	-3.5	-6.2	-1.0
4	-0.5	-1.3	0.4	0.1	-1.0	1.2	-4.2	-7.3	-1.3
5	-0.2	-1.1	0.8	0.4	-0.8	1.8	-3.1	-6.5	0.3
6	0.3	-0.7	1.4	1.4	0.0	2.8	-2.9	-6.6	1.2
7	1.1	-0.1	2.2	1.9	0.4	3.3	-0.9	-4.8	3.5
8	1.5	0.2	2.8	2.4	0.9	4.0	-0.3	-4.5	4.0
	Difference between states of high and low external liabilities								
1	0.0	-0.5	0.4	0.4	-0.2	0.9	-0.7	-2.3	0.8
2	-0.6	-1.2	0.0	-0.1	-0.8	0.6	-2.1	-4.4	0.1
3	0.2	-0.5	0.8	0.2	-0.7	1.1	-1.1	-3.7	1.4
4	0.2	-0.6	1.0	0.5	-0.5	1.5	-1.8	-4.9	1.0
5	0.4	-0.5	1.3	0.7	-0.4	1.8	-1.2	-4.5	2.2
6	0.9	0.0	1.9	0.9	-0.3	2.2	0.0	-3.7	3.9
7	1.0	-0.1	2.0	0.8	-0.4	2.0	-0.7	-4.5	3.2
8	1.0	-0.1	2.1	0.4	-0.8	1.8	-0.4	-4.6	3.9

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

Table C.11: Regression results underlying Fig. 6

Horizon	Current account			Imports			Exports		
	Mean	Confidence interval		Mean	Confidence interval		Mean	Confidence interval	
	Difference between states of high and low financial integration								
1	0.5	-3.5	4.2	-0.8	-2.7	1.3	-3.1	-5.0	-1.3
2	-1.3	-5.8	3.1	0.6	-1.8	3.1	-1.6	-3.7	0.6
3	0.3	-4.6	5.2	-0.3	-3.1	2.6	-2.0	-4.4	0.3
4	-0.3	-6.1	5.7	-0.5	-3.5	2.7	-2.0	-4.6	0.3
5	0.3	-5.5	6.3	-0.7	-4.0	2.8	-0.7	-3.5	2.1
6	-2.4	-9.1	3.7	-0.1	-3.8	3.7	-1.8	-4.7	1.2
7	-1.5	-8.9	5.3	-1.7	-5.7	2.5	-1.5	-4.7	1.4
8	1.0	-0.1	2.2	0.6	-0.8	2.0	-2.1	-6.2	2.1
	Difference between states of high and low external assets								
1	-2.3	-6.6	2.3	-0.1	-1.8	1.6	1.0	-0.6	2.5
2	-3.8	-9.2	1.9	-1.6	-3.8	0.7	-1.5	-3.5	0.3
3	2.0	-4.1	7.8	-2.0	-4.8	0.7	-1.3	-3.4	0.8
4	-2.7	-9.4	3.8	-2.5	-5.7	0.7	-2.4	-4.9	0.1
5	-1.6	-8.8	4.7	-2.8	-6.2	0.7	-1.6	-4.1	0.9
6	-0.6	-7.8	6.7	-1.5	-4.9	2.2	-0.7	-3.5	2.1
7	-3.7	-11.1	3.6	0.8	-2.8	5.0	-1.7	-4.8	1.3
8	-3.2	-11.4	4.6	1.1	-2.7	5.1	-1.8	-4.9	1.5
	Difference between states of high and low external liabilities								
1	0.6	-2.6	4.1	0.1	-1.4	1.6	-1.2	-2.6	0.1
2	0.0	-4.3	4.1	0.1	-2.0	2.3	-3.1	-5.1	-1.3
3	-2.2	-6.8	2.0	1.6	-0.9	4.1	-1.9	-3.9	0.0
4	-0.1	-5.1	5.0	0.8	-1.9	3.6	-2.4	-4.8	0.1
5	-0.5	-5.9	5.0	0.6	-2.4	3.9	-1.8	-4.5	0.5
6	-0.9	-7.4	5.1	0.3	-3.0	3.8	-0.7	-3.5	2.2
7	-2.0	-8.8	4.4	1.1	-2.6	4.9	-1.8	-4.5	1.2
8	-2.5	-9.8	4.3	1.4	-2.5	5.2	-1.4	-4.5	1.4

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

Table C.12: Regression results underlying Fig. 7

Horizon	External equity assets			External debt assets			External equity liabilities			External debt liabilities		
	Mean	CI		Mean	CI		Mean	CI		Mean	CI	
1	0.5	0.1	0.9	1.3	0.8	1.9	0.8	0.3	1.3	-0.8	-1.3	-0.3
2	0.3	-0.4	1.0	1.2	0.4	1.9	0.6	-0.1	1.2	-0.2	-0.9	0.4
3	0.3	-0.5	1.0	0.5	-0.4	1.5	0.4	-0.4	1.1	-0.7	-1.4	0.1
4	0.5	-0.4	1.3	1.3	0.3	2.2	0.5	-0.4	1.4	-0.9	-1.8	0.1
5	0.5	-0.5	1.5	1.3	0.1	2.4	0.4	-0.6	1.5	-1.4	-2.4	-0.4
6	0.7	-0.5	1.9	1.9	0.6	3.0	0.8	-0.3	1.9	-2.2	-3.4	-1.1
7	1.0	-0.2	2.3	2.4	1.2	3.7	1.0	-0.2	2.4	-3.2	-4.5	-2.1
8	1.3	-0.2	2.6	3.4	2.1	4.7	1.3	0.0	2.7	-4.1	-5.5	-2.9

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

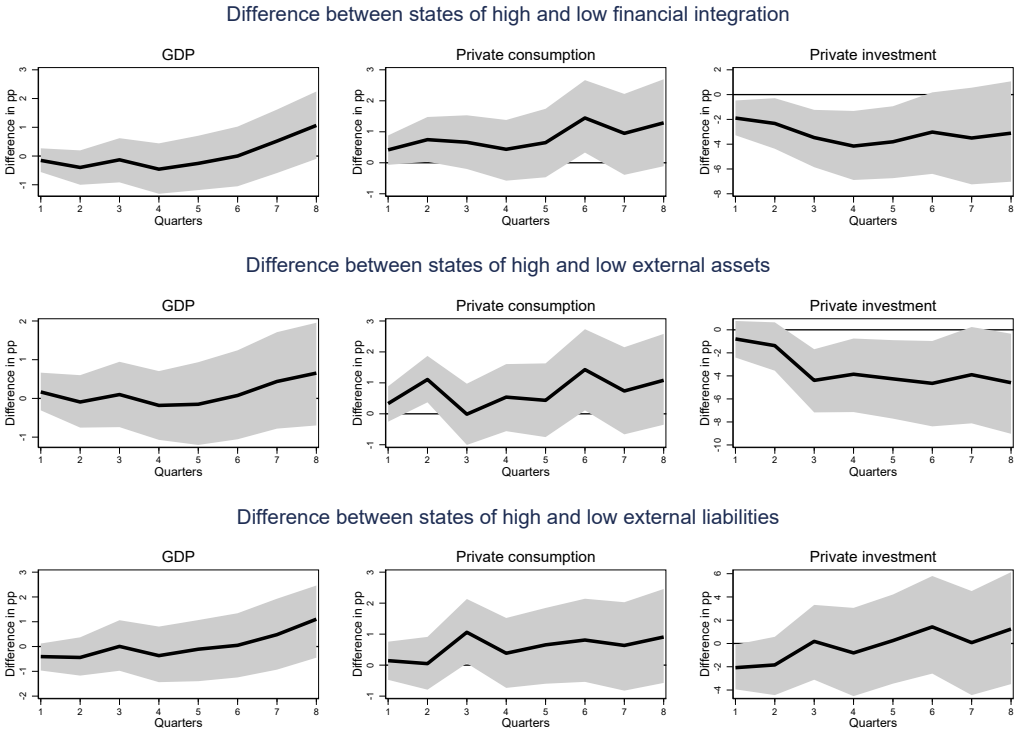
Table C.13: Regression results underlying Fig. 8

Horizon	GDP			Consumption			Investment		
	Mean	Confidence interval		Mean	Confidence interval		Mean	Confidence interval	
	Low institutional quality								
1	0.8	0.1	1.6	0.6	-0.3	1.4	0.8	0.0	1.5
2	-0.1	-1.0	1.0	0.4	-0.8	1.5	-0.3	-1.5	0.8
3	0.4	-1.0	2.1	0.6	-0.7	2.1	-0.2	-1.4	1.0
4	0.0	-1.8	1.5	0.7	-0.9	2.3	-0.8	-2.3	0.9
5	0.0	-2.1	2.0	0.4	-1.4	2.2	-1.0	-2.8	0.7
6	0.2	-1.9	2.3	0.7	-1.4	2.8	-0.9	-2.9	1.1
7	1.9	-0.1	3.9	2.6	0.4	4.9	0.6	-1.5	2.6
8	3.3	1.1	5.2	4.5	2.1	6.9	2.2	0.2	4.4
	High institutional quality								
1	0.1	-0.6	0.7	-0.4	-1.0	0.3	0.0	-0.7	0.7
2	1.3	0.3	2.2	0.3	-0.5	1.1	1.2	0.2	2.2
3	0.7	-0.4	1.9	0.3	-0.6	1.2	0.2	-0.9	1.3
4	1.7	0.5	3.3	1.1	0.1	2.2	1.1	-0.2	2.3
5	1.8	0.2	3.4	1.2	0.0	2.6	1.0	-0.6	2.3
6	2.3	0.6	3.9	1.3	-0.2	2.9	1.5	0.0	2.9
7	2.5	0.7	4.3	0.9	-0.6	2.3	1.6	-0.1	3.5
8	2.4	0.5	4.5	0.7	-0.9	2.3	1.6	-0.1	3.5

Notes: The table shows the regression results underlying the figure referenced in the table caption. It contains the point estimates and one-standard deviation confidence bands based on 500 draws.

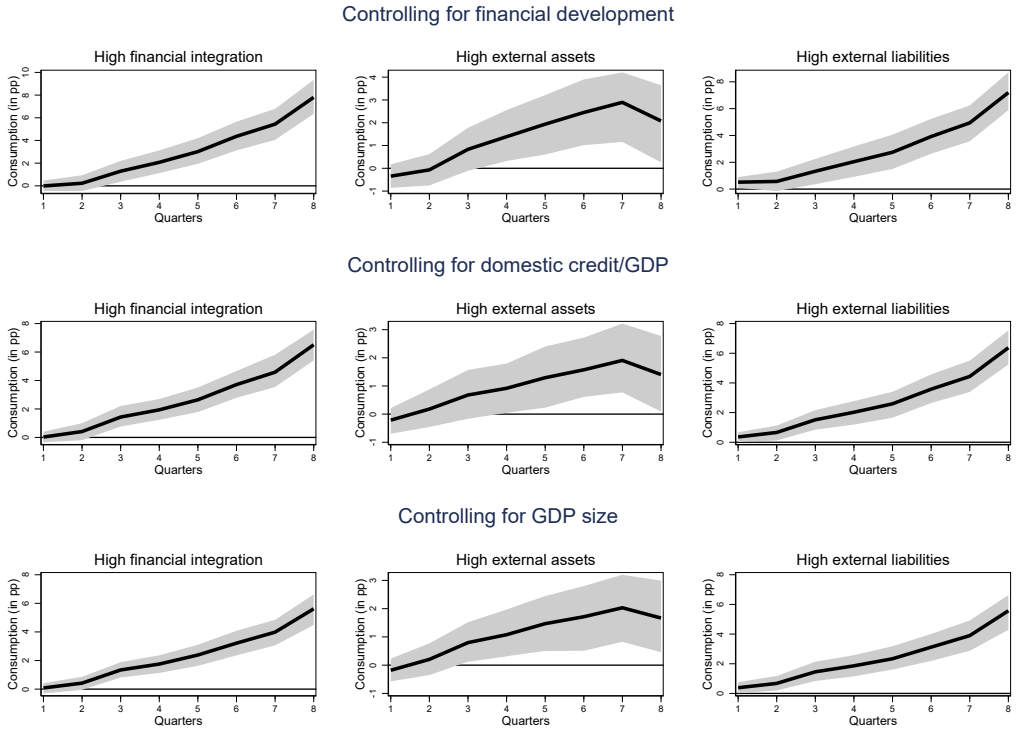
D Sensitivity analysis

Figure D.7: Fixed classification of emerging markets



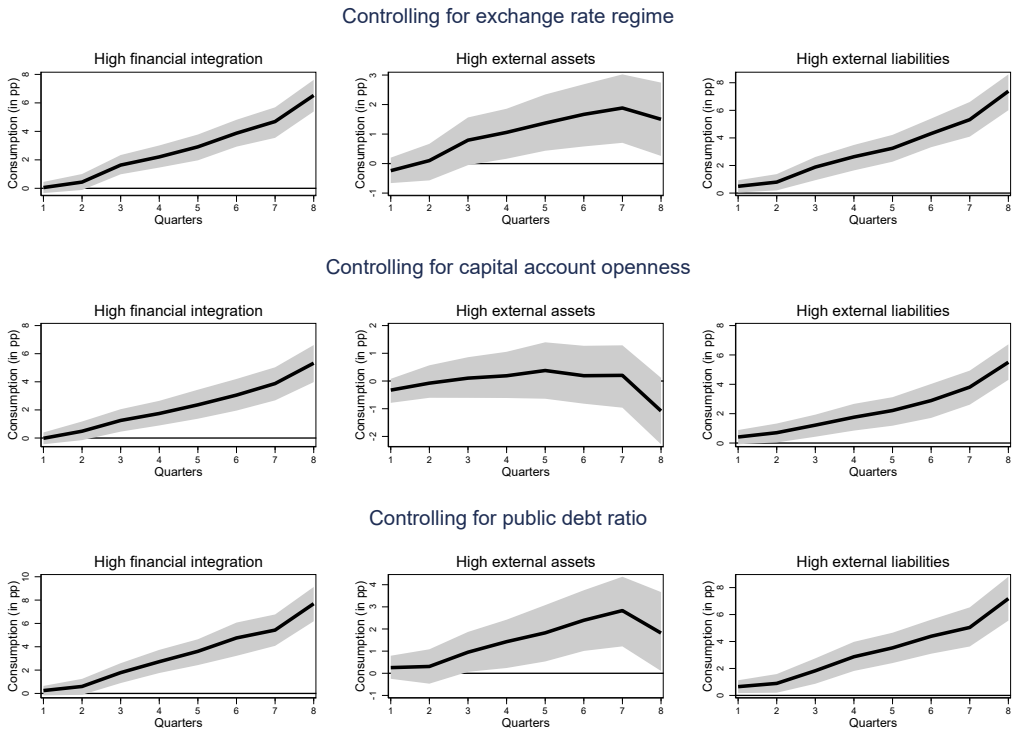
Notes: The figure shows the cumulative difference of GDP, private consumption, and private investment between countries with high and low external financial positions following a natural disaster for a sample of emerging economies. The financial indicators are based on total external assets and liabilities/GDP (top panels), total external assets/GDP (middle panels), and total external liabilities/GDP (bottom panels). The indicators are fixed per country. The indicator is 1 if the country mean of the financial integration variable is above the sample median; and 0 otherwise. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.8: Controlling for domestic financial shock absorbers



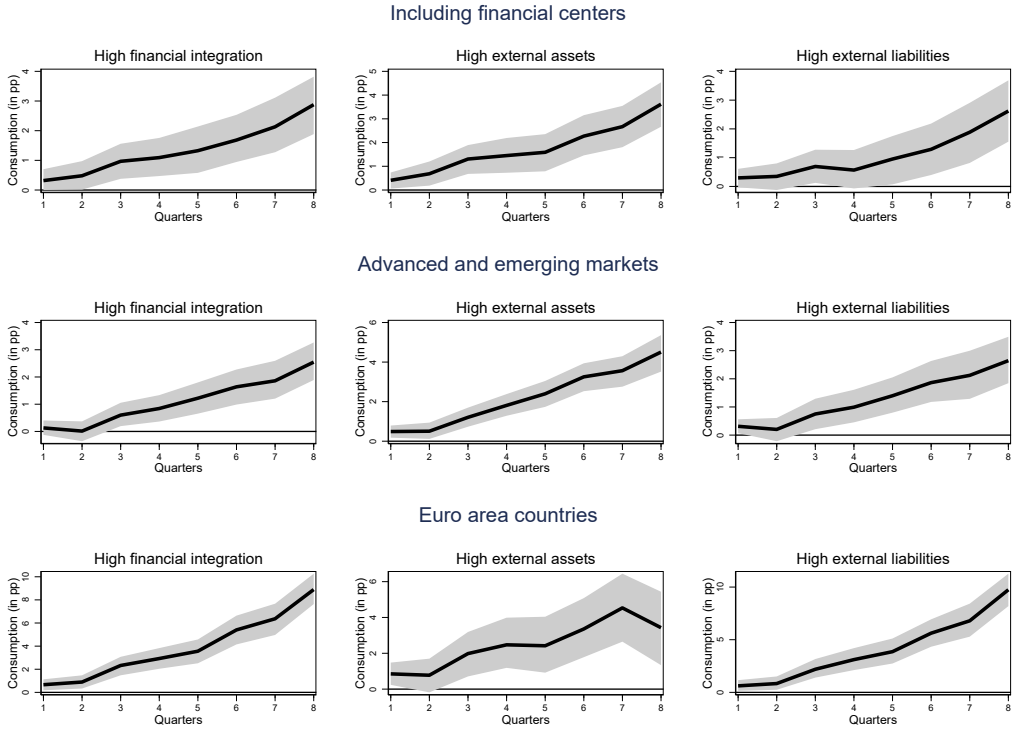
Notes: The figure illustrates the cumulative difference of private consumption between states of high and low external financial positions following a natural disaster for a sample of advanced economies. Model (1) is extended one-by-one with the level of financial development, the domestic credit/GDP ratio, or GDP size as well as with interaction terms between these and the shock variable for 8 lags. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.9: Controlling for alternative economic shock absorbers



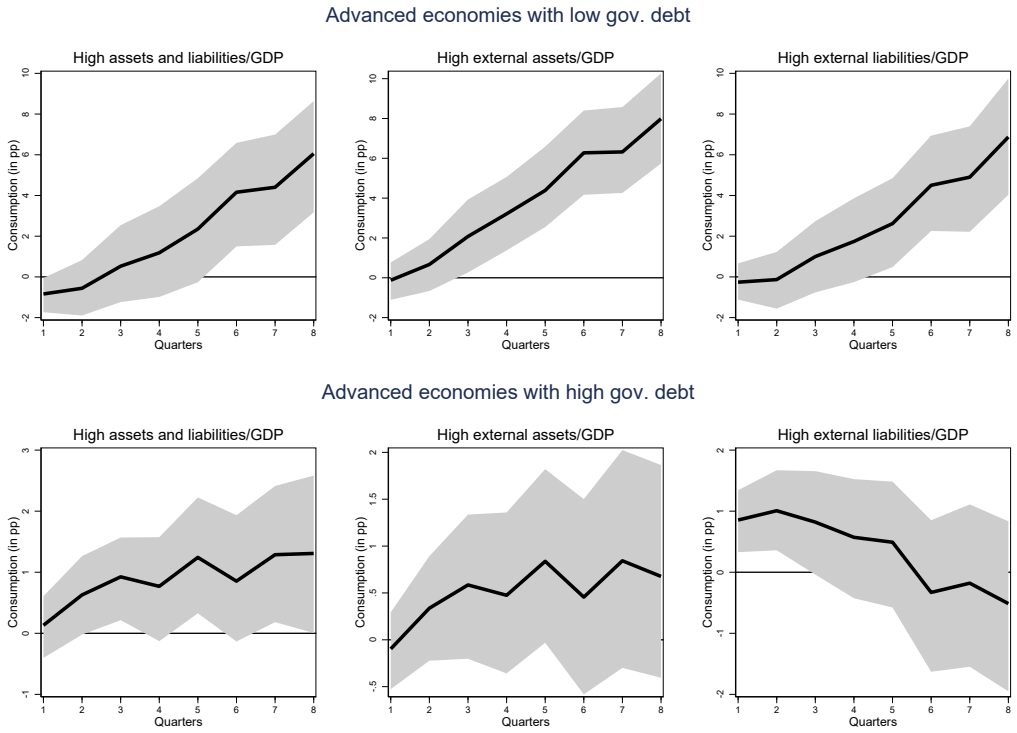
Notes: The figure illustrates the cumulative difference of private consumption between states of high and low external financial positions following a natural disaster for a sample of advanced economies. Model (1) is extended one-by-one with GDP, public debt to GDP, and the ratio of foreign reserves to GDP, respectively, as well as interaction terms between these variables and the shock variable for 8 lags. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.10: Sensitivity to sample composition



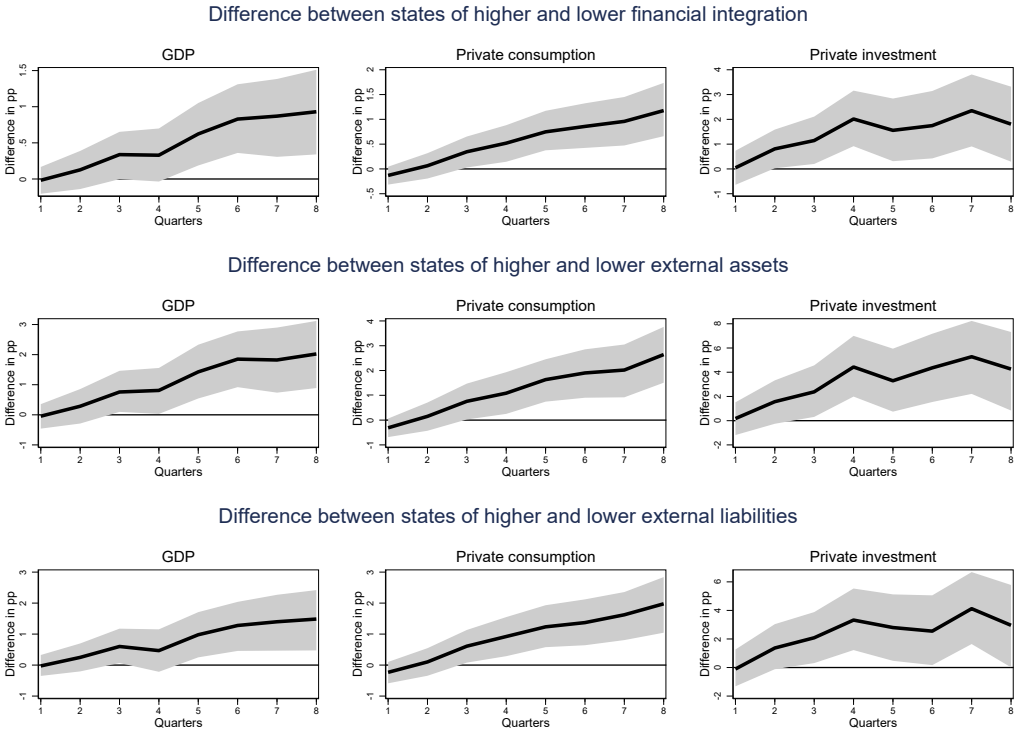
Notes: The figure illustrates the cumulative difference of private consumption between states of high and low external financial positions following a natural disaster for a sample of (a) advanced economies plus financial center countries, (b) advanced and emerging countries, and (c) euro area countries. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.11: Sensitivity to splitting sample based on government debt



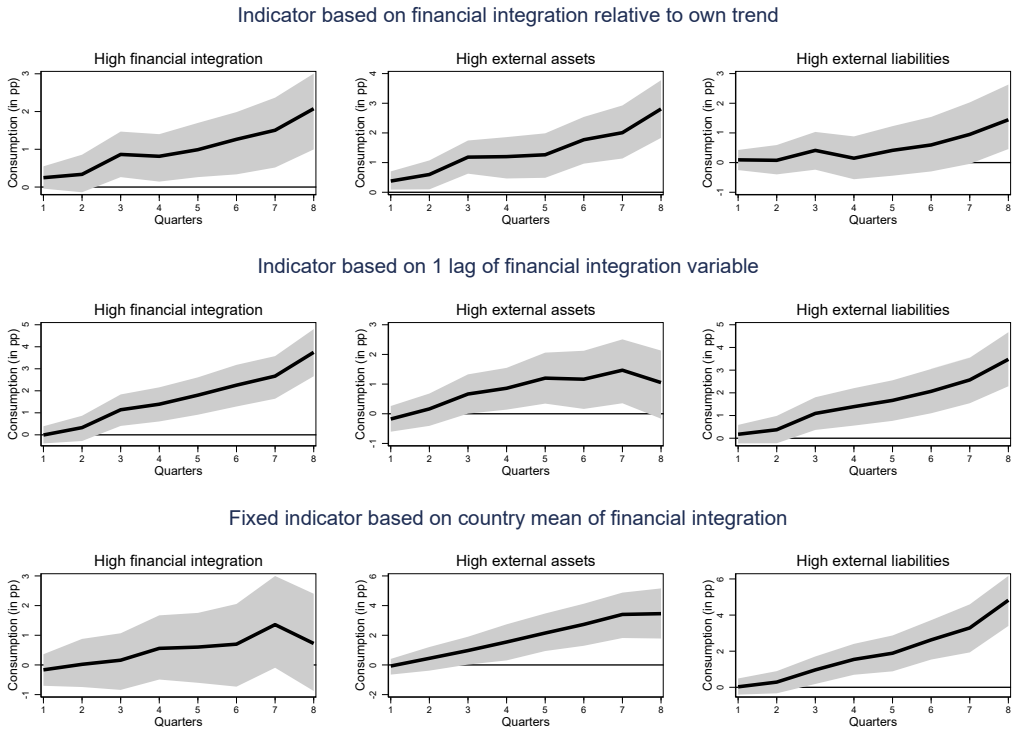
Notes: The figure illustrates the cumulative difference of private consumption between states of high and low external financial positions following a natural disaster for a sample of advanced economies with low government debt (upper panels) and high government debt (bottom panels). Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.12: Sensitivity to using continuous financial integration measure



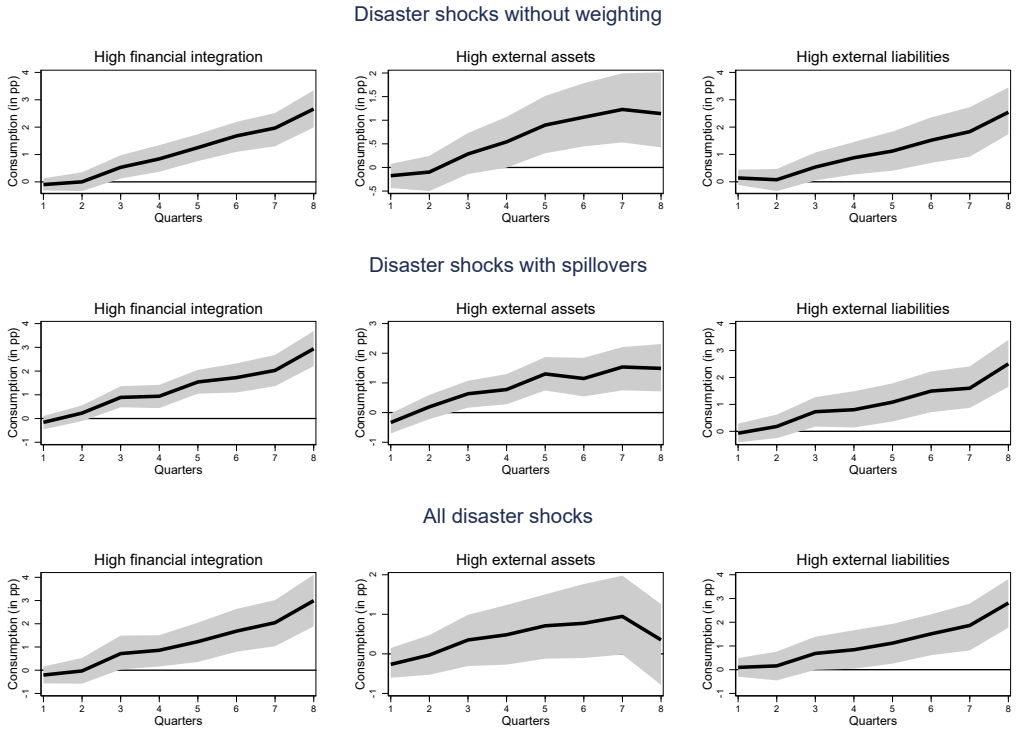
Notes: The figure shows the cumulative difference of GDP, private consumption, and private investment between countries with high and low external financial positions following a natural disaster for a sample of advanced economies. Financial integration is continuously measured as total external assets and liabilities/GDP (top panels), total external assets/GDP (middle panels), and total external liabilities/GDP (bottom panels). Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.13: Sensitivity to construction of state variable



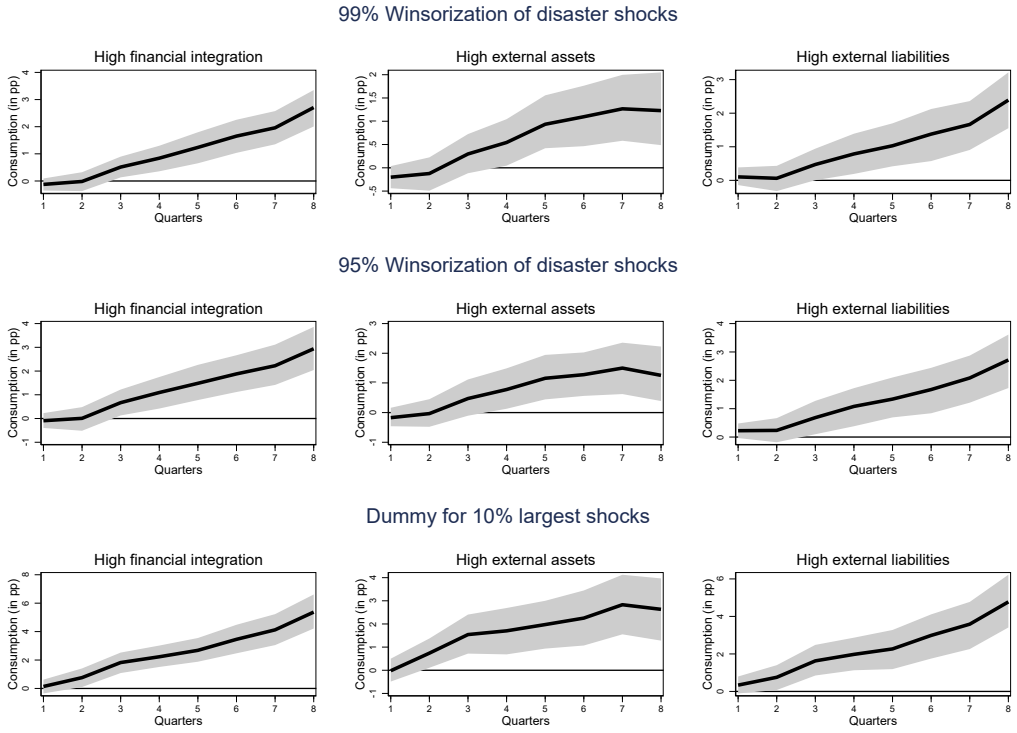
Notes: The figure illustrates the cumulative difference between the response of private consumption for high and low external financial positions following a natural disaster for the sample of advanced economies. The indicators of financial integration are computed based on whether (a) the two year trailing moving average of the continuous financial integration variable is above or below the country specific log trend of the variable, (b) the lagged financial integration variable is above or below the sample median, (c) the country-average of the financial integration variable is above or below the sample median, resulting in a time-invariant indicator by country. Shaded areas are one-standard error confidence bands based on 500 draws.

Figure D.14: Sensitivity to different shock measures



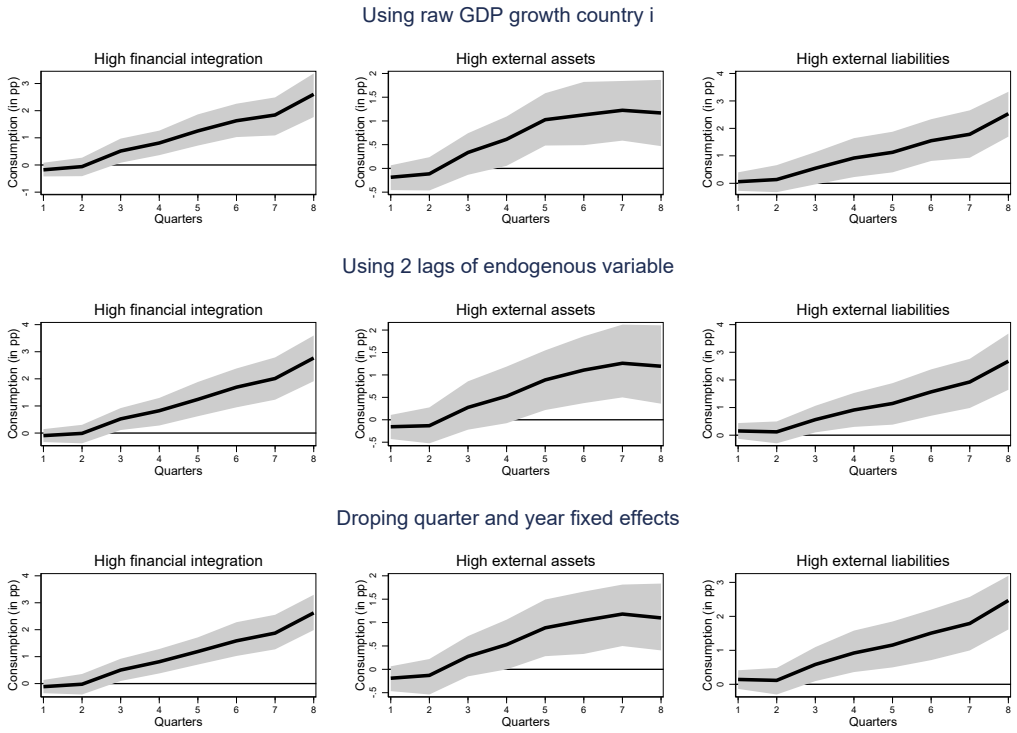
Notes: The figure illustrates the cumulative difference between the response of private consumption for high and low external financial positions following a natural disaster for the sample of advanced economies for alternative shock measures. The shocks are computed (a) without weighting by the onset month, (b) including spillovers into the next quarter, (c) using all shocks, not just the 50% largest ones. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.15: Sensitivity to winsorization and indication of shocks



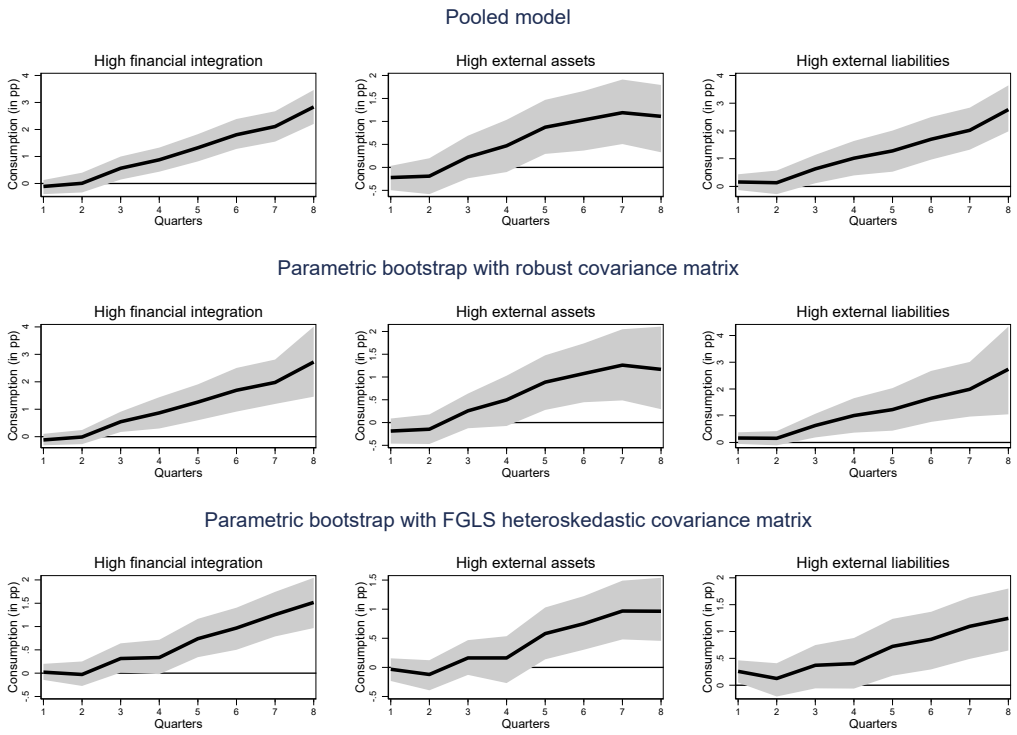
Notes: The figure illustrates the cumulative difference between the response of private consumption for high and low external financial positions following a natural disaster for the sample of advanced economies for alternative shock specifications. In the top and middle panels, the shocks are winsorized at the 99th and 95th percentile, respectively, while the bottom panel shows the responses based on a dummy variable for the 10% largest shocks. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.16: Sensitivity to variable and model specification



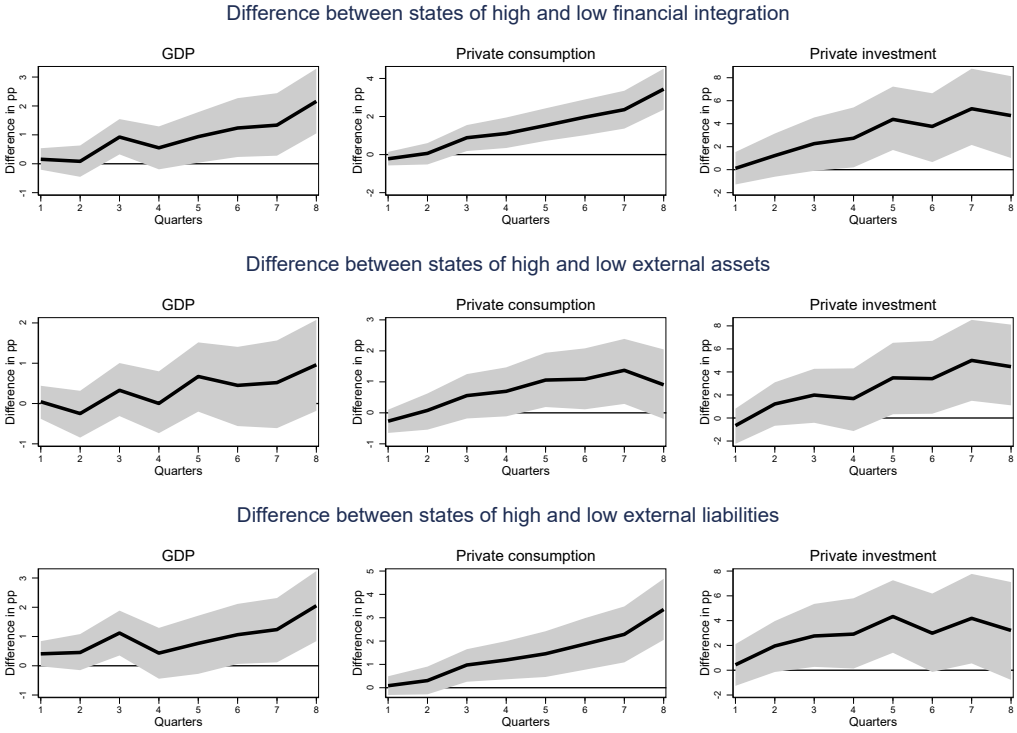
Notes: The figure illustrates the cumulative difference between the response of private consumption for high and low external financial positions following a natural disaster for the sample of advanced economies for alternative variable and model specifications. In the top panels, we use raw ouput growth instead its difference to average growth in that quarter. In the middle panels, the model contains two lags of the endogenous variable. In the bottom panels, we drop quarter and year fixed effects. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.17: Sensitivity to alternative estimators



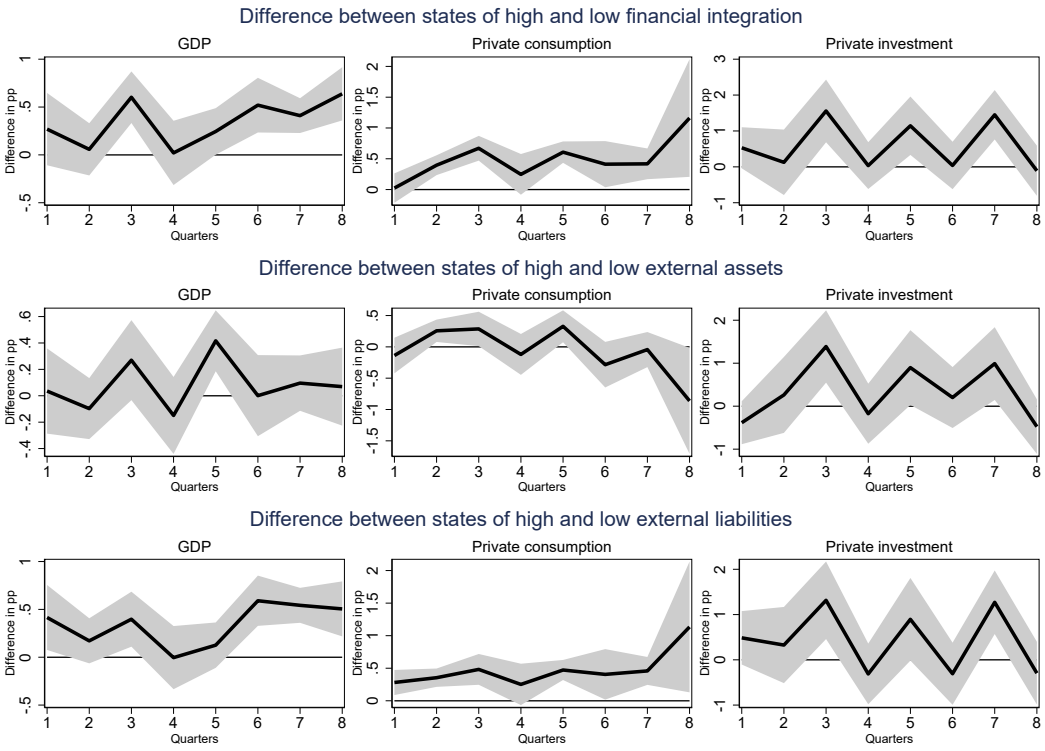
Notes: The figure illustrates the cumulative difference between the response of private consumption for high and low external financial positions following a natural disaster for the sample of advanced economies based on different estimators. The estimators are (a) a pooled model without country fixed effects, (b) the baseline model but with a Huber/White robust covariance matrix for the bootstrap, (c) the baseline model but with a FGLS covariance matrix for the bootstrap that accounts for cross-sectional heteroskedasticity. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.18: Sensitivity to full set of quarter-time dummies



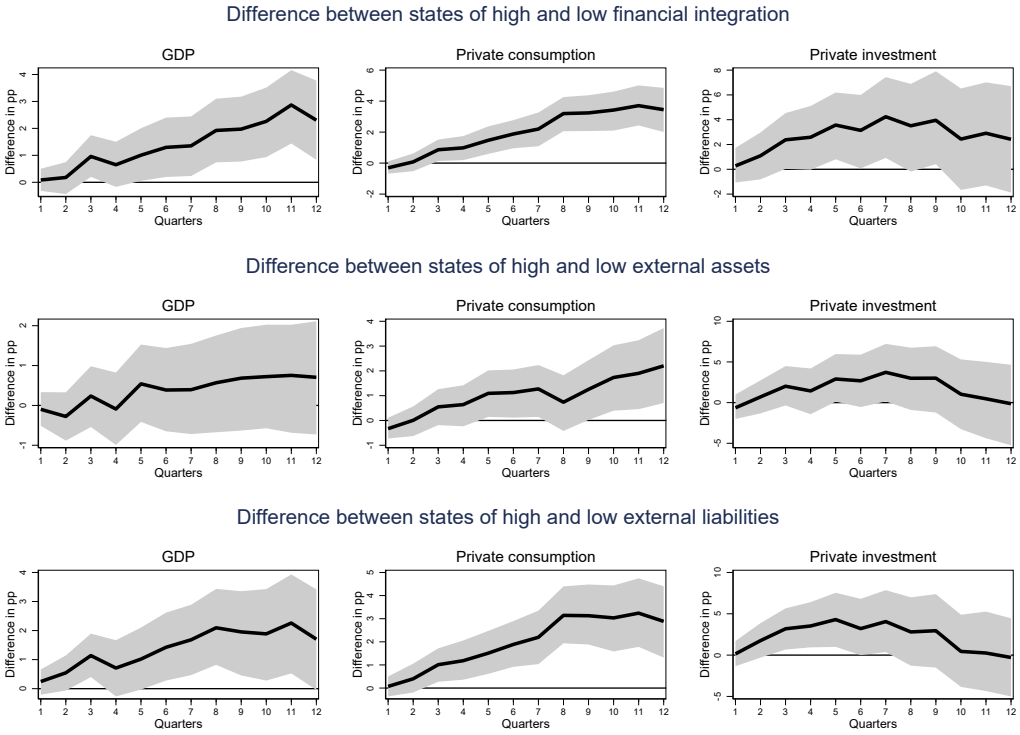
Notes: The figure illustrates the cumulative difference between the response of GDP, private consumption, and private investment for high and low external financial positions following a natural disaster for the sample of advanced economies based on a model that includes a full set of quarter-time dummies and excludes the year-time dummies. Shaded areas are one-standard deviation confidence bands based on 500 draws.

Figure D.19: Sensitivity to using local projections



Notes: The figure illustrates the cumulative difference between the response of GDP, private consumption, and private investment for high and low external financial positions following a natural disaster for the sample of advanced economies based on local projections. Shaded areas are one-standard deviation confidence bands based country clustered standard errors.

Figure D.20: Sensitivity to using 12 lags



Notes: The figure shows the cumulative difference of output, private consumption, and private investment between states of high and low financial integration over 12 quarters following a natural disaster based on model (1) in 25 advanced economies (in percentage points, y-axis). Shaded areas are one-standard error confidence bands based on 500 Monte Carlo draws. The x-axis displays the quarters after the shock.