Contagion from equity market shocks: A framework for measuring losses in the European Union

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2026 RiskLab/BoF/ESRB Joint Conference on AI and Systemic Risk Analytics (SRA 2026)
Helsinki, 3 June 2026

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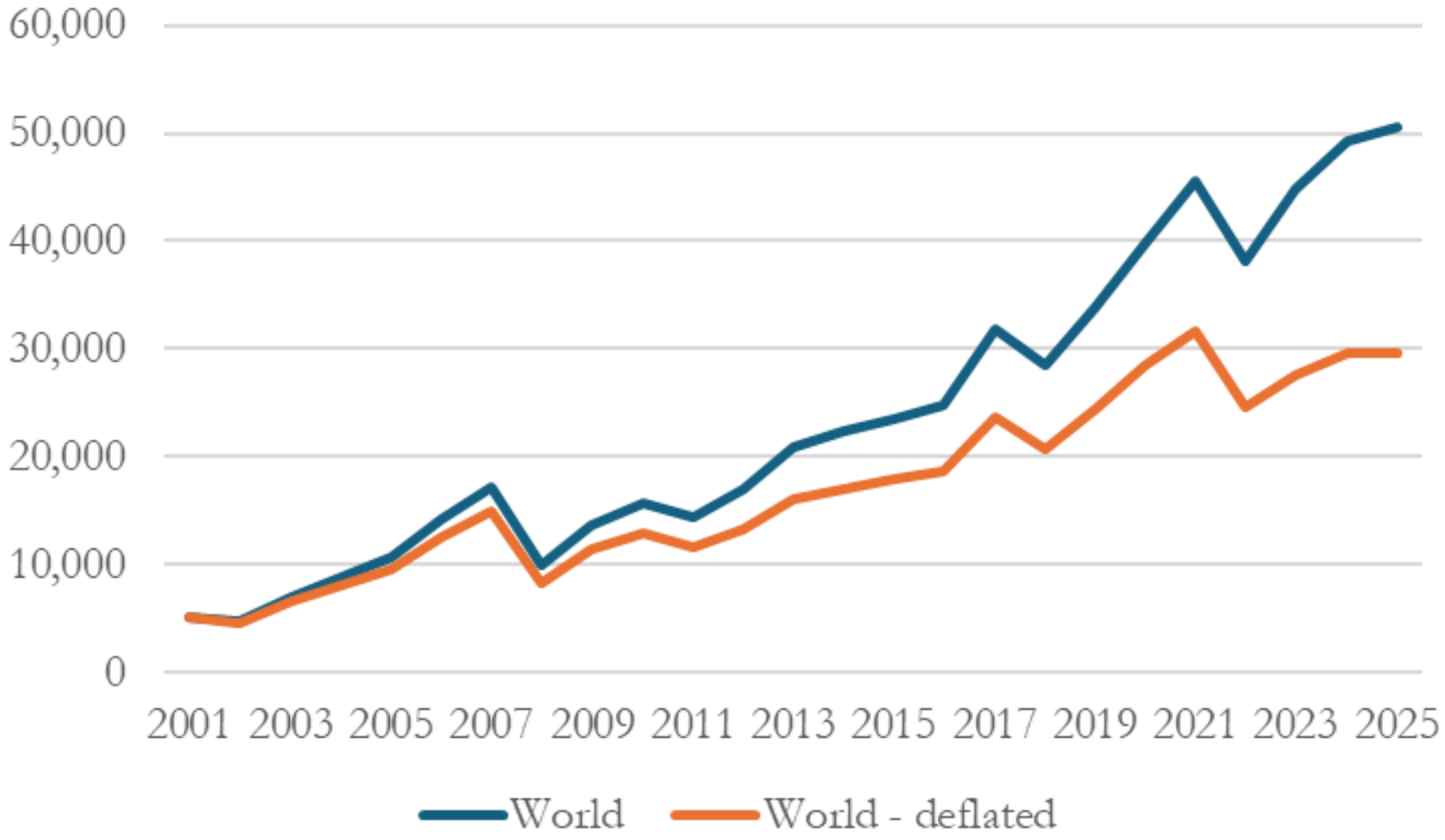
Motivation

- Financial globalisation has been a defining feature of the post-Second World War era. Countries have become increasingly interconnected through real and financial linkages.
- This process has been characterised by a sustained rise in cross-border portfolio holdings as documented by Lane and Milesi-Ferretti (2001, 2007).
- Countries are increasingly exposed to developments in foreign financial markets through their holdings, among others, of equities and investment fund shares.
- This channel of interconnectedness has important implications for financial stability.

World equity portfolio investment (billion USD)



Source: IMF and Haver Analytics. Notes: the price index of advanced economies from the IMF World Economic Outlook has been used to deflate the series.

Purpose

- Develop a framework for quantifying the transmission of equity market shocks via cross-border portfolio holdings, and estimating the sectoral distribution of the related losses.
- The framework focuses on listed shares and investment fund shares and captures four channels of loss transmission.
- Four channels of transmission:
  - Direct losses from exposures in the country where the shock originates,
  - Indirect losses transmitted via investment funds domiciled in other countries but investing in the affected market,
  - Cross-country contagion effects driven by the co-movement of equity prices, and
  - Domestic spillovers via local equity markets.

Literature

- Use of international investment position data to assess global financial linkages: Kubelec and Sá (2012), Almeida (2015), Peltonen et al. (2019), Coppola et al. (2021).
- Use of who-to-whom (flow of funds) data to analyse contagion channels and transmission of shocks: Castrén and Kavonius (2009), Grodzicki and Silva (2017), Oura (2022), Acharya et al. (2024).
  - Map financial interconnections in the euro area: Andersen and Sánchez Serrano (2024), Sánchez Serrano (2025).
  - Map financial interconnections in EU countries: Mouakil et al. (2024), Saldias and Mizinski (2025), Sánchez Serrano (2025).

Main data sources

- Who-to-whom accounts of EU countries.
- Portfolio investment in equity and investment fund shares, and in debt securities, from Eurostat (EU countries) and IMF (non-EU countries).

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<tr><td colspan="2"></td><td colspan="4">European Union</td><td colspan="4">Extra European Union</td></tr>
<tr><td colspan="2"></td><td>Country 1</td><td>Country 2</td><td>…</td><td>Country 27</td><td>Country 28</td><td>Country 29</td><td>…</td><td>Country N</td></tr>
<tr><td rowspan="4">European Union</td><td>Country 1</td><td colspan="4" rowspan="4">Eurostat – International Investment Positions</td><td colspan="4" rowspan="4"></td></tr>
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<tr><td rowspan="4">Extra European Union</td><td>Country 28</td><td colspan="8" rowspan="4">IMF – Portfolio Investment Positions</td></tr>
<tr><td>Country 29</td></tr>
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<tr><td>Country N</td></tr>
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- Reference date for both datasets is end 2024.

Combining data sources

- Who-to-whom: rest of the world.
- International investment position: country breakdown.
- Both datasets are based on consistent methodologies but the total for the rest of the world does not usually match the country breakdown.
- First step: create an unknown category for the data from the international investment position not attributed to a country.
- Second step: compute the share of each country over the total in international investment position.
- Third step: apply these shares to the aggregate for the rest of the world.

Limitations

- High level of aggregation leaves aside significant intra-sectoral heterogeneity in business models (for instance, life and non-life insurance).
- Our focus is on equity price shocks, abstracting from interactions with other asset classes (i.e., debt securities) or feedback effects with the real economy.
- Valuation is at market prices, so changes between two periods can be due to changes in volume (i.e., transactions) or changes in prices.
- Therefore, the results should be interpreted as first-order estimates rather than precise predictions.

Computation of losses

Direct losses

$$DL_t^{i,j^*} = \sum_{s=1}^{3} \alpha_t^{j^*,s} E_t^{i,j^*,s}$$

Indirect losses

$$IL_t^{i,j^*} = \alpha_t^{j^*,s=2} IX_t^{i,j^*}$$

$$= \left[\omega_t^{i,j^*} \alpha_t^{j^*,s=1} + \left(1 - \omega_t^{i,j^*}\right) \alpha_t^{j^*,s=3}\right] \sum_{\quad} \sum^{K} IX_t^{k,i,j,j^*}$$

Cross-country contagion losses

$$TCCL_t^i = DCCL_t^i + ICCL_t^i$$

$$= \sum_{j \neq j^*} \sum_{s=1}^{3} \gamma^{j,s} \alpha_t^{j^*,s} E_t^{i,j,s} + \sum_{j \neq j^*} \gamma^{j,s=2} \alpha_t^{j^*,s=2} IX_t^{i,j}$$

$E_t^{i,j^*,s}$	Exposure of country i to country j* under shock through financial instrument s (s=1 debt securities, s=2 investment fund shares, s=3 listed shares)
ω_t^{i,j^*}	Share of bond funds in portfolios of investment funds
$\alpha_t^{j^*,s}$	Proportional change in the valuation of instrument s issued in country j*
IX_t^{k,i,j,j^*}	Exposure of sector k in country i to investment fund shares issued in country j≠j* and whose underlying portfolios are invested in country j*
$\gamma^{j,s}$	Sensitivity of asset prices in country j to shocks in country j*
$IX_t^{i,j}$	Country i's indirect exposure to country j via investment funds

Total losses and realisation of losses

- Total losses are the sum of direct, indirect and cross-country contagion losses. Unless the securities are sold, they remain latent (i.e., unrealised).
- They could be realised when exceeding a threshold of own funds at sectoral level:

$$RL_t^{k,i} = \begin{cases} 0, & \text{if } TL_t^{k,i} < \beta^{k,i} OF_t^{k,i} \\ TL_t^{k,i}, & \text{otherwise} \end{cases}$$

- Once losses are realised, they can propagate within countries through domestic balance sheet linkages between sectors. When a sector absorbs losses, its weakened balance sheet reduces the value of claims held by other sectors.
- Moreover, the shock may persist over time and trigger further rounds of losses, albeit with lower intensity.

Simulation of a shock to U.S. equity prices

- Let's assume a 10% drop of prices in stock markets in the United States.
- How large would that shock be?

10-Worst Single-Day Percent Declines for US Stocks 1981–2025

Date	Cause	One-Day Decline (%)	# Days To Reach Previous High	Annualized (%)		
				Return After 1 Year	Return After 3 Years	Return After 5 Years
1. October 19, 1987	Black Monday	-20.47	264	23.19	11.59	13.03
2. March 16, 2020	COVID-19 Pandemic	-11.98	19	66.07	18.41	18.77
3. March 12, 2020	COVID-19 Pandemic	-9.51	20	58.96	15.91	17.69
4. October 15, 2008	Global Financial Crisis	-9.03	15	20.79	10.50	13.34
5. December 1, 2008	Global Financial Crisis	-8.93	6	35.85	15.11	17.22
6. September 29, 2008	Global Financial Crisis	-8.79	410	-4.14	1.60	8.87
7. October 26, 1987	Black Monday 2.0	-8.28	5	23.59	10.20	12.92
8. October 9, 2008	Global Financial Crisis	-7.62	3	17.76	8.30	12.73
9. March 9, 2020	COVID-19 Pandemic	-7.60	57	41.10	12.58	16.01
10. October 27, 1997	Asian Financial Crisis	-6.87	8	21.48	16.30	0.47

Past performance does not guarantee future results. Data shown is for the S&P 500 Price Index as of 3/17/25. Indices are unmanaged and not available for direct investment.

Data Sources: Morningstar, Ned Davis Research, and Hartford Funds, 3/25.

Computation of losses: additional assumptions

- Estimation of the share of bond investment funds, using data from the ECB (IVF): only bond and real estate investment funds.
  - When there is no data for non-euro area countries, we use the euro area average.
- Exposures to Ireland and Luxembourg:
  - Only for investment fund shares (no listed shares).
  - Associated losses are distributed according to the share of each EU country over total exposures.
  - Non-EU countries do not invest in investment funds to get exposure to non-EU markets, only to get exposed to EU markets.
- Correlation between the stock index of the United States and other stock indices is calculated from weekly data between 2007 and 2024.
  - US-Europe: 0.9
  - US-advanced economies (CA, AU, KR, JP, NZ): 0.9
  - US-emerging economies: 0.6

Computation of losses

Direct losses

$$DL_t^i = 0.1 \cdot \left[\theta_t^i \cdot \left(1 - \omega_t^i\right)\right] \cdot E_t^{i,\mathrm{US}}$$

Indirect losses

$$IL_t^{i,j^*} = \left(\beta_t^{i,\mathrm{IE}} \cdot DL_t^{\mathrm{IE,US}} + \beta_t^{i,\mathrm{LU}} \cdot DL_t^{\mathrm{LU,US}}\right)$$

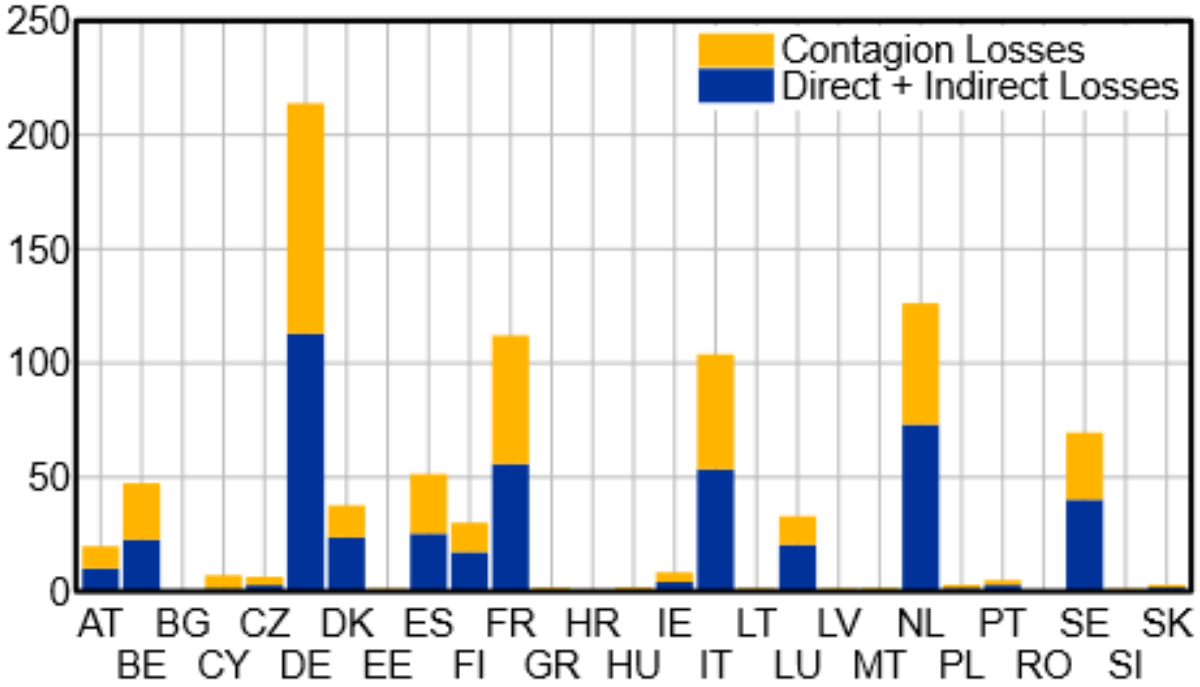
Cross-country contagion losses

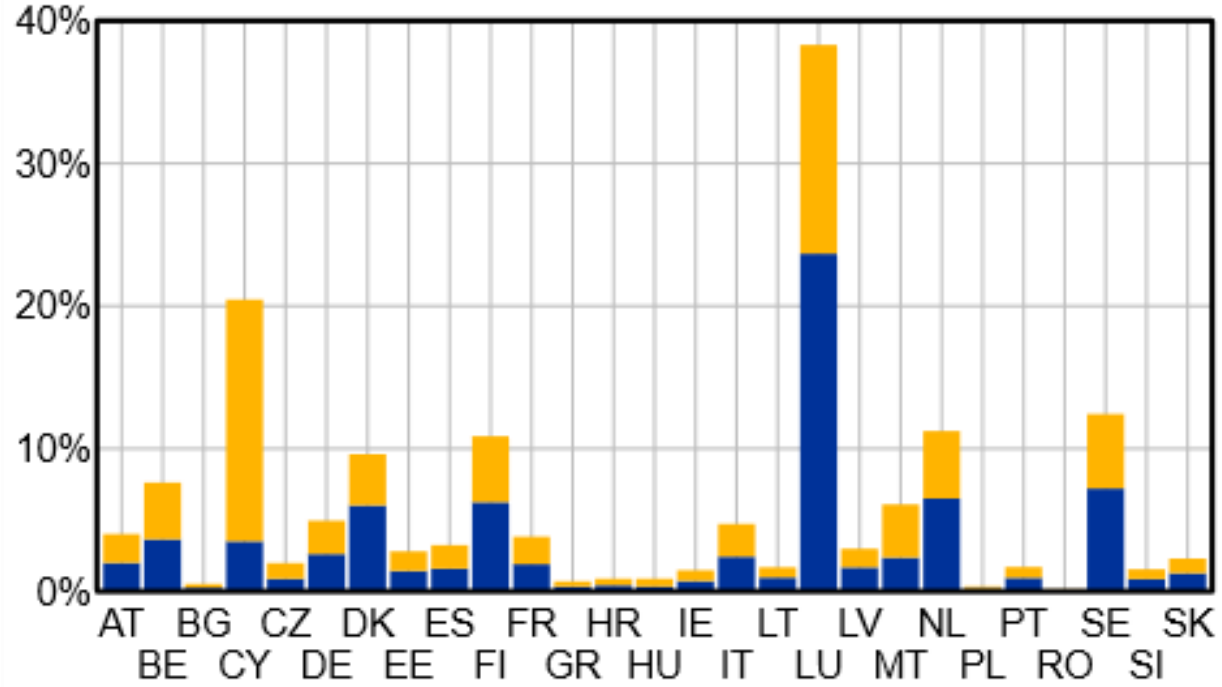
$$\begin{aligned} TCCL_t^i &= \left[\left(\theta_t^i \cdot \left(1 - \omega_t^i\right)\right)\right. \\ &\cdot \left(\left(0.1 \cdot \gamma^{\mathrm{US,EU}} \cdot E_t^{i,\mathrm{EU}}\right) + \left(0.1 \cdot \gamma^{\mathrm{US,AE}} \cdot E_t^{i,\mathrm{AE}}\right)\right. \\ &\left.\left. + \left(0.1 \cdot \gamma^{\mathrm{US,EM}} \cdot E_t^{i,\mathrm{EM}}\right)\right)\right] + \left(\beta_t^{i,\mathrm{IE}} \cdot CCL_t^{\mathrm{IE,US}} + \beta_t^{i,\mathrm{LU}} \cdot CCL_t^{\mathrm{LU,US}}\right) \end{aligned}$$

θ_t^i	Share of investment fund holdings in country i's total foreign listed shares and investment fund holdings
ω_t^i	Share of bond and real estate funds in portfolios of investment funds
$\beta_t^{i,\mathrm{IE}}$, $\beta_t^{i,\mathrm{LU}}$	Share of country i in the investment fund holdings intermediated via Ireland and Luxembourg
$\gamma^{\mathrm{US,EU}}$, $\gamma^{\mathrm{US,AE}}$, $\gamma^{\mathrm{US,EM}}$	Correlations of equity prices between the U.S. and the EU, other advanced economies and emerging economies, respectively

Overall impact: EU latent losses around 890 bn EUR and 5% of GDP

(Latent) losses following a 10% decrease in stock prices in United States, million EUR (lhs) and percentage of GDP (rhs)





Source: ECB, Eurostat, IMF, and authors' calculations. Notes: direct, indirect, and contagion losses assuming a 10% decline in U.S. equity prices. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

Distribution of losses across sectors

- Use who-to-whom data to get the sectoral exposure (HH, NFC, insurance, pensions, banks, investment funds, captive financial institutions, financial auxiliaries and other financial intermediaries) towards the rest of the world through listed shares and investment fund shares.
  - Government and money-market funds are excluded.
- Losses relating to listed shares are allocated in proportion to the respective sector's share in foreign listed shares.
- Losses transmitted via investment funds are allocated on the basis of sectoral holdings of foreign investment fund shares.
- Additional adjustment to exclude bond and real estate funds owned by insurance corporations and pension funds.
- Domestic investment funds are only used by domestic sectors, except in Ireland and Luxembourg.

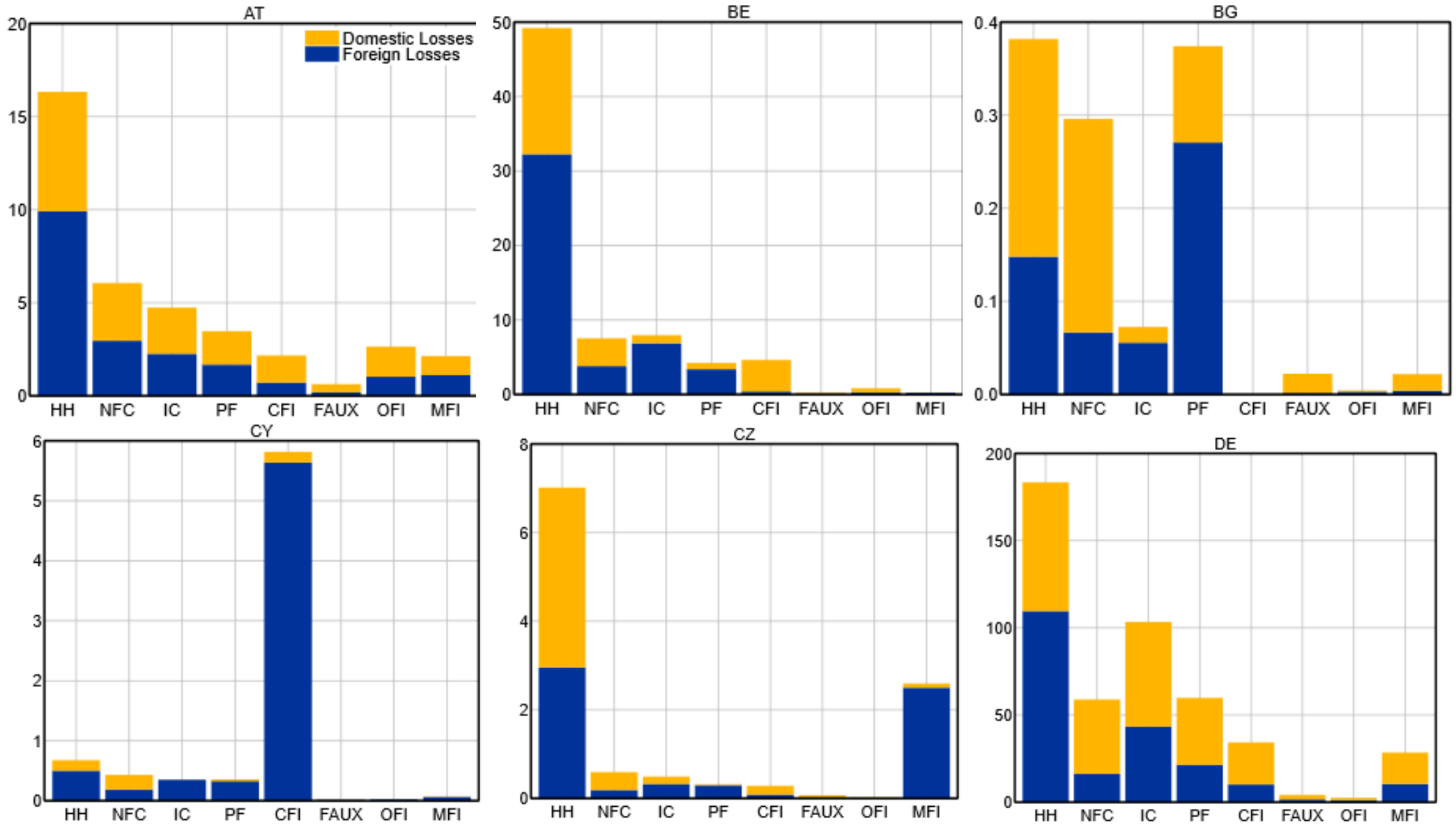
Computation of domestic losses

Domestic losses

$$DOL_t^{k,i} = \left[\theta_t^i \cdot \left(1 - \omega_t^i\right)\right] \cdot \left(0.1 \cdot \gamma^{\mathrm{US,i}} \cdot DX_t^{k,i}\right) + \left(\mu_t^{k,i,s=2} \cdot DOL_t^{k=\mathrm{IF},i}\right)$$

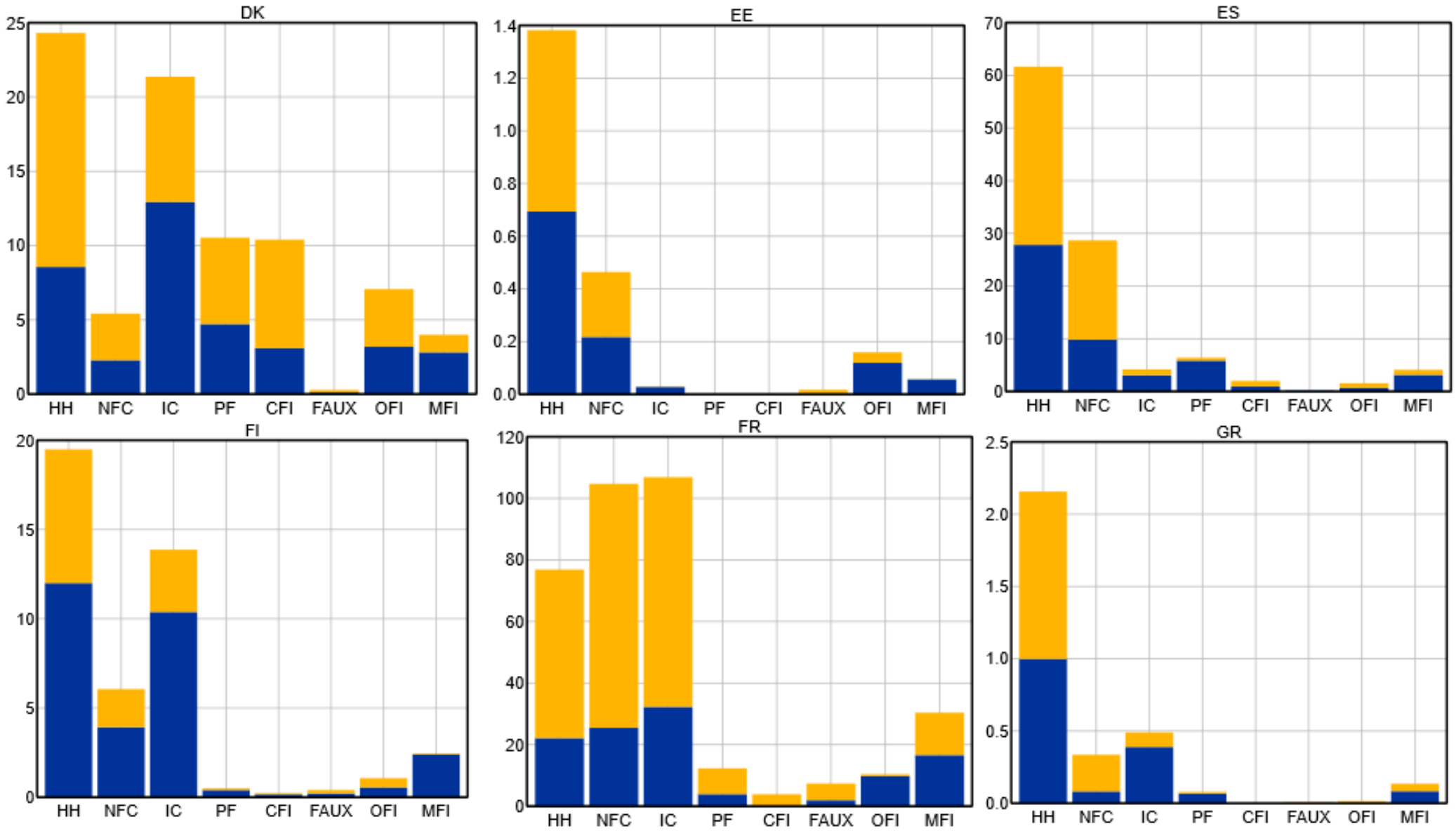
$DX_t^{k,i}$	Domestic holdings of listed shares and investment fund shares
$\mu_t^{k,i,s=2}$	Share of sector k in domestic fund holdings
$DOL_t^{k=\mathrm{IF},i}$	Losses at the level of the domestic investment fund sector

(Latent) losses following a 10% decline in U.S. equity prices, billion EUR (1)



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

(Latent) losses following a 10% decline in U.S. equity prices, billion EUR (2)



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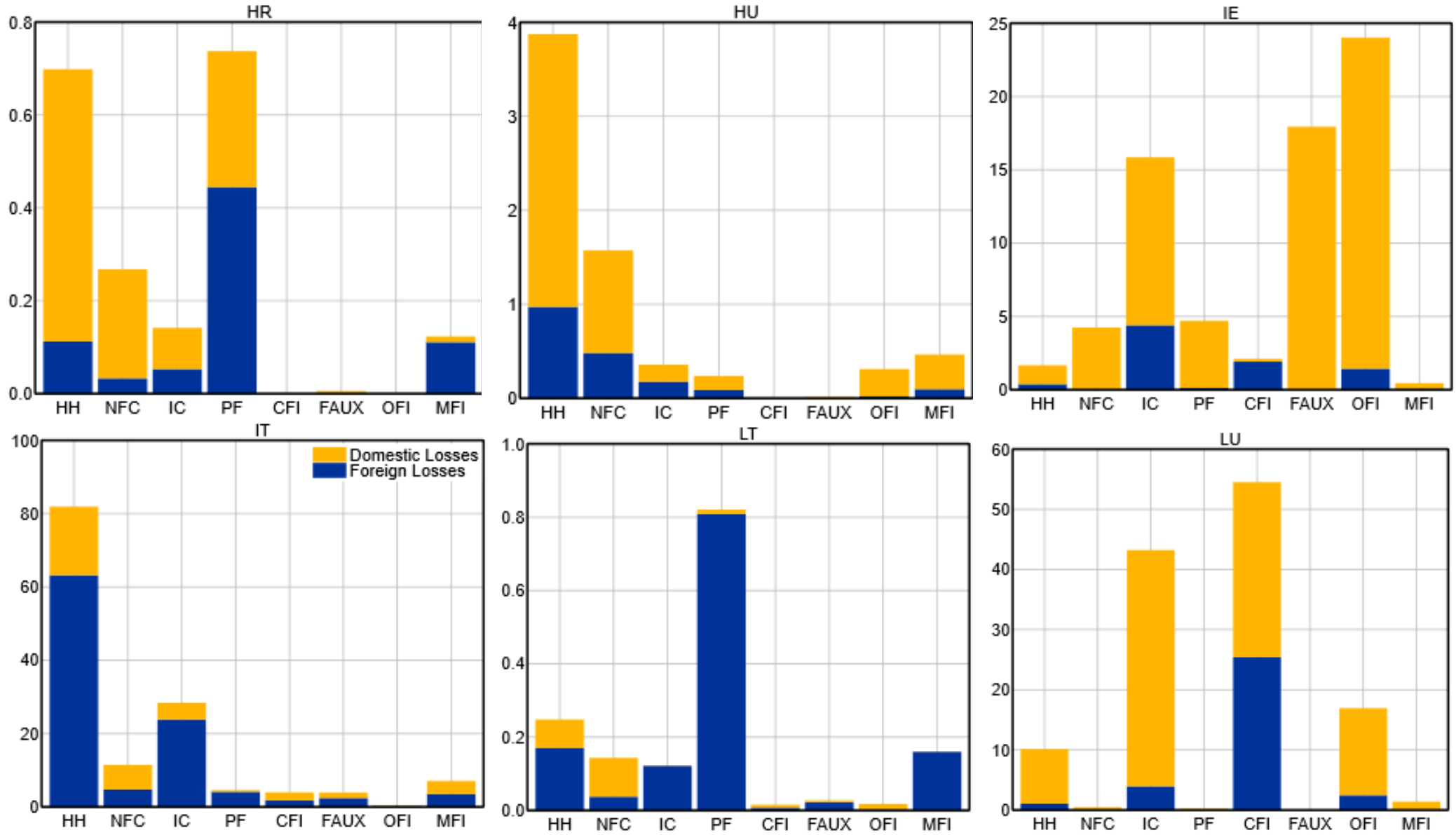
(Latent) losses following a 10% decline in U.S. equity prices, billion EUR (3)



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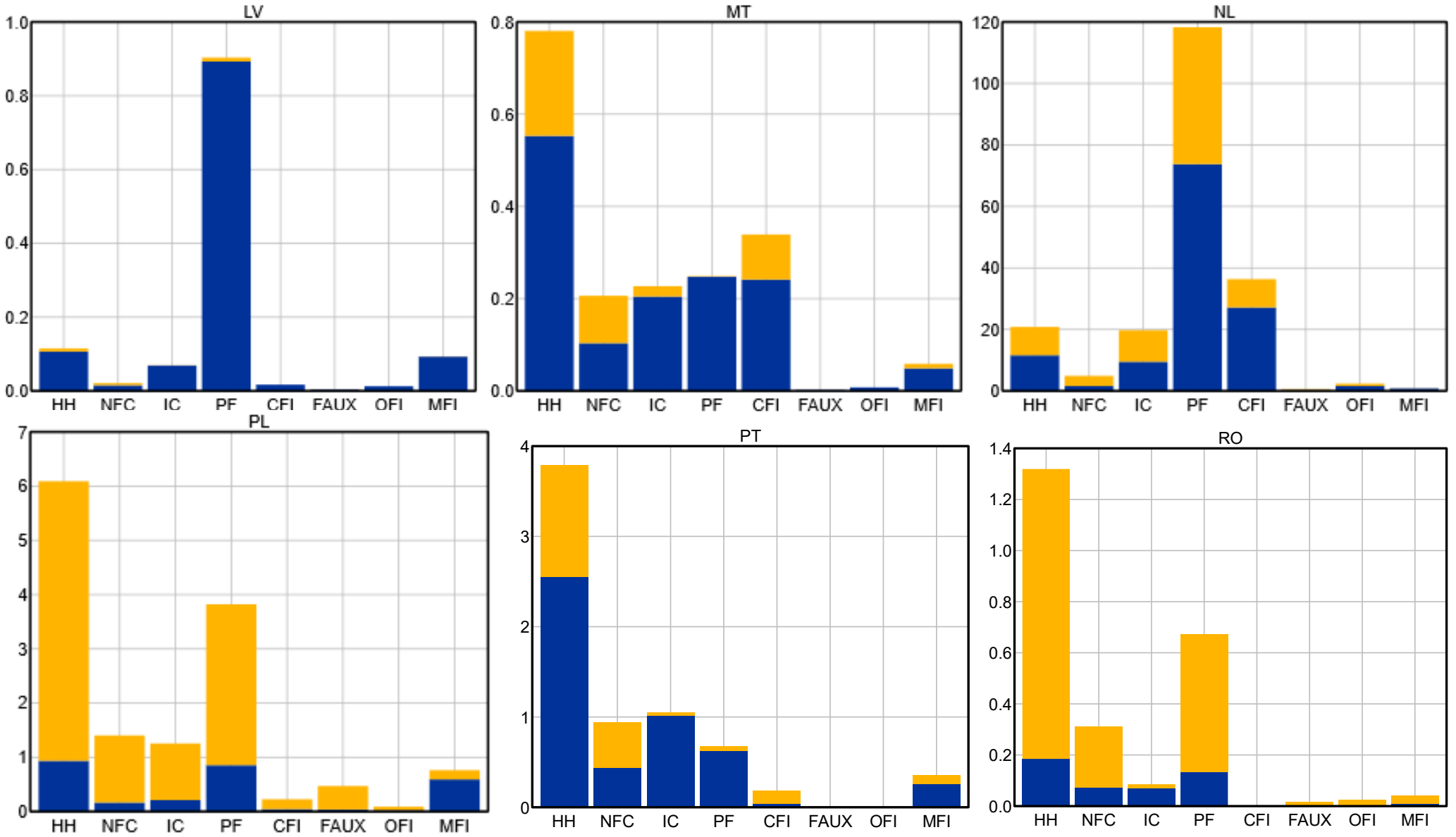
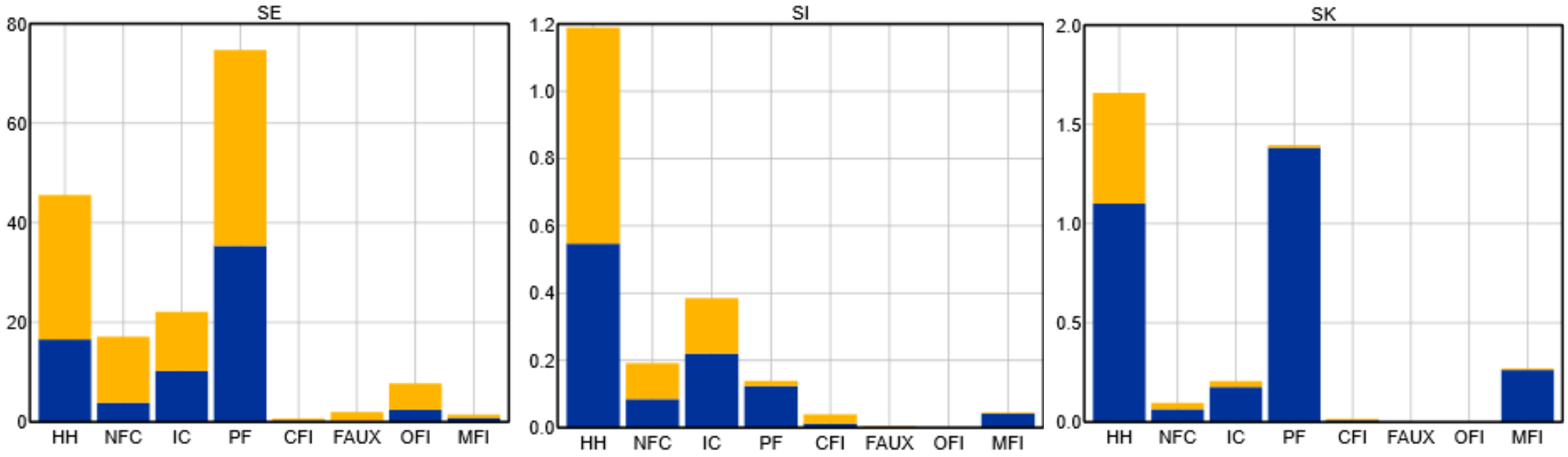
(Latent) losses following a 10% decline in U.S. equity prices, billion EUR (4)



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

(Latent) losses following a 10% decline in U.S. equity prices, billion EUR (5)



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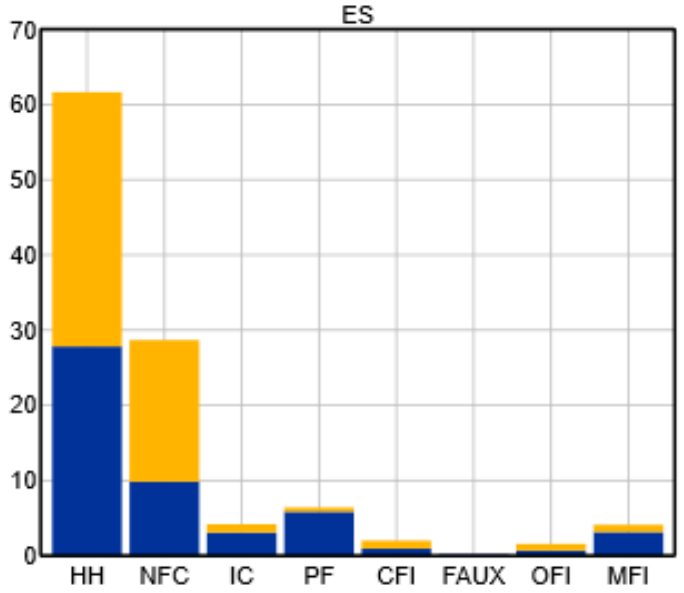
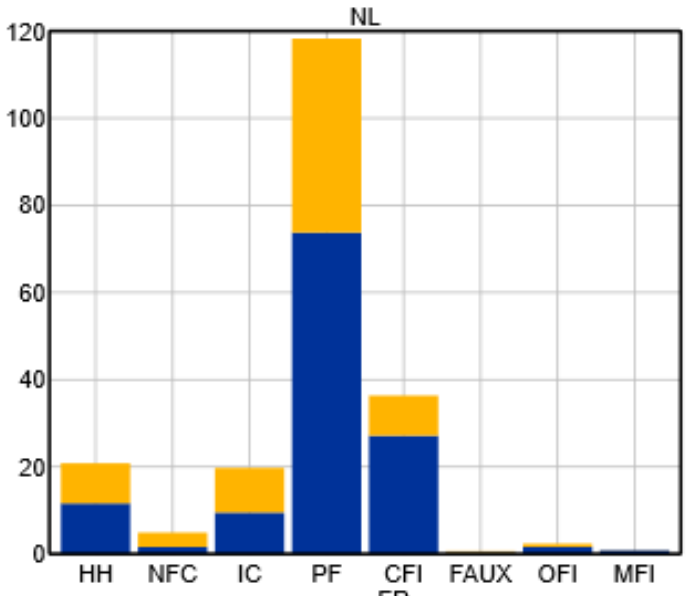
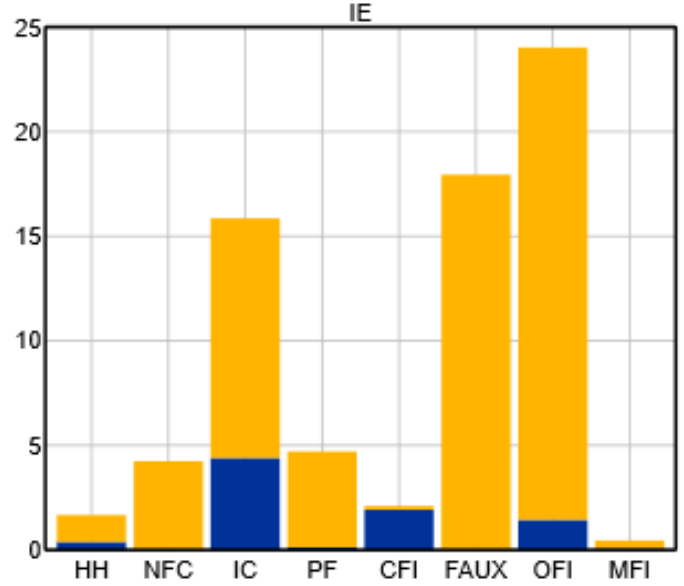
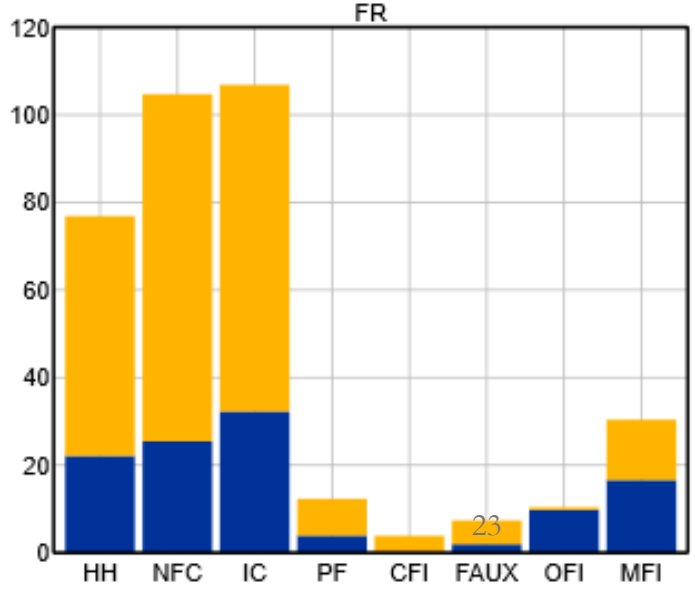
Distribution of losses across sectors

- The relative importance of domestic losses compared with foreign losses varies considerably.
  - In France, Ireland, Luxembourg, and several Central and Eastern European economies, domestic losses account for more than half of total losses.
  - Domestic losses are comparatively low in smaller economies such as Cyprus, Latvia, and Malta.
- At the sectoral level:
  - Households in many countries bear the lion's share of the losses.
  - In few countries, large losses of pension funds and insurance corporations.









From latent to realised losses

- Stock markets tend to rebound quickly after a large fall, so investors may retain their holdings if they are not under pressure to realise the losses.
- Besides, losses are realised only if accounting is at market prices (likely for insurance, pension funds and banks, only).
- Losses could be realised only if they
  - exceed a given threshold of own funds,

$$TRL_t^{k,i,US} \neq 0 \; iif \; TL_t^{k,i,US} > \beta^{k,i} OF_t^{k,i}$$

  - OR accounting follows market values,
  - OR affect leveraged business models.

Computing sectoral own funds: asusmptions

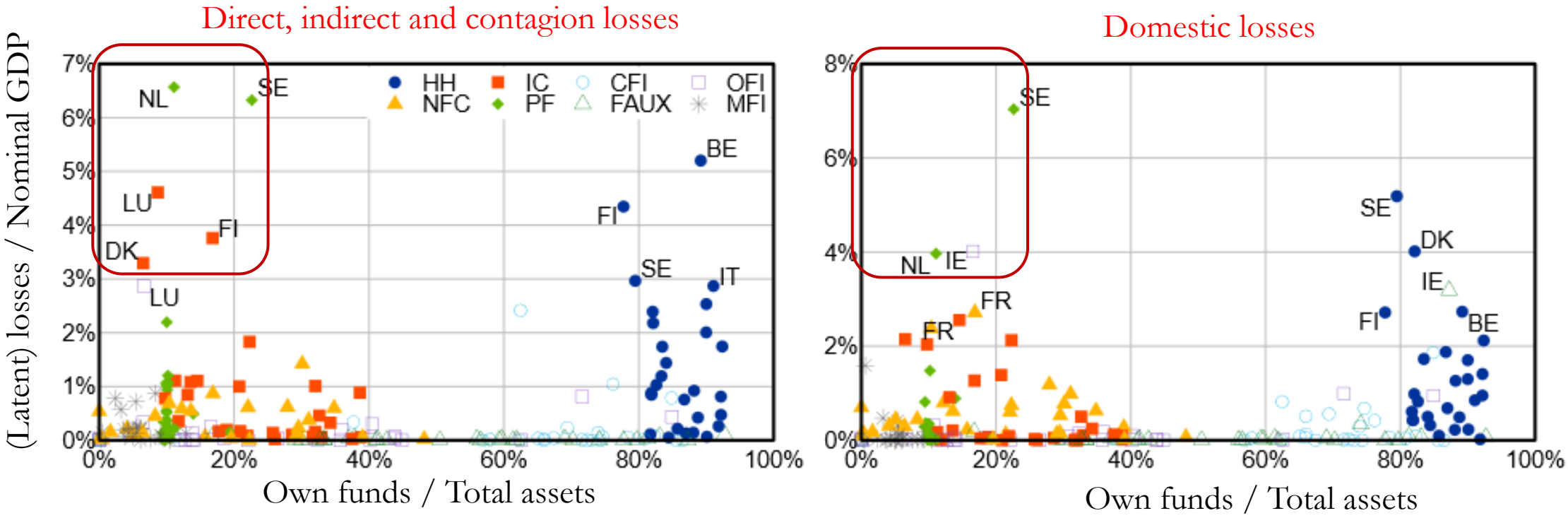
- Own funds are computed from quarterly sectoral accounts, adding several items such as net worth, unlisted shares, listed shares, other equity,…
- Own funds for non-financial corporations do not take into account unlisted shares, which should be mainly related to intragroup holdings.
- Due to data gaps in pension funds, their own funds are computed as the maximum of 10% of total assets and reported net worth and equity.
- Own funds for insurance computed from EIOPA data (excess of assets over liabilities / total assets, multiplied to total assets).

(Latent) losses as share of own funds, percentages

Sector	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK
HH	0.8	1.7	0.2	0.5	0.9	0.9	1.5	1.6	0.7	2.7	0.6	0.2	0.4	0.8	0.1	0.8	0.2	3.8	0.1	1.3	0.4	0.7	0.4	0.4	2.4	0.5	0.6
NFC	1.1	1.4	0.6	-1.8	0.3	1.3	2.6	2.3	1.6	2.2	3.5	-0.4	0.2	0.8	0.7	5.8	0.2	1.7	0.1	2.9	1.5	37	6.9	0.1	5.3	0.4	0.1
IC	15	20	3.0	18	7.2	20	70	5.0	6.8	99	27	13	7.0	15	35	20	12	168	19	3.7	30	5.3	16	3.4	63	12	10
PF	121	87	27	75	13	58	40		37	71	48	32	29	36	36	25	86	126	92	29	56	67	35	21	45	29	66
CFI	2.0	1.4	0.0	1.8	0.7	3.6	1.4	0.0	0.6	16	2.8	0.0	0.0	0.0	0.5	1.9	0.1	0.9	0.4	0.1	1.2	3.0	0.3	0.0	0.4	1.3	-2.7
FAUX	2.1	0.7	2.2	1.1	1.2	1.9	3.4	1.2	0.3	4.8	6.9	0.0	0.5	1.4	13	2.0	1.9	0.0	0.1	0.1	0.4	5.0	0.1	1.7	7.9	0.8	0.0
OFI	53	1.3	0.3	0.4	0.4	-18	3.8	2.1	4.5	5.7	14	0.8	-0.8	5.3	15	0.1	0.4	46	0.9	0.4	4.4	-1.6	0.0	0.4	7.4	0.1	0.0
MFI	3.4	9.8	0.4	2.0	26	5.0	5.9	29	2.2	4.3	6.9	0.6	1.1	2.6	16	3.3	4.3	14	5.3	3.0	0.8	1.2	0.8	0.2	1.7	1.6	6.0

Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. Own funds are generally defined as the sum of net worth, listed shares, unlisted shares, and other equity. Several refinements are introduced. For IC, own funds are measured as the excess of assets over liabilities using EIOPA supervisory data. For PF, own funds are defined as the maximum of 10% of total assets and the base-line measure. For NFCs, unlisted shares are excluded, while for MFIs, own funds are limited to listed shares and other equity. Finally, for HHs and NFCs, we also include fixed assets such as dwellings, buildings, and machinery. Cells are highlighted in red if the ratio of domestic and total losses to own funds exceeds 10%, and in yellow if it lies between 5% and 10%.

Leverage and latent losses



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. Own funds are generally defined as the sum of net worth, listed shares, unlisted shares, and other equity. Several refinements are introduced. For IC, own funds are measured as the excess of assets over liabilities using EIOPA supervisory data. For PF, own funds are defined as the maximum of 10% of total assets and the base-line measure. For NFCs, unlisted shares are excluded, while for MFIs, own funds are limited to listed shares and other equity. Finally, for HHs and NFCs, we also include fixed assets such as dwellings, buildings, and machinery. Total assets include both financial and non-financial assets. The countries with the ten largest losses are annotated.

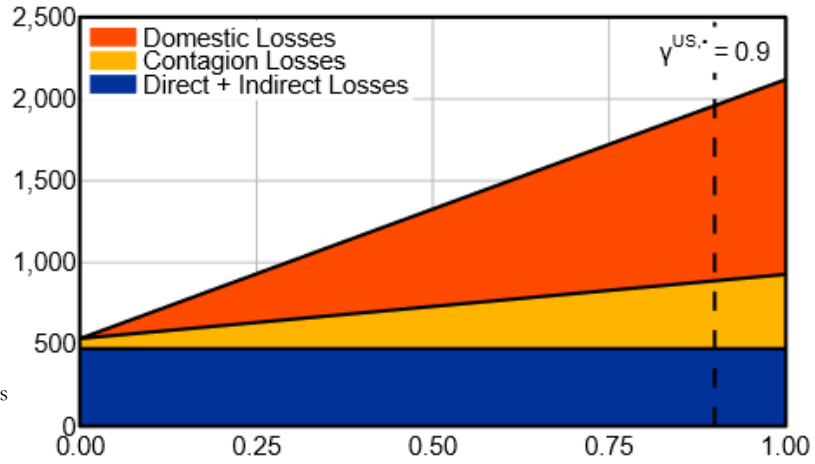
Robustness checks (1)

1. Losses under alternative growth rates of U.S. exposures
   - Global holdings of U.S. listed shares and investment fund shares have risen substantially since 2014 (263% in US dollars).
   - While this increase is partly attributable to valuation effects, it also points to a significant expansion of international investment in U.S. equity markets.
   - In a counterfactual with smaller growth rates of exposures to the U.S., direct and indirect losses would be lower: slightly above 200bn EUR with a growth rate of 100% since 2014 (in our baseline, they are around 450bn EUR).
2. Losses under alternative market correlations
3. Losses from shocks originating in other major economies

Robustness checks (2)

1. Losses under alternative growth rates of U.S. exposures
2. Losses under alternative market correlations
   - By construction, direct and indirect losses resulting from exposures to U.S. assets remain unaffected by changes in correlations.
   - But contagion and domestic losses increase with the extent of cross-market co-movements.

Direct, indirect, contagion, and domestic losses of EU countries following a 10% decline in U.S. equity prices under alternative market correlations between U.S. and global equity markets, in billion EUR



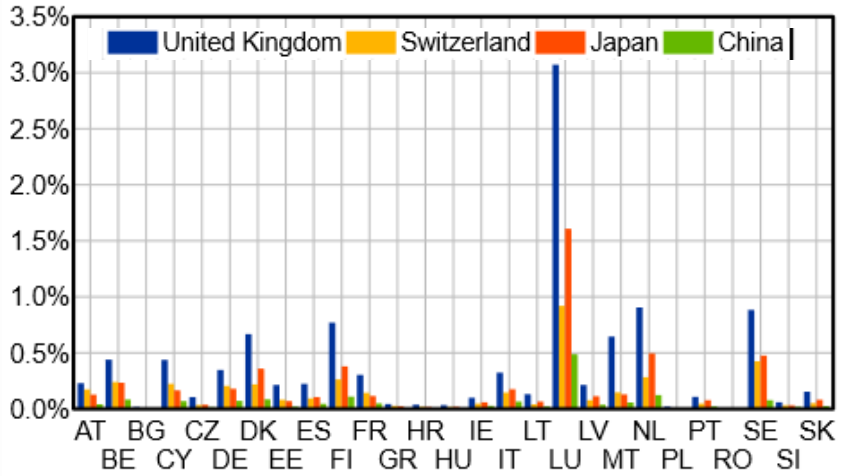
Source: ECB, Eurostat, IMF, and authors' calculations. Notes: direct, indirect, and contagion losses are computed assuming a 10% decline in U.S. equity prices. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. The x-axis represents alternative assumptions on the correlation between U.S. equity markets and those in Europe and other advanced economies. The correlation between U.S. and emerging market equities is held constant at 0.6.

3. Losses from shocks originating in other major economies

Robustness checks (3)

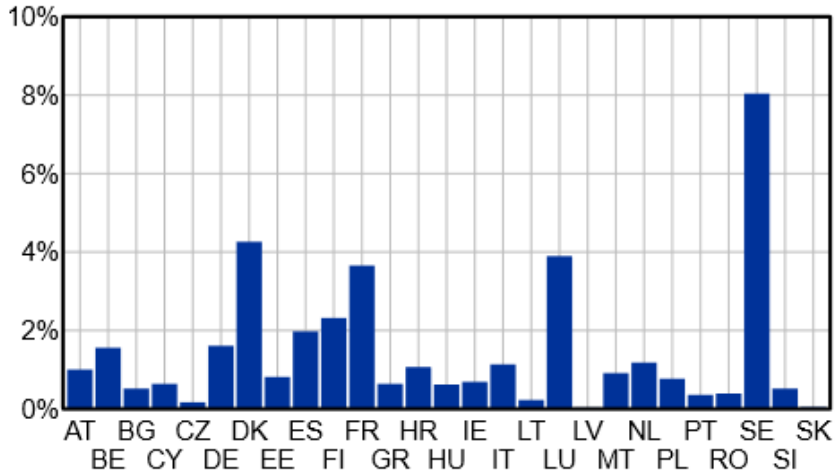
1. Losses under alternative growth rates of U.S. exposures
2. Losses under alternative market correlations
3. Losses from shocks originating in other major economies

Direct and indirect losses in EU countries following a 10% decline in equity prices in the respective countries, as a percentage of nominal 2024 GDP



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: direct and indirect losses are computed assuming a 10% decline in equity prices in the United Kingdom, Switzerland, Japan, and China. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

Domestic losses in EU countries following a 10% decline in equity prices in the United Kingdom, as a percentage of nominal 2024 GDP



Sources: ECB, Eurostat, IMF, and authors' calculations. Notes: domestic losses are estimated assuming a 10% decline of equity prices in the United Kingdom and a correlation between equity markets in the United Kingdom and in the EU of 0.8.

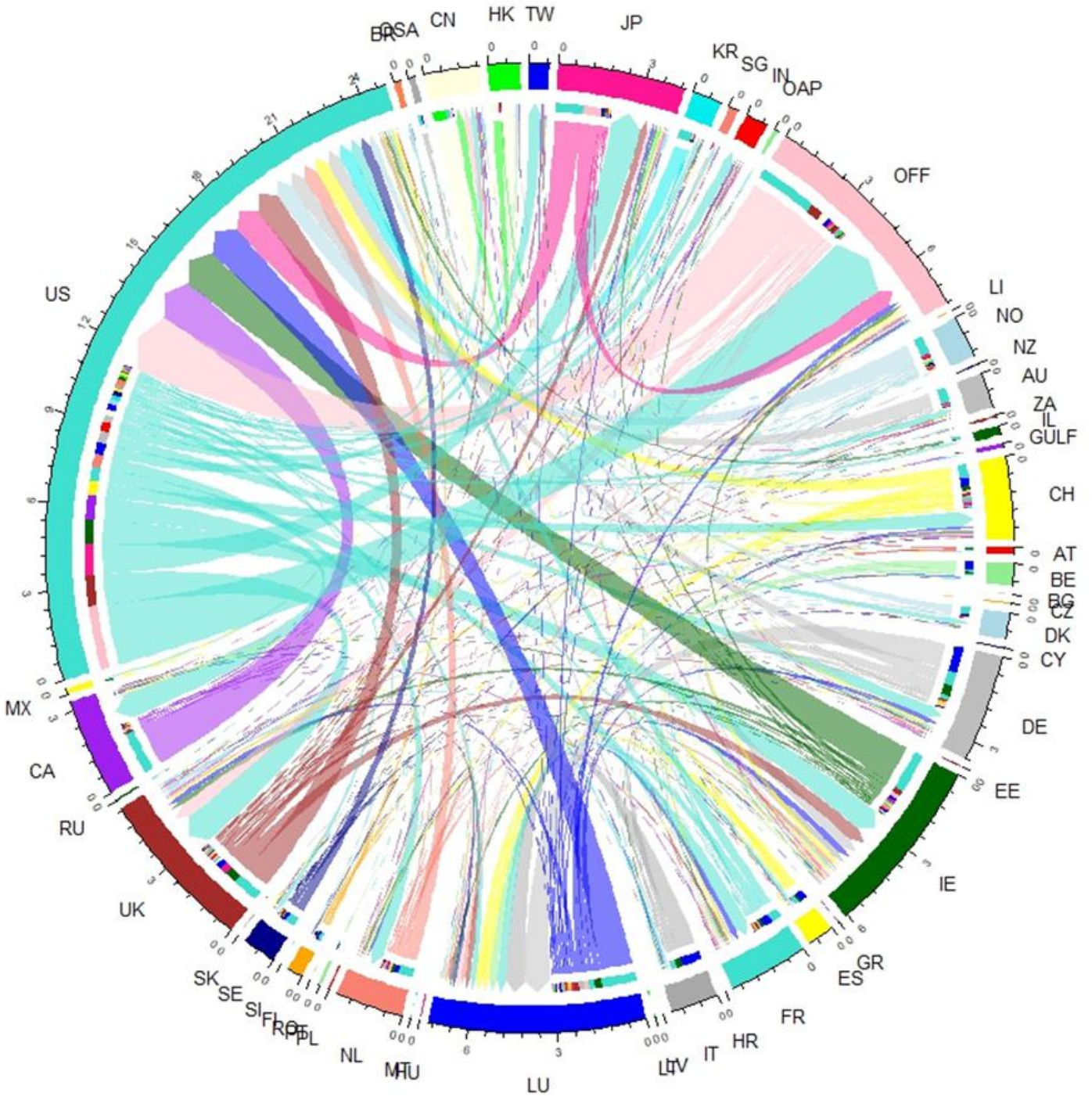
Final remarks

- We develop a framework to provide a rough estimate of losses due to shocks to stock markets outside the EU, using data aggregated at sectoral level.
- A simulation where stock prices in the U.S. fall by 10% leads to losses in the range of 890bn EUR for the EU (around 1,900bn EUR when including domestic losses).
  - Scandinavian countries and Benelux seem the most exposed countries.
- At sectoral level, the shock results in sizable impacts on households, insurance corporations and pension funds, after allocating initial losses of investment funds and contagion to other markets.
  - The impact on banks is very limited.
  - The long-term business model of pension funds and insurance corporations may avoid immediate asset sales.
  - In defined-contribution pension funds, market risk is ultimately borne by households.
- The interplay between leverage, accounting frameworks, and business models plays a central role in determining whether losses are realised, and thus in shaping the macro-financial impact of major market shocks.
- Losses are driven not only by direct exposures, but also by cross-market spillovers.
  - The dominant role of U.S. equity markets means that shocks originating there have far-reaching effects, while shocks in other major economies have only limited effects unless they spread to U.S. markets.
  - This underscores the importance of market size and network centrality for the global propagation of financial shocks.

Many thanks for your attention

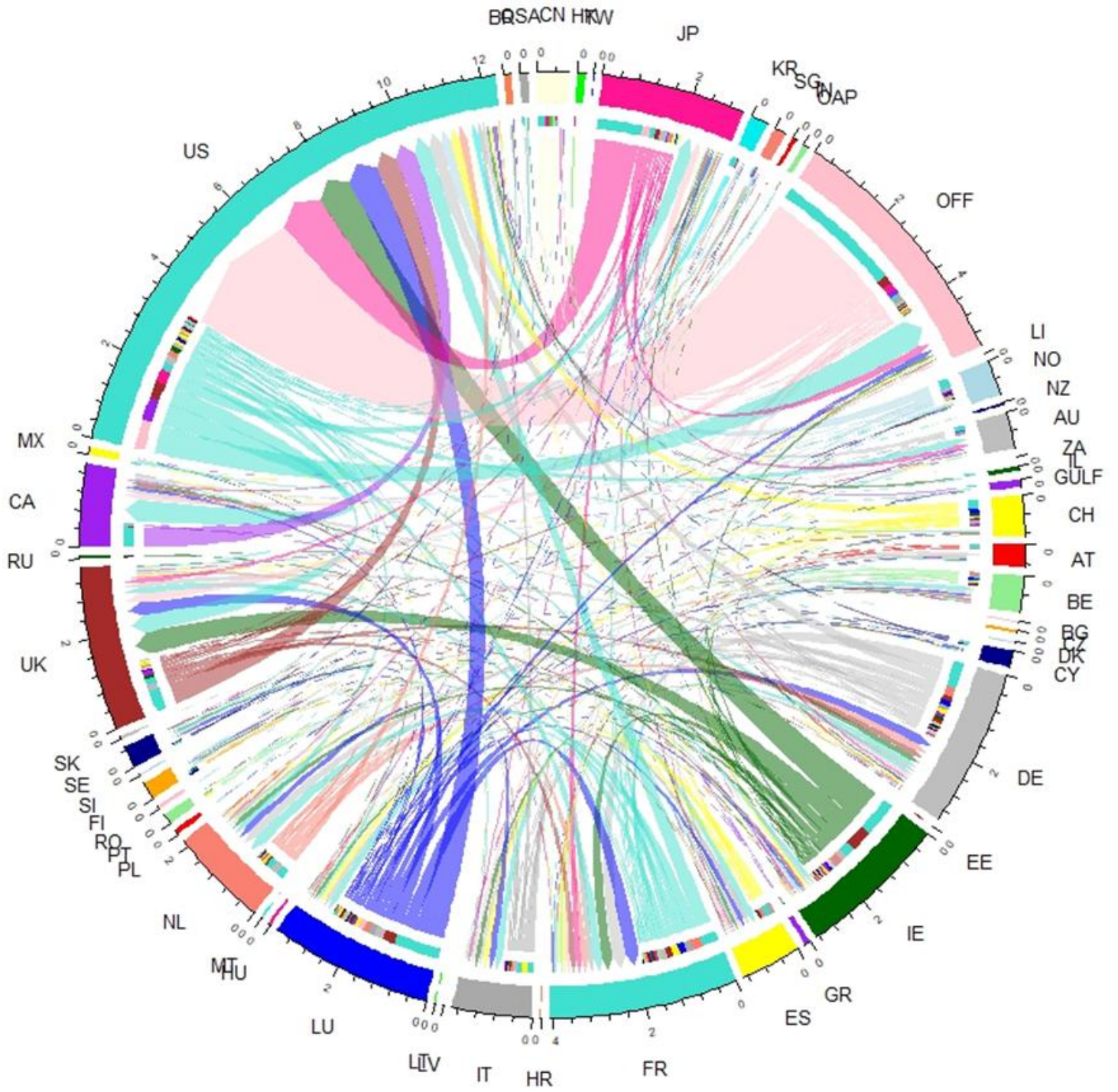
Background slides

Global network of portfolio equity investment, 2024, trillion euros



Source: Eurostat, International Monetary Fund, Statistics Canada, Central Bank of Russia, Ministry of Finance of Japan, Swiss National Bank, Australian Bureau of Statistics, Banque Centrale de Luxembourg, Haver Analytics and author's calculations. Notes: OSA stands for Other South America, OAP for Other Asia Pacific, OFF for offshore financial centres and GULF for countries in the Persian Gulf. Data for Russia refers to the end of 2021.

Global network of portfolio debt, 2024, trillion euros



Source: Eurostat, International Monetary Fund, Statistics Canada, Central Bank of Russia, Ministry of Finance of Japan, Swiss National Bank, Australian Bureau of Statistics, Haver Analytics and author's calculations. Notes: OSA stands for Other South America, OAP for Other Asia Pacific, OFF for offshore financial centres and GULF for countries in the Persian Gulf. Data for Russia refers to the end of 2021.

Contagion from equity market shocks: A framework for measuring losses in the European Union

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March 30, 2026

Abstract

This paper develops a framework to quantify losses in EU countries from shocks to global equity markets through cross-border portfolio holdings. The framework focuses on listed shares and investment fund shares and captures four channels of loss transmission: (i) direct losses from exposures in the country where the shock originates, (ii) indirect losses transmitted via investment funds domiciled in other countries but investing in the affected market, (iii) cross-country contagion effects driven by the co-movement of equity prices, and (iv) domestic spillovers via local equity markets. The framework integrates sectoral balance sheet data with bilateral portfolio holdings, thereby enabling a consistent decomposition of losses by country and sector. Applying the framework to a 10% decline in U.S. equity prices, we estimate that direct, indirect, and cross-country contagion losses across the EU amount to around 900 billion euros, equivalent to 5% of nominal GDP. The inclusion of domestic spillovers substantially increases total losses. The losses are concentrated in the Nordic countries and the Benelux, and are borne primarily by households, pensions funds, and insurance corporations. Despite their magnitude, it is unlikely that these losses will be fully realised in the short term, owing to the low level of leverage in households and the long-term investment horizons of institutional investors. The dominant role of U.S. equity markets implies that shocks originating there have far-reaching effects, while shocks in other major economies have only limited spillovers.

Keywords: portfolio investment, systemic risk, interconnectedness, contagion, simulation.

JEL codes: F65, G15, G20, G51.

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1. Introduction

Financial globalisation has been a defining feature of the post-Second World War era. With the growth of cross-border trade and capital flows, countries have become increasingly interconnected through real and financial linkages. At the same time, this process has been characterised by a sustained rise in cross-border portfolio holdings as documented by Lane and Milesi-Ferretti (2001, 2007). Their database on external assets and liabilities highlights the growing importance of portfolio investment as a key channel of global financial integration (Milesi-Ferreti, 2024). Although financial globalisation slowed down following the global financial crisis – partly due to a retrenchment in cross-border banking activities – portfolio investment continues to play a central role. As a result, countries are increasingly exposed to developments in foreign financial markets through their holdings of equities and investment fund shares. This interconnectedness has important implications for financial stability. A large body of literature shows that financial linkages can both absorb and amplify shocks, depending on the structure of the network and the severity of the disturbance (Allen and Gale, 2000; Elliott et al., 2014; Acemoglu et al., 2015; Glasserman and Young, 2016). Beyond direct balance sheet exposures, amplification may arise through indirect channels, including fire sales, leverage, and correlated asset price movements (Forbes and Rigobon, 2002; Cifuentes et al., 2005; Acharya, 2009). Episodes such as the sharp rise in global financial stress following the outbreak of the COVID-19 pandemic illustrate how quickly shocks can spread in an integrated financial system (Financial Stability Board, 2020).

This paper develops a framework for quantifying the transmission of equity market shocks via cross-border portfolio holdings. The framework focuses on listed shares and investment fund shares and captures four channels of loss transmission: (i) direct losses from exposures in the country where the shock originates, (ii) indirect losses transmitted via investment funds domiciled in other countries but investing in the affected market, (iii) cross-country contagion effects driven by the co-movement of equity prices, and (iv) domestic spillovers via local equity markets.

Another key contribution of this work is the construction of a novel dataset that combines sectoral balance sheet information with bilateral portfolio investment positions. Cross-border exposures are derived from the International Investment Position (IIP) data compiled by Eurostat and complemented by the IMF's Portfolio Investment Positions by Counterpart Economy (PIP) data. The sectoral allocation is based on 'who-to-whom' data from the Quarterly Sectoral Accounts (QSA). This integration results in a consistent mapping of exposures across countries, sectors, and financial instruments, enabling us to quantify how losses are distributed within the financial system. By

combining bilateral and sectoral information, the framework bridges the gap between two strands of the literature that have, until now, largely developed in isolation.

The use of international investment position data to assess global financial linkages and measure contagion channels is well established. An early contribution comes from Kubelec and Sá (2012), who compiled a dataset of external assets and liabilities for 18 countries covering the period from 1980 to 2005, broken down into foreign direct investment, portfolio equity investment, debt, and foreign exchange reserves. Using network analysis, they document a substantial increase in global financial interconnectedness and show through simulations that shocks can cause large losses across countries. Almeida (2015) combines sectoral accounts with data from the IMF's Coordinated Portfolio Investment Survey, the IIP, and the Bank for International Settlements (BIS) to estimate bilateral exposures across major economies, including the euro area, Japan, the United Kingdom, and the United States. Peltonen et al. (2019) construct a macro-financial network of the euro area based on deposits, shares, loans, and debt securities, and show that a more central role of banks in this network increases both the probability and the severity of banking crises. Coppola et al. (2021) examine the role of offshore financial centres and show that these are used extensively by advanced economies to channel portfolio investment into emerging markets, particularly China, with estimated flows of up to 600 billion US dollars from the United States being routed through these centres.

A related strand of the literature uses who-to-whom data to analyse contagion channels and the transmission of shocks within financial systems. Castrén and Kavonius (2009) construct a sector-level network based on flow-of-funds data and simulate the transmission of balance sheet shocks in the euro area. Grodzicki and Silva (2017) use the quarterly sectoral accounts of euro area countries to develop a cross-sectoral contagion framework, whereby losses are distributed across sectors according to the linkages to sectors affected in the previous round. Oura (2022) develops a methodology for system-wide liquidity stress tests using sectoral balance sheets derived from sectoral accounts, thereby providing a tool for macroprudential analysis. Focusing on the United States, Acharya et al. (2024) use expanded financial accounts data to examine linkages between banks and non-banks as well as the transformation of risks across sectors. More recent contributions use who-to-whom data to map financial interconnections, including for the euro area (Andersen and Sánchez Serrano, 2024; Sánchez Serrano, 2025a) as well as for individual countries such as France, Portugal, and Spain (Mouakil et al., 2024; Saldias and Mizinski, 2025; Sánchez Serrano, 2025b).

We apply the framework to a hypothetical 10% decline of equity prices in the United States (U.S.). The direct, indirect, and cross-country contagion losses across the EU amount to around 900 billion euros, equivalent to 5% of nominal GDP in 2024. These estimates capture only immediate, first-round effects and abstract from persistence, behavioural responses, and dynamic feedback mechanisms that could amplify losses over time. The inclusion of domestic spillovers significantly increases the total losses, reflecting the strong link between the U.S. and European equity markets. The losses are concentrated in financially open economies, including the Nordic countries and the Benelux states, and are borne at the sectoral level primarily by households, pension funds, and insurance corporations. The impact on monetary financial institutions (i.e., banks) is overall limited across EU countries. It is even possible to group EU countries depending on which sector is most affected by the shock: households (e.g., Spain), pension funds (e.g., Latvia) or others (e.g., France and Luxembourg). Despite their magnitude, these losses are not necessarily realised immediately, as households hold substantial real assets and institutional investors operate with long-term business models and investment horizons. A key finding is that total losses are driven not only by direct exposures, but also often by cross-market co-movements. The dominant role of U.S. equity markets implies that shocks originating there have far-reaching effects, while shocks in other major economies have more limited effects unless they are transmitted to U.S. markets or closely interconnected regions such as the EU. In some cases, U.S. markets may also act as a relatively safe haven and dampen global spillovers.

The framework has several limitations. It focuses on equity price shocks and abstracts from interactions with other asset classes or feedback effects with the real economy. These channels may either amplify or mitigate the overall impact. In addition, the analysis is conducted at country and sector level and does not capture heterogeneity across individual institutions. The results should therefore be interpreted as first-order estimates rather than precise predictions. Despite these limitations, the framework offers a tractable and data-driven approach to assessing the transmission of equity market shocks. It provides insights into the distribution of losses across countries and sectors and highlights the role of global financial integration in shaping systemic risks.

The remainder of the paper is organised as follows. Section 2 describes the data and methodology. Section 3 introduces the simulation framework. Section 4 presents the main results. Section 5 reports robustness checks and additional analyses. Section 6 concludes.

2. Data and methodology

This section describes the construction of the dataset underlying the empirical analysis. We first outline the reasons for combining multiple data sources, then describe the main datasets, provide an explanation of how bilateral portfolio positions are constructed, discuss additional data sources, and finally highlight key limitations.

2.1. Combining sectoral and bilateral data

Our empirical analysis requires detailed information on sectoral balance sheets, including cross-sectoral and cross-country holdings of financial assets. No single dataset provides this information in a consistent and comprehensive form. We therefore construct a novel dataset that combines sectoral accounts with bilateral portfolio investment statistics, thereby providing a unified and internally consistent representation of cross-border financial exposures.

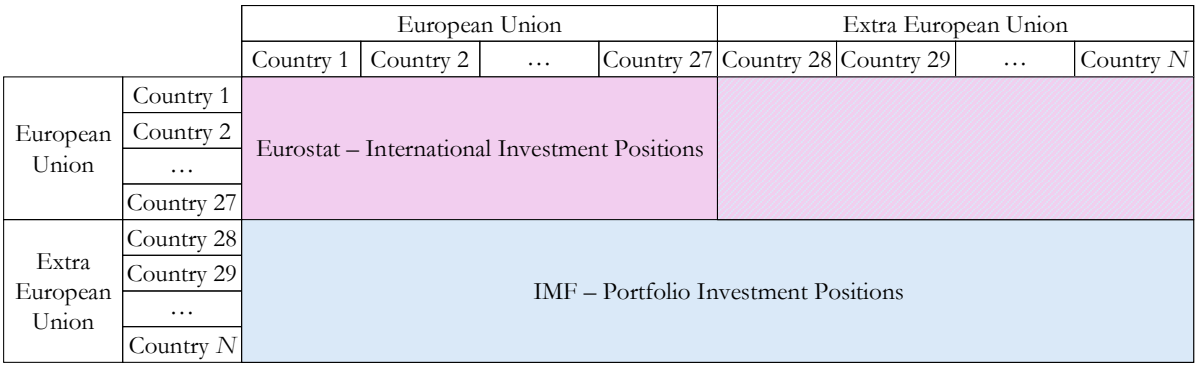
We use the Quarterly Sectoral Accounts (QSA), published jointly by the European Central Bank (ECB) and Eurostat, as the backbone for our dataset. The QSA provide detailed sectoral balance sheets and counterpart information, allowing us to identify which domestic sectors hold financial assets and which sectors issue them. However, they do not include a bilateral breakdown of cross-border positions. To recover this dimension, we combine the QSA with bilateral data on international portfolio investment.

Specifically, we use Eurostat's International Investment Position (IIP) data as our primary source for bilateral positions of EU countries and complement this data with the IMF's Portfolio Investment Positions by Counterpart Economy (PIP) data, where Eurostat's coverage is incomplete.[1] This integration allows us to construct a country-by-country matrix of portfolio positions, in which rows correspond to investor countries (i.e., the holders of foreign assets) and columns to the issuing countries (i.e., the location of the underlying liabilities).[2] Figure 1 shows a schematic representation of this structure. A key feature of our approach is that it ensures internal consistency across countries and sectors. By anchoring bilateral exposures to the total sectoral balance sheet amounts, we reconcile aggregate positions with their cross-country distribution while preserving comparability across countries and over time.

[1] In principle, these data also allow the analysis to be extended to non-EU countries on the holding side.

[2] While portfolio investment statistics are primarily reported on the asset side, the symmetry of cross-border positions can generally be used to derive liabilities from the corresponding asset holdings reported by partner countries. In particular, a given country's liabilities to the rest of the world can be determined by aggregating the corresponding asset positions of all partner countries.

Figure 1. Overview of data sources used by country



Source: authors. Notes: the dashed pattern for holdings by EU residents of securities issued by non-EU countries indicates that Eurostat's IIP data are used where available, and IMF's PIP data are used otherwise.

2.2. Main datasets

Quarterly Sectoral Accounts. The QSA provide information on sectoral balance sheets of all 27 EU countries,[3] compiled in line with the European System of Accounts.[4] The financial accounts comprise holdings of financial instruments, such as listed shares and investment fund shares, at market value and track their changes over time.[5] The data are reported on a non-consolidated basis, which means that intra-group positions are retained (e.g., financial subsidiaries of non-financial corporations are classified within the financial sector). While the QSA ensure internal consistency, they do not provide a complete breakdown of positions by counterpart country or sector.

To incorporate the sectoral dimension, we use who-to-whom data, which captures cross-sectoral holdings of financial instruments within each country and is a component of QSA. These data allow us to decompose aggregate positions into individual sectors and map country-level exposures to sectoral balance sheets. Following Andersen and Sánchez Serrano (2024), we construct simplified, non-consolidated balance sheets for the main institutional sectors: households, non-financial corporations, and a disaggregated financial sector comprising monetary financial institutions, insurance corporations, pensions funds, investment funds, captive financial institutions and money lenders, financial auxiliaries, and other financial intermediaries. An additional sector covers the rest of the world.[6] The government and central bank sectors are excluded because their holdings of

[3] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.
[4] We refer to the European System of Accounts (2010) published by Eurostat (2013) for the underlying methodological framework.
[5] These changes are either valuation effects (price changes) or transactions (changes in volume). Non-financial assets and liabilities are not included in the financial accounts.
[6] The rest of the world sector is an important component that closes the system; if deficits of the domestic borrowing sectors exceed surpluses of the domestic lending sectors, the remainder must be financed by the rest of the world.

foreign listed shares and investment fund shares are negligible, and their inclusion would introduce additional methodological complexity regarding the allocation of Eurosystem balance sheet items (Sánchez Serrano, 2025a).

International Investment Position. To determine bilateral cross-country positions, we use Eurostat's IIP data, which are part of the Balance of Payments dataset compiled according to the sixth edition of the Balance of Payments and International Investment Position Manual (BPM6) framework (International Monetary Fund, 2009a).[7] These data provide quarterly portfolio investment positions by counterpart country and are conceptually consistent with the System of National Accounts. The coverage includes both EU and major non-EU economies, including advanced and emerging markets. However, for some EU countries – notably Austria, France, Luxembourg, and Portugal – the bilateral data are incomplete.

Portfolio Investment Positions. To close these gaps and complement coverage, we use the IMF's PIP dataset. The PIP provides semi-annual data on bilateral portfolio holdings. We align these data with the quarterly frequency by keeping the values constant within each half-year and converting them into euros using the ECB's exchange rates at period-end. Although reporting is voluntary and may contain gaps, the PIP represents an important complement to Eurostat data.

2.3. Construction of bilateral portfolio positions

The key contribution of our data construction is to link internally consistent sectoral totals with the bilateral structure of international portfolio holdings. We use the QSA as a reference for aggregate positions. For each country i and each time t, the QSA provide the total portfolio holdings vis-à-vis the rest of the world, denoted as $B_{i,t}$.

In a first step, we create a residual category to account for incomplete bilateral reporting in the internation portfolio holdings data. Let $x_{i,j,t}$ be the reported positions vis-à-vis partner country j, and $T_{i,t}$ the corresponding total. The residual category 'Unknown' is then defined as:

$$x_{i,\text{Unknown},t} = \max\{0, T_{i,t} - \sum_{j \neq \text{Total}} x_{i,j,t}\}. \quad (1)$$

This ensures that all positions are captured and avoids overstating exposures to observed countries.

[7] In March 2025, the IMF released the seventh edition of the Balance of Payments and International Investment Position Manual (BPM7), which further strengthens its alignment with the System of National Accounts, currently under revision. Entry into force is expected in 2029–2030.

In a second step, we reconcile the bilateral positions with the total sectoral figures. Although bilateral data provide insight into the cross-country distribution of exposures, they may not fully correspond to the aggregate positions reported in the QSA due to differences in scope of coverage, valuation, and reporting. We therefore rescale the positions using:

$$\delta_{i,t} = \frac{B_{i,t}}{\sum_j x_{i,j,t}}, \qquad \tilde{x}_{i,j,t} = \delta_{i,t} \cdot x_{i,j,t}, \tag{2}$$

where $\delta_{i,t}$ denotes the corresponding scaling factor. This procedure preserves the cross-country distribution while ensuring consistency with the sectoral balance sheets. Overall, this approach combines the strengths of the various data sources: the QSA provide reliable and internally consistent aggregate positions, while the IIP and PIP datasets provide the bilateral structure.

2.4. Additional data sources

We complement the main datasets with additional sources to ensure consistency and calibration. ECB exchange rates are used to convert PIP data from USD to euros, and nominal GDP data from the ECB are used to express losses relative to economic output. For households and non-financial corporations, we incorporate fixed assets (e.g., dwellings and machinery) from the ECB and Eurostat to better capture balance sheet capacity of non-financial sectors. For insurance corporations, own funds are computed using European Insurance and Occupational Pensions Authority (EIOPA) supervisory data. We also use ECB data on investment funds to estimate the share of non-equity components in investment fund portfolios.

Finally, we use weekly equity price data from various sources, including the Financial Times, the Wall Street Journal, Standard & Poor's, Dow Jones, Haver Analytics, and several national stock exchanges, to estimate correlations between U.S. equity markets and those in Europe, other advanced economies, and emerging markets. These correlations play a central role in calibrating cross-market transmission mechanisms in the model.

2.5. Limitations

Our approach is based on combining several data sources, each with specific limitations. While the QSA are internally consistent, they do not capture the heterogeneity within sectors and do not take into account intra-sectoral linkages. For example, life- and non-life insurance corporations are aggregated, even though they have different balance sheet structures, and institutions with distinct business models, such as central clearing counterparties, may be classified as part of the banking sector, even though they operate under different risk profiles. In addition, the QSA lack a bilateral breakdown of cross-border positions, which must be derived from external data sets.

The bilateral data also have limitations. Both IIP and PIP data are reported at market values, which means that changes over time reflect both valuation effects and transactions. While observing market prices is straightforward for listed shares and fund shares, it may be less accurate for less frequently traded instruments such as debt securities. Reporting gaps and differences in coverage may introduce measurement errors, particularly for smaller economics and offshore financial centres. Finally, the focus on portfolio investment excludes controlling stakes, reported under foreign direct investment, and may therefore omit certain channels of financial interdependence, while also mitigating concerns related to non-consolidation.

3. Stylised framework for shock transmission

We consider a multi-country, multi-sector financial system in discrete time. Countries are indexed by $i, j \in \{1, \dots, J\}$, sectors by $k, \ell \in \{1, \dots, K\}$, and financial instruments by $s \in \{1,2,3\}$, which correspond to (1) listed shares, (2) investment fund shares, and (3) debt securities. The framework is designed to capture how valuation shocks propagate across countries and sectors through financial exposures, financial intermediation, and balance sheet linkages.

At time $t = 0$, an exogenous shock occurs in country j^* that affects the valuation of financial instruments issued in that country. The magnitude of the shock may vary depending on the instrument and reflects differences in seniority, liquidity, and risk exposure. Let $\alpha_t^{j^*,s}$ denote the proportional change in the valuation of instrument s issued in country j^*.

3.1. Direct and indirect losses

Let $E_t^{k,i,j,s}$ denote the exposure of sector k in country i to instruments s issued in country j. Aggregating across all sectors yields the total exposure at the country level:

$$E_t^{i,j,s} = \sum_{k=1}^{K} E_t^{k,i,j,s}. \tag{3}$$

Direct losses arise from holdings of assets issued in the shocked country j^*:

$$DL_t^{i,j^*} = \sum_{s=1}^{3} \alpha_t^{j^*,s} E_t^{i,j^*,s}. \tag{4}$$

These losses represent the first round of international shock transmission via cross-border financial exposures.

In addition to direct holdings, investors may have indirect exposures to country j^* through investment funds domiciled in other countries. This reflects the fact that financial intermediation

separates investor's location from the location of the underlying assets. Let IX_t^{k,i,j,j^*} denote the exposure of sector k in country i to investment fund shares issued in country $j \neq j^*$ and whose underlying portfolios are invested in country j^*. Aggregating across all sectors and fund domiciles:

$$IX_t^{i,j^*} = \sum_{j \neq j^*} \sum_{k=1}^{K} IX_t^{k,i,j,j^*}. \tag{5}$$

The valuation of investment fund shares reflects the composition of their underlying portfolios. In particular, investment funds combine holdings of equities and debt securities, which is why their valuation reflects the risk characteristics of these assets. We model this by representing the shock to investment fund shares as a convex combination of shocks to listed shares and debt securities:

$$\alpha_t^{j^*,s=2} = \omega_t^{i,j^*} \alpha_t^{j^*,s=1} + \left(1 - \omega_t^{i,j^*}\right) \alpha_t^{j^*,s=3}, \tag{6}$$

where $\omega_t^{i,j^*} \in [0,1]$ captures the share of equity exposures in the underlying fund portfolios. This parameter summarises the portfolio composition and thus determines how strongly the valuations of investment fund shares react to equity or debt shocks. Indirect losses are given by:

$$IL_t^{i,j^*} = \alpha_t^{j^*,s=2} IX_t^{i,j^*}. \tag{7}$$

This channel captures the transmission of shocks through financial intermediation, even if investors do not hold assets issued directly in the shocked country j^*.

3.2. Cross-country contagion losses

Beyond direct and intermediated exposures, shocks can propagate through global adjustments in asset prices. These arise from mechanisms such as the global repricing of risks, portfolio rebalancing by international investors, and liquidity-driven fire sales. We capture this channel by allowing the shock in country j^* to affect valuations in other countries:

$$\alpha_t^{j,s} = \gamma^{j,s} \alpha_t^{j^*,s}, \qquad j \neq j^*, \tag{8}$$

where $\gamma^{j,s} \in [0,1]$ measures the sensitivity of asset prices in country j to shocks in country j^*. This parameter captures the strength of cross-country financial linkages and the co-movement in asset prices.

Country i is affected by these spillovers through its holdings of foreign assets. Direct contagion losses are given by:

$$DCCL_t^i = \sum_{j \neq j^*} \sum_{s=1}^{3} \gamma^{j,s} \alpha_t^{j^*,s} E_t^{i,j,s}. \quad (9)$$

Contagion also operates through investment funds that hold assets in affected countries. Let $IX_t^{i,j}$ denote country i's indirect exposure to country j via investment funds. Indirect contagion losses are given by:

$$ICCL_t^i = \sum_{j \neq j^*} \gamma^{j,s=2} \alpha_t^{j^*,s=2} IX_t^{i,j}. \quad (10)$$

Total contagion losses combine the two channels:

$$TCCL_t^i = DCCL_t^i + ICCL_t^i. \quad (11)$$

These losses reflect the degree of global financial integration and the extent to which asset prices co-move across countries.

3.3. Total losses

Total losses for country i at time t are given by:

$$TL_t^i = DL_t^{i,j^*} + IL_t^{i,j^*} + TCCL_t^i. \quad (12)$$

At the sectoral level, we have:

$$TL_t^{k,i} = DL_t^{k,i,j^*} + IL_t^{k,i,j^*} + TCCL_t^{k,i}. \quad (13)$$

This decomposition distinguishes between direct exposures, intermediated exposures, and spillovers resulting from global adjustments in asset prices.

3.4. Realisation of losses

Losses are initially unrealised and only affect economic behaviour once they are recognised on balance sheets. We assume that losses are realised when they exceed a threshold relative to sector's own funds:

$$RL_t^{k,i} = \begin{cases} 0, & \text{if } TL_t^{k,i} < \beta^{k,i} OF_t^{k,i} \\ TL_t^{k,i}, & \text{otherwise} \end{cases}, \quad (14)$$

where $OF_t^{k,i}$ denotes own funds and $\beta^{k,i} \in [0,1]$ captures the sector-specific loss tolerance. This formulation captures the role of capital constraints, regulatory requirements, and risk management practices in determining when valuation losses lead to realised balance sheet adjustments.

3.5. Cross-sectoral contagion losses

Once losses are realised, they can propagate within countries through domestic balance sheet linkages between sectors. When a sector absorbs losses, its weakened balance sheet reduces the value of claims held by other sectors, for example through increased default risk, mark-to-market revaluation, or fire-sale externalities. Let $DX_t^{\ell,k,i,s}$ denote the domestic exposure of sector ℓ to sector $k \neq \ell$ in country i via instrument s. Cross-sectoral contagion losses are given by:

$$SCL_{t+1}^{\ell,i} = \sum_{k=1}^{K} \sum_{s=1}^{3} \psi^{k,s} DX_{t+1}^{\ell,k,i,s}, \tag{15}$$

where $\psi^{k,s}$ captures the share of exposures in sector k via instrument s that are effectively written off when that sector encounters financial distress, thereby converting balance sheet losses in sector k into valuation losses for its creditors. Aggregation across all sectors yields the total cross-sectoral contagion losses:

$$TSCL_{t+1}^{i} = \sum_{\ell=1}^{K} SCL_{t+1}^{\ell,i}. \tag{16}$$

3.6. Dynamic propagation

Shocks may persist over time and trigger further rounds of losses, albeit with lower intensity. We model persistence as a proportional (geometric) decay process:

$$\alpha_{t+1}^{j^*,s} = \rho^s \alpha_t^{j^*,s}, \qquad 0 < \rho^s < 1, \tag{17}$$

where ρ^s determines the persistence of shocks for instrument s. Thus, a constant proportion of the shock is carried over to subsequent periods, reflecting the gradual adjustment of asset prices following large disturbances.

Total losses evolve recursively as a function of past and newly generated losses. For all $t \geq 0$:

$$TL_{t+1}^{i} = \left(TL_t^i - RL_t^i\right) + DL_{t+1}^{i,j^*} + IL_{t+1}^{i,j^*} + TCCL_{t+1}^{i} + TSCL_{t+1}^{i}. \tag{18}$$

The first term captures unrealised losses carried over from period t, while the remaining terms reflect new losses arising from the persistent shock, cross-country contagion, and domestic sectoral linkages. The same recursive structure applies to all subsequent periods, and the rule for loss realisation in Equation (14) continues to apply at every point in time. Through this mechanism, realised losses weaken sectoral balance sheets, increase their vulnerability to subsequent shocks, and thereby amplify the propagation of losses over time.

4. Simulation of a shock to U.S. equity prices

4.1. Simulation strategy

We study the transmission of a negative shock to U.S. equity prices via international financial linkages. Given the central role of U.S. equity markets in global portfolios, we consider a scenario in whereby U.S. equity prices fall by 10% over a short period of one to two days. This magnitude is intended to reflect a severe but plausible market correction and is consistent with the sharp price declines observed during major episodes of financial stress, including the 1929 crash, the global financial crisis of 2007–08, and the onset of the COVID-19 pandemic (Table 1). Although such events are rare, they provide a useful benchmark for assessing the resilience of financial systems under extreme conditions. The simulation should therefore be interpreted as a tail-risk scenario that captures the impact of a sharp but plausible decline in equity prices.

Table 1. Largest daily declines in the S&P500

Date	Context	Daily change (%)
19 October 1987	Black Monday	-20.47%
28 October 1929	Great Depression	-12.34%
16 March 2020	COVID-19	-11.98%
29 October 1929	Great Depression	-10.16%
6 November 1929	Great Depression	-9.92%
12 March 2020	COVID-19	-9.51%
18 October 1937	Great Depression	-9.27%
15 October 2008	Global financial crisis	-9.04%
1 December 2008	Global financial crisis	-8.93%
20 July 1933	Great Depression	-8.88%

Source: Wikipedia: List of largest daily changes in the S&P 500 Index.

The analysis has three objectives. First, we quantify the losses incurred by investors in EU countries through direct and indirect exposures to U.S. equity markets. Second, we examine how these losses are distributed across the various sectors. Third, we assess the extent to which such losses are likely to be realised, given the sectoral balance sheet positions and institutional features.

The simulation study is based on data as of end-2024. This is due to limitations in data availability, as some statistics on portfolio investments are reported on an annual basis with a lag. As the analyses focus on balance sheets at country and sector level, which evolve relatively slowly, this timing does not have a material impact on the results.

For brevity, it is assumed that the shock occurs within a single period. Accordingly, the dynamic propagation mechanisms described in Section 3, including persistence and multi-period feedback effects, are not incorporated in the baseline simulations. The results therefore capture the

immediate effects of the shock, whilst abstracting from the subsequent adjustment dynamics. To maintain tractability, the simulation study focuses exclusively on equity price movements and abstracts from changes in the valuation of debt securities. This restriction isolates the role of equity exposures in the propagation of losses and avoids imposing additional assumptions about the joint dynamics of the asset classes.

4.2. Total losses across EU countries

We first quantify total losses at country level. Based on the framework outlined in Section 3, total losses comprise direct exposures to U.S. equity markets, indirect exposures via investment funds, and cross-country contagion effects. The impact through the domestic equity market is analysed separately in Section 4.4 below.

To operationalise the model, we adapt Equation (12) to the available portfolio holding statistics. The total latent losses for country i following a 10% decline in U.S. equity prices are given by:

$$TL_t^i = \begin{Bmatrix} 0.1 \cdot \left[\theta_t^i \cdot \left(1-\omega_t^i\right)\right] \cdot E_t^{i,\mathrm{US}} \\ +\left(\beta_t^{i,\mathrm{IE}} \cdot DL_t^{\mathrm{IE,US}} + \beta_t^{i,\mathrm{LU}} \cdot DL_t^{\mathrm{LU,US}}\right) \\ +\begin{Bmatrix} \left[\theta_t^i \cdot \left(1-\omega_t^i\right)\right] \times \\ \left[\left(0.1 \cdot \gamma^{\mathrm{US,EU}} \cdot E_t^{i,\mathrm{EU}}\right) + \left(0.1 \cdot \gamma^{\mathrm{US,AE}} \cdot E_t^{i,\mathrm{AE}}\right) + \left(0.1 \cdot \gamma^{\mathrm{US,EM}} \cdot E_t^{i,\mathrm{EM}}\right)\right] \end{Bmatrix} \\ +\left(\beta_t^{i,\mathrm{IE}} \cdot CCL_t^{\mathrm{IE,US}} + \beta_t^{i,\mathrm{LU}} \cdot CCL_t^{\mathrm{LU,US}}\right) \end{Bmatrix}, \quad (19)$$

where θ_t^i denotes the share of investment fund holdings in country i's total foreign listed shares and investment fund holdings, and ω_t^i indicates the share of non-equity funds (bond and real estate funds) in total investment funds. $E_t^{i,\mathrm{US}}$ is country i's exposure to the U.S. via listed shares and investment fund holdings, while $E_t^{i,\mathrm{EU}}$, $E_t^{i,\mathrm{AE}}$, and $E_t^{i,\mathrm{EM}}$ denote exposures to other European countries, non-European advanced economies, and emerging markets.[8] The parameters $\beta_t^{i,\mathrm{IE}}$ and $\beta_t^{i,\mathrm{LU}}$ measure the share of country i in the investment fund holdings intermediated via Ireland and Luxembourg. $DL_t^{\mathrm{IE,US}}$ and $DL_t^{\mathrm{LU,US}}$ denote direct losses in these fund domiciles, and $CCL_t^{\mathrm{IE,US}}$ and $CCL_t^{\mathrm{LU,US}}$ capture the contagion losses transmitted via them. Finally, $\gamma^{\mathrm{US,EU}}$, $\gamma^{\mathrm{US,AE}}$, and $\gamma^{\mathrm{US,EM}}$ are the correlations of equity prices between the U.S. and the respective country groups.

The first term captures direct exposures to U.S. equity markets, adjusted for the share of funds invested in non-equity assets. The second term reflects indirect exposures via funds domiciled in

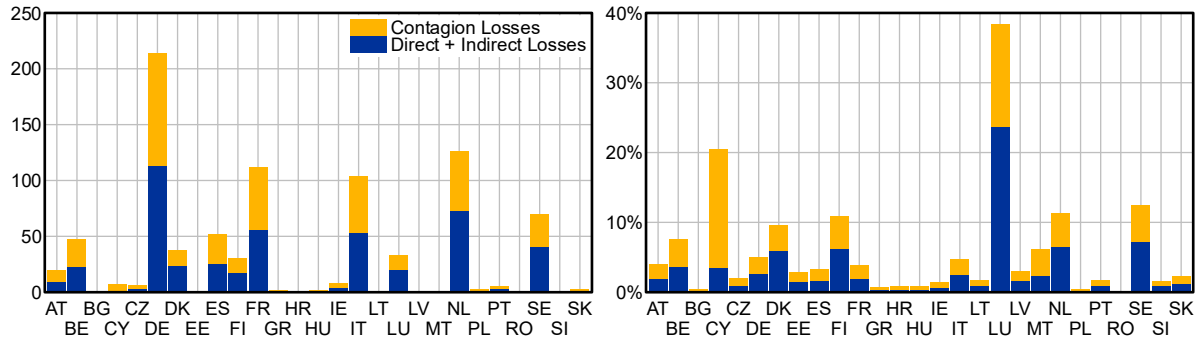
[8] In principle, exposures could be specified at the individual country level. However, since exposures within each group share a common correlation parameter, we aggregate them at the group level for brevity.

Ireland and Luxembourg, which act as key intermediaries in cross-border portfolio allocation. The third term captures cross-country effects arising from the co-movement of equity prices across the globe. The final term accounts for contagion effects transmitted indirectly via fund linkages.

The implementation relies on several assumptions. First, the exposures are adjusted to exclude bond and real estate funds, as the simulation focuses only on equity price shocks. For non-euro area countries, euro area averages are used as proxies for the fund portfolio composition. Second, it is assumed that exposures to Ireland and Luxembourg arise primarily through investment fund shares rather than listed shares, which is consistent with the relatively small size of the domestic equity markets in these countries. Third, indirect losses are allocated in proportion to the countries' holdings of funds domiciled in Ireland and Luxembourg, implying that these funds act primarily as intermediaries for investments within the European financial system. This implicitly assumes that non-EU investors do not use Irish and Luxembourg-domiciled investment funds to obtain exposure to non-EU assets. As a result, indirect losses are not transmitted from Ireland and Luxembourg to non-EU countries. Finally, the parameters for cross-country contagion are calibrated using historical correlations of equity prices over the period 2007 to 2024, yielding values of 0.9 for other European and other advanced economies and 0.6 for emerging markets.

Figure 2 shows the total (latent) losses across EU countries following a 10% decline in U.S. equity prices. Aggregate losses amount to around 890 billion euros, suggesting that even a short-lived shock to U.S. equity markets has material valuation effects for European investors. The losses are highly concentrated: Germany, the Netherlands, France, and Italy together account for more than 60% of the total. This concentration reflects both the size of their financial systems and their high degree of integration into global capital markets, including significant exposures to U.S. equities held directly and via investment funds. Smaller economies have correspondingly lower losses in absolute terms, which is consistent with a lower degree of international portfolio diversification. A decomposition shows that direct and indirect exposures to U.S. securities account for slightly more than half of total losses on average, although there are considerable differences between individual countries. The share of these components ranges from around 17% in Cyprus to around 63% in Denmark. Hence, in some countries, the losses are primarily attributable to direct holdings of U.S. securities, while in others they are more closely linked to global equity co-movements.

Figure 2. Total (latent) losses following a 10% decline in U.S. equity prices, in billion EUR (left) and as a percentage of nominal 2024 GDP (right)



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: direct, indirect, and contagion losses are computed according to Equation (19), assuming a 10% decline in U.S. equity prices. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

Examining losses in relation to the size of the economy provides a complementary perspective on vulnerabilities. Measured relative to nominal GDP, total losses for the EU amount to around 5%, but there is considerable cross-country heterogeneity, ranging from around 0.1% in Romania to more than 38% in Luxembourg. Financially open economies, including Denmark, Finland, the Netherlands, and Sweden, record losses in the order of 10%, while Cyprus stands out at around 20%. These differences underscore the role of financial openness and the size of the financial sector relative to domestic output in shaping the macroeconomic relevance of external shocks.

In the largest EU economies – Germany, France, Italy, and Spain – losses remain below the EU average (i.e., 5%). While these losses are economically meaningful, they are modest compared to those observed during systemic crises. For example, Laeven and Valencia (2018) document losses exceeding 25% of GDP in many cases during the global financial crisis. However, our estimates capture only immediate, first-round effects and abstract from persistence, behavioural responses, and dynamic feedback mechanisms, e.g., via domestic equity markets, that could amplify losses over time.

4.3. Distribution of losses across sectors in the EU

We next allocate the losses at country level across sectors to determine which entities ultimately bear the brunt of a shock to U.S. equity markets. This allocation takes into account both direct holdings of foreign assets and indirect exposures via investment funds. Sectoral exposures are measured using who-to-whom data from the QSA. We consider households, non-financial corporations, monetary financial institutions, insurance corporations, pensions funds, investment funds, captive financial institutions and money lenders, financial auxiliaries, and other financial

intermediaries. The government and central bank sectors are excluded, given that their holdings of foreign listed shares and fund shares are negligible.

The allocation is based on a proportional rule derived from the sectoral portfolio holdings. Losses relating to listed shares are allocated in proportion to the respective sector's share in foreign listed shares. Losses transmitted via investment funds are allocated on the basis of sectoral holdings of foreign investment fund shares. This approach ensures that exposures at country level are consistently allocated to the sectors that ultimately hold the underlying assets.

Formally, we adapt Equation (13) to the sectoral level. The total latent losses for sector k in country i following a 10% decline in U.S. equity prices are given by:

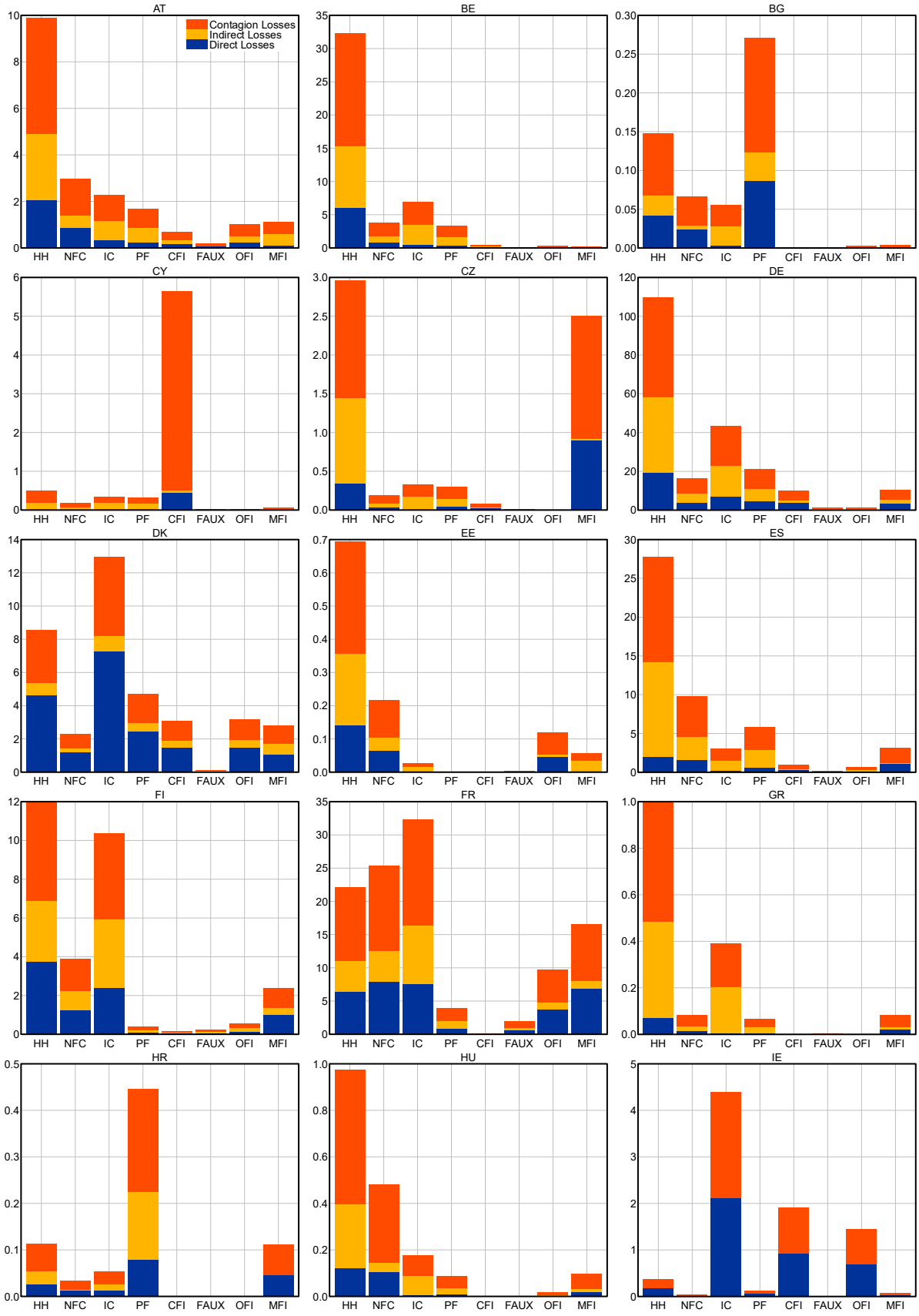
$$TL_t^{k,i} = \begin{Bmatrix} \left(\tau_t^{k,i,s=1} \cdot DL_t^{i,\mathrm{US}} + \mu_t^{k,i,s=2} \cdot DL_t^{k=\mathrm{IF},i,\mathrm{US}}\right) \\ +\left(\tau_t^{k,i,s=2} \cdot IL_t^{i,\mathrm{US}} + \mu_t^{k,i,s=2} \cdot IL_t^{k=\mathrm{IF},i,\mathrm{US}}\right) \\ +\tau_t^{k,i,s=1} \\ \times \begin{Bmatrix} \left[\theta_t^i \cdot \left(1-\omega_t^i\right)\right] \times \\ \left[\left(0.1 \cdot \gamma^{\mathrm{US,EU}} \cdot E_t^{i,\mathrm{EU}}\right) + \left(0.1 \cdot \gamma^{\mathrm{US,AE}} \cdot E_t^{i,\mathrm{AE}}\right) + \left(0.1 \cdot \gamma^{\mathrm{US,EM}} \cdot E_t^{i,\mathrm{EM}}\right)\right] \end{Bmatrix} \\ +\tau_t^{k,i,s=2} \cdot \left(\beta_t^{i,\mathrm{IE}} \cdot CCL_t^{\mathrm{IE,US}} + \beta_t^{i,\mathrm{LU}} \cdot CCL_t^{\mathrm{LU,US}}\right) \\ +\mu_t^{k,i,s=2} \cdot CCL_t^{k=\mathrm{IF},i,\mathrm{US}} \end{Bmatrix}, \quad (20)$$

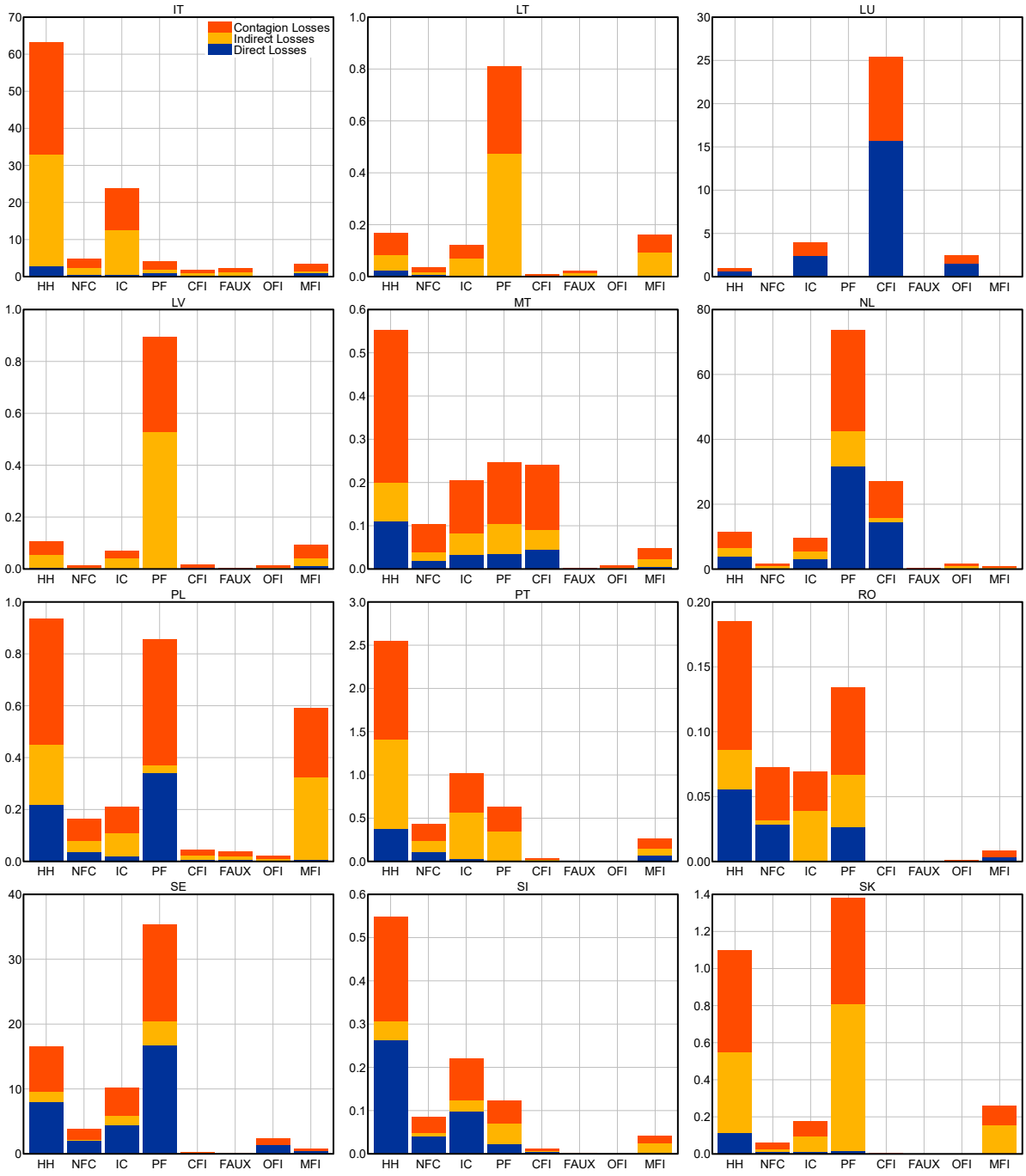
where $\tau_t^{k,i,s=1}$ and $\tau_t^{k,i,s=2}$ denote the share of sector k in country i's holdings of foreign listed shares and foreign investment fund shares, respectively. These parameters capture how direct, indirect, and contagion losses are distributed across the sectors. The term $\mu_t^{k,i,s=2}$ captures sector k's share of domestic investment fund holdings and serves to pass through losses incurred in the domestic investment fund sector to its end investors. Accordingly, the losses recorded by investment funds are not borne by the investment fund sector itself but are allocated to the sectors holding fund shares. The terms DL_t, IL_t, and CCL_t denote direct, indirect, and contagion losses at the country level and within the domestic investment fund sector, while all other components are defined as in Equation (19).

This formulation ensures that all losses arising from direct holdings, indirect exposures, and contagion effects are consistently allocated to the sectors that ultimately bear them. Another concern is the treatment of fund domiciles. In most countries, domestic funds are largely held by domestic sectors. However, Ireland and Luxembourg act as international fund hubs, channelling investments from across the EU. To reflect this, losses incurred in these countries are partially reallocated across EU countries using bilateral fund exposure shares. This adjustment ensures that losses are attributed to the ultimate investors rather than to the location of the fund's domicile.

Figure 3 shows the distribution of total (latent) losses across sectors for each EU country following a 10% decline in U.S. equity prices. The distribution of losses varies considerably between countries, reflecting differences in portfolio composition and the structure of financial systems. A first pattern emerges in economies where households bear the largest share of the losses, including Germany, Italy, Spain, and Belgium. In these countries, households hold a large share of listed shares and investment fund shares, either directly or via retail investment products, which exposes them directly to fluctuations in global asset markets. A second group, comprising the Netherlands, Sweden, and several Central and Eastern European economies, is characterised by the dominant role of pension funds. Pension funds invest heavily in global equity markets and therefore bear a substantial share of the losses. In intermediary financial hubs such as Luxembourg and Cyprus, a clear pattern is emerging, with losses concentrated in captive financial institutions and related financial intermediaries. These sectors facilitate cross-border investment flows and therefore absorb losses associated with internationally diversified portfolios rather than the domestic balance sheets. In the remaining countries, including France, Finland, and Denmark, losses are distributed more evenly across households, insurance corporations, and non-financial corporations, which is consistent with more diversified financial systems in which multiple sectors participate in global asset markets.

Figure 3. Total (latent) losses following a 10% decline in U.S. equity prices by sector, in billion EUR





Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. The allocation of losses across individual sectors is based on Equation (20). Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

Overall, the results show that the sectoral distribution of losses depends not only on the size of foreign exposure, but also on the structure of financial intermediation. In economies with significant household participation in equity markets, losses are concentrated in the household sector,

whereas in economies with large institutional investors such as insurance corporations and pensions funds, losses are primarily transmitted through these institutions. Financial intermediary hubs, in turn, concentrate losses within the intermediary sector, which channels cross-border investments. These differences are of central importance for assessing both the distributional consequences of global shocks and their potential macro-financial transmission to European economies.

4.4. Domestic losses across sectors in the EU

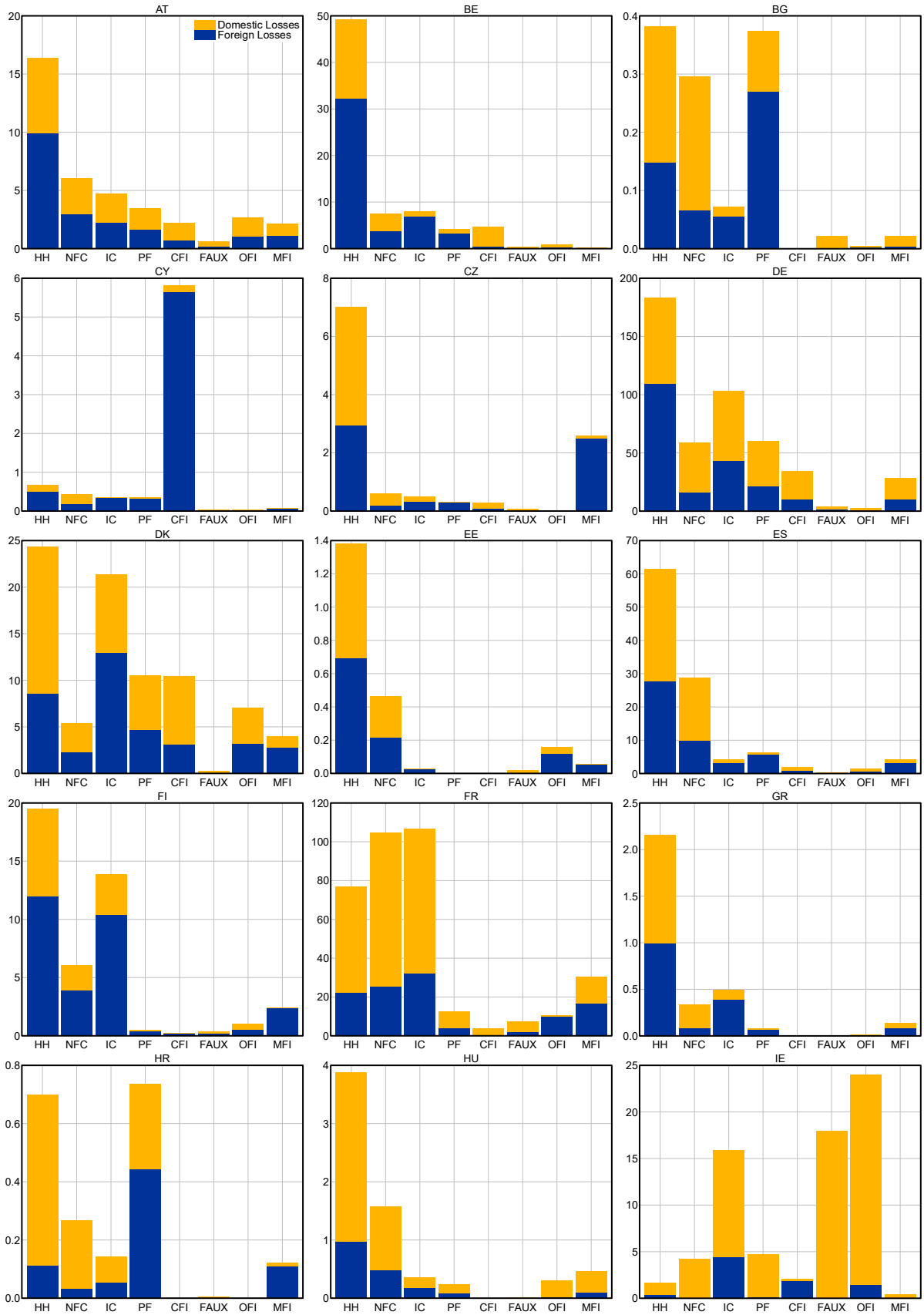
To obtain a comprehensive assessment of sectoral losses, we now incorporate the propagation of global shocks to domestic equity markets. In addition to cross-border exposures, sectors incur losses from holdings of domestically issued assets, whose valuations co-move with global markets. Hence, a decline in U.S. equity prices leads to a proportional valuation adjustment of domestic assets, reflecting a global repricing. The domestic losses for sector k in country i are given by:

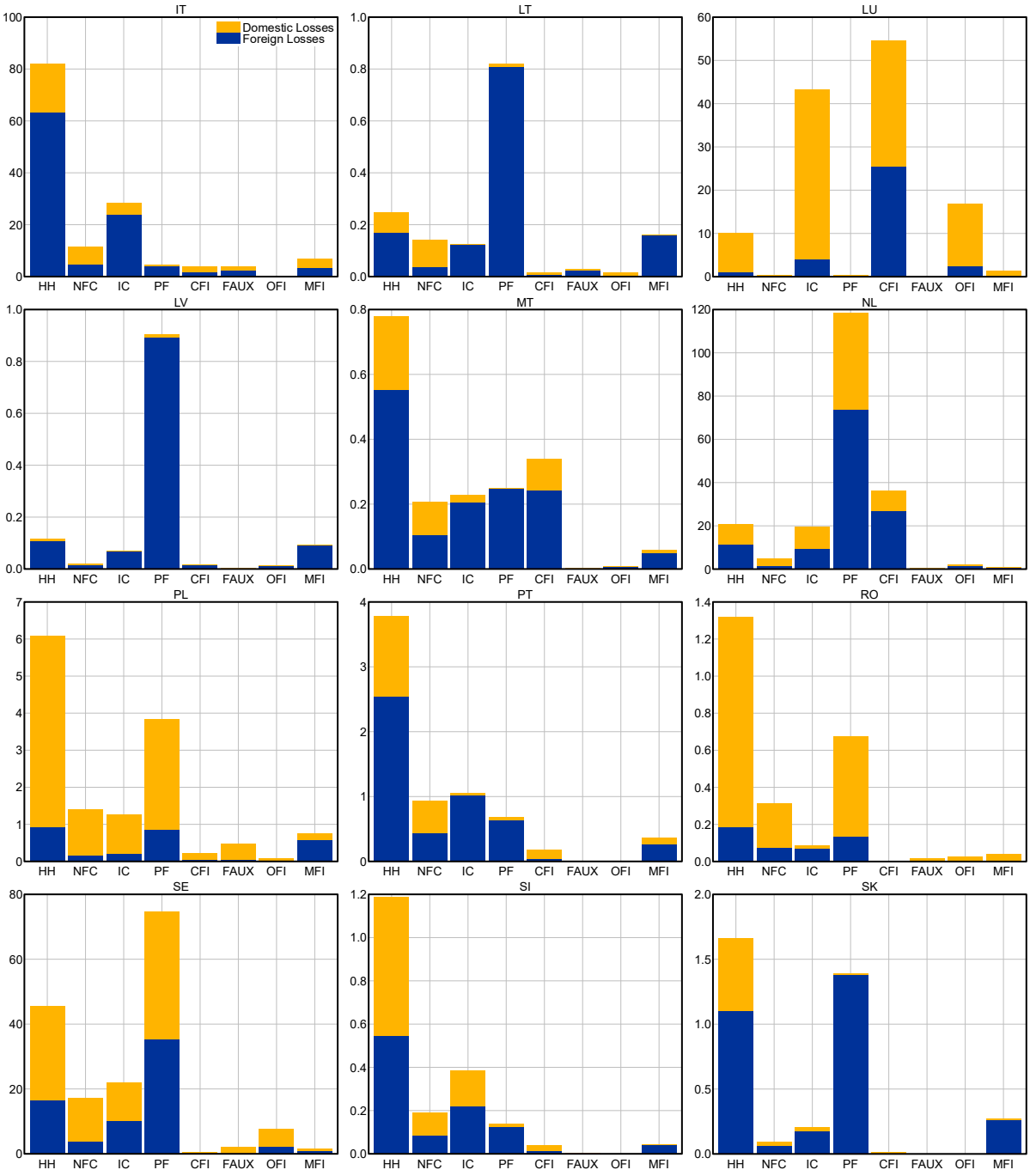
$$DOL_t^{k,i} = \left[\theta_t^i \cdot \left(1 - \omega_t^i\right)\right] \cdot \left(0.1 \cdot \gamma^{\mathrm{US,i}} \cdot DX_t^{k,i}\right) + \left(\mu_t^{k,i,s=2} \cdot DOL_t^{k=\mathrm{IF},i}\right). \tag{21}$$

The term $\left[\theta_t^i \cdot \left(1 - \omega_t^i\right)\right]$ adjusts for the share of equity exposure in the total portfolio, in line with the treatment in Equation (19) and Equation (20). The second component captures losses from domestic holdings of listed shares and investment fund shares, where $DX_t^{k,i}$ denotes the value of these holdings. The parameter $\gamma^{\mathrm{US},i}$ measures the co-movement of the U.S. and domestic equity markets and determines the strength of the transmission. The third component captures the pass-through of losses incurred by domestic investment funds to their end investors. The parameter $\mu_t^{k,i,s=2}$ denotes the share of sector k in domestic fund holdings, while $DOL_t^{k=\mathrm{IF},i}$ represents the losses at the level of the domestic investment fund sector. As a result, these losses are not borne by the funds themselves but are passed on to the sectors holding fund shares. This formulation integrates domestic contagion into the broader framework and enables us to capture both international and domestic channels of shock transmission at the sectoral level.

Figure 4 combines the domestic and foreign components of total (latent) losses across sectors and countries following a 10% decline in U.S. equity prices. A key finding is that domestic losses play a significant role and, in several countries, exceed the losses associated with cross-border exposures. This highlights the importance of the co-movements of domestic markets in amplifying the impact of global shocks.

Figure 4. Domestic and foreign total (latent) losses following a 10% decline in U.S. equity prices by sector, in billion EUR





Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. The allocation of losses across individual sectors is based on Equation (20), while domestic losses are estimated according to Equation (21). Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

At an aggregate level, domestic losses amount to around 1,070 billion euros, reflecting the strong link between the U.S. and European equity markets. When combined with losses from direct

holdings of U.S. securities, indirect holdings via investment funds, and cross-country contagion, total losses rise to around 1,960 billion euros. Although these estimates represent valuation effects rather than realised losses, their magnitude is economically meaningful and underscores the potential scale of market-based shocks. By way of comparison, non-performing loans reached a peak of around 1,000 billion euros at the height of the European sovereign debt crisis (Council of the EU, 2017).

The relative importance of domestic losses compared with foreign losses varies considerably between countries. In countries such as France, Ireland, Luxembourg, and several Central and Eastern European economies, domestic losses account for more than half of total losses, reflecting the importance of domestic equity markets and local asset holdings. In contrast, domestic losses are comparatively low in smaller economies such as Cyprus, Latvia, and Malta, which is attributable to the relatively small size of domestic equity markets and a greater reliance on cross-border assets.

At the sectoral level, the inclusion of domestic losses largely confirms the patterns observed previously, with households in many countries continuing to bear the lion's share of the losses due to their exposure to equity and fund markets. In some cases, however, domestic exposures also shift the distribution of losses. In several Central and Eastern European economies, household exposure increases compared to pension funds due to material holdings of domestic assets, while in Ireland losses are more concentrated among other financial intermediaries and financial auxiliaries, reflecting their central role in managing and intermediating large portfolios of both domestic and cross-border assets.

Overall, the results show that domestic transmission channels significantly amplify the impact of global shocks and shape their distribution across sectors. Ignoring these channels would understate the total losses and misrepresent the sectors most exposed to adverse market developments.

4.5. From latent to realised losses

A key distinction in any analysis of the impact of a shock in securities prices is between unrealised and realised losses. Valuation changes initially result in unrealised losses, which do not necessarily trigger immediate balance sheet adjustments. Investors may absorb such losses without liquidating positions, particularly if their capital buffers are sufficient or if the shocks are perceived as temporary. Consequently, unrealised losses do not automatically translate into solvency concerns.

However, losses may be realised through various channels. First, as stated in Equation (14), sectors may be required to realise losses if these exceed a certain threshold relative to their own funds, reflecting internal risk limits or regulatory constraints. Second, in accordance with mark-to-market

accounting standards, changes in asset prices are recognised immediately in the financial statements, which has a direct impact on reported capital positions. This channel is particularly relevant for monetary financial institutions, insurance corporations, and pensions funds. Third, leverage can amplify the effects of adverse price movements by triggering deleveraging and forced asset sales, thereby converting unrealised losses into realised losses. These mechanisms imply that the same underlying shock can have heterogeneous effects across sectors depending on balance sheet structure, accounting practices, and the regulatory environment.

To assess the likelihood that unrealised losses will turn into realised losses, we scale the losses against sectoral own funds, used as a measure of each sector's capacity to absorb valuation changes. Own funds are generally defined as the sum of net worth, listed shares, unlisted shares, and other equity, based on QSA. Several refinements are introduced to better reflect sector-specific balance sheets. For insurance corporations, own funds are measured as the excess of assets over liabilities using EIOPA supervisory data. For pension funds, own funds are defined as the maximum of 10% of total assets and the baseline measure, reflecting data constraints. For non-financial corporations, unlisted shares are excluded to avoid double counting of intra-group positions, while for monetary financial institutions, own funds are limited to listed shares and other equity to better approximate regulatory capital. Finally, for households and non-financial corporations, we also include fixed assets such as dwellings, buildings, and machinery to reflect the importance of real assets in their balance sheets.

Table 2 shows total losses – including direct, indirect, contagion, and domestic components – as a share of own funds across sectors and countries. A decomposition into direct, indirect, contagion, and domestic losses is provided in Annex 1. Cells are highlighted in red if the ratio of domestic and total losses to own funds exceeds 10%, and in yellow if it lies between 5% and 10%. The results suggest that institutional investors are, in relative terms, the most exposed sectors. For insurance corporations and pensions funds, losses frequently exceed 10% of own funds, due to their large, market-based, and internationally diversified portfolios. Other financial intermediaries and financial auxiliaries also show elevated losses in several countries, while monetary financial institutions exhibit more moderate loss ratios in most countries.

Table 2. Total losses and domestic losses as a share of own funds, in percentages

Sector	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK
HH	0.8	1.7	0.2	0.5	0.9	0.9	1.5	1.6	0.7	2.7	0.6	0.2	0.4	0.8	0.1	0.8	0.2	3.8	0.1	1.3	0.4	0.7	0.4	0.4	2.4	0.5	0.6
NFC	1.1	1.4	0.6	-1.8	0.3	1.3	2.6	2.3	1.6	2.2	3.5	-0.4	0.2	0.8	0.7	5.8	0.2	1.7	0.1	2.9	1.5	37	6.9	0.1	5.3	0.4	0.1
IC	15	20	3.0	18	7.2	20	70	5.0	6.8	99	27	13	7.0	15	35	20	12	168	19	3.7	30	5.3	16	3.4	63	12	10
PF	121	87	27	75	13	58	40		37	71	48	32	29	36	36	25	86	126	92	29	56	67	35	21	45	29	66
CFI	2.0	1.4	0.0	1.8	0.7	3.6	1.4	0.0	0.6	16	2.8	0.0	0.0	0.0	0.5	1.9	0.1	0.9	0.4	0.1	1.2	3.0	0.3	0.0	0.4	1.3	-2.7
FAUX	2.1	0.7	2.2	1.1	1.2	1.9	3.4	1.2	0.3	4.8	6.9	0.0	0.5	1.4	13	2.0	1.9	0.0	0.1	0.1	0.4	5.0	0.1	1.7	7.9	0.8	0.0
OFI	53	1.3	0.3	0.4	0.4	-18	3.8	2.1	4.5	5.7	14	0.8	-0.8	5.3	15	0.1	0.4	46	0.9	0.4	4.4	-1.6	0.0	0.4	7.4	0.1	0.0
MFI	3.4	9.8	0.4	2.0	26	5.0	5.9	29	2.2	4.3	6.9	0.6	1.1	2.6	16	3.3	4.3	14	5.3	3.0	0.8	1.2	0.8	0.2	1.7	1.6	6.0

Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. The allocation of losses across individual sectors is based on Equation (20), while domestic losses are estimated according to Equation (21). Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. Own funds are generally defined as the sum of net worth, listed shares, unlisted shares, and other equity. Several refinements are introduced. For IC, own funds are measured as the excess of assets over liabilities using EIOPA supervisory data. For PF, own funds are defined as the maximum of 10% of total assets and the baseline measure. For NFCs, unlisted shares are excluded, while for MFIs, own funds are limited to listed shares and other equity. Finally, for HHs and NFCs, we also include fixed assets such as dwellings, buildings, and machinery. Cells are highlighted in red if the ratio of domestic and total losses to own funds exceeds 10%, and in yellow if it lies between 5% and 10%.

The extent to which these losses are actually realised depends crucially on accounting and behavioural responses. Financial institutions, particularly monetary financial institutions, insurance corporations, and pensions funds, are more likely to recognise valuation changes due to mark-to-market accounting standards and regulatory capital constrains, thereby increasing the likelihood that losses will be translated into balance sheet adjustments. In contrast, households and non-financial corporations are less likely to realise losses immediately, as they have longer investment horizons and employ less stringent valuation practices.

Beyond their direct impact on the balance sheet, valuation losses may also affect the real economy through behavioural channels. For example, households might adjust their consumption in response to a decline in financial wealth. However, holdings of listed shares and investment fund shares tend to be concentrated among wealthier households, which generally exhibit a lower marginal propensity to consume (Carroll et al., 2014; Sánchez Serrano, 2025a). Consequently, the aggregate impact of such wealth effects on consumption is likely to be limited. Overall, while the simulated losses are initially latent, their potential to materialise varies considerably across sectors. Institutional investors appear to be most vulnerable, owing both to their balance sheet structure and to the regulatory and accounting framework within they operate.

To provide a complementary perspective, we examine sectoral leverage, measured as the ratio of own funds to total assets using data from the QSA. This ratio is the inverse of standard leverage:

lower values indicate higher leverage and a reduced capacity to absorb valuation losses. Sectors with lower ratios are therefore more inclined to liquidate assets following adverse shocks, while those with higher ratios are better able to absorb losses.

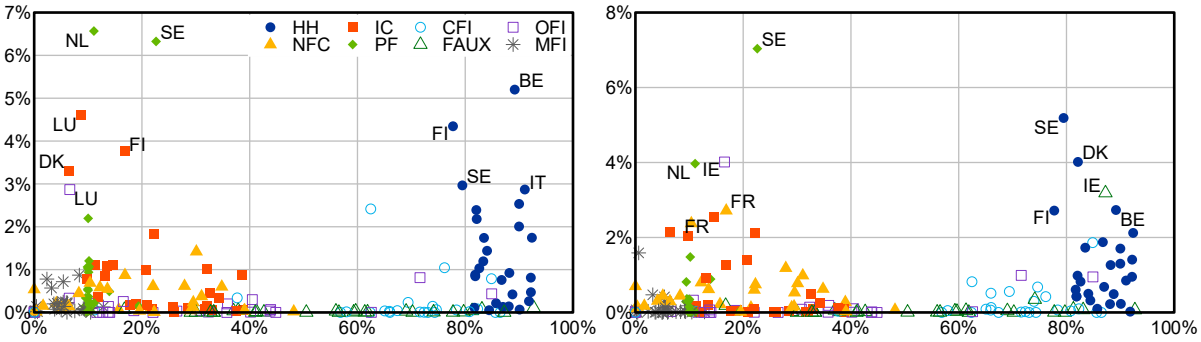
Figure 5 (left panel) shows this measure against direct, indirect, and contagion losses as a share of nominal GDP.[9] We annotate the country of the sectors with the ten largest losses. A clear pattern emerges. Households often incur relatively high losses, reflecting their exposure to U.S. equity markets, but they also have high own funds ratios – partly due to substantial holdings of real assets – which provide a buffer against immediate adjustments. In contrast, pensions funds and insurance corporations have lower own funds ratios, often below 20%, due to balance sheets dominated by financial assets matched by long-term liabilities. This combination of higher leverage and market exposure suggests that these sectors face a greater potential for realising losses. Among the other sectors, captive financial institutions appear relatively well capitalised despite large losses in certain jurisdictions, while other financial intermediaries, particularly in Cyprus and Luxembourg, combine sizeable losses with smaller capital buffers, suggesting greater vulnerability.

Figure 5 (right panel) shows the corresponding analysis for domestic losses.[10] The overall structure is similar. Here too, households show relatively high losses alongside a sound balance sheet position, while pensions funds and insurance corporations, particularly in Ireland, France, Germany, and the Netherlands, are concentrated among more highly leveraged sectors. Financial auxiliaries in Ireland stand out with high own funds ratios, despite incurring non-negligible losses.

[9] Two observations are excluded for visualisation purposes: captive financial institutions in Luxembourg and Cyprus, with losses of around 16% and 30% of GDP and own funds ratios of around 65%.

[10] Four observations for Luxembourg are excluded for visualisation purposes: insurance corporations, captive financial institutions, other financial intermediaries, and households, with losses of around 45%, 34%, 17%, and 11% of GDP, and own funds ratios of 9%, 65%, 7%, and 83%, respectively.

Figure 5. Own funds relative to total assets by sector (x-axis) and estimated latent losses following a 10% decline in U.S. equity prices as a share of nominal 2024 GDP (y-axis), in percentages. The left panel shows direct, indirect, and contagion losses, while the right panel shows domestic losses.



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. The allocation of losses across individual sectors is based on Equation (20), while domestic losses are estimated according to Equation (21). Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. Own funds are generally defined as the sum of net worth, listed shares, unlisted shares, and other equity. Several refinements are introduced. For IC, own funds are measured as the excess of assets over liabilities using EIOPA supervisory data. For PF, own funds are defined as the maximum of 10% of total assets and the baseline measure. For NFCs, unlisted shares are excluded, while for MFIs, own funds are limited to listed shares and other equity. Finally, for HHs and NFCs, we also include fixed assets such as dwellings, buildings, and machinery. Total assets include both financial and non-financial assets. The countries with the ten largest losses are annotated.

Taken together, these findings suggest that, due to their leverage levels and exposure to market valuations, pension funds and insurance corporations are in principle more inclined to realise losses following adverse shocks. However, this conclusion should be interpreted with caution. Both sectors operate under long-term business models that may enable them to absorb short-term valuation changes without immediate asset sales, and unlike investment funds, they are not subject to short-term redemption pressure. In the case of pension funds operating through defined-contribution schemes, market risk is ultimately borne by households, implying that losses are more likely to be materialised gradually through lower future benefits than through immediate balance sheet adjustments.[11] Overall, the interplay between leverage, accounting frameworks, and business models plays a central role in determining whether unrealised losses are realised, and thus in shaping the macro-financial impact of major market shocks.

[11] According to ECB data on pension funds, defined-contribution plans accounted for more than 80% of total pension entitlements at the end of 2024 in Austria, Croatia, France, Greece, Italy, Latvia, Lithuania, Malta, Spain, and Slovakia, while their share was below 10% in Belgium, Finland, the Netherlands, and Slovenia.

5. Robustness checks and additional analyses

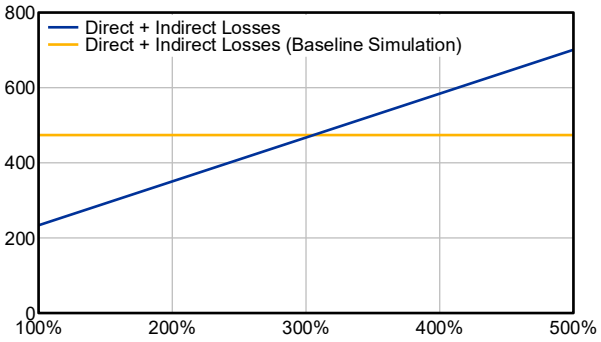
The baseline results depend on two key factors: the level of EU exposures to U.S. equity markets and the co-movement between U.S. and global equity prices. In this section, we perform a series of robustness checks and additional analyses to assess how sensitive the results are to alternative assumptions regarding these components.

5.1. Losses under alternative growth rates of U.S. exposures

Since the global financial crisis, global holdings of U.S. listed shares and investment fund shares have risen substantially, from around 3.3 trillion euros in 2014 to over 14 trillion euros in 2024. This represents an increase of about 263% in US dollars and 330% in euros. While this increase is partly attributable to valuation effects, as international investment positions are valued at market prices, it also points to a significant expansion of international investment in U.S. equity markets.

In Figure 6, we examine the impact of these developments on EU investors by analysing how losses vary depending on the increase in their exposure to U.S. equity markets.[12]

Figure 6. Direct and indirect losses of EU countries following a 10% decline in U.S. equity prices under alternative growth rates of exposures to U.S. listed shares and investment fund shares, in billion EUR



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: the yellow line shows direct and indirect losses from our baseline simulation computed according to Equation (19), assuming a 10% decline in U.S. equity prices. The blue line shows losses under counterfactual scenarios in which EU exposures to U.S. listed shares and investment fund shares increase by between 100% and 500% relative to their 2014 levels. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

We consider counterfactual scenarios in which exposure increases by between 100% and 500% compared with 2014 levels. For each scenario, we compute the corresponding direct and indirect losses following a 10% decline in U.S. equity prices. The losses rise roughly in proportion to the exposures: a doubling of exposures results in losses of around 200 billion euros, while a fivefold

[12] The data on portfolio investment in U.S. listed shares and investment fund shares do not include Malta in 2014.

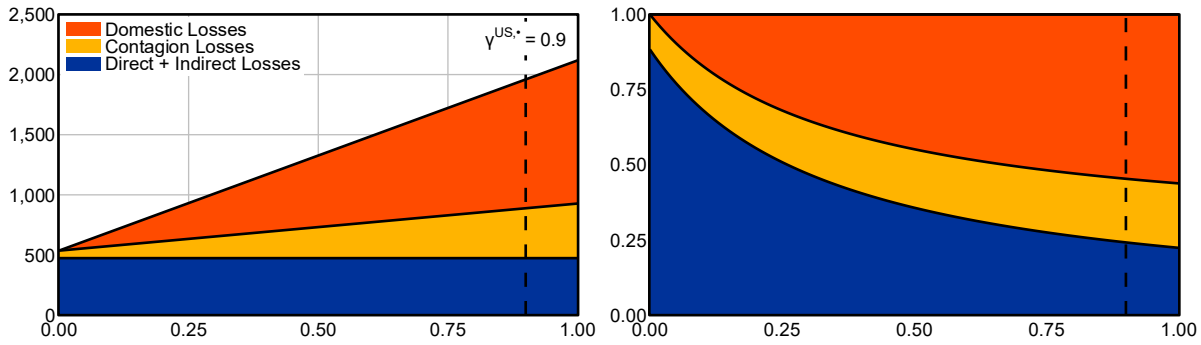
increase raises losses to over 700 billion euros. The baseline simulation estimate in our main analysis corresponds to an increase of around 300%, which is largely consistent with the observed growth in exposures over this period. Overall, the results show that as financial integration with U.S. equity markets deepens, the vulnerability of European portfolios to external shocks rises proportionally.

5.2. Losses under alternative market correlations

Next, we examine the extent to which losses depend on the degree of co-movements between U.S. and global equity markets. In the model, this channel is determined by the correlation parameters $\gamma^{\mathrm{US,EU}}$ and $\gamma^{\mathrm{US,AE}}$, which specify the extent to which shocks in U.S. equity prices are transmitted to other European and other advanced economies. Given the relatively low exposure of EU investors to emerging markets, we hold $\gamma^{\mathrm{US,EM}}$ fixed at 0.6.

Figure 7 shows total losses, decomposed into direct, indirect, contagion, and domestic components, under alternative correlation assumptions. By construction, direct and indirect losses resulting from exposures to U.S. assets remain unaffected by changes in correlations. In contrast, contagion and domestic losses increase with the extent of cross-market co-movements and determine the variations in total losses across the different scenarios.

Figure 7. Direct, indirect, contagion, and domestic losses of EU countries following a 10% decline in U.S. equity prices under alternative market correlations between U.S. and global equity markets, in billion EUR (left) and percentages (right)



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: direct, indirect, and contagion losses are computed according to Equation (19), assuming a 10% decline in U.S. equity prices. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. Domestic losses are estimated according to Equation (21). The x-axis represents alternative assumptions on the correlation between U.S. equity markets and those in Europe and other advanced economies. The correlation between U.S. and emerging market equities is held constant at $\gamma^{\mathrm{US,EM}} = 0.6$.

At low levels of correlation, losses are limited and largely reflect direct and indirect exposures. In the limiting case of zero correlation, total losses amount to around 540 billion euros, with more

than 88% attributable to direct and indirect channels.[13] As correlation increases, contagion effects and domestic losses become quantitatively more important. With a correlation of 0.5, for example, total losses rise to around 1.3 trillion euros, with domestic losses accounting for a substantial share of this increase. At high correlation, the amplification effect dominants: as correlations approach one, total losses exceed 2.1 trillion euros, with domestic losses accounting for more than half of the total. The baseline scenario ($\gamma^{\mathrm{US,EU}} = 0.9$) lies close to this upper range.

Investments in U.S. and EU equity markets can be seen as substitutes. For a given amount of available savings to invest, EU investors choose between the two markets, keeping the footprint in other advanced and emerging economies constant. In these circumstances, when exposures to the U.S. decrease, exposures to EU markets mechanically increase. Therefore, latent losses from a correction of equity prices in the U.S. would not vary much given the high contagion from the U.S. equity markets to the EU equity markets. However, it is logical to think that lower investments in U.S. equity markets would also decrease the correlation with EU markets ($\gamma^{\mathrm{US,EU}}$), leading overall to lower losses.

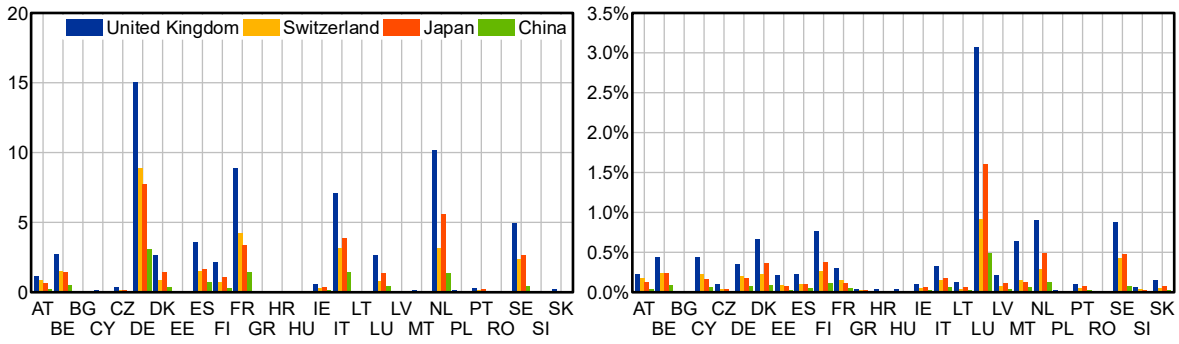
In general, these results highlight a simple mechanism. While direct and indirect exposures determine the initial impact of the shock, the amplification of the shock depends on cross-market correlations. In more integrated financial systems, shocks in U.S. equity markets are transmitted more strongly to other markets, leading to larger and more widespread losses. Conversely, in the absence of such correlations, losses remain largely confined to direct and indirect exposures. Negative correlations could in principle offset losses, but such scenarios are unlikely in practice, as sharp declines in U.S. equity markets are typically accompanied by widespread global downturns.

5.3. Losses from shocks originating in other major economies

We now examine how losses change when shocks originate outside the U.S. Using the same framework as in Section 4, we simulate a 10% decline in equity prices in the United Kingdom, Switzerland, Japan, and China, and compute the resulting direct and indirect losses for EU investors. Figure 8 shows the results. Losses are generally modest, although there are notable exceptions in countries with stronger bilateral exposures. In particular, Germany and the Netherlands incur losses of over 10 billion euros in response to a shock in the United Kingdom, reflecting relatively stronger financial linkages. Across all countries, exposures to China result in the lowest losses, which is consistent with limited portfolio investment by EU investors in Chinese equity markets.

[13] The remaining 12% refers to contagion losses from equity holdings in emerging economies, which correlation remains at 0.6.

Figure 8. Direct and indirect losses in EU countries following a 10% decline in equity prices in the respective countries, in billion EUR (left) and as a percentage of nominal 2024 GDP (right)



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: direct and indirect losses are computed according to Equation (19), assuming a 10% decline in equity prices in the United Kingdom, Switzerland, Japan, and China. Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries.

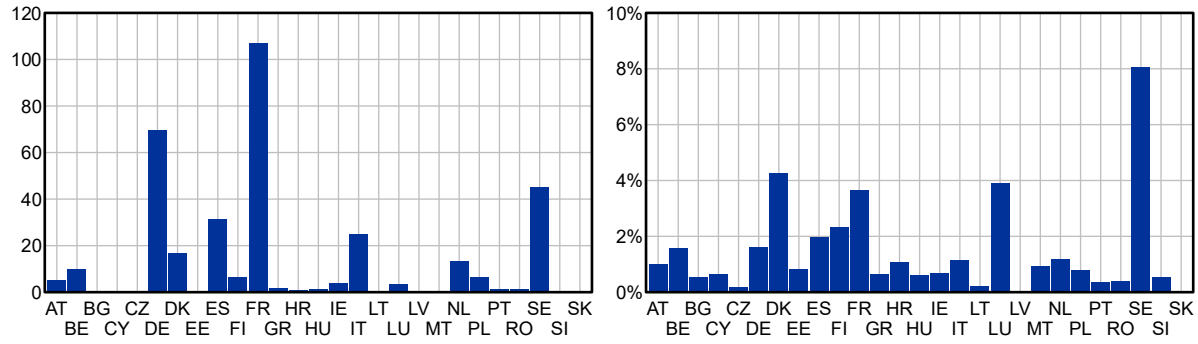
At an aggregate level, total losses amount to around 63 billion euros, 29 billion euros, 31 billion euros, and 11 billion euros respectively for shocks originating in the United Kingdom, Switzerland, Japan, and China. These figures are an order of magnitude lower than those associated with a comparable shock on the U.S. equity markets. Expressed relative to GDP, the losses remain small for most countries and exceed 1% of GDP only in Luxembourg, reflecting the size of its financial sector relative to domestic output. Among EU economies, the Netherlands, Sweden, Finland, and Denmark show the highest relative losses, although these remain limited, particularly when compared to the magnitudes observed in the baseline shock scenario for the U.S. (Figure 2). Overall, these results underscore that shocks originating outside the U.S. have only limited direct effects on EU investors, provided they do not propagate to U.S. equity markets, where EU exposures are more concentrated.

The extent of losses resulting from shocks originating outside the U.S. is determined primarily by cross-market spillovers rather than by direct and indirect exposures. Therefore, the key question arises as to whether shocks affecting the equity markets in the United Kingdom, Switzerland, Japan, or China are transmitted to U.S. equity markets and domestic EU markets, where exposures are greater. To answer this question, we focus on events where shocks can reasonably be interpreted as originating from a single market, so that the observed co-movement is attributable to spillovers rather than common global factors. The United Kingdom provides two such episodes: the period surrounding the Brexit referendum in June 2016 and the 'mini-budget' episode in September 2022. Although the exact timing of these shocks is difficult to isolate, both episodes show a consistent pattern. The correlations between equity prices in the United Kingdom and the U.S. are strongly negative, at around -0.7 around the Brexit episode and -0.9 following the mini-budget

announcement, suggesting that U.S. markets acted as a relative safe haven. Consequently, shocks in the equity markets of the United Kingdom did not spill over to the U.S. and therefore caused only limited global spillovers. In contrast, correlations between the United Kingdom and the EU equity markets remained high during these episodes, typically between 0.8 and 0.9, reflecting strong regional financial linkages and suggesting that such a shock can still generate sizeable domestic losses within the EU.

Figure 9 quantifies the implications of this channel. Assuming a correlation of 0.8 between equity markets in the United Kingdom and the EU, a 10% decline in equity prices in the United Kingdom leads to sizeable domestic losses within the EU, exceeding 60 billion euros in both France and Germany and totalling more than 350 billion euros.[14] The largest relative losses occur in financially open economies such as Luxembourg, Denmark, and Sweden. These estimates should be interpreted as upper bounds, as sharp declines of equity prices in the United Kingdom are rare; for example, daily declines of over 10% have occurred only in exceptional cases.[15] In addition, correlations with other non-U.S. markets are generally lower, suggesting more limited spillover effects in these cases.

Figure 9. Domestic losses in EU countries following a 10% decline in equity prices in the United Kingdom, in billion EUR (left) and as a percentage of nominal 2024 GDP (right)



Source: ECB, Eurostat, IMF, and authors' calculations. Notes: domestic losses are estimated according to Equation (21), assuming a 10% decline of equity prices in the United Kingdom. The correlation between equity markets in the United Kingdom and in EU countries is set to $\gamma^{\mathrm{UK},\cdot} = 0.8$.

[14] This analysis considers only the impact through domestically issued listed shares. It assumes that investment funds are not materially affected by shocks originating in the United Kingdom, reflecting its limited role as an international fund hub compared with jurisdictions such as Ireland and Luxembourg, which intermediate investments from across the EU.

[15] For instance, the FTSE100 was down 7.3% on 1 March 1974, 9.1% on 19 October 1987, 11.4% on 20 October 1987, or 10.8% on 12 March 2020.

6. Conclusion

This paper develops a framework to quantify losses resulting from shocks to equity markets, capturing both direct exposures and indirect transmission via cross-country and domestic contagion channels. By combining sectoral balance sheet data with bilateral portfolio holdings, the approach provides a transparent and internally consistent measure of how shocks spread across countries and sectors. A key contribution is the integration of publicly available datasets (i.e., the Quarterly Sectoral Accounts, the EU International Investment Position, and the IMF's Portfolio Investment Positions), into a unified framework that can be readily used for macro-financial analytics. In an environment of increasing cross-border portfolio holdings and interconnections in the financial sector, the framework offers a timely tool for policymakers to assess vulnerabilities to global equity market shocks.

Applying the framework to a 10% decline in U.S. equity prices, we estimate that direct, indirect, and cross-country contagion losses across the EU amount to nearly 900 billion euros, equivalent to around 5% of nominal GDP. Although this represents a severe scenario (market corrections of this magnitude have occurred only four times in the last century), it remains plausible and can be regarded as an upper bound for potential losses. At the same time, these estimates capture only immediate, first-round effects and do not take into account persistence, behavioural responses, and dynamic feedback mechanisms that could amplify losses over time. When domestic spillovers are considered, total losses rise substantially, reflecting strong correlations between U.S. and European equity markets. The losses are unevenly distributed: they are concentrated in financially open economies, including the Nordic countries and the Benelux, and are borne at the sectoral level primarily by households, pension funds, and insurance corporations. At the same time, differences in balance sheet structure and investment horizons imply that high valuation (unrealised) losses do not necessarily translate into immediate asset sales.

A key finding is that losses are driven not only by direct exposures, but also by cross-market spillovers. The dominant role of U.S. equity markets means that shocks originating there have far-reaching effects, while shocks in other major economies have only limited effects unless they spread to U.S. markets or closely interconnected regions such as the EU. This underscores the importance of market size and network centrality for the global propagation of financial shocks.

The framework has several limitations. It focuses on equity price shocks and abstracts from interactions with other asset classes, such as debt securities, or feedback effects with the real economy. These channels may either amplify or mitigate the overall impact. In addition, the analysis is conducted at country and sector level and does not take into account the heterogeneity between

individual institutions. Accordingly, the framework cannot be regarded as a substitute for institution-level stress tests. Despite these limitations, the approach provides a tractable and data-driven benchmark for assessing the extent and distribution of losses following shocks to equity markets. It offers a useful starting point for identifying vulnerabilities and informing more granular stress tests. More broadly, the results underscore that global financial integration both contribute to portfolio diversification and amplify the transmission of systemic risks.

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Annex 1. Breakdown of domestic and total losses as a share of own funds

Total and domestic losses as a share of own funds, reported in Table 2, can be decomposed into direct, indirect, contagion, and domestic losses. Table A1, Panel A–D show the corresponding breakdown by country and sector.

Table A1. Direct, indirect, contagion, and domestic losses as a share of own funds, in percentages

Sector	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK
Panel A. Direct Losses																											
HH	0.1	0.2	0.0	0.0	0.0	0.1	0.3	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.1	0.0	0.0	0.0	0.4	0.1	0.0
NFC	0.2	0.2	0.0	-0.0	0.0	0.1	0.6	0.3	0.1	0.4	0.3	-0.0	0.0	0.1	0.0	0.3	0.0	0.2	0.0	0.3	0.1	1.0	0.8	0.0	0.6	0.1	0.0
IC	1.0	1.2	0.1	0.0	0.2	1.4	24	0.0	0.4	17	2.0	0.1	0.7	0.3	4.7	0.4	0.0	9.6	0.0	0.5	4.6	0.1	0.4	0.0	13	3.0	0.5
PF	8.5	6.7	6.3	0.3	1.7	4.6	9.3		3.6	12	3.4	2.3	3.2	1.5	0.4	5.0	0.1	0.0	0.3	4.1	15	6.0	0.5	0.8	10.0	4.8	0.7
CFI	0.1	0.0	0.0	0.1	0.0	0.4	0.2	0.0	0.1	3.2	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.3	0.1	0.0	0.5	0.1	0.0	0.0	0.1	0.2	-0.2
FAUX	0.2	0.1	0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.2	0.0
OFI	4.4	0.1	0.1	0.0	0.0	-1.2	0.8	0.6	0.4	0.8	5.0	0.0	-0.0	0.1	0.4	0.0	0.0	4.1	0.2	0.1	0.5	-0.1	0.0	0.0	1.4	0.0	0.0
MFI	0.2	1.9	0.0	0.0	9.1	0.7	1.6	0.0	0.6	1.7	1.5	0.1	0.4	0.1	1.1	0.5	0.0	0.1	0.7	0.2	0.3	0.0	0.2	0.0	0.5	0.1	0.0
Panel B. Indirect Losses																											
HH	0.1	0.3	0.0	0.1	0.1	0.2	0.0	0.2	0.1	0.4	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.2
NFC	0.1	0.2	0.0	-0.3	0.0	0.1	0.1	0.2	0.2	0.4	0.2	-0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.3	0.2	1.1	1.0	0.0	0.1	0.0	0.0
IC	2.7	7.3	1.0	10	2.4	3.1	2.9	2.8	2.1	25	2.2	5.3	0.6	3.4	0.0	8.5	7.0	0.0	11	0.8	3.5	0.4	8.3	1.5	4.1	0.8	4.2
PF	22	28	2.6	37	3.9	6.4	1.9		13	21	4.3	10	5.7	4.2	0.0	5.6	50	0.0	54	8.1	5.2	0.5	17	1.3	2.2	9.7	37
CFI	0.2	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	-0.5
FAUX	0.1	0.1	0.0	0.2	0.1	0.2	0.1	0.1	0.1	0.8	0.3	0.0	0.0	0.0	0.0	0.6	0.9	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
OFI	5.7	0.1	0.0	0.1	0.0	-3.2	0.3	0.1	0.5	0.9	1.3	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.2	-0.1	0.0	0.0	0.0	0.0	0.0
MFI	0.8	2.0	0.0	1.0	0.2	0.3	1.0	17	0.1	0.7	0.3	0.1	0.0	0.1	0.0	0.3	2.5	0.0	1.6	1.0	0.2	0.5	0.2	0.0	0.0	0.8	3.4
Panel C. Contagion Losses																											
HH	0.3	0.6	0.0	0.2	0.2	0.3	0.2	0.4	0.1	0.7	0.1	0.1	0.0	0.1	0.0	0.3	0.1	0.1	0.1	0.6	0.1	0.1	0.1	0.0	0.4	0.1	0.2
NFC	0.3	0.4	0.1	-0.4	0.1	0.2	0.4	0.6	0.3	0.6	0.4	-0.1	0.0	0.2	0.0	1.2	0.0	0.1	0.0	0.9	0.2	2.2	1.4	0.0	0.5	0.1	0.0
IC	3.5	8.5	1.1	7.9	2.2	3.9	15	2.0	2.5	32	4.1	5.0	1.4	3.7	5.1	8.1	5.0	5.9	7.8	2.0	6.0	0.4	7.1	1.2	12	3.0	3.9
PF	28	35	11	31	6.2	9.8	6.7		17	24	7.5	14	8.7	7.6	0.5	12	35	0.0	37	17	15	8.4	14	2.1	8.9	11	27
CFI	0.3	0.1	0.0	1.6	0.1	0.5	0.2	0.0	0.2	5.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	0.2	0.2	0.0	0.4	0.3	0.0	0.0	0.0	0.2	-0.7
FAUX	0.3	0.1	0.1	0.5	0.1	0.3	0.5	0.1	0.2	1.1	0.9	0.0	0.1	0.1	0.0	0.6	0.6	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.1	0.2	0.0
OFI	10	0.3	0.1	0.2	0.0	-3.9	0.6	0.9	1.0	1.3	6.7	0.0	-0.0	0.2	0.5	0.0	0.0	2.6	0.5	0.3	1.3	-0.2	0.0	0.0	0.9	0.0	0.0
MFI	0.8	4.5	0.0	0.8	16	0.9	1.7	12	1.0	1.8	1.9	0.2	0.6	0.4	1.2	0.9	1.8	0.1	3.0	1.3	0.3	0.4	0.3	0.0	0.4	0.6	2.4
Panel D. Domestic Losses																											
HH	0.3	0.6	0.1	0.1	0.5	0.4	1.0	0.8	0.4	1.0	0.4	0.1	0.3	0.6	0.1	0.2	0.1	3.4	0.0	0.4	0.2	0.6	0.1	0.3	1.5	0.3	0.2
NFC	0.6	0.7	0.4	-1.0	0.2	1.0	1.5	1.2	1.1	0.8	2.6	-0.3	0.2	0.5	0.7	3.4	0.2	1.4	0.0	1.4	1.0	32	3.7	0.1	4.1	0.2	0.0
IC	7.9	2.6	0.7	0.3	2.4	12	27	0.2	1.9	25	19	2.7	4.4	7.7	25	3.2	0.1	153	0.3	0.4	15	4.4	0.5	0.6	34	5.1	1.4
PF	63	18	7.5	6.3	0.8	38	22		3.1	13	33	5.0	12	23	35	2.2	1.2	126	1.1	0.1	21	52	2.5	17	23	3.1	0.6
CFI	1.3	1.2	0.0	0.1	0.5	2.5	1.0	0.0	0.3	4.3	2.8	0.0	0.0	0.0	0.0	1.0	0.1	0.5	0.0	0.0	0.3	2.4	0.3	0.0	0.3	0.9	-1.3
FAUX	1.5	0.4	2.0	0.3	0.9	1.2	2.1	1.0	0.0	2.3	5.1	0.0	0.4	1.2	13	0.8	0.3	0.0	0.0	0.0	0.2	4.6	0.0	1.7	7.7	0.4	0.0
OFI	32	0.8	0.1	0.1	0.3	-9.3	2.1	0.5	2.6	2.8	0.9	0.7	-0.7	5.0	14	0.0	0.4	39	0.0	0.0	1.4	-1.2	0.0	0.4	5.1	0.0	0.0
MFI	1.6	1.4	0.3	0.2	0.9	3.2	1.7	0.4	0.5	0.1	3.1	0.2	0.1	2.0	14	1.7	0.0	14	0.0	0.5	0.1	0.3	0.2	0.2	0.8	0.1	0.2

Source: ECB, Eurostat, IMF, and authors' calculations. Notes: HH denotes households; NFC non-financial corporations; IC insurance corporations; PF pension funds; CFI captive financial institutions and money lenders; FAUX financial auxiliaries; OFI other financial intermediaries; and MFI monetary financial institutions. The allocation of losses across individual sectors is based on Equation (20), while domestic losses are estimated according to Equation (21). Exposures are adjusted to exclude holdings of bond funds that are not affected by the shock. Losses incurred by domestic investment funds are attributed to their ultimate holders and thus allocated to the domestic sectors, with the exception of Ireland and Luxembourg, which act as international fund domiciles. For indirect losses, the losses incurred in Ireland and Luxembourg are allocated across EU countries in proportion to their holdings of investment fund shares domiciled in those countries. Own funds are generally defined as the sum of net worth, listed shares, unlisted shares, and other equity. Several refinements are introduced. For IC, own funds are measured as the excess of assets over liabilities using EIOPA supervisory data. For PF, own funds are defined as the maximum of 10% of total assets and the baseline measure. For NFCs, unlisted shares are excluded, while for MFIs, own funds are limited to listed shares and other equity. Finally, for HHs and NFCs, we also include fixed assets such as dwellings, buildings, and machinery. Cells are highlighted in red if the ratio of domestic and total losses to own funds exceeds 10%, and in yellow if it lies between 5% and 10.