

Staff Memo

Portfolio Commonality and Financial Interconnectedness

Evidence from the Swedish Financial System

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November 2026

SVERIGES RIKSBANK

Contents

1	Introduction	4
2	The Dimensions and Measures of Financial Interconnectedness	6
2.1	Measures of Portfolio Commonality	6
2.2	Data	7
3	Pairwise Portfolio Similarity	9
3.1	Cross-Sectional Snapshot	9
3.2	Potential implications for financial stability	15
4	Determinants of Portfolio Similarity	16
4.1	Differences in Portfolio Similarity across Different Institution Types	17
4.2	The Role of Portfolio Concentration	18
5	Common Sales Pressure	19
5.1	Similarity and Common Sales	19
5.2	Financial Conditions and the Level of Common Sales	20
6	Conclusion	23
	References	25
	APPENDIX – The evolution of portfolio similarity over time	26

Summary

Financial institutions are interconnected not only through direct exposures to one another but also indirectly through holdings of assets issued by the same firms. Such portfolio commonality can create channels through which financial stress can spread across institutions, even in the absence of contractual relationships. Common holdings may amplify shocks when institutions respond to financial stress by selling the same assets, potentially putting downward pressure on prices and reducing market liquidity.

This Staff memo examines the degree of portfolio commonality in the Swedish financial system using detailed securities holdings data covering banks, insurance companies, pension funds and AP funds as well as investment in some analyses over the period December 2018 to December 2025.

We find that average portfolio similarity in Sweden is relatively modest but masks substantial heterogeneity across institutions and asset classes. Portfolio similarity is particularly high for covered bonds, reflecting the limited number of issuers in this market. Similarity in listed equity portfolios has increased over time, partly driven by the growing importance of a small number of large technology companies. We also find that similarity tends to be higher among banks and among investment and AP funds, while insurance companies generally exhibit lower similarity. Moreover, institutions with more concentrated portfolios tend to have less similar holdings. Finally, we find that institutions with more similar portfolios are more likely to sell the same assets in the subsequent period. This association points to a potential channel of risk transmission through common selling; whereby simultaneous asset sales may amplify price declines and liquidity pressures.

Overall, the findings highlight the importance of considering portfolio commonality alongside direct exposures when assessing interconnectedness and potential vulnerabilities in the Swedish financial system.

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[1] The authors would like to thank David Forsman, Einar Lennelöv, Christina Nordh Berntsson, and Olof Sandstedt, as well as seminar participants at Sveriges Riksbank for valuable comments and suggestions.

1 Introduction

Financial interconnectedness has grown substantially across global financial systems over recent decades (Haldane, A. G., 2009). In Sweden, asset holdings across financial sectors have expanded markedly, raising the question of whether the network of cross-institutional exposures has also deepened (Sveriges Riksbank, 2024). From a central bank perspective, understanding these interconnections is essential for assessing systemic risk and safeguarding financial stability. Interconnections create channels through which shocks can be amplified and propagated across banks, non-bank financial institutions (NBFIs) and financial markets. Mapping those linkages and identifying the channels through which stress can propagate to the financial system are therefore important components for financial stability. They are also a basis for the design and calibration of macroprudential policy. At a broad level, financial interconnectedness can arise either through *direct relationships* between institutions or through *indirect linkages* that do not require a contractual relationship.[2] Direct interconnectedness includes bilateral exposures arising, for example, through interbank lending, repo markets, derivatives and holdings of securities issued by other financial institutions. Credit losses or liquidity stress at one institution can therefore be transmitted directly to its counterparties.

Indirect interconnectedness can emerge when institutions are exposed to the same type of underlying assets or the same issuer. One important indication of indirect exposures is portfolio commonality (Allen et al., 2012). Institutions with a high degree of portfolio commonality are exposed to common sources of valuation risk and to each other's responses to shocks, which is particularly important from a financial stability perspective. When multiple institutions hold similar assets, a shock to valuations can force simultaneous deleveraging. If an institution facing losses or liquidity strains sells assets, it can result in price declines that will affect other institutions holding the same assets. Valuation losses may, in turn, induce those other institutions to deleverage, potentially giving rise to a self-reinforcing fire-sales spiral (Greenwood et al., 2015). Moreover, as multiple institutions may try to sell the same assets at the same time, common holdings can make asset liquidity more fragile by stretching the market’s absorption capacity, reducing market depth and increasing trading costs and haircuts. Importantly, this fire-sale spiral can occur even in the complete absence of any direct contractual relationship between institutions (Cont and Schaanning, 2017). However, the systemic importance of this channel depends not only on the degree of commonality, but also on factors such as leverage, liquidity shortages and market liquidity of the assets held in common. Evidence from Swedish bond markets illustrates the importance of investor behaviour: during the initial COVID-19 shock, insurance and pension institutions bought corporate bonds sold by investment funds facing liquidity pressures, while acting procyclicality in covered bonds (Andersson, 2024).

[2] We divide financial interconnectedness into four broad categories: i) direct interconnectedness such as cross-holdings, ii) balance sheet commonality such as portfolio overlap, iii) intermediation chains, and iv) network centrality. The latter three are commonly thought of as indirect exposure, because they do not require institutions to hold each other’s asset directly. See Amberg et al. (2026) for a comprehensive description.

The distinction between direct exposures and portfolio commonality highlights two complementary dimensions of systemic interconnectedness. Network analysis asks *who is exposed to whom* and is particularly informative about the transmission of credit and liquidity shocks through contractual counterparty relationships. It can therefore identify institutions whose position in the network makes them risk transmitters or receivers of shocks. Portfolio-commonality analysis instead asks *who is exposed to the same assets or issuers* and identifies potential transmission through market prices and common portfolio adjustments. Considering only one of the interconnectedness dimensions may therefore provide an incomplete picture of the channels through which financial stress can propagate.

In this staff memo, we focus on portfolio commonality as a measure of indirect interconnectedness in the Swedish financial system. The work fits into a broader agenda aimed at improving our understanding of the different types of interconnections of Swedish financial institutions. Unlike measures based on correlations of traded assets, the measure of portfolio commonality is constructed using detailed information about institutions' asset holdings. The holdings-based measure therefore allows us to say more about the underlying balance sheet links through which common shocks may spillover. For instance, portfolio similarity measures have increasingly been used by central banks and other financial authorities to assess indirect linkages between different parts of the financial system. For example, the European Central Bank has employed such measures to analyse linkages between banks and non-bank financial intermediaries in its assessment of systemic risk (ref: ECB FSR 2023, Key linkages between banks and the non-bank financial sector).

The analysis in this note covers a broad range of institutional sectors, including banks, insurance companies, and pension funds over the period from December 2018 to December 2025. In some parts of the analysis, investment funds are also included. We use securities-level holdings data and construct cosine similarity measures at issuer level for all pairwise combinations of institutions in the sample. Cosine similarity is particularly useful, because it also allows portfolio composition to be compared across institutions that differ on several characteristics such as sector and size for example. This feature is especially relevant for a *system-wide* analysis of spillover risks in a country such as Sweden, where the financial system is composed of institutions that vary considerably in both size and business model. We aggregate securities to the issuer level to capture common exposure to the same underlying issuer even when institutions hold different individual securities issued by the same issuer.

The remainder of the note is structured as follows. Section 2 describes the background to this project and introduces the terms used, as well as the data and measures used in the empirical part. Section 3 presents a cross-sectional snapshot of pairwise similarity for a recent quarter, identifying several clusters of institutions with highly overlapping portfolios, and then draws these results together in a discussion of the channels through which portfolio commonality can transmit risk. The evolution of average pairwise similarity over time is reported in the appendix, as the patterns are stable over the sample period. Section 4 examines the structural determinants of portfolio similarity. Section 5 studies the consequences of asset similarity for firms' common sales behaviour.

2 The Dimensions and Measures of Financial Interconnectedness

This project fits into the larger work on financial interconnectedness of the Swedish financial system done at the Riksbank. To guide our analyses, the note *"A conceptual framework of interconnectedness in the financial system"* (2026) introduces four distinct types of financial interconnectedness that aim to capture different aspects of the structure of financial systems that can influence the propagation and amplification of shocks, focusing on institutions rather than markets.

The first dimension is *direct interconnectedness*, defined as securities cross-holdings or direct bilateral exposures between financial institutions. Such linkages are beneficial in normal times as they support risk sharing, but they create contagion risks and feedback loops during crises.

The second form is intermediation chains, which arise when funds pass through multiple intermediaries between ultimate savers and ultimate borrowers. These chains create indirect interconnectedness that may either absorb or amplify shocks, depending on the scale of stress and the complexity of the system.

The third category is network centrality, which focuses on the structural importance of certain institutions within financial networks. Highly central institutions, such as clearing parties through which a disproportionate share of financial flows pass, can transmit and amplify shocks far beyond what their individual balance sheet size would suggest.

The fourth category is balance sheet commonality, which captures correlated exposures or funding structures across institutions even in the absence of any direct bilateral links. For instance, asset or portfolio commonality can arise if several financial actors own the same assets such as government bonds or are exposed to the same sectors such as the US technology sector through equity or bond holdings. Portfolio similarity is a concern for financial stability because it increases the risk of contagion. It can amplify systemic stress through fire sales and liquidity spirals.

Drawing on these aspects of financial interconnectedness, the focus of this memo is on portfolio commonality, with the aim of quantifying the degree of overlap across Swedish financial institutions and its importance for common sales.

2.1 Measures of Portfolio Similarity

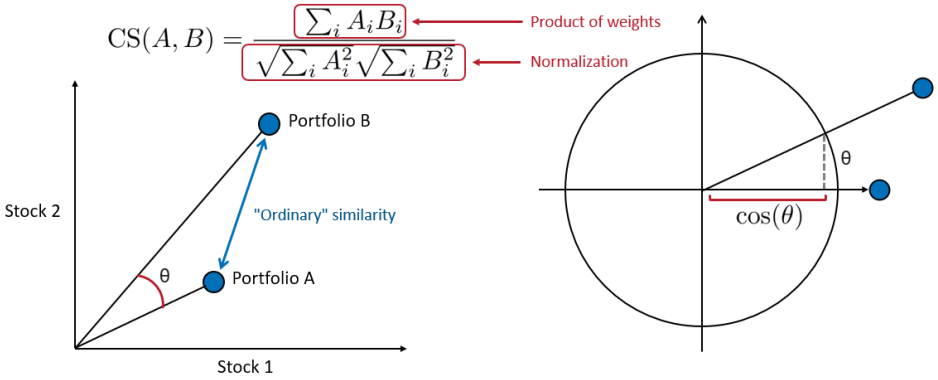
Several approaches can be used to measure portfolio similarity, that can broadly be categorized in three groups: first, measures based on security-holdings data; second, measures based on market prices; and third, measures based on stress test simulations. In this project, we focus on the first approach making use of the granular securities holdings data available at the Riksbank. Specifically, we consider three commonly used alternatives: portfolio overlap, Euclidean distance and cosine similarity. Our preferred measure is the cosine similarity because it measures the similarity of portfolio composition independently of their portfolio size, whereas the Euclidean distance would treat

two portfolios with the same composition but different size as less similar, and captures how exposures are distributed across issuers rather than simply measuring common holdings, as in portfolio overlap.[3]

More specifically, cosine similarity measures how closely two portfolios resemble each other in terms of their asset exposures, independently of portfolio size. It does so by treating each portfolio as a vector of asset exposures and calculating the cosine of the angle between the two vectors, as illustrated in Figure 1.

Figure 1: Cosine similarity – a schematic representation

Measuring cosine similarity involves first vectorizing the two portfolios and then measuring the cosine of the angle between the two vectors. Cosine similarity is then measured on the unit circle on the right: A value of 1 implies that the two portfolios have identical relative weights, while a value of 0 implies that they are orthogonal, that is, no security is held by both institutions. A value of -1 would imply that an institution has an exact mirror (short) position of the other.



The measure ranges from -1 to 1. A value of 1 indicates that the portfolios have identical relative exposures (weights), even if they differ in size. A value of 0 indicates no common holdings in the case of long-only portfolios, while -1 indicates opposite exposures, with one institution holding long positions in the same assets in which the other institution holds short positions. The bounded range facilitates comparisons across institutions and over time. However, the absolute value should not be overinterpreted: a cosine similarity of, for example, 0.7 indicates some degree of commonality in portfolio exposures but has no clear economic significance on its own. We therefore focus on relative differences, examining how portfolio similarity evolves over time and varies across pairs of institutions.

2.2 Data

The analysis draws on the VINN dataset, a microdata register of Swedish investors' holdings of securities (largely stocks and bonds) reported on a quarterly basis. The

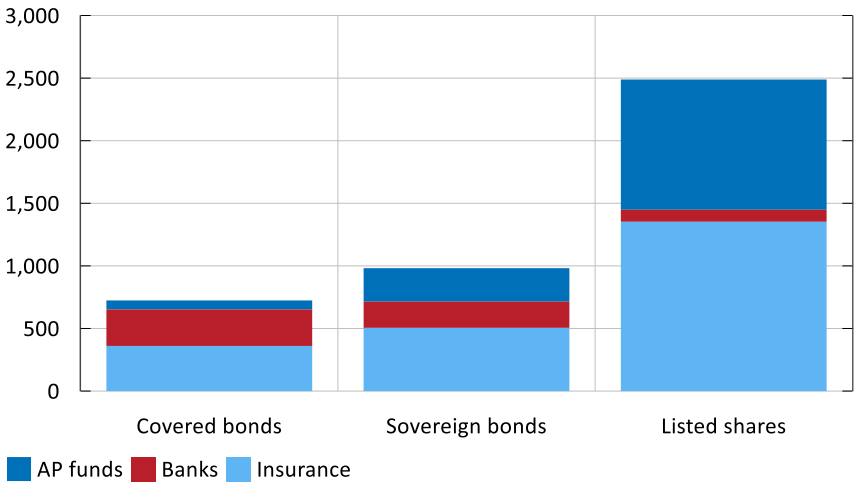
[3] Portfolio overlap measures the share of assets held in common by two portfolios. For example, if institution A invests half its portfolio in assets 1 and 2, while institution B invests half in assets 1 and 3, their portfolio overlap is 0.5. Although intuitive, the conventional measure does not distinguish between long and short positions, which can imply opposite exposures to the same asset.

observation period runs from 31 December 2018 to 31 December 2025, yielding 29 quarterly observations.

For section 3, we restrict the sample to the 23 largest institutions in the Swedish context: 8 banks, 4 national pension funds (AP-funds), and 11 insurance companies. The selection is designed to maximise systemic coverage while keeping pairwise calculations manageable and enabling further analysis of the individual companies' specific portfolios. For insurance companies, the sample is restricted to the largest firms with a substantial share of traditional insurance business; companies with almost exclusively unit-linked insurance are excluded. The sample of 23 institutions is equivalent to 75 percent of all non-investment fund securities reported in VINN, representing a substantial amount of total holdings, while the number of institutions remains small enough to analyse their individual portfolios and visualize their pairwise similarities clearly. In addition, to show their connection to the rest of the financial system, 11 investment funds are included in the overall portfolio commonality in section 3. For the regression in section 4 the sample is larger since we are not restricted by the visualization or by the need to compare each portfolio pairwise.

The analysis focuses on the companies' holdings of covered bonds, sovereign bonds and listed equities. These asset classes play a central role in the companies' asset allocation decisions, as portfolio construction aims above all to maximise expected returns for a given level of risk, including through the diversification benefits arising from exposure to different asset classes. In addition, the valuation of these assets is important from both a solvency and a liquidity perspective.

Figure 2: Assets held by the 23 institutions, by type of asset and type of company (in Billion SEK).



As can be observed in figure 2 the banks hold primarily covered bonds and sovereign bonds, while they hold a relatively small number of listed shares. The insurance companies hold a relatively even amount of covered bonds and sovereign bonds, while they hold substantially more listed shares. The AP funds hold a smaller amount of covered bonds, sovereign bonds in similar amount to the banks and listed shares similar to the insurance companies.

3 Pairwise Portfolio Similarity

Computing pairwise cosine similarity scores for 23 institutions and 11 investment funds results in 544 measures, for every point in time. The number of scores gets even larger when computing them separately for different asset classes. However, the primary aim of this project is to get a better understanding of portfolio similarity among Swedish institutions. Thus, we proceed by reducing the dimension in two steps: First, in section 3.1, we focus on a single point-in time to understand the cross-section of similarity scores. In a second step, we focus on a point in the distribution (i.e. mean) and study the time-series of similarity scores (see appendix).

To protect the confidentiality of sensitive information, individual companies' portfolios are anonymized. Furthermore, both the labels assigned to the companies and the order in which they are presented vary across asset classes and are determined by the degree of portfolio similarity within each asset type. For example, Bank #1 is different in each matrix and is the bank with the highest average pairwise similarity for that asset type.

3.1 Cross-Sectional Snapshot

As described in section 2, one way to analyse cosine similarity is by comparing the pairwise computed similarity scores in the full cross-section, that is between several pairs of companies. This helps in interpreting the results, as the focus is not on the precise level of the similarity but instead the value of similarity between a pair of companies relative to another pair. Thus, in a first step, we report all pairwise similarity scores of the 34 institutions included in the analysis in a single matrix. Reporting all pairwise similarity scores allow us to identify patterns in the data and detect potential groups of companies with similar portfolio exposures. This, in turn, provides insight into which firms may be more vulnerable to common shocks and more likely to be affected by contagion effects arising from fire-sale dynamics. In this section we compare the pairwise similarities for a single point in time, namely December 31, 2025.

Overall securities portfolios

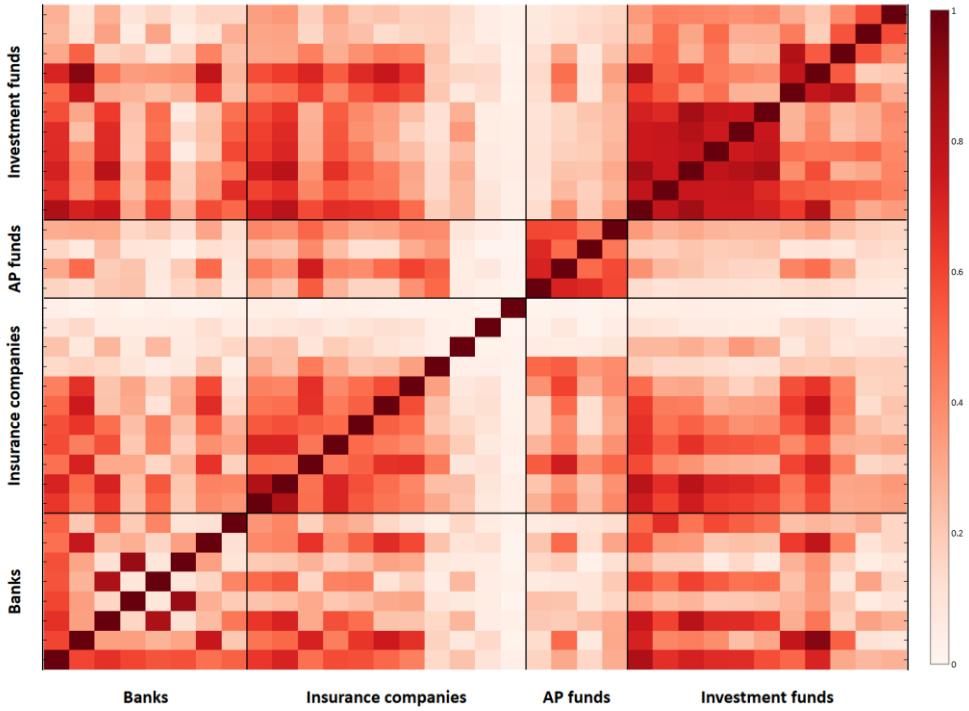
Figure 3 shows the cosine similarity matrix for the companies' overall securities holdings sector by sector, that is when looking at the entire portfolio of securities available in VINN combining equity and bond holdings. The matrix has one row and one column for each company and is symmetrical, meaning the upper left corner and lower right corner mirror each other, with the diagonal showing the company's portfolio similarity with itself. The similarity is thus perfect and equals 1, which is represented as dark red in the matrix.

The matrix shows considerable variation in the pairwise similarities between the companies in the sample. The similarity scores point to several observable clusters: certain banks in the lower left-hand corner have very high similarity with each other. The AP funds, shown in the centre right of the figure, also have high similarity with each other. For the banks, the similarity could reflect similar business or liquidity management

strategies and requirements. For the AP funds, it could reflect their shared investment rules.

For insurance companies there is a cluster of companies with a high similarity with other insurance companies, and a few companies with low similarity. The companies with high similarity are overall larger in size, with substantial holdings of both fixed income and equity issued by both domestic and foreign companies. The less similar insurance companies are overall smaller and have a larger share of fixed income in their portfolios. Investment funds appear to be clustered in one larger set of funds with a very high similarity, and a smaller subset of companies with a moderately high similarity.

Figure 3: Cosine similarity matrix – overall securities holdings



Furthermore, for a comparison between the sectors several specific insurance companies and investment funds report very similar portfolios as the larger banks. There appears to be a set of 7 investment funds, 7 insurance companies and 3 banks that all have a high similarity with each other. The AP funds, on the other hand, report relatively low similarity with the banks and the investment funds. There is then a set of insurance companies and banks that differ quite heavily from the rest of the companies in the sample, showing low levels of similarity to all companies. These companies are on average smaller with more specialised business strategies.

Observing the overall portfolio of companies' securities holdings is useful for understanding how the different companies' total portfolios would co-move if they were affected by an exogenous shock, or if a fire sale was triggered by one of these companies. However, parts of these companies' portfolios can be very similar even if their overall

portfolios are not, which means that there could be specific risks in certain segments of their portfolios. This can be particularly relevant when certain securities are important for liquidity or regulatory purposes.

To examine if this is the case, we calculate the cosine similarity for sections of these companies' portfolios, focusing on their holdings of covered bonds, sovereign bonds and listed shares. It is important to keep in mind that the cosine similarity will often be higher when we calculate it for a subset of holdings as the amount of assets the companies can hold in that subset is smaller than for the overall portfolio.

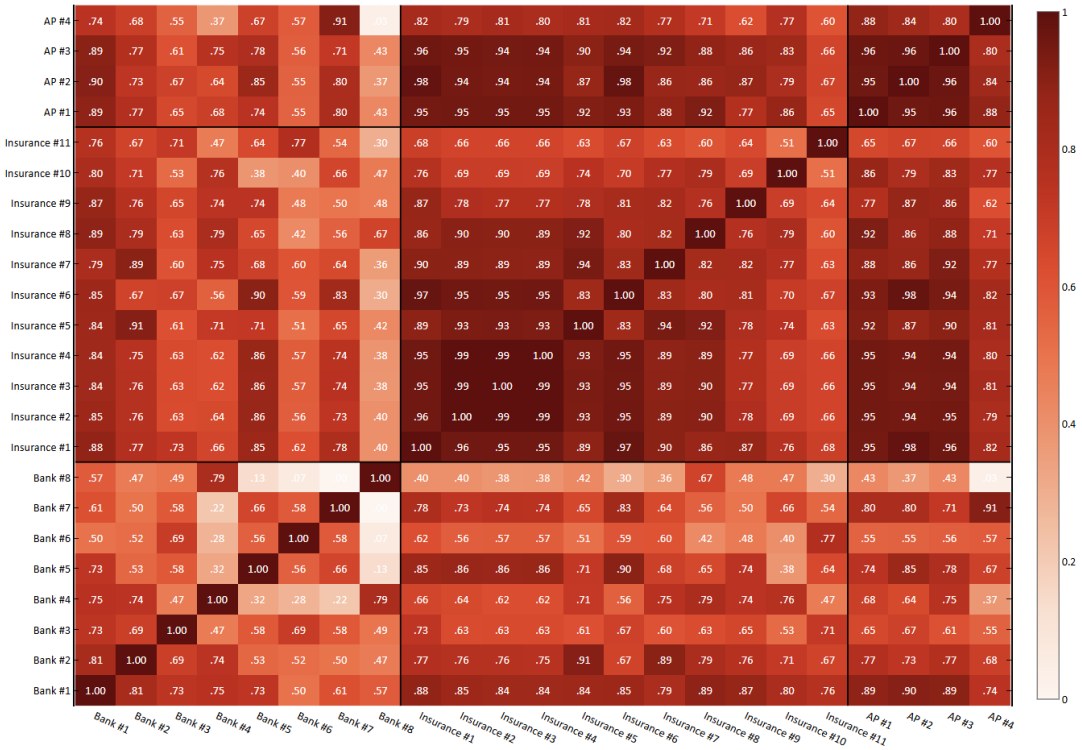
Covered bonds: Few and large issuers give rise to near identical portfolios for insurance companies and AP-funds.

As can be observed in Figure 4, the insurance companies, in the middle of the matrix, hold very similar covered bond portfolios. Section 3.2 returns to what this degree of overlap implies for the transmission of shocks.

Going back to the pairwise similarity scores in Figure 4, we can also identify similarities in business strategies. For instance, *Insurance 2*, *3* and *4* all have very high similarity scores in relation to each other. The high similarity scores are explained by them holding very similar compositions of covered bonds, issued almost entirely by four banks, differing only by a few basis points between their portfolios.

While the similarity scores between the insurance companies and AP funds is mostly in the range above 0.9, it is noticeably lower between banks ranging from 0 to 0.8.

Figure 4: Similarity in covered bonds portfolios



There are above all two reasons for the lower similarity scores for banks. The first is the composition of their holdings: banks hold a more varied set of covered bonds and are less likely to hold their own. There are relatively few Swedish banks issuing covered bonds. The three most common covered bonds account for roughly 68 percent of the average portfolio in the sample. Since the banks are on average less likely to hold their own bonds, the more covered bonds a bank issues the less their similarity is, on average, with the rest of the companies in the sample.

The second reason is that banks also have short positions of covered bonds of up to 10 percent of their total covered bond portfolios. The negative direction of these short positions decreases the overall similarity of their portfolios and is an especially large factor in explaining the lower similarity for a couple of banks.

Sovereign bonds: The larger the holdings of sovereign bonds, the more diversified the portfolio

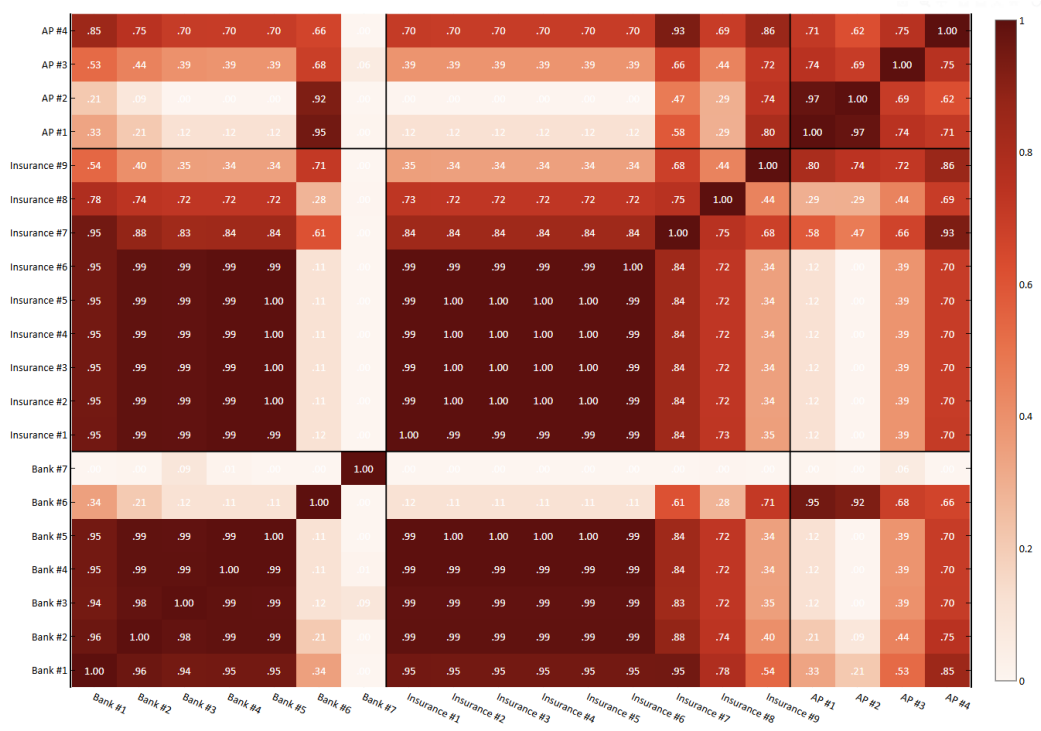
Similarity in sovereign bonds reflects the choice of issuer and currency rather than of maturity, which we do not separate here. The similarity scores for sovereign bonds, reported in Figure 5, differ from the similarity scores observed for covered bonds: A majority of companies have a pairwise similarity of 0.99 or 1. This is explained by the fact that the sovereign bond portfolios of most banks and of several insurance companies consist almost entirely of Swedish government bonds. Five companies own only Swedish government bonds in the sovereign bond portfolio.[4]

Most banks have very similar portfolio compositions, which is reflected in the matrix. In general, their Swedish government bonds comprise about 70 to 90 percent of their sovereign bond portfolios and the rest being EUR and USD. Certain banks also have bonds in other currencies, but in the single percentages range. One bank in the matrix deviates from the others, as it holds almost exclusively municipal bonds. The companies that otherwise diverge in their portfolios are the AP funds and Insurance 8 and 9. These companies hold larger shares of USD and EUR bonds, some with a mix of other currencies, and the share of Swedish government bonds is between 1 and at most 40 percent.

[4] Three companies that do not hold sovereign bonds are excluded from the matrix.

Holdings are also highly concentrated. Of the approximately 1000 billion SEK held by the 20 companies included in the matrix, 650 billion SEK is accounted for by the seven largest holders. These firms also maintain more diversified portfolios, with substantial exposures to USD and EUR-denominated bonds.

Figure 5: Similarity in sovereign bonds portfolios



Listed shares: Index concentration is a key driver of portfolio overlap

As can be observed in Figure 6, the pairwise similarity scores of banks in the sample are relatively low as they hold a negligible number of stocks and hold them for a different purpose than insurance companies and AP funds.[5] The 20 companies which hold stocks have on average lower pairwise similarity scores for listed shares than for both covered bonds and sovereign bonds. This reflects the vastly larger number of different companies that issue stocks compared to how many issue covered and sovereign bonds, meaning that the potential for diversification is much higher. However, it is noticeable that the pairwise similarity scores are still around 0.6 to 0.8 for most firm-pairs involving insurance and AP funds in some combination, while the pairwise similarity scores of banks vary from 0.1 to 0.42. It should be kept in mind, though, that the levels are inherently difficult to interpret.

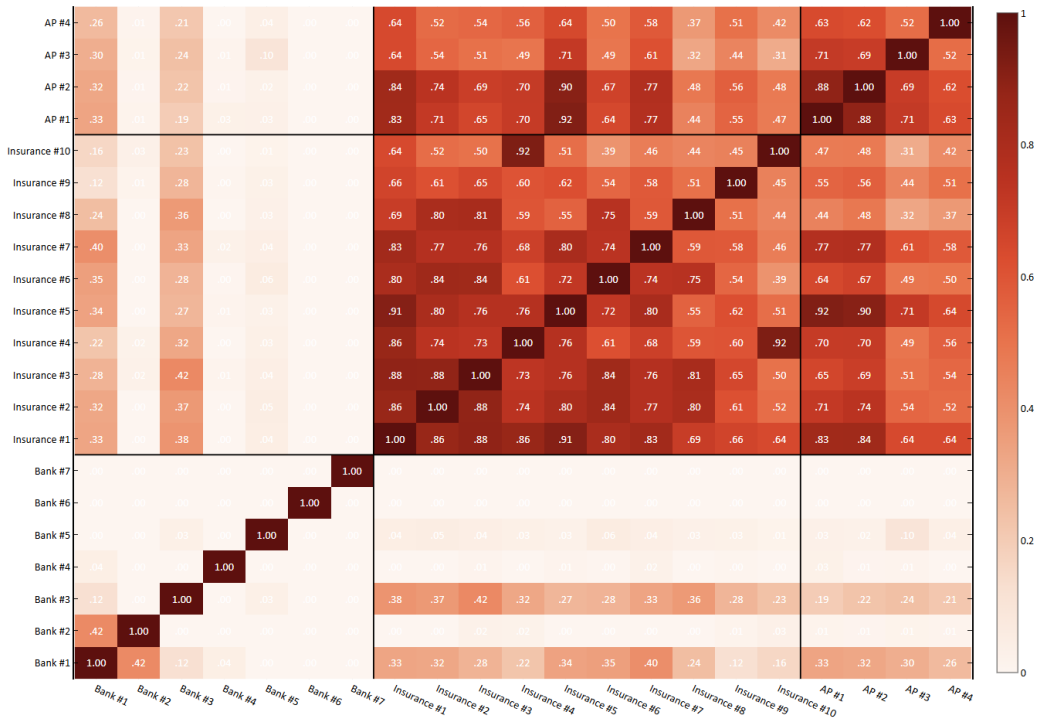
One important factor for the relatively high average similarity scores for insurance companies and AP funds is the importance of the stock portfolios invested in the US, especially the US tech sector, as per the period analysed in this note (31 December 2025). USD stocks make up about 40 to 50 percent of the stock portfolios of ten companies. Much of this US equity exposure is concentrated in a small number of companies.

[5] Three companies with no holdings of listed shares are excluded from the matrix.

On average the insurance companies and AP funds in the sample had slightly above 30 percent of their US stocks invested in the seven largest US tech stocks. These seven tech stocks make up on average 12 percent (and up to 20 percent) of the entire stock portfolios of the non-bank companies in the sample. However, the allocation to these seven tech companies is in line with these seven companies' share of the US stock market, where they made up about 34 percent of the S&P 500 index in December 2025.

There are, however, other parts of the listed shares directly held by insurance companies and AP funds that also contribute to the high degree of portfolio similarity. Their listed shares in SEK are similar in certain investment and holding companies, industrial companies and banks. Some companies that hold a specific banking group's issued covered bonds also own a substantial amount of that banks' stock, which could have further amplifying effects under stress. They also invest in EUR denominated stocks to diversify their portfolios and increase their potential returns, but the picture is similar to their EUR and SEK stocks in that they hold relatively similar weights in EUR as well.

Figure 6: Similarity in listed shares portfolios



The combination of similar shares of several stocks in USD, SEK and EUR indicates that these companies either employ index-based investment strategies, rely on external asset managers that invest close to the index or actively invest in a way that ends up closely matching stock indices. Index-based investment strategies are both cheap and have performed well over a long time, while historically providing good diversification benefits for individual companies. However, the more common the strategy becomes the more similar stock portfolios will become on average. As large stock indices have also become continuously more concentrated over the last few years, the diversification benefits of investing close to the index have also been reduced. Most of these companies are likely to employ a combination of passive and active investment

strategies, so it is noticeable that several companies end up with stock portfolios that have a relatively high similarity.

3.2 Potential implications for financial stability

During periods of financial distress, financial institutions can contribute to market resilience countercyclically by buying assets whose prices have fallen, thereby helping to stabilize the markets (Andersson, 2024). Such behaviour may help reduce risks to financial stability when markets are under stress. However, if firms hold highly similar portfolios, they may be exposed to shocks in similar ways and may therefore respond in a more synchronized manner. As discussed above, this can become a source of systemic risk even when firms are individually well diversified. While smaller shocks may be easily absorbed without major portfolio adjustments, larger shocks may lead many firms to rebalance their portfolios simultaneously and in similar ways.

The matrices above describe where portfolios overlap for the full portfolio of securities held by the main Swedish financial institutions as well as separately for three different categories of securities. The matrices show that similarity is highest in sovereign bond portfolios with most cosine similarity scores between 0.99 and 1. Only AP funds and a few insurance companies have lower scores because they also hold a substantial amount of bonds issues in USD and EUR. These more diversified companies are also large holders of SEK-denominated sovereign bonds. The sovereign bond overlap is followed by similarity in covered bond holdings, where insurance companies and pensions funds are very similar, while some banks have a high similarity and others do not. The dispersion in similarity scores is larger within the banking sector than between different sectors. This contrasts with the portfolio overlap of listed shares, likely representing different business lines. Banks typically hold few shares, while insurance companies and AP funds seem to follow similar equity investment strategies, especially for foreign equities, leading them to purchase similar stocks.

The relatively high concentration in sovereign bond and covered bond holdings point towards the potential risk of holder concentration. A majority of the SEK-denominated sovereign bonds are held by the companies in the matrix shown in Figure 5. Several of the firms with the largest SEK sovereign bond holdings are also among the most diversified investors in the sample, with sizeable sovereign bond portfolios denominated in foreign currencies, primarily USD and EUR. While this diversification may reduce their exposure to shocks affecting a single sovereign bond market, a shock that affected the value of SEK sovereign bonds would still have a substantial impact on the SEK-denominated portion of their sovereign bond portfolios. These same firms are also exposed to the actions of other investors that hold these bonds, if these investors were forced to sell their holdings.

The story is similar for covered bonds. Since they are issued by a relatively small set of banks, the ability to diversify is limited and the holdings are overall concentrated. This makes these holdings more susceptible to fire sale dynamics if companies need to sell them in a market downturn, as they will impact most holders of these bonds in a relatively equal manner.

The strongest diversification is found in the holdings of listed shares. One explanatory factor is that listed shares is the asset class with the largest share of non-SEK instruments. Furthermore, listed shares are traded in the market with the greatest liquidity. The dynamics are therefore different compared to SEK-denominated sovereign bonds and covered bonds. These equity holdings are more exposed to developments outside of Sweden, and the companies in the sample have a more limited ability to influence their prices through their own actions, for example if they sell part of their holdings. In terms of financial interconnectedness, listed shares and the sovereign debt in foreign currencies are therefore a channel through which financial stress abroad could spread to the Swedish financial system. For example, a decline in foreign equity or foreign sovereign bond markets would directly reduce the value of these holdings, potentially prompting portfolio rebalancing or deleveraging by Swedish institutions. In this way, shocks originating abroad may affect Swedish institutions even when the institutions have diversified domestic portfolios and do not all hold the same SEK sovereign bonds or covered bonds.

Whether these channels operate in practice is an empirical question. Section 4 examines which institutional characteristics account for the overlap documented here, and Section 5 tests whether pairs with more similar portfolios do in fact sell the same assets at the same time.

4 Determinants of Portfolio Similarity

The descriptive analysis in section 3 shows substantial differences in portfolio similarity across institutions and asset classes. In this section we ask whether such observed differences reflect institution-specific characteristics or more systematic factors, such as business models, portfolio size and investment strategies.

To investigate this, we move beyond the descriptive analysis and examine which institutional characteristics are systematically associated with greater portfolio similarity across pairs of Swedish financial institutions. We apply and extend the framework introduced in Girardi et al. (2021) to the Swedish financial sector. Girardi et al. (2021) study portfolio similarity in the U.S. insurance sector. They find that insurers operating in the same line of business tend to hold more similar portfolios, consistent with the idea that institutions with similar liabilities may also make similar asset allocation decisions.

We investigate whether the same pattern holds in Sweden. Unlike Girardi et al. (2021), who study insurance companies, our sample also includes banks, pension funds and investment funds. This lets us test whether the sector clusters visible in the matrices in section 3 hold once size and portfolio concentration are taken into account.

The key explanatory variables capture whether the two institutions in a pair belong to the same sector. For example, Insurance_Pair takes the value one when both institutions are insurance companies and zero otherwise. We define similar indicators for pension funds, banks and investment funds. These variables allow us to test whether institutions of the same type tend to have more similar portfolios than institutions from different sectors. We also include two characteristics of the pair. Prod_Size, the (log)

product of the two institutions' portfolio assets, captures whether pairs of larger institutions hold more or less similar portfolios. Prod_Conc_I, the product of their issuer-level Herfindahl indices, captures whether institutions with more concentrated portfolios are also more similar to each other. We estimate the following regression:

$$Similarity_{ij,t} = \beta_1 InsurancePair_{ij,t-1} + \beta_2 PensionPair_{ij,t-1} + \beta_3 BankingPair_{ij,t-1} + \beta_4 InvFundsPair_{ij,t-1} + \beta_5 ProdSize_{ij,t-1} + \beta_6 ProdCon_{ij,t-1} + \tau_t + \varepsilon_{ij,t} \quad (1)$$

The dependent variable is the cosine similarity between the issuer-level portfolio weights of institutions i and j in year t, bounded between zero and one. Higher values indicate more similar portfolios. Year fixed effects absorb developments that affect all institutions in a given year, such as the broad rise in equity valuations discussed in section 3. We estimate the equation using OLS with Driscoll-Kraay standard errors with four lags.

4.1 Differences in Portfolio Similarity across Different Institution Types

Table 1 reports results for the full sample of institution pairs (column 1) and separately for large institution pairs only (column 2).

The results point to banks as the sector with the most similar portfolios, which confirms the bank cluster visible in the lower left-hand corner of Figure 3. Bank pairs show the strongest positive association with similarity in both samples, 0.19 in the full sample and 0.20 among large institutions, followed by investment fund pairs at 0.16 in the full sample and pension fund pairs at 0.13 and 0.12 respectively. In terms of magnitude, two banks hold portfolios that are about 0.19 more similar on the cosine scale than an otherwise comparable pair of institutions drawn from different sectors. This is consistent with banks facing similar regulatory requirements and business models, which appear to lead them towards similar issuer exposures. From a financial stability perspective, this is the combination most conducive to coordinated selling under stress, since a shock affecting one bank's holdings is more likely to affect banks with comparable portfolios.

Insurance pairs follow a different pattern: portfolios are not more similar across insurance pairs and are even somewhat less similar among large institutions (-0.06). This mirrors the cross-section in Figure 3, where the insurance companies split into a cluster of large firms with overlapping holdings and a set of smaller, more specialised firms. It contrasts with the U.S. evidence in Girardi et al. (2021), where insurers in the same line of business hold more similar portfolios. One interpretation is that Swedish insurers have more varied investment mandates than their U.S. counterparts, leading to more differentiated portfolios even within the insurance sector, especially amongst the largest institutions. This may reflect that large Swedish insurers are more likely to operate across multiple product lines and pursue differentiated credit strategies tailored to their specific liabilities.

The difference between banking pairs and insurance pairs is informative from a systemic-risk perspective: Banks operating under similar regulatory and business-model constraints appear to converge on similar issuer exposures, making their portfolios particularly susceptible to fire sale risks.

Table 1: Portfolio Similarity Across Institutions

	Similarity_I	
	Full Sample	Large Institutions
	(1)	(2)
Insurance_Pair	0.00	-0.06***
	(0.00)	(0.01)
Pension_Pair	0.13***	0.12***
	(0.02)	(0.02)
Banking_Pair	0.19***	0.20***
	(0.01)	(0.02)
InvFunds_Pair	0.16***	
	(0.01)	
Prod_Size	0.00	-0.02**
	(0.00)	(0.01)
Prod_Conc_I	-0.20***	-0.37***
	(0.02)	(0.09)
R^2	0.11	0.08
Observations	59,045	8,109
Year fixed effects	✓	✓

*Note: The table reports OLS estimates of equation (1). The dependent variable is the issuer-level cosine similarity between the portfolios of institutions i and j, which takes values between zero and one, with higher values indicating more similar portfolios. The unit of observation is an institution pair in a given year. Column (1) covers all pairs in the sample; column (2) is restricted to pairs of large institutions. Insurance_Pair, Pension_Pair, Banking_Pair and InvFunds_Pair take the value one when both institutions in the pair belong to the sector in question and zero otherwise. Prod_Size is the log product of the two institutions' portfolio assets and Prod_Conc_I the product of their issuer-level Herfindahl indices. All explanatory variables are lagged one period. The regressions include year fixed effects. Driscoll-Kraay standard errors with four lags are reported in parentheses. ***, ** and * denote significance at the 1, 5 and 10 percent level.*

4.2 The Role of Portfolio Concentration

Portfolio concentration is defined as how much of each institution's holdings are concentrated in a small number of issuers. Table 1 shows that it is negatively related to similarity both for all firms and in the sample of large institutions (-0.20 in the full sample and -0.37 among large institutions). The sign may be surprising at first sight. It is, however, in line with the cross-sectional results in section 3: institutions with highly concentrated portfolios tend to be concentrated in different issuers, so their portfolios end up looking distinct from one another. The specialised insurance companies and banks at the edges of Figure 3 are the clearest example. Conversely, more diversified institutions are more likely to end up holding overlapping exposures, since diversification tends to involve broadly similar sets of large, liquid issuers, as the equity results in

Figure 6 illustrate. This finding is also consistent with Girardi et al. (2021), who document a similar pattern among large U.S. insurers, and our results suggest that the relationship extends to the Swedish financial sector more broadly.

Combined institution size (Prod_Size) shows no meaningful relationship with similarity in the full sample, and a small negative and marginally significant relationship (−0.015) among large institutions. This suggests that among the largest institutions, size is associated with somewhat more differentiated, rather than more similar, portfolios. This differs from Girardi et al. (2021), where larger institutions show more similarity, reportedly because large portfolios are harder to differentiate. One interpretation is that this reflects the diversity of mandates among large Swedish institutions: a large universal bank and a large life insurer may both meet the size threshold while holding substantially different issuer-level portfolios.

5 Common Sales Pressure

Portfolio similarity on its own does not tell us whether risk has actually materialized. It is a signal of potential vulnerability, not proof that anything harmful has happened. The concern set out in section 3.2 is specifically that institutions holding similar portfolios might also sell in similar ways, which puts pressure on prices and strains market making capacity. If one institution comes under pressure to sell a specific asset, for instance because it experienced unexpected losses, the price of the asset may fall, affecting other institutions holding it, which in turn may be forced to sell the asset. This amplifies price declines and potentially creates problems for financial stability. This section tests whether that concern is visible in the data. To do so, we construct a measure called common sales pressure, which captures the degree to which two institutions' net selling activity overlaps, based on changes in the holdings data. We then proceed in two steps: we first ask whether portfolio similarity is associated with selling of similar assets, and then whether common selling is more pronounced when financial conditions deteriorate.

5.1 Similarity and Common Sales

For the first question, we run the following regression:

$$CommonSales_{ij,t} = \beta_1 Similarity_{ij,t-1} + \beta_2 SizeFirm1_{i,t} + \beta_3 SizeFirm2_{j,t} + \beta_4 CommonIssuerConcentration_{ij,t} + \alpha_{ij} + \tau_t + \varepsilon_{ij,t} \quad (2)$$

The main variable of interest is again *Similarity*, where the same issuer-level cosine similarity measure as earlier is used, here measured at the end of the prior period. The regressions include pair fixed effects, which account for characteristics specific to each institution pair that do not change over time, and month fixed effects, which account for factors affecting all pairs at a given point in time. Standard errors are again calculated using the Driscoll-Kraay method with four lags.

If portfolio similarity is a meaningful driver of common selling behaviour, we would expect to see a positive and statistically significant coefficient on *Similarity*, that is, pairs with more overlapping portfolios should also show more correlated selling.

Table 2 presents results from the baseline specification, adding controls progressively across columns: first institution size (Size Firm 1 and Size Firm 2), then Common Issuer Concentration, and finally different combinations of year, pair, and month fixed effects. The results support the hypothesis that a higher portfolio similarity is linked to more correlated asset sales. The results are consistent with Girardi et al. (2021) and Andersson (2024). The coefficient on *Similarity* is positive and significant across all specifications. Larger institutions (as measured by Size Firm 1 and Size Firm 2) are associated with more common selling. Pairs whose overlapping exposures are more concentrated (Common Issuer Concentration) also show higher common sales, which suggests that greater diversification may help reduce some of the risks that portfolio similarity poses for common selling dynamics in the Swedish context.

Table 2: Baseline Results for Similarity and Common Sales.

	Common Sales				
	(1)	(2)	(3)	(4)	(5)
Constant	36.81***	-18.68***			
	(0.27)	(2.89)			
Similarity	5.53***	6.73***	6.77***	2.96***	2.61***
	(0.11)	(0.17)	(0.17)	(0.51)	(0.40)
Size Firm 1		1.07***	1.06***	2.23***	2.01***
		(0.04)	(0.03)	(0.42)	(0.24)
Size Firm 2		1.10***	1.07***	2.00***	1.87***
		(0.08)	(0.07)	(0.27)	(0.19)
Common Issuer Concentation		1.26***	1.14***	0.39**	0.51***
		(0.13)	(0.15)	(0.15)	(0.11)
R^2	0.08	0.23	0.25	0.55	0.58
Observations	49,334	48,971	48,971	48,971	48,971
Year fixed effects			✓	✓	
Pair fixed effects				✓	✓
Period fixed effects					✓

*Note: The table reports OLS estimates of equation (2). The dependent variable, Common Sales, measures the extent to which the net selling of institutions i and j overlaps in period t, constructed from changes in their reported holdings. The unit of observation is an institution pair in a given period. Similarity is the issuer-level cosine similarity between the two portfolios, measured at the end of the prior period. Size Firm 1 and Size Firm 2 are the log portfolio assets of the two institutions, and Common Issuer Concentration measures how concentrated their overlapping exposures are across issuers. Controls are added progressively across columns, with the fixed effects included in each specification indicated at the foot of the table. Driscoll-Kraay standard errors with four lags are reported in parentheses. ***, ** and * denote significance at the 1, 5 and 10 percent level.*

5.2 Financial Conditions and the Level of Common Sales

In the previous section, we showed that institutions with more similar portfolios tend to sell the same assets at the same time. Portfolio similarity reflects a structural vulnerability; it describes how asset selling by one institution could affect others with similar portfolios. Whether that vulnerability matters in practice also depends on the timing of

the common selling. If common sales only happen when markets are stable, the risks are presumably low; if however, they increase when markets are already strained, then correlated selling adds more downward pressure on prices, precisely at a time when other investors are least willing or even able to buy and absorb the assets. Falling prices then reduce the value of the same securities held elsewhere in the system further, leading to further sales of these assets, ultimately with the risk of raising funding costs for the banks and companies that issue them. In this section, we therefore examine whether common sales are more pronounced when financial market conditions deteriorate.

To test this, we use four indicators of financial conditions. We choose them to span two dimensions that matter for the mechanism we study: whether the stress is domestic or global in origin, and whether it reflects broad market conditions or the price of credit risk specifically.

i. FSI, the Riksbank's Financial Stress Index, which combines stress in the Swedish bond, foreign exchange, money and stock markets. It is our measure of domestic financial stress (see Johansson and Bonthron, 2013).
ii. VIX, which measures expected volatility in the US stock market and is commonly used as a measure of global risk aversion (e.g. used in Miranda-Agrippino and Rey, 2020) .
iii. EBP, the excess bond premium (Gilchrist and Zakrajšek, 2012). This is the part of US corporate credit spreads that is not explained by expected default risk. It is commonly interpreted as a measure of investors' willingness to take on credit risk.
iv. GZ, the total US corporate credit spread, which includes both the excess bond premium and the part related to expected default risk.

We use them because they are widely used in the literature, available at the frequency and over the sample period we require, and because having domestic and global indicators allows us to check whether the results are driven by the choice of any single index. One caveat applies to the FSI. The index aggregates stress in four different markets into a single number, so the same level of the index can reflect quite different combinations of stress across those markets. Co-movement between markets also enters the construction of the index itself. The FSI is therefore informative about overall conditions in Swedish financial markets, but less suited to identifying where a given episode of stress originates.

We add each indicator separately to the baseline regression from the previous subsection. Table 3 shows that common sales are higher when VIX, EBP and GZ are higher, and all three relationships are statistically significant. In other words, the institutions in our sample tend to sell the same securities to a greater extent when global risk aversion is elevated and credit conditions are tighter. For example, a one standard deviation increase in the EBP is associated with common sales that are around 2% higher than on average. This is consistent with institutions reducing their holdings of riskier assets in periods of market turbulence.

The Swedish stress index, FSI, is not significantly related to common sales. One possible explanation is that FSI combines several subcomponents into a single measure. The result may also indicate that the selling behaviour of Swedish institutions is more closely linked to global conditions than to domestic ones. The analysis does not allow us to establish this conclusively.

These estimates line up with episodes that have already been documented for the Swedish market. Andersson (2024) shows that investor behaviour in Swedish bond markets varies with market conditions, and that insurance and pension companies have sold covered bonds procyclically, both during the turbulence in the first quarter of 2020 and again as interest rates rose and margin requirements on derivative positions increased in 2022. These are the same institutions that the matrices in section 3 identify as holding the most similar covered bond portfolios. The segment where overlap is highest is therefore also the segment where correlated selling has been observed, which is what the regression results would lead one to expect.

Table 3: Financial Conditions and the Level of Common Sales

	Common Sales			
	(1)	(2)	(3)	(4)
FSI	2.87			
	(2.52)			
VIX		0.05***		
		(0.01)		
EBP			2.04***	
			(0.33)	
GZ				1.55***
				(0.21)
Similarity	2.96***	2.65***	2.68***	2.67***
	(0.42)	(0.40)	(0.38)	(0.40)
Size Firm 1	2.41***	2.31***	2.40***	2.40***
	(0.59)	(0.42)	(0.41)	(0.47)
Size Firm 2	2.17***	2.10***	2.18***	2.19***
	(0.35)	(0.26)	(0.25)	(0.28)
Common Issuer Concentation	0.32	0.43***	0.39***	0.44***
	(0.21)	(0.12)	(0.13)	(0.13)
R^2	0.57	0.56	0.56	0.56
Observations	41,629	48,971	48,971	48,971
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓

*Note: The table reports OLS estimates of the specification in Table 2, column (4), adding one indicator of financial conditions at a time. FSI is the Riksbank's Financial Stress Index (Johansson and Bonthron, 2013), VIX is the implied volatility of the US stock market, EBP is the excess bond premium of Gilchrist and Zakrajšek (2012) and GZ the corresponding total US corporate credit spread. The dependent variable and the remaining explanatory variables are defined as in Table 2. The smaller number of observations in column (1) reflects the availability of the FSI over the sample period. All specifications include pair and year fixed effects. Driscoll-Kraay standard errors with four lags are reported in parentheses. ***, ** and * denote significance at the 1, 5 and 10 percent level.*

The same episode also shows the limits of the mechanism. Andersson (2024) documents that banks together with insurance and pension companies absorbed roughly two thirds of the corporate bonds that funds sold in the secondary market during the first quarter of 2020. Common exposure does not translate into common selling when some holders have the capacity and the mandate to buy. The results in this section should therefore be read as evidence that portfolio overlap raises the likelihood of correlated selling, not that it determines the direction of trading in any given episode.

The relationship between portfolio similarity and common sales remains positive and significant in all specifications.

From a financial stability perspective, these results indicate that correlated selling is related both to a structural feature of the system, namely portfolio overlap, and to cyclical conditions in financial markets. Common sales tend to rise when conditions tighten, which is when markets are typically less able to absorb them. The results in this section concern the average level of common sales, however. They do not tell us whether stress strengthens or weakens the link between portfolio similarity and common selling, which would require further analysis.

6 Conclusion

This Staff memo examines portfolio commonality as a measure of indirect interconnectedness in the Swedish financial system. Using detailed securities holdings data - VINN register - for the period 2018-2025, we analyse portfolio similarity across banks, insurance companies and national pension funds and, in some parts of the analysis, investment funds. We document how similarity varies across institutions, asset classes and over time. We examine the characteristics associated with greater similarity and investigate its relationship with common selling behaviour.

Our results show that average portfolio commonality across institutions is relatively modest and stable over time, but the system is characterised by pronounced pockets of concentrated overlap.

Similarity is particularly high and persistent in covered bond portfolios, reflecting the limited number of issuers in the Swedish market. In contrast, similarity in listed equity holdings is substantially lower, but has increased over time, particularly among non-bank institutions, partly driven by the growing importance of a small number of large US technology companies in institutional portfolios. These findings illustrate how common exposures can emerge or increase within specific asset classes without necessarily being reflected in measures of overall portfolio similarity.

The analysis also reveals systematic differences across institutional sectors. Banks tend to have particularly similar portfolios, consistent with common business models and regulatory requirements while insurance companies exhibit more heterogeneous holdings. We also find that portfolio concentration is negatively associated with similarity: institutions with more concentrated portfolios tend to hold more distinct exposures, whereas more diversified portfolios are often invested in similar sets of issuers. This paradox of diversification, that well-diversified portfolios tend to overlap more than

concentrated ones, emerges clearly in the data, consistent with the U.S. evidence of Girardi et al. (2021). This highlights an important distinction between diversification from an individual institution's perspective and common exposures at the system-wide level.

Importantly, we find that institutions with more similar portfolios are also more likely to sell the same assets in the subsequent period. Common selling is also more pronounced when global financial conditions deteriorate, suggesting that overlapping portfolios may be particularly relevant when financial markets are under stress. These findings are consistent with portfolio commonality being a potential channel of risk transmission through asset sales and market prices. However, they do not establish that common selling leads to fire-sale dynamics or amplifies financial stress. Institutions holding similar assets may respond differently to shocks. Andersson (2024) shows that institutions' responses to shocks depend on their liquidity needs, investment strategies, the assets they hold and prevailing market conditions.

From a financial stability perspective, these findings reinforce the case for monitoring portfolio commonality alongside direct exposures. While network analysis identifies potential transmission through contractual relationships, portfolio similarity can reveal common exposures and vulnerabilities to simultaneous asset sales that may not be apparent from direct linkages alone. Because real-world stress episodes almost always engage both channels simultaneously, direct network losses can trigger asset sales, which in turn destabilise other institutions through price effects. Nevertheless, portfolio commonality is not in itself a measure of systemic risk. Its implications depend on other factors, including institutions' liquidity needs, leverage and the capacity of markets to absorb asset sales.

Taken together, these considerations suggest that portfolio similarity can provide a useful additional indicator for monitoring vulnerabilities in the Swedish financial system. Future work can build on this analysis by modelling stress transmission dynamics explicitly, to study fire-sale amplification under different market conditions and assessing the macroprudential implications of rising concentration in specific asset classes such as covered bonds and large-cap equities.

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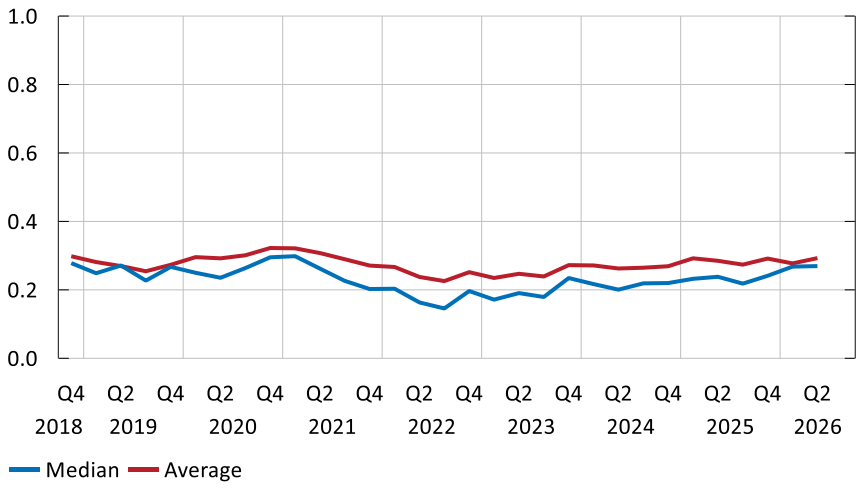
APPENDIX – The evolution of portfolio similarity over time

Another aspect of portfolio similarity is how it changes over time. For each quarter we first calculate cosine similarity for every pair of institutions and then take the average across all pairs. We do this calculation first for the overall portfolio and then for the portfolios of covered bonds, sovereign bonds and listed shares.

Overall portfolio

Figure 7 shows how average and median portfolio similarity has developed over time for all securities holdings.[6] Overall portfolio similarity is relatively stable over the period, with only moderate changes from quarter to quarter. This suggests that, when looking at all securities together, there is no clear long-term trend towards either substantially more or less similar portfolios. As the median is slightly below the average for the entire period it indicates that there are some companies in the sample with substantially higher similarity than the average.

Figure 7: The evolution of portfolio similarity over time – all securities holdings

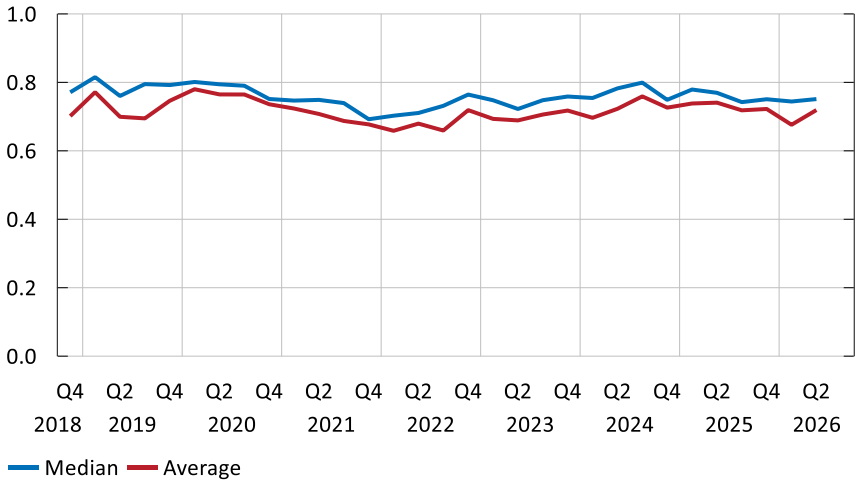


[6] The average for each quarter is an unweighted average.

Covered bonds

Figure 8 shows that similarity in covered bond holdings is high and relatively stable, generally between 0.7 and 0.8 for the entire time period. Similarity decreases between 2020 and 2022 and increases again somewhat from 2023 onwards. This timing broadly coincides with changes in monetary policy, including the Riksbank's asset purchases in 2020 to 2022, and their subsequent phasing out, starting in 2023, which may have resulted in a reduction in the standard available covered bonds purchased by Swedish financial institutions, leading to a diversification in their covered bond purchases. The median follows the average quite close, reflecting that the similarity is quite equal between companies over the sample.

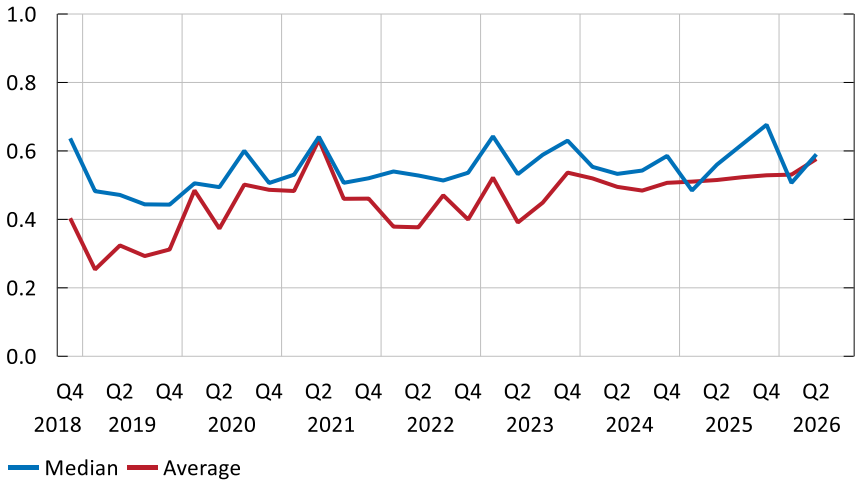
Figure 8: The evolution of portfolio similarity over time – covered bond holdings



Sovereign bonds

Figure 9 shows the similarity scores for sovereign bond holdings, which vary more over time. The average similarity score starts at about 0.4 and increases to 0.55 by the end of the period. One possible explanation is that institutions that held a more diversified sovereign bond portfolio shifted over the period towards holding more Swedish sovereign securities. This could increase their portfolio similarity with institutions that already held mainly Swedish government bonds. The increasing supply of Swedish government bonds from 2023 onwards may also have contributed to such a development. This is, however, a possible explanation rather than something we can establish from the similarity measure alone. The relatively large difference between the average and the often higher median also reflects the high concentration amongst most companies, with a few companies having close-to-zero similarities with the rest of the sample.

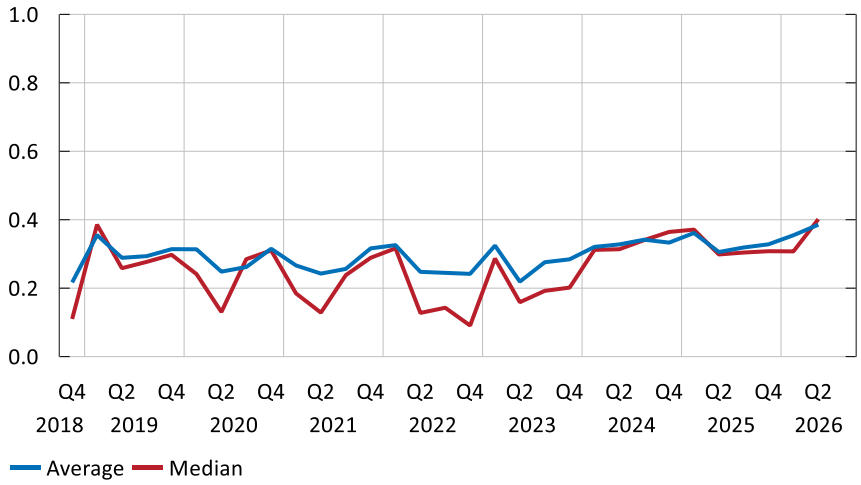
Figure 9: The evolution of portfolio similarity over time – sovereign bond holdings



Listed shares

Figure 10 shows the average cosine similarity for listed shares, which is lower than for covered or sovereign bonds. The average is around 0.3 for the entire time period, with the median being slightly below the average for most of the period and fluctuating somewhat more. The lower average is partly explained by the banks holding relatively small amounts of listed shares and for different purposes than the insurance companies and AP-funds. For comparison, if banks are excluded the average similarity starts at 0.4 in 2019 and increases to 0.65 in 2025. The increase in similarity over time is most likely a reflection of the increased valuations of certain widely held US stocks. This illustrates how portfolios can become more similar over time, even without institutions actively buying the same stock. If the price of stocks that are widely held increases, their weight increases in several portfolios at the same time, resulting in increased similarities.

Figure 10: The evolution of portfolio similarity over time – listed shares holdings





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